MACMILLAN'S TEACHING IN PRACTICE FOR SENIORS

VOLUME EIGHT

MACMILLAN'S TEACHING IN PRACTICE FOR SENIORS

AN ENCYCLOPAEDIA OF MODERN METHODS
OF TEACHING IN THE SENIOR SCHOOL
WRITTEN BY RECOGNISED AUTHORITIES
IN EDUCATION AND

EDITED BY

E. J. S. LAY

Editor of Macmillan's *Teaching in Practice in the Junior School,*
Teaching in Practice for Infant Schools, etc.

In Eight Volumes, with a Portfolio
of 150 Class Pictures

VOLUME EIGHT

MACMILLAN AND CO., LIMITED
ST. MARTIN'S STREET, LONDON
1938

CONTENTS OF VOLUME VIII

THE TEACHING OF MATHEMATICS

TREATMENT OF THE DULL AND BACKWARD CHILD

LEAVERS' CLASSES AND VOCATIONAL GUIDANCE

GETTING A FIRST JOB

SCHOOL CLUBS AND SOCIETIES

THE SCHOOL CAMP AND THE LONDON JOURNEY

SCHOOL TIME-TABLES

MISCELLANEOUS ARTICLES

PRINCIPAL CONTENTS OF THE EIGHT VOLUMES

VOLUME I

The Teaching of English Literature and Composition; Some Notable Authors; The Teaching of Poetry illustrated by some forty poems by modern poets; Some Notable Poets; Speech Education; Senior School Drama; Speeches for Notable Occasions; Some Notable Orators.

VOLUME II

Biology; Science Teaching; Domestic Science; Health Education; First Aid; Home Nursing; A Telephone Project.

VOLUME III

Art and Craft.—The Teaching of Book Crafts; Sketching Out of Doors; The Making of Presents in Needlework; The Teaching of Woodwork.

VOLUME IV

Art and Craft (continued).—Gardening for the School and Home; A Three Years' Course of Needlework; The Mothercraft Course of Needlework; Handicraft in Science; Repairs in the Home; The Foundations of Drawing.

VOLUME V

Art and Craft (continued).—The Teaching of Drawing; Beauty in the Home; Decorative Metalwork; Engineering Metalwork; Weaving.

VOLUME VI

The Teaching of Music; The Story of Music; Some Famous Musicians; A Three Years' Course of Geography; Holidays in Europe.

VOLUME VII

The Teaching of British History; The History of British Costume; Ancient History and Helps to Bible Teaching; Common Law for the Home and School; The Teaching of Civics; Notes on the History of Ancient Greece, Ancient Rome, China, Japan and India.

VOLUME VIII

Time-tables; The Teaching of Mathematics; The Treatment of the Backward Child; The Leavers' Class and Vocational Guidance; Getting a First Job; School Clubs and Societies; The House and Team System; The School Camp and London Journey.

ACKNOWLEDGMENT

The Editor is indebted to the following for permission to make use of the copyright material contained in this volume:

MR. LEONARD HAYES and THE EDITOR *of The Schoolmaster* for "The London Journey."

THE TEACHING OF MATHEMATICS

SYLLABUS OF THE COURSE

Vulgar fractions, squares and cubes.—Vulgar fractions; least common multiple; highest common factor; squares and square roots; cubes and cube roots.

Decimal fractions and the metric system.—1st decimal place; 2nd and 3rd decimal places; metric system; decimal money.

Percentages.—Meaning of %; percentages as fractions; harder applications.

Proportion.—Preparatory; written examples; inverse proportion; compound proportion; proportional division; geometrical representation.

Geometry.—Teaching and revision of right angles; "direction," turning through right angles and simple scale drawing; square measure; right-angled triangles and half right angles; circle and preparation for measuring angles; equilateral triangles; isosceles triangles; scalene triangles; 3, 4, 5 right-angled triangles; parallel lines and parallelograms; cube and rectangular prism; cubic inch; area (continued); measurements needed to copy triangles; circles—ratio of circumference to diameter; right-angled triangles and the squares on their sides; pyramids; equality of triangles; inscribed and circumscribed figures; area of circle and circular rings; sectors of circles, arcs, angles at centre, areas; cylinder; cone; angles in a circle; chords and their distances from the centre; tangents to circles; sphere.

Graphs.—Continuous graphs; column graphs; graphs of simple functions.

Applications to everyday life.—Post office; insurances; wages and the laying out of money; housekeeping expenses; heating a house and producing supplies of hot water; house furnishing and decorations; buying houses; partnerships and companies; rates; income tax.

Practical work out of doors.—Surveying; observation by sun and shadows; measurement of heights; levelling and contouring.

Experimental work indoors.—Practical mathematics and physics; apparatus; suggested experiments.

Algebra.—Making of formulae; simple equations; indices, index laws, logarithms; variation; directed numbers.

Trigonometry.—Introduction and use of tangents of angles; sines of angles; cosines of angles; formulae $\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$;

Area of triangle$=\frac{1}{2}$ ab sin C

I. INTRODUCTION

Mathematical ability of children.—Mathematical ability is often spoken of as though it were one self-contained gift, bestowed upon some but denied to most; a fairy godmother kind of gift which enables its possessors to solve every kind of mathematical problem. This is the popular version of the old theory of mental faculties.

Teachers know mathematical ability as a power requiring development, a group of potentialities rather than one gift.

Psychologists' point of view.

The faculty theory.—As a result of scientific investigation, psychologists discarded the faculty theory early in the twentieth century.

Two-factor theory.—At present, most psychologists accept the two-factor theory. One general factor "g" enters into every mental activity. This factor is closely related to what is loosely called general intelligence. A child with a high endowment of "g" has wide interests and does most things well. In addition to "g" there are specific abilities, limited in range, which enter into particular activities. A child with "no ear for music," or tone-deaf, cannot learn music however much "g" he may possess. Musical ability implies good "g" plus certain specific factors. From these initial potentialities the mental powers and the associated habits and skills can be developed.

This theory that every ability involves two factors—the general factor "g" and one or more specific factors—is generally accepted to-day, but it is still in the experimental stage. Much work remains to be done, particularly with regard to the specific factors and their range. Mathematical ability is largely "g" plus some specific factor or factors that have not yet been defined. "G" is measured by tests which are usually called intelligence tests. Arithmetic and mathematical questions form an important part of all intelligence tests. Mathematics require an adequate degree of "g," but there are also specific factors. Possibly one of them is connected with visual imagination; that is, the ability to see special relationships. Children with good visual imagination see relationships in geometry more quickly than others, even though they may be below the average in algebra. Good visual imagination is of particular value in solid geometry, in drawing sections and diagrams of any kind.

At present we have no definite knowledge about the specific factor, but a child's intelligence quotient can be measured. This is not an absolute measurement but it compares a child with the average child of his age and indicates his potentialities in mathematics and other subjects. The study of mathematics develops whatever potentialities there may be and is of value to all children, but the stage of difficulty that can be reached is indicated by the "I.Q." (intelligence quotient).

Factors in mathematical ability from the teacher's point of view.—For practical purposes a teacher can distinguish a number of factors which play a part in the development of a child's abilities.

1. Part played by memory.—Memory is of great importance, especially in the early stages. Many things must be memorised. Multiplication and addition tables should be understood, but they must also become matters of mechanical memory. The same applies to the methods for the fundamental processes and all the tables. They are the tools of calculation and must be available, quickly and with certainty, whenever they are required. For this they must be memorised, otherwise time and thought are wasted. There has been much swinging of the pendulum of educational thought between two extremes. On the one side: "There should be nothing mechanical in arithmetic or mathematics, not even mechanical memory;

even infants should think out everything for themselves." On the other side: "Don't waste time explaining; teach mechanical rules as quickly as possible." To-day it is generally recognised that the mean position of the pendulum is the best.

The former extreme produces children who are continually hampered by not knowing tables. The latter produces children who cannot do a question unless they recognise it as a well-known type and remember "*how* to do it." It is a pity that the two extremes should have arisen at all and that mechanical accuracy should have been regarded as incompatible with intelligent work. To-day we know that both are required. Intelligence requires the aid of mechanical memory in mathematical work; and, from the teacher's point of view, memory is a factor in mathematical ability and teaching methods are largely concerned with establishing memories. Coaching for examinations consists largely of training the pupil in recognition of types of sums and, in memory, of how to do them. Some teachers are more interested in developing the memory side in their children. They feel that they get quicker, more accurate "results" from their class. They certainly get good examination results. Other teachers are more interested in developing the thinking side of their children and are inclined to neglect the drilling required for establishing memories. They do get interested children, full of enthusiasm but liable to be equally full of inaccuracies.

Every teacher has to keep the balance and train children to use both intelligence and memory. The two should work together. It usually happens that good intelligence and good memory are associated together in children. *A* stream children learn more quickly as well as understand more quickly; *C* stream children memorise more slowly and take longer to understand. In the early stages the differences between *A*, *B* and *C* children are chiefly differences in speed.

2. Part played by conative factors. Mathematics is essentially cognitive, but no human activity is purely cognitive. However abstract a piece of mathematical reasoning may be, it is not achieved without some effort of will, nor is it entirely free from emotional colouring. One can analyse the activity and observe the three sides, but one can never separate them. The whole personality enters into every effort. This is very noticeable in children who throw the whole of their being into everything that holds their attention.

The conative factors are of fundamental importance to the teacher. If a child wants to learn multiplication tables, he will learn them; if he wills to gain ability in mathematics, he will develop to the full extent of his powers. His determination may be aroused by immediate ends such as pleasing the teacher or parent, or gaining some reward, or by some competitive motive. Remote ends have more influence with older children. The will to pass an examination, to prepare for a career, to gain a scholarship, arouse the will to learn in many children. Teachers can deliberately arouse the determination to learn in children. To be able to do so is one of the secrets of successful teaching. At the same time, the strength of a child's will, his ability to give concentrated attention, his power of application and his perseverance are inborn qualities. Some of these are linked with "g", for mental vigour enters into all of them.

3. Part played by emotional factors.—Emotional factors in mathematics are: (1) Satisfaction in doing the work; (2) pleasure in a neat solution, especially if found under difficulties; (3) joy in the discovery of underlying principles; and sometimes (4) a sense of order and beauty.

All these may be experienced at any stage, from the earliest steps of learning to count, to the most advanced discoveries. In the infant school, "number" gives great joy to many children. They are allowed to work at their own pace; they learn by discovery. These are the conditions under which the best work is done; work satisfactory to child and to teacher. Being free from external examinations, the senior school has the opportunity of establishing the same happy conditions.

Emotional and conative factors are closely interlinked. In practice it is very difficult to separate them, but it is helpful for a teacher to consider both aspects of the child's activities. Both conative and emotional factors are powerful to help or to hinder the development of a child's powers.

4. Emotional steadiness and mental steadiness.—The mental state of a child determines the degree to which he can use his intellectual abilities. When the mind is calm and able to concentrate, it does its best work. If it be slightly disturbed by some emotion or distraction, it becomes less clear, less sure, and slips are liable to be made. If the disturbance increases, the mental condition becomes confused, the line of argument is lost, ideas are muddled and extreme confusion of thought results. All who have marked examination papers know how some candidates fall into incredible confusion and make most absurd statements. Children who are good at their work are not immune from mental confusion. The mental state of any child depends upon the balance between the disturbing and the steadying influences. Emotional factors may help or hinder to an almost unlimited extent.

Among the disturbing forces are:

1. Distaste for the work or for something connected with it—the pen, the paper, the desk, the room, the teacher, etc.
2. Hurry; anxiety; worry; fear.
3. Ill health or bodily discomfort.
4. Any emotional disturbance.

Among the steadying factors are:

1. Good habits of work.
2. Confidence in ability to do work.
3. Influence of teacher and "atmosphere" of classroom.

The balance is largely determined by the innate ability of the individual child to maintain a steadiness of mind in spite of all distractions. Some children are well endowed with this mental stability, others are very "easily upset" and never "do themselves justice" in an examination.

Mental stability has not been established as a recognised "factor" by psychologists but it, or something akin to it, will probably become recognised as work on conative and emotional factors makes progress. For the teacher it is a very practical thing. Hardly a lesson passes without an example of a child who fails to maintain mental steadiness in face of the disturbing forces that beset him. The teacher may reduce them to a minimum but cannot eliminate them, because some come from within the child. The teacher should watch and help the child to keep his mind steady. It sometimes happens that a slow child is asked to work a sum aloud and is so overwhelmed by a sense of his own incompetence that he becomes almost speechless. Storming at a child in this condition and threatening punishment make matters worse. The child has to regain mental steadiness before he can do any sums or make any progress. The best treatment is to let the child relax, take some deep breaths, think of something else and not return to the sum until his mind has regained possession of itself.

It is in problems, at all stages, that mental steadiness is of greatest importance. The mental processes involved in the solution of an arithmetical problem may be compared with the steps taken in doing a jig-saw puzzle. In both cases success depends upon recognition of the relationships existing between the given data, or "pieces", and also upon the steadiness with which they are held together while being built into the required picture. The speed with which relationships are discovered depends, in each case, upon intelligence and experience. A slow child has to examine each piece of the puzzle separately, study its shape and colour, and slowly construct, bit by bit, the picture which a more intelligent child or an adult can visualise almost before he fits the parts together. Similarly, the more intelligent "A" may see the answer to a problem long before the less gifted "B" has put together the pieces, stage by stage, and arrived laboriously at the same result. Intelligence determines the speed of the work and the complexity of the relationships that can be seen as wholes. In both cases success depends upon finding the links between one piece of data and another, fitting them together into groups, arranging the groups together and holding everything steadily until the whole picture, or solution, emerges. Lack of stability in the mental field causes pieces to become misplaced and even lost. According to its degree, it produces confusion in the working of the sum, which may or may not be realised by the child.

Analysis of the mistakes made by children, and their causes, show that the inability to hold things steadily in the mind is commonly the cause of mistakes. Some children are very prone to letting things slip and others are very steady. In a class there is wide variation in this quality, as in all others. Mental steadiness does not correlate with "g". It is akin to controlled attention and, probably, to character traits. Experiments with older children suggested that it could be developed, to some extent, if the child realised his own weakness, studied the conditions likely to disturb his mind and made a deliberate attempt to improve matters. If this is so, one might say that mental steadiness is an inborn potentiality, possessed in varying degree by different children and capable of being developed. It is certain that teachers can help children to use whatever power they possess.

II. AIMS OF TEACHING MATHEMATICS IN SENIOR SCHOOLS

Part played by mathematics in civilised life.—Education should prepare a child for fullness of life. Modern life makes use of mathematics in every department. All enterprises have their quantitative side; nothing is produced, under modern conditions, without the aid of mathematics at some stage. In the seventh century it was decreed by the Statutes of Shrewsbury that no man was qualified to appear as witness in a court of law unless he could count up to nine. To-day's needs are much more complex. Mathematics are an important factor in all skilled work; men and women have to deal with income tax, rates and insurances; many of them buy houses. As citizens we should all know something of public finance; as voters we are asked to form opinions about free trade, tariffs and even problems of international finance and the whole economic system.

Mathematics for the child.—Arithmetic gives a child the tools that will enable him to deal with figures when he meets them. Application to practical affairs develops his powers of dealing with everyday life, but a much broader basis than that of pure arithmetic is needed. During the past forty years, more and more geometry has appeared in syllabuses, under the name of *practical arithmetic*, or *mensuration*, or *geometrical drawing*. The work done under these names has usually been limited by its association with arithmetic. It should be considered as elementary goemetry and dealt with as such., Trigonometry and algebra should be drawn upon for their useful and effective methods. All of these—arithmetic, algebra, trigonometry—are not separate subjects but are different branches, much interlinked, of one big subject—mathematics. What is needed in senior schools is *mathematics for* *the child.* To some, the name appears pretentious for work done in elementary schools, but no other name will cover all that should be done. "Arithmetic" is too limited. The cultural aim is attained through the applications to a wide range of interests and topics. "Mathematics" is closely associated with many other subjects—geography, science, meteorology, gardening, handwork, civics, economics—and teachers of these subjects should co-operate with the teacher of mathematics.

The part played by mathematics in training mental powers and the association of mathematics with English are dealt with under the two following headings.

Formal training.—When the aims of teaching mathematics, and arithmetic, were stated forty years ago, they included "to train reasoning"; "to develop mental power"; the implication being that the methodical work of mathematics (arithmetic) and the reasoning involved would develop a power of reasoning that would be available in all fields of activity. That meant that learning to do one thing well improved a child's ability in doing everything else. In the words of Thorndike, "The common view was that the words accuracy, quickness, discrimination, memory, observation, attention, concentration, judgment, reasoning, etc., stand for some real elementary abilities which are the same, no matter what material they work upon; that these elementary abilities are altered, to a large extent, by special discipline in any one subject, say, mathematics; that they retain these alterations when turned to other fields."

This theory was of fundamental importance to educators. It justified the inclusion in the curriculum of any subject which gave formal training. Mathematics had a secure place in the syllabus because, in addition to having practical value, it was believed to train children's power to reason, in everything; to give concentrated attention, and to make them more accurate in all their work. A challenge to this belief came from practical investigators at the end of the nineteenth century. In 1901 there appeared in the *Psychological Review* an article entitled *Influence of Improvement in One Mental Function upon Efficiency in Other Mental Functions* by Thorndike and Woodworth. This gave experimental evidence to prove "That improvement in any single mental function rarely brings about equal improvement in any other function, no matter how similar."

On the experimental results, Thorndike based his theory of "identical elements":—"The change in one mental function alters any other only in so far as the two functions have as factors, identical elements." Many other researches have followed. Modifications have been made in Thorndike's original theory, but the general thesis stands. Belief in the training values of subjects has decreased to such an extent that in modern statements the aims of mathematics are almost entirely utilitarian. Any cultural benefits are to be obtained by association with practical applications to affairs of daily life. It is stated in *Senior School Mathematics*, "With a small time allowance it becomes all important to scrutinise carefully the content of the syllabus and to ask what mathematics is essential to girls, how this may best be treated and how far it is desirable or possible to go beyond the utilitarian minimum." The tendency in many schools is to cut down mathematics for boys as well as for girls, because its benefits are considered to be uncertain, if not illusory. Teachers tend to cling to the older theory. One believes that if Tommy is led consciously to appreciate the value of neatness when doing sums, he may apply it in other directions. Doing neat sums may not reduce his untidiness in English; experiments have shown that it does not. But developing the habit of tidiness, in doing sums, may also produce a conscious appreciation of the value of tidiness. This may cause Tommy to apply tidiness to his work in English. Under a good teacher, this kind of thing happens and justifies the teacher's reluctance to accept the experimenter's results as final and complete.

Individual experience supports the idea that there can be a transfer from one activity to another. A successful business man, who left school when he was fourteen years old, says: "When I was twenty-one I learnt to play chess. That taught me to look at situations from all angles; to consider alternative courses of action; to weigh evidence and never to regard a situation as hopeless. Chess showed me how to deal with problems and difficulties in real life. It gave me confidence in my power to deal with situations, and belief that I could get back to fundamental principles, however confused the issue appeared to be." This is a case where powers developed in one activity were consciously transferred to another, after the age of twenty-one. Some children, in their 'teens, make some transfers, consciously. There is little evidence as to the extent to which it is done or might be done under a capable teacher.

The experimenters themselves do not take an extreme view. In over 80 per cent. of the researches published between 1901 and 1927 there was evidence of "definite" or "appreciable" transfer; and in nearly half there was "considerable" transfer. Referring to this,[1] Professor H. R. Hamley says, "Some of these experiments, it is true, may be discounted, but when the less satisfactory experiments have been eliminated there still remains a substantial balance in favour of formal discipline." We do not know the exact nature of the common factor through which transfer takes place but we do know that a power is more likely to be usable if the learner becomes clearly conscious of its nature and of its general applicability. In the words of Burt, "Active or deliberate transfer is far more effective and frequent than passive, automatic or unintentional transfer."

Of special interest to teachers is Miss E. P. Johnston's experiment on the value of geometry as a training in logical thinking. Miss Johnston used three experimental groups. One group was taught geometry by a method which trained the children consciously to use a technique of logical thinking. The second was taught geometry without special effort to develop a conscious technique. The third (control) group received no teaching in geometry. At the end of the course all three groups were given the same test in non-geometrical logical thinking. In this test the first group, though of lower average intelligence, performed appreciably better than the other two. In Miss Johnston's words, "They try more varied methods of attack, reject erroneous suggestions more readily, and, without becoming discouraged, maintain an attitude of suspended judgment until the method has been shown to be correct." In other words, "geometry has transfer value in so far as its logical principles are consciously recognised and applied."

It is in the hands of teachers to devise and apply teaching methods which will derive full training value from geometry and other mathematical subjects.

Problems and mechanical work—Mathematics and English.—Mechanical work has a definite place in mathematics. The tables must be known so that the answer to any question on them is given mechanically; the first four rules and their application to money must be so familiar that they can be done with a minimum of thought. Algebra, on its manipulative side, is a mechanism for dispensing with thought.

But these are the mere tools of mathematics. In learning how to use them the children gain satisfaction, but an intelligent mind cannot live upon mechanical processes. If a teacher over-emphasises this side, the class finds the work tedious; the more intelligent children become bored and feel that the work is useless.

It is in problems that the tools are used and justify themselves. Children like prob-

[1] *Formal Training: A Critical Survey of Experimental Work*, by H. R. Hamley; *British Journal of Experimental Psychology*, November, 1936.

lems that are within their powers. Grown-ups find recreations in puzzles and in games that present problems. To say, "Our children cannot do problems," or, "Our children hate problems," shows lack of understanding. Children do dislike problems that are too difficult for them, but every child enjoys problems suited to his stage of development. To say, "We have no time for problems in our classes," and to omit them, is to lose an important side of the work. Real life does not present sums that can be solved by routine methods; it sets problems to be thought out. Mathematics provides excellent material for training children in the technique of dealing with problems of all kinds. It deals with simple things; it requires clear statements, logical thinking, and asks for accurate results. It teaches children to look at all aspects of a question and not to jump to conclusions on insufficient information.

The first step in dealing with any problem is to get a clear view of the situation. For this, the child must understand English and read intelligently. English and mathematics are very closely related at this point and give great help to one another. If a child does not grasp the meaning of the words, he cannot do the problem. Many children fail at this point, either because their English is too weak or because the situation is too complicated for their powers. The second step is to analyse the situation. The child should state what is given and what is to be found. Clear statements should be made about them—practical work in English!—and this helps the children to see the relationships between the data. Infant school teachers find it profitable to let the children "draw a picture" of the problem. Senior school children should be encouraged to draw diagrams whenever they assist in gaining clear ideas. Having realised the relationships between what is given and what is to be found, the child quickly arrives at the answer.

If the teacher *tells* the children "how to do" the problem, or does it on the board first and then tells the children to do it, he has destroyed most of its value. Such a plan may appear "to save time" but it reduces the problem to an exercise in "copying down" or memory. The teacher's business is to select suitable problems; go through one with the class, emphasising the method of tackling it; getting the children to realise that they must first say what is given and what is to be found out; and then think out how they can get from the things given, to the thing required. The children should then attempt other problems for themselves. Some may not succeed; they should be helped, but not by being shown how to do the difficult problem. The teacher helps best by saying, "Read the question to me." If often happens that after a child has read the problem aloud he says, "I see how to do it now." If not, the teacher asks, "Do you understand what you have read?" "Tell me what is given." "Tell me what you have to find." "Now think about it." If a child does not succeed in reaching the solution after making an honest effort, the problem is too difficult for him and he should be given easier ones first. The teacher should try to find out where the difficulty lies. In the senior school the problem may have involved too many steps for the child, and he has to be led up to it by carefully graded easier examples. Or it may be that the situation dealt with is unfamiliar to the child and the problem unsuited to him because it lies outside of his experience. Or it may be that the child had not sufficient intelligence to do the question and should be provided with easier ones. Sometimes the same problem with easier numbers will meet the case—large numbers are a difficulty in themselves. If a child meets several difficulties at the same time, it makes him utterly at sea and his feeling of helplessness prevents his making any progress. The teacher's aim is to give the child confidence in his power to analyse problems and deal with them.

Some children will not get beyond very easy problems but, within their limits, they will learn to think more clearly and to use words more carefully. In adult life there is much misuse of words; much vague, uncertain thinking; much unsound argument; much jumping to unjustified conclusions. Mathematics and English, working together, can do much towards cultivating clearness of expression, power to analyse situations and, maybe, to the creation of a more enlightened public opinion.

Examples of graded problems.—The situation dealt with is similar in each. The first can be done by younger or slower children. For older and quicker children the difficulty can be adjusted to suit their powers.

In all, the child should make clear statements about what is given and the steps of his solution, for no one can learn to do mathematics, however elementary, without constant striving after clearness of expression.

1. A dealer bought 10 bicycles for £4 each. He sold them all at £5 each. How much profit did he make?

One child will say:

He made £1 profit on each.
He sold ten bicycles.
Therefore he made £10.

Another child will say:

He spent £40.
He got £50.
Therefore he made £10.

The two methods should be compared. The first is easier and neater.

2. A dealer bought 12 bicycles for £4 10*s*. each. He sold half of them at £6 each and the other half at £5 15*s*. How much profit did he make?

One child says:

When he bought at £4 10*s*. and sold at £6, he made 30*s*.

He sold 6 at £6 and made 6×30*s*.=£9.

When he bought at £4 10*s*. and sold at £5 15*s*., he made £1 5*s*.

He sold 6 at £5 15*s*. and made 6×£1 5*s*.= £7 10*s*.

Therefore he made £9+£7 10*s*.=£16 10*s*.

Another says:

He bought 12 bicycles at £4 10*s*. each.
Therefore he spent £54.
He sold 6 at £6 and got £36.
He sold 6 at £5 15*s*. and got £34 10*s*.
Therefore he gets £36+£34 10*s*.=£70 1
Therefore he makes £70 10*s*.—£5 £16 10*s*.

The children see that the first methoc the easier but that one method may be u as a check upon the other.

3. A dealer bought 12 bicycles at £4 1 each. He sold one-third of them at £6 one-quarter at £6, and the rest at £5 1 How much profit did he make?

A child will say:

When he bought at £4 10*s*. and sold £6 5*s*., he made £1 15*s*.

He sold 4 at £6 5*s*. and made 4×£1 1 =£7.

When he bought at £4 10*s*. and sold at he made £1 10*s*.

He sold 3 at £6 and made 3×£1 10*s* £4 10*s*.

When he bought at £4 10*s*. and sold £5 15*s*., he made £1 5*s*.

He sold 5 at £5 15*s*. and made 5×£1 =£6 5*s*.

Therefore he makes £7+£4 10*s*.+£6 5*s* £17 15*s*.

The only parts actually written would those underlined.

The alternative method:

He sold 4 at £6 5*s*. and got	£25
He sold 3 at £6 and got	£18
He sold 5 at £5 15*s*. and got	£28 15*s*.
Therefore he got	£71 15*s*.

He bought 12 at £4 10*s*. and paid £54.
Therefore he made £71 15*s*.—£54=£17 1

The following are further examples shc ing how graded problems may be made:

4. A boy's bus fare between home a school is 1*d*. What will he spend on fa in a week if:—

(*a*) He goes home to dinner every day a uses the bus for every journey?

(*b*) He goes home to dinner every d He uses the bus at dinner time and in morning, but walks home in the afterno (*c*) He goes home to dinner every day except Monday, and uses the bus for all his journeys.

5. A boy goes home to dinner every day except Monday and uses the bus except for his return home for tea. He walks home after school unless it is raining. If Tuesday and Friday were wet days and his fare was $1\frac{1}{2}d.$, what would he pay in the week?

6. Four children from the same family go to a school. The bus fare is 1*d*. The two younger children stay at school for dinner and use the bus to go to school in the morning. The two older boys use the bus, both ways, to go home to dinner but walk in the mornings and afternoons. What does the family spend per week on bus fares?

It is obvious that further complications can be added *ad lib.*

The easiest of the examples, the parts of No. 4, would suit very weak children.

Similar grading can be done with most problems and is very useful when problems are taken as mental work, with a group.

Written work in problems.—To write out a full explanation of every step is tedious whether the problem be easy or hard. Children should be allowed to work in their heads and write as little as possible, maybe only the answer. It is desirable that children should work in their heads, but it is wise to require that some examples should be written out in full, especially if the children find difficulty in doing it. The ability to make clear statements, and arrange them in logical order, is to be cultivated, but written work should not be done when children can dispense with it. For example, in the first group of examples, on bicycles, it is necessary that the child should make the statements, in his mind, but writing them all down makes clumsy work. The alternative method of setting down, shown for No. 3, is neat and concise. An even shorter method of writing would be:

	£	s.
	25	0
	18	0
	28	15
	71	15
	54	0
Profit	£17	15

This is acceptable provided that the child can give explanations.

III. WEAKNESSES OF CHILDREN IN MATHEMATICS

Situation in senior schools to-day.—Senior school teachers often say that arithmetic is the weakest subject in the school and the hardest to teach. Some have gone farther and concluded that senior school children cannot do arithmetic beyond the first four rules and that trying to teach it is waste of time, especially for girls.

It is true that many children appear to be very weak, but their inability is often apparent rather than real. Backwardness in arithmetic, as in other subjects, is due to a multiplicity of causes and the child has to be studied as a whole before any conclusions about his capacities can be arrived at. Children of the same age and children in the same class exhibit marked differences in abilities and in experiences. An intelligence test is desirable because it gives information about "g," indicates the child's possibilities and separates the dull and backward from the merely backward.

Investigating the causes of weakness.

Intelligence tests.—The giving of an intelligence test has a technique of its own and teachers should study it carefully before attempting to use an intelligence test. The instructions must be followed in detail, otherwise the information obtained is not valid.

Why children make mistakes.—A child's attitude towards arithmetic, his emotional reactions, his ambitions, his mental steadiness and control over emotions can be discovered only by continuous observations. They all influence the child's progress.

Studying the experiences of the weak children.—A child's experiences in arithmetic are more easily discovered once the confidence of the child is gained. One of the difficulties is lack of sufficient time to find out about all the children. A beginning should be made with those whose arithmetic falls below the level of their intelligence. "I could do sums in Standard I but I never could do them after that." "I could do arithmetic until I went to a new school." "I was ill when I was in Standard II so I missed a lot of Standard II work and never could do sums after that." "I jumped a class in the junior school and got all mixed up about arithmetic." "I could do arithmetic in Miss Brown's class but couldn't do it at all in Miss Thompson's." These are typical statements indicating common causes of gaps in a child's training.

Learning to do arithmetic is a process which can be wrecked by the omission of any links. Change of school, frequent absence, too rapid promotion, change of method, an unsympathetic teacher; any of these may result in confusion of mind and a break in the child's progress. An intelligent and purposeful child may get the necessary help and bridge the gap, but the average child who has fallen by the way remains there and develops a helpless, hopeless attitude towards arithmetic. Because of large classes and pressure of work, the junior school teacher cannot give the individual attention required in order to succour these children. Under modern conditions the inclination is to give help to the brighter children, who may become winners of scholarships, while the weaker children are left to their fate and labelled "very weak" or "hopeless" in arithmetic.

The senior school receives many children who have suffered some mischance in their training. "I never know what to do with noughts, in division. I cannot do arithmetic." "I cannot understand fractions; they are all cancelling and I do not know how to do it." "I don't see any sense in decimals; what is the point for? And why do you move it?" These are typical remarks of children who have missed essential steps. An ex-secondary school girl once said, "I have never understood vulgar fractions."

Finding the weak spots and repairing them.—Whatever the cause of the difficulty, the teacher must know its exact nature. In order to discover this, an arithmetic test should be given soon after the children are admitted. This should consist of carefully selected short questions which will test all the foundations. Once the gaps are discovered, they can be filled in; until they are filled in, no useful work can be done. In the case of very backward children, it is necessary to go back to addition and subtraction, to analyse the steps involved in the first four rules and to test all of them. Schonell's Diagnostic Tests are well suited for this purpose. Some children have to be re-taught arithmetic from an early stage. This can be done by individual work, and as the child discovers how to overcome his difficulties, one by one, he gains confidence. Tests, whether standardised or the teacher's own, have to be used with judgment and conclusions drawn with care. The same child varies from day to day and this presents a difficulty in testing. Even when there are no apparent distractions, deviations in the performance of the individual child appear. Slips are the bane of a teacher's life!

Slips, their causes and cure.—Slips are worthy of more consideration than they usually receive. We are inclined to say, "Just a slip." Yet a slip makes all the difference between a right answer and a wrong, and slips are not tolerated in the world of business.

A slip is due to a lapse of attention, perhaps momentary but none the less fatal to accuracy. The cause of the lapse may be the presence of something that distracts attention from the sum; it may be some bodily condition, fatigue, mental worry or emotional agitation. Some children are more prone to slips than others; all vary from time to time in the frequency with which they make slips; all can be improved by careful training. When children are interested in the result, they are not so liable to make slips. If they wish to improve the accuracy of their work they will succeed in doing so.

The teacher's first step is to gain the co-operation of the class. External distractions should be reduced to a minimum. Practice should be given in doing short sums in the simple processes, the aim being to develop speed and accuracy. Perfecting tables may be required as a preliminary step because uncertainty about addition and multiplication tables is responsible for many "slips". Accuracy and speed should be aimed at, but accuracy must not be sacrificed to speed. When working at a high pressure, uniform speed cannot be maintained even when the work is very familiar and done by mechanical memory. This can be tested by writing a long column of figures under 10, adding them in pairs and writing the answer beside the lower figure of the pair:

Example.

8	
3	11
7	10
4	11
5	9
0	5
1	1
8	9
9	17

If one tries to run down a long column at top speed one finds the speed pulled up by a momentary check every now and then. The mind quickly recovers itself and, if it is alert, no error is made. If it is possessed by the idea of speed, a mistake is likely to be made. This is a recognised phenomenon and is probably a fatigue effect. It justifies the habit of checking work. To add or multiply quickly, and then quickly check, is the safest way of doing accurate work. Speed can be trained in mental work. In written work accuracy should be given first place.

Slips are often the result of a poor method of setting work down. When children do work in the margin, most of the slips are found there, particularly where small figures are written untidily, at an angle with the lines. This kind of work should not be allowed. Modern methods of setting down work eliminate margin work as much as possible.

IV. ORGANISATION OF WORK

Use of groups.—In most first year classes there is wide diversity of ability, particularly during periods of reorganisation of schools. This entails individual work or working in small groups. The teacher's first step is to investigate, as discussed in Section III. After diagnosing the symptoms, he has to prescribe the treatments. As far as possible these should be given to groups so as to simplify the organisation. Adequate supplies of examples are required and careful records must be kept. The chief aims are to revise and extend junior school work. The best children can find profitable occupation in harder examples, while the slower do very easy examples of the same type. In this way the average class can be kept together. If the diversities are too great, the class must be divided into two or more groups that are kept separate for all mathematics, except, perhaps, geometry.

In the later years the class can be dealt with as a whole by adopting the methods suggested in Sections VI to XIV. These utilise temporary groups for dealing with special difficulties, but aim at dispensing with division of the class into sections. The slower children go through the same topics as the quicker children, but they do fewer and easier examples. Unless the diversities among the children are too great, this is a practicable scheme. It is made possible by having books of well graded examples from which children can work. The chief difficulty arises in the marking.

Marking.—Marking is a problem for every teacher. Ideally, a sum should be marked as soon as it is finished and any corrections should be done at once. In practice it is impossible for one teacher to do this for every member of the class. In a well trained class the children may be allowed to have the answers and to mark their own sums. The teacher supervises and sees that the work is being done properly. The disadvantage of this plan is that some children misuse it. Their aim is to get the right answer and they take the easiest way. Younger children have not developed any moral sense about the method of getting it. They can be trained to use freedom aright, and senior school children should become sufficiently responsible to mark their own sums. The teacher can control the accuracy of the methods of writing down by looking through the books afterwards. It is not necessary to go through every book in detail every day. The teacher knows the children, knows their weaknesses, sees something of their work during the lesson and can avoid the dangers associated with the method of marking. Other methods overburden the teacher with piles of books to be marked. This method does not free the teacher from responsibility. It demands thought and careful supervision, but when it is properly carried out it is excellent training for the children.

Preparation of lessons.—The first necessity is to have a clear idea of what is to be taught and how the written work is to be set down.

The next is to consider it from the child's point of view. A good course of senior school mathematics is designed to satisfy the natural needs of a growing child. The lessons are stages in a process of development. Each lesson should be linked with the previous one, each one arising from what the child can already do and leading on towards the next lesson. The lesson is alive in so far as it follows the interests of children and its points of contact with the children's lives must be considered when deciding what applications are to be made and how the lesson is to be introduced.

Introduction.—The purpose of an introduction is to arouse interest by relating the lesson to real life from a child's point of view. Some apparently dull lessons are means to an end. Their success depends upon realisation of their purpose.

Presentation.—The presentation should be thought out carefully and the new work graded so that the lesson proceeds step by step, from the known to the unknown, tackling one difficulty at a time. The most satisfactory method of learning is by enquiry, experiment and discovery. Whenever possible, practical work should be utilised so as to lead to this method. Children enjoy doing things and gain a sense of power over their environment and a better appreciation of relationships when they have handled and measured concrete things. The exercise of initiative in carrying out practical work, the testing of results and conclusions, make a further addition to the value of the lesson. In any case, the presentation should lead up to the formulation of a rule or a conclusion. This should be *discovered* by the children, not stated for them by the teacher. If the children have found a rule for themselves, they know it and can use it. The teacher should lead but must adopt the pace of the children. Forcing too rapid generalisation may spoil a lesson completely and leave the class without any grip of what has been taught.

Application.—The last stage of the lesson is the application of what has been learnt, and usually consists of practice in the use of a new method or a new rule. The examples should be chosen with care; their purpose is to give the child confidence that he can handle his new tool. Their difficulty must be adjusted to the intelligence of the individual child. Many short easy examples give the best exercise. Weaker children need examples with smaller numbers because the degree of difficulty depends very much upon the size of the numbers involved. A class usually contains children of varied abilities and the lesson has to be planned so as to cater for all. The presentation should be such that all the children can follow it. The applications should provide suitable examples for all capacities. Much time can be saved by good organisation. A new topic can be introduced to the class as a whole; applications can be given so as to provide what each child needs. The better children will work more quickly and do harder examples; the weaker children will need individual help; but the class can be kept together. The following lessons will consist of more applications of increasing difficulty and diversity.

Textbooks.—The modern books of examples, give sets suited to "A," "B" and "C" children and are very helpful to teachers in finding the examples required both for the new rules and for revision. All children need frequent revision of the processes most often required, and good sets of examples should be provided so that children may do individual work and practise the various techniques. A teacher can make cards of examples, and this is often desirable. There are many good books on the market, but even the best must be used with discretion. No book can fit the needs of all schools, all classes or all pupils. A teacher should not surrender his responsibility for the choice, order and treatment of subject matter. Books of examples should be selected to suit the environment and special circumstance of the school, but it is rarely desirable that they should decide the syllabus. The teacher should use them in so far as they help his scheme. It is better to have more than one set of books. Even when two or more sets are provided, it may be necessary to make cards of examples for special cases. Success with "C" and "D" children depends upon ample provision of easy examples, and extra examples specially suited to them are often required.

Practical work and how to make it successful.—At times, practical work has meant no more than sums about practical everyday affairs. In modern teaching it means that every child makes an intelligent contribution of data, of some kind; for example, measurements of length, weight, area, volume, angles, made by himself; or he may apply the results of the lesson in some concrete form. To-day the emphasis is upon practical work, but teachers often wonder whether it is worth the time it takes. It *can* be abundantly worth while; far more worth while than any teaching without it; but it *can* result in much waste of time and considerable disorder. The secret of good results is organisation.

Organisation of practical work.—Practical work, whatever its nature, must be very carefully prepared and planned in every detail.

1. The teacher must have clear ideas about what is to be done. An adequate supply of apparatus must be available. If there is not enough apparatus and space for all the children to do the work at the same time, then work must be organised so that everyone does the practical work in turn while the rest of the class is otherwise occupied. When measurements are to be

made, children should work in groups of two or three. They should take turns in making the readings, recording the results and checking one another. This co-operation gives added value to the work, but care must be taken in arranging the groups. Children of unequal abilities do not make a good team. The quicker child either does everything and leaves the slower child bewildered, or he becomes impatient of the slow pace and loses interest. Children usually group themselves satisfactorily, but the teacher must keep an eye on the group and see that everyone takes a fair share of the work. For the quick groups, additional work must be provided of the same stage of difficulty. This enables the teacher to keep the class together without making the pace too quick for the slower pupils.

Details of organisation are given in some of the suggestions about practical work out of doors. Details cannot be given about indoor work because conditions vary so much and teachers have to exercise ingenuity, making the most of the space and material available.

2. It is essential that the teacher should carry out the work beforehand. One never knows how things will work out or what complications will arise unless one has actually done the work. This is very important with regard to degree of accuracy. The teacher must determine the range of error of the instruments used. In all the exercises on measuring heights and distances, a satisfactory base line should be found beforehand. If the angle of elevation is about 15°, an error of 3° causes an error in the result twice as big as if an error of 3° had been made in measuring an angle about 40°. The best children in the class might discover this, after they had had some experience, but it is wise to protect the class at first.

3. Before the pupils begin to do any practical work they must know exactly what they are going to do. All previous knowledge that is required must have been revised, otherwise the whole lesson may be spoilt.

The aim must be stated and the procedure discussed. Each child must know what material he will require, where to get it, what he is going to do, in detail, how results are to be recorded, what to do when he is finished, where to return apparatus, and what to do next. The teacher is then free to exercise general supervision of the whole.

V. CONTENT OF THE COURSE

IT is obvious that the content of the course will vary for different children. The extent of the course will be greater for "A" stream than for "B." It will be more limited for "D" than for "C." It will vary from district to district; local conditions and industries determine the appropriate applications. It will vary from school to school, as special interests are developed by particular schools or individual teachers. Very few children will cover all the work that is suggested in *Senior School Mathematics* and in the *Handbook of Suggestions for Teachers*, both issued by the Board of Education.

Senior school topics.—When selecting what shall be done and what omitted, the best guidance is obtained by considering what the children *need* and what they *like* to do. Both considerations lead to practical work and, if practical issues are made the basis of the work, other issues emerge. A desire to approximate to a secondary school syllabus should not be permitted to exert influence in a senior school. Senior schools are fortunate in escaping the blight of external examinations and being free to develop non-academic schemes of work. To sacrifice this freedom for the sake of examination results would be disastrous. When children are "working for an examination," there is no time for them to find out things for themselves, no time to explore interesting byways; "they must get on with their real work for the examination," say the teachers who are anxious for "good results." So long as teachers and schools are judged by their examination successes, so long will examination standards dominate education. The external examination stereotypes methods and curriculum; it cramps the initiative of the teacher and the development of the school. It obscures much of the joy of learning and puts undue pressure upon children. The Home Work Report, published in 1937, gives evidence of this in secondary and junior schools. Even the infant school is not free from the shadow of the junior scholarship examination. The senior school has the opportunity of making the work and the pace suit the children and so avoiding the ill effects of examinations. Its business is to develop a child's powers, to awaken interests, to widen his outlook—not to make him able to pass examinations.

Treatment and distribution through the course.—The first year should begin with a study of the capabilities of the children, a filling in of gaps and rubbing up of junior school work (cf. Section III). Practice in quick accurate work should be given. Junior school work has often included things that would be better left to the senior school stage. The unfortunate result of trying to do too much is that nothing is done thoroughly. Hence many of the difficulties of senior school teachers.

The junior school syllabus as given in *Senior School Mathematics* is:

1. Addition and subtraction of whole numbers, money, lengths, times, weights and capacities, without undue complexity as regards numbers and units.
2. Short and long multiplication of numbers.
3. The process of reduction applied to simple examples only.
4. Short multiplication and division of money, lengths, times, weights and capacities.
5. Addition, subtraction, multiplication and division of fractions with small denominators.
6. Mensuration of rectangles and cuboids.

When this is known thoroughly and the children are able to apply it to widely varied examples, the work should be extended to cover (1) long multiplication and division of money, lengths, times, weights and capacities; (2) use of alternative methods such as simple practice; (3) the decimal notation as an alternative way of writing tenths and its use in geometrical drawing.

The introduction of some of the senior school topics now follows. These are:

1. Vulgar fractions (beyond junior school stages).
2. Decimals; percentages.
3. Proportion; functional relations.
4. Geometry.
5. Graphs and statistics.
6. Applications to everyday life—insurances; discount; interest; buying and selling; housekeeping; accounts and balance sheets; rates and taxes; business affairs.
7. Practical work out of doors; measuring heights and distances; applications to geography; trigonometry.
8. Experimental work indoors; measurement of volumes; weights and densities; mechanics; other work related to physical science.
9. Algebra in so far as it is of practical use.
10. Special projects involving mathematical work.

Logarithms.—The practical use of logarithms can be taught at an early stage to "A," and the best of "B," stream children. It can be taught as a mechanical process and the difficulties associated with negative indices can be avoided. If fractions are included in the expression that is to be valued, it can be multiplied by the power of 10 necessary to clear it of fractions.

Example: If $4{\cdot}2\times{\cdot}713$ is to be found, 42×713 can be evaluated by logarithms and the result divided by 10^4.

If $3 \cdot 6 \div 8 \cdot 4$ is required, the question can be changed to $36 \div 84$.

If there is to be any real understanding of logarithms, they must be introduced in the way set out in the section on algebra (XV). This can be done without any other work from that section. If logarithms are to be taught, they should be introduced sufficiently early in the course for children to acquire reasonable facility in their use.

The use of the slide rule is probably better than the purely mechanical use of logarithms.

These topics are dealt with in succeeding sections.

Their *treatment* is of great importance. They are *not* to be taken in order, each one dealt with completely before the next is finished. The earliest stages of all the topics are taken in turn; then the harder stages in each and in the last years the most advanced stages of each topic. In this way every child gets some ideas about each topic. He may not go far with any of them, but he has some acquaintance with all. This scheme is comprehensive and gives possibilities of wide variations. It can be used so as to suit any children in any environment.

First year.—In the first year, average children in the average school will *begin* topics 1 to 5. They will apply them to practical affairs and may touch upon subjects mentioned in No. 7. Simple projects add great interest to the work. The extent of the work done in each topic depends upon circumstances, time available and the capacities of the children.

Second year.—In the second year, the children carry on each topic from the points reached in the first year. They will probably have finished all that needs to be done in topic 1. They will begin to deal with topic 7 and perhaps the simplest stages in topics 8 and 9. Projects (10) should be worked out.

Third year.—The third and fourth years should see the further stages of topics 2 to 5, 7, 8 and perhaps 9. Topic 6 should be introduced and worked through in these last years. Preliminary work will have been done as part of topics 1, 2 and 3, but there should be this gathering up of applications to everyday life.

Drawing.—Practice in drawing should be included throughout the course, not merely in the geometry. Children should gain experience in sketching plans, elevations, outline drawings, perspective drawings, sections; these will be rough at first, but the child will gain in accuracy as he develops power of self-criticism. Scale drawing in geometry can be used to lead up to mechanical drawing and the making of accurate plans and elevations.

The child should also learn to read dimensioned sketches and drawings. Books of examples that use these are of great value. Many modern books do incorporate this feature.

Every class should be provided with suitable equipment for drawing—rulers, set squares, compasses, protractors.

Popularity of arithmetic among children.—An enquiry[1] was made as to the relative popularity of subjects in the elementary schools of Worcestershire. 9,127 children between 10 and 14 years old arranged 15 subjects in order of preference. Among girls, arithmetic appears ninth among the 10 year olds. Among boys it appears seventh among the 10 year olds; third, second and fifth among the 11, 12 and 13 year olds. The children's reasons showed that likes and dislikes in school subjects are fluctuating and are influenced by many causes that are external to the subject. Among reasons directly connected with it, were the facts that children like doing something for themselves; 11 and 12 year olds like "getting results." At 13 years of age, utilitarian reasons begin to take a larger place; children

[1] *Popularity of School Subjects*, by J. J. Shakespeare; *British Journal of Experimental Psychology*, June, 1936.

develop a sense of more remote ends and the need for acquiring knowledge as a means to these ends. This is largely responsible for the low place given to arithmetic by girls of 13 and for 13 year old boys giving it a lower place than 12 year olds. These results were obtained from children working on the old type of syllabus and the new senior school work should increase its popularity among older children.

VI. VULGAR FRACTIONS, SQUARES AND CUBES

VULGAR FRACTIONS

Common sources of difficulty.—Weaknesses in dealing with vulgar fractions are common among children coming into the senior school and are not unknown among those passing into the secondary school. In her book, *The Case against Arithmetic,* Miss Renwick gives many examples of misconceptions and things in fractions that puzzle high school children. Study of the difficulties experienced by children who are backward in fractions almost always reveals that the source of the trouble lies in the early stages of learning fractions. "A" stream children and the best of "B" stream find no trouble about taking steps that require careful negotiation by the weaker children. The following steps are common causes of difficulty:

I. *Passing from concrete to abstract, and generalising.*—A child sees that $\frac{3}{8}$ of a cake plus $\frac{1}{8}$ of the same cake make $\frac{4}{8}$; that is, $\frac{1}{2}$ of the cake. But he has to take a big step before he can go on to say $\frac{3}{8}+\frac{1}{8}=\frac{4}{8}=\frac{1}{2}$.

Less familiar fractions involve further difficulty.

Example.

$$\frac{5}{24}+\frac{1}{6}+\frac{3}{8} = \frac{5+4+9}{24} = \frac{18}{24} = \frac{3}{4}$$

II. *Passing from fractions of a whole to fractions of a group of things.*—A child who has learnt to deal with eighths of a strip of paper or of a cake cannot immediately apply his knowledge to eighths of a group of nuts or people. Eighths of 1s. or £1 present a further difficulty. "You cannot get $\frac{1}{8}$ of a shilling," says a child.

III. *Finding the meaning for multiplication by a fraction.*—A child learns how to find $\frac{1}{8}$ of 16 things but may be confused by the use of the "$\times$" sign. "5×6 means 5 times 6. How can $\frac{1}{5}\times6$ mean $\frac{1}{5}$ times 6? You cannot take a thing $\frac{1}{5}$ times. How can you multiply by a fraction?" says the child.

IV. *Finding a meaning for division by a fraction.*—Most children would say that $10\div5$ means "10 things shared among 5 people," or, "10 things divided into 5 groups." That is, they have the "sharing" conception of division. Only when they have the "measuring" conception of division can they begin to understand what division by a fraction means:

$10\div5$ asks, "How many fives in 10?"
$10\div\frac{1}{5}$ asks, "How many fifths in 10?"

Children who do not see the meaning of sums in fractions may have been taught to use mechanical methods for "doing" easily recognised types of sums, but all their work is mechanical, and very absurd errors are likely to arise.

Treatment for very weak children.—Treatment for all such cases is to go back to the beginnings of fractions and give much practice with concretes. Strips of paper should be folded; lines divided; counters divided into groups; circles cut up into equal parts; rectangles drawn and fractions shaded (or coloured). By these means, simple sums in addition, subtraction, multiplication and division should be illustrated. Sums should be well graded so as to introduce one difficulty or one new point at a time, and only small numbers should be used. Easy fractions of sums of money should be introduced as a preparation for later work.

Drill in factors; multiples; equivalent fractions.—All children require drill in factors and multiples of numbers. This can be done along with revision of multiplication tables, in mental work. Practice in finding common factors and common multiples is necessary before children can deal with cancelling and finding the least common multiple. Drill in finding equivalent fractions should form a regular part of the mental arithmetic at this stage.

LEAST COMMON MULTIPLE

The least common multiple of a group of small numbers can be found by inspection. Most of the children should not be required to do sums that require any other method.

If desired, the old method of setting out an L.C.M. sum may be taken at this stage. It is merely a compact form of setting out the factors:

$$\begin{array}{r|l} 4 & \underline{12,\ 8,\ 3,\ 5} \\ 3 & \underline{\ \ 3,\ 2,\ 3,\ 5} \\ & \ \ 1,\ 2,\ 1,\ 5 \end{array}$$

$$\text{L.C.M.}=4\times3\times2\times5=120$$

This is now usually written:

$$\begin{aligned} 12&=\underline{3}\times\underline{4} \\ 8&=\underline{2}\times4 \\ 3&=3\times1 \\ 5&=\underline{5}\times1 \end{aligned}$$

$$\text{L.C.M.}=3\times4\times2\times5=120$$

The latter form can be used in all cases; it is less compact but is satisfactory for all questions suitable for senior schools.

HIGHEST COMMON FACTOR

A method for highest common factor is not needed. Children can work from first principles in all questions that are suitable for them. The drill given above prepares them for this.

SQUARES AND SQUARE ROOTS

All children should know the meaning of "squared" and how to write it. Exercises in finding squares and square roots should be incorporated in the mental work of the paragraph on *Drill* above. They should be linked up with the measurements of area of squares and length of side of square.

The better children may be given the quick mental method of squaring numbers 13 to 19:

$$13^2=(13+3)10+3^2$$
$$14^2=(14+4)10+4^2 \text{ etc.}$$

The method for finding the square root of any number is required for some of the later work, and it can be given as a mechanical process to those who are likely to need it. Explanations hamper rather than help children.

CUBES AND CUBE ROOTS

Cubes can be introduced in connection with volumes. Cubes and cube roots of the simplest numbers can be taken, but cube roots should be postponed until logarithms are taken.

Types of question in vulgar fractions.—Long and cumbersome questions should be avoided. When choosing examples in fractions, the teacher should have in mind the future requirements of the children. Those who go beyond the first few stages in proportion and percentages will soon have to deal with expressions like the following:

$$\frac{3\frac{1}{2}}{12\frac{1}{4}} \text{ of } £2\ 8s.$$

$$\frac{4\frac{1}{2}}{100} \text{ of } £465$$

$$\frac{3\frac{1}{4}\times4\times£76}{100}$$

Graded examples in finding fractions of sums of money should lead up to these. The grading and the kind of example used must be arranged to suit the children.

Examples

1. Express as pounds and fractions of a pound:

(*a*) £2 5*s*.; (*b*) £5 15*s*.; (*c*) £3 4*s*.; (*d*) £4 6*s*. 8*d*.

2. Write the following as £ *s*. *d*.:

(*a*) £$\frac{9}{4}$; (*b*) £$\frac{27}{8}$; (*c*) £$\frac{26}{5}$.

3. (*a*) $\frac{1}{2}$ of $\frac{31}{3}$; (*b*) $\frac{3}{5}\times\frac{33}{4}$; (*c*) $\frac{5}{9}$ of $\frac{15}{7}$.

4. (*a*) $1\frac{3}{4}\div\frac{7}{16}$; (*b*) $6\frac{3}{8}\div4\frac{1}{4}$; (*c*) $\frac{15}{16}\div3\frac{3}{4}$.

5. (*a*) $\frac{5}{8}$ of £5 16*s*. 8*d*.; (*b*) $\frac{9}{20}$ of £9 8*s*. 4*d*.; (*c*) $\frac{7}{12}$ of £8 12*s*. 6*d*.

6. (*a*) Find the cost of 625 glazed bricks at £22 per 1,000.

(*b*) A man bought $1\frac{1}{2}$ cwt. of sugar for £3 10*s*. How many cwt. could he have purchased for £8 15*s*.?

VII. DECIMAL FRACTIONS AND THE METRIC SYSTEM

Historical note.—Our notation is a decimal notation, each figure in 11, 111, representing ten times as much as its right hand neighbour, and decimal fractions are a natural development from it. They first appeared in England about 1607, when an Englishman, Robert Norton, translated the work of their discoverer, Stevinus, a Flemish mathematician. Norton's work was entitled, "*Disme; The Art of Tenths, or Decimall Arithmetike*, teaching how to perform all computations whatsoever by whole numbers without fractions, by the Four Principles of Common Arithmetic, namely Addition, Subtraction, Multiplication and Division. Invented by the Excellent Mathematician Simon Stevinus. Published in English, with some additions, by Robert Norton, Gentleman." The chief attraction of this new art appears to have been its convenience for commercial calculations dealing with compound interest.

In 1610, 42·165 was written $42^{\circ}\ 1^{1}\ 6^{2}\ 5^{3}$ and during the following years various other methods appeared for indicating the place values of the figures. The "dot" which, to us, is an essential part of decimals, was introduced by John Napier in 1650. The "dot" is simply a mark to show where the whole numbers end and the fractional numbers begin. In strict accuracy we should not talk about moving "the point". When we multiply by 10 or 100, we move the figures, not "the point".

The first users of decimals were not concerned with the theory of decimals; their methods would not satisfy the standards of our modern schools; they considered that they were "avoiding the intricacies of fractions" when they used Decimall Arithmetike.

So originated the divorce between vulgar and decimal fractions. Decimals won their place in the business world because of their ease and convenience. They win their place in our senior school syllabuses because of their practical value in everyday affairs. Decimals are closely linked with percentages and are commonly used in stating statistics. Some understanding of the use of decimals is needed for intelligent reading of the newspapers, despite the fact that many people in Great Britain look with misgiving even on the first decimal place, and the use of tenths instead of twelfths.

The English systems of money, weights and measures avoided tenths, preferring halves, quarters, eighths; thirds, sixths, twelfths. Because of this, we do not think so easily in tenths and, in the past, decimals have not entered daily life in Great Britain so much as in other parts of the world. Yet an Englishman, James Watt, made one of the first suggestions, in 1783, of a decimal system for the measurement of length. The unit he suggested was the length of a second's pendulum in Lat. 45°. He considered this a natural unit, linking length and time. Another Englishman, Thomas Williams, in 1788, wrote a book about a decimal system of measures. Before the French Revolution, English and French mathematicians were discussing the question of a more satisfactory system of units. Up to the time of the French Revolution, every province in France had had its own units for weight, length and area, and one of the early tasks of the new government was the unification of weights and measures. A French commission was appointed to consider the matter, English scientists were invited to assist in the discussion, and in 1799 the metric system was adopted. It was made legal in 1840. The length of the seconds pendulum (39·37 inches) became the unit of length, the metre, and all the other measures were derived from this. English scientists made their contribution to the metric system but the English weights and measures, with all their inconvenience, have maintained themselves in England.

Some day a government may reform our systems of money, length and weight, but in the meantime we adopt the metric system for many purposes. Science has used it for many years; engineers use it because engineering is a world trade and requires international units; kilometres have become familiar in motor, cycle, and motor boat records; and as sport becomes international metres become the recognised units. Wireless waves are standardised in metres. Probably the English and the metric systems will go on, side by side, for many years. The ease and convenience of the decimal system are obvious, yet many of the young people who have passed through secondary schools regard decimals with disfavour. This unfortunate result indicates that our teaching methods are not above reproach. We make of decimals a neat but complicated puzzle instead of a useful tool. Some children enjoy manipulating the processes, but to most they are a difficult and uninteresting mystery. Our treatment of decimals should make children familiar with their use for practical purposes and calculations.

Teaching of decimals in the senior school.—The qualifications of children entering the school vary considerably. For some, the first stages are purely revision. The majority will have covered Stage 1 in the junior school, but need to revise it. For some, Stage 1 is new work and may require much time.

STAGE 1. 1st DECIMAL PLACE

Aim.—To teach the use of the first decimal place and apply it in drawing and measuring.

To teach +, −, and × and ÷ by whole numbers.

I. *Introduction and use in drawing and measuring.*—Children find tenths of one inch on rulers and use them in work such as the following:

1. Draw a line $1\frac{4}{10}$ in. long. Write its length above it, using the decimal way of writing; i.e., 1·4.

2. Draw another line, 1·7 in. long. How much longer is this than the first line?

3. Draw another line ·9 in. long. How much shorter is this than the first one?

4. Draw a line and mark one end of it A. Measure from A 1·2 in. and make a dot. Measure along the line another 1·7 in. and put another dot. How far is this from A? Repeat, adding 1·3 in., ·8 in., etc., as is required.

II. *Addition and subtraction.*

The results of practical addition should be checked by working the sums:

$$\begin{array}{r} 1{\cdot}2 \\ 1{\cdot}7 \\ \hline 2{\cdot}9 \\ \hline \end{array} \qquad \begin{array}{r} 1{\cdot}3 \\ {\cdot}8 \\ \hline 2{\cdot}1 \\ \hline \end{array}$$

1. Draw a line 2·3 in. long. Measure off from it 1·2 in.

Measure what is left.

Repeat, cutting off ·9 in.

$$\begin{array}{r} 2{\cdot}3 \\ \underline{1{\cdot}2} \\ \underline{1{\cdot}1} \end{array} \qquad \begin{array}{r} 2{\cdot}3 \\ \underline{{\cdot}9} \\ \underline{1{\cdot}4} \end{array}$$

2. Draw an oblong with sides 1·2 in. and 1·6 in. If a fly walked all round the sides, how far would it walk? If it went across from corner to corner, how far would it walk? How much shorter is it to go across from corner to corner than to walk along 2 sides?

$$\begin{array}{r} 1{\cdot}2 \\ 1{\cdot}6 \\ 1{\cdot}2 \\ \underline{1{\cdot}6} \\ \underline{5{\cdot}6} \end{array} \qquad \begin{array}{r} 1{\cdot}2 \\ \underline{1{\cdot}6} \\ 2{\cdot}8 \\ \underline{2{\cdot}0} \\ \underline{{\cdot}8} \end{array}$$

Measure the distance between the lines on your paper.

How far apart are they? Is that exactly true?

This and other measurements bring in the idea of degree of accuracy. Children should make many measurements and state them as correct to ·1 inch.

III. *Multiplication and division by whole numbers.*

1. Draw a square with sides 1·2 in. If a fly walked all round the sides, how far would it go? Repeat for a square of side 1·3 in.

This introduces multiplication by 4, and the children quickly pick up the method:

$$\begin{array}{r} 1{\cdot}2 \\ \underline{4} \\ \underline{4{\cdot}8} \end{array} \qquad \begin{array}{r} 1{\cdot}3 \\ \underline{4} \\ \underline{5{\cdot}2} \end{array}$$

2. Mark off ·7 in., 6 times along a line. Measure the total length and check by multiplying:

$$\begin{array}{r} {\cdot}7 \\ \underline{6} \\ \underline{4{\cdot}2} \end{array}$$

Other examples of a similar kind should be given.

3. Cut a strip of paper 6·4 in. long. Fold it into two and measure. Write down: $2\overline{)6{\cdot}4}$
$\quad 3{\cdot}2$

Fold into 4 and then into 8, measuring and checking by writing: $4\overline{)6{\cdot}4}$ $\quad 8\overline{)6{\cdot}4}$
$\quad 1{\cdot}6 \qquad {\cdot}8$

Other examples of a similar type should be given.

IV. *Use of decimals in drawing to scale.*—Examples on drawing to scale of 10 ft. (yards or miles) to 1 in.: these should refer to practical things and may be linked with manual work, handwork, geography.

1. A greenhouse is 24 ft. wide. Its walls are 10 ft. high. The greatest height, in the centre, is 17 ft. Draw a scale diagram of the end of the greenhouse.

2. A garden is 18 yd. wide and 28 yd. long, and is a rectangle in shape. Around its edges there is a 2 yd. wide bed of shrubs and flowers. Inside this is a gravel path 1 yd. wide. The centre is a lawn. Draw a plan to scale, 10 yd.=1 in.

V. *Applications to money.*—Examples in finding ·5, ·1, ·2, ·4, etc., of given quantities: many easy mental examples should be done before written examples are introduced.

Examples

1. I have a 10*s.* note. How much is ·5 of that?

2. I have a £1 note. How much is ·5 of that?

3. What is ·2 of 15*s.*? (Worked from $\cdot 2 = \frac{1}{5}$).

4. How many is ·3 of a class of 40?

5. What fraction is 15 of 30? Of 50?

VI. *Multiplication and division by* 10.—Exercises in multiplication and division by 10 should be given until the children are quick and sure about the operation.

Note.—The earlier steps of Stage 1 are very easy; "Hardly worth the time spent upon them," say some. But they do lay the foundations. They are waste of time for children who have the foundations but most profitable use of time for those who have not. How much time should be given to them is indicated by the children's response to the work. As long as they are interested in the work, it is helpful. As soon as they have grown beyond it, they have little patience with it.

The degree of difficulty can be increased by devising more elaborate examples, but the primary aim, as stated, must be kept in view and it is not to do complex examples.

STAGE 2. 2nd AND 3rd DECIMAL PLACES

Aim.—To introduce the second and third decimal place. To teach multiplication and division by decimals.

I. *Introduction of second decimal place.*—An effective method is by use of squared paper.

$\cdot 1$ of a large square is a strip of 10 small squares.

$\cdot 1$ of $\cdot 1$ is one small square.

$\cdot 1$ of $\cdot 1$ is $\frac{1}{10}$ of $\frac{1}{10}$; i.e., $\frac{1}{100}$ written $\cdot 01$, etc.

Mental examples, illustrated by shading in squares to familiarise children with the second decimal place and its use in $+$, $-$, and $\times$ and $\div$ by whole numbers: this should include some appreciation of when it is useful and when it is not; e.g., in drawing and measuring in inches the children can be accurate, at best, only to $\cdot 05$ in. In dealing with the population of a town of 250,000 inhabitants, $\cdot 01$ of the population means 2,500 people.

II. *Multiplication of a decimal by a decimal —Introduction of third and fourth places.*—Knowledge of vulgar fractions leads to discovery of the easiest method of multiplying a decimal by a decimal.

By comparison of $\frac{1}{2}\times\frac{1}{2}=\frac{1}{4}$
and $\frac{5}{10}\times\frac{5}{10}=\frac{25}{100}$
children arrive at $\cdot 5\times\cdot 5=\cdot 25$,
and by practice with many examples they learn the rule:—Ignore the points; multiply the numbers; count up the number of decimal places; count back that number of places in the answer and put in the point.

```
  23·14          23·14
   1·65            ·03
 -------         ------
 2314            ·69 42
 1388 4
  115 70
 -------
 38·18 10
```

This is really a vulgar fraction method. It is equivalent to

$$\frac{2314}{100}\times\frac{165}{100}=\frac{381810}{10000}=38\cdot 181$$

$$\frac{2314}{100}\times\frac{3}{100}=\frac{6942}{10000}=\cdot 6942$$

The purely decimal methods are good exercises in manipulation and in the understanding of place values, but they have no real advantage over the more simple method. In fact, it is quicker, more accurate and more reliable than the "decimal" methods. If any one of them is used, much time has to be spent in making it mechanical and the time could be spent to better advantage.

III. *Division by a decimal.*—There are several methods of dividing by a decimal, but the one that gives greatest satisfaction is the one which changes the sum, multiplying *both numbers by the same power of 10,* so as to clear the divisor of decimals.

(*a*) $42\cdot 7\div 3\cdot 5$ becomes $427\div 35$
(*b*) $10\cdot 4\div\cdot 13$ becomes $1040\div 13$
(*c*) $24\cdot 8\div 6\cdot 02$ becomes $2480\div 602$

(*a*)

```
     12·2
35)427·0
   35
   --
    77
    70
    --
     70
     70
     --
```

$\therefore\ 42\cdot 7\div 3\cdot 5=12\cdot 2$

(*b*)

```
     80
13)1040·
   104
```

$\therefore\ 10\cdot 4\div\cdot 13=80$

(c)

$$\begin{array}{r} 4{\cdot}11 \\ 602\overline{)2480{\cdot}00} \\ 2408 \\ \hline 720 \\ 602 \\ \hline 1180 \\ 602 \\ \hline 578 \end{array}$$

$\therefore$ $24{\cdot}8 \div 6{\cdot}02 = 4{\cdot}119$ or, to 2 places of decimals, $4{\cdot}12$.

In introducing this method, the children should be shown that:

$$\frac{\cdot 04}{\cdot 02} = \frac{\cdot 4}{\cdot 2} = \frac{4}{2} = \frac{40}{20} = \frac{400}{200}, \text{ etc.}$$

Sufficient examples should be given to make them realise that both dividend and divisor may be multiplied by the same quantity, without changing the answer.

Alternatively, they may express the first question as 427 tenths divided by 35 tenths, and proceed to find how many times 35 is contained in 427.

The second question is stated as 1040 hundredths divided by 13 hundredths; i.e., $1040 \div 13$.

The third, 2480 hundredths divided by 602 hundredths; i.e., $2480 \div 602$.

In both multiplication and division, the children should consider whether their answers are reasonable. In both, questions of degree of accuracy arise and should be dealt with by commonsense methods. In both, sufficient examples should be done to give confidence but the numbers dealt with should not be large.

IV. ***Further decimal places and degrees of accuracy.***—The third decimal place is always discovered in the course of doing multiplication and division and can be dealt with when it arises.

The class should be told the meaning of third, fourth and fifth places and should discuss their importance or unimportance. No new rules are required and children like to know that they can deal with as many decimal places as they wish. They also like to know that they may exercise their own discretion as to how many places they work to, and how accurately they give the answer.

The amount of time given to examples which involve third place (and higher) of decimals may be very short. Some children do not need them at all. There is little value for anyone in laborious sums.

V. *Applications.*

Aim.—To give practice in the use of decimals in preparation for applications to profit and loss, percentages, etc.

The following types should be practised, easy examples being done mentally and harder numbers being dealt with in written work.

1. Find $\cdot 25$ of 16*s.* 8*d.*; of £3 4*s.* 8*d.*

2. What decimal is 6*d.* of 1*s.*; of £1; of £2 5*s.*?

3. How many yards are there in $\cdot 4$ of a mile?

4. What decimal is 2 ft. of 10 yd.?

5. Find $\cdot 3$ of 1 ton; of 5 stones.

6. What decimal is 8 stones of 1 ton?

Similar examples should be given for time, area, volume.

Note.—This should be done in the form of easy mental examples, throughout the work on decimals. The difficulties can be increased as the children progress in knowledge of decimals.

STAGE 3. METRIC SYSTEM

Aim.—To teach the metric system.

I. *Introduction—Historical note.*—This can be prefaced by a talk on the units of measurement and their standardisation. The children are interested to know how we got our English units and they quickly realise the need for a standardised unit. An English table of length was established by law in the reign of Edward II. It confirmed earlier customs and states:

3 barley corns (round and dry, placed end to end) make 1 inch.

12 inches make 1 foot.

3 feet make 1 yard.

$5\frac{1}{2}$ yards make 1 perch.

In the reign of Edward III the yard was substituted for the barley corn as the fundamental unit. A metal bar, the length of the monarch's arm, was made and preserved as the standard English yard. The difficulties that arise in using a measure with accuracy are illustrated by the old custom of giving an extra "thumb's breadth" with every yard. Unscrupulous traders deducted the "thumb's breadth" of uncertain size, and an Act in 1711 directed that *one inch* should be added to each yard when measuring cloth for sale.

A uniform length for the mile came much later. The roads of England had never been officially measured before 1675. In that year a survey was made by John Ogilby, cartographer to His Majesty Charles II. In spite of his impressive title, Ogilby's records are inaccurate. He used the local measurements, and "miles" varied widely in different parts of the country. The old English mile was *about* a statute mile and a half, and the ancient Scottish mile about 1,984 yards. "Country miles" to-day are notoriously long.

The tale of the gradual working up to standards in England helps children to understand the adoption of the metric system in France.

II. *Work involving the use of centimetres and millimetres.*—The children should find centimetres on their rulers, note the division into ten and use them for measuring as many things as possible, stating the measurement in decimal notation; e.g., 3·4 cm.; ·7 cm.

Along with this, work in drawing lines of given length, drawing squares and rectangles of given size, and measuring diagonals, etc., should be given.

III. *Comparison of inch and centimetre.*—The children are asked to find out how many centimetres make an inch. They say, "Two and a bit," and are asked how they can find out more exactly. They suggest, "Looking across the ruler from centimetres to inches." "Laying paper across the ruler from centimetres to inches." "Measuring one inch on one ruler, by centimetres on another ruler." "Drawing one inch and measuring it in centimetres." All suggestions should be discussed and the children led, by wise questions, to see that the best result will be obtained by measuring a line, several inches long. The teacher can give the information that 5 inches is a good length to use, because it is an exact number of millimetres in length.

Usually, good results are obtained from this and the class is told that the exact value is 1 in.=2·54 cm.

Note.—The method of teaching by discovery adds greatly to the value of the lesson.

IV. *Comparison of metre and yard.*—Children find by measuring the metre that it is 39·4 in. This can be done working with two or three in a group while the rest of the class does examples.

Various calculations can be made about the relations of the metric and the English systems. The following should be established:

$$1 \text{ yd.} = 36 \times 2{\cdot}54 \text{ cm.} = 91{\cdot}4 \text{ cm.} = {\cdot}914 \text{ m.}$$

$$1 \text{ m.} = \frac{100 \text{ in.}}{2{\cdot}54} = 39{\cdot}4 \text{ in.} = 1{\cdot}094 \text{ yd.}$$

Examples should be given such as, "How long would a cricket pitch be if measured in metres? If it were made 20 m., how much would it be wrong?"

$$\begin{aligned} 1 \text{ yd.} &= {\cdot}914 \text{ m.} \\ 22 \text{ yd.} &= 22 \times {\cdot}914 \text{ m.} \\ &= 20{\cdot}108 \text{ m.} \end{aligned}$$

V. *Comparison of kilometre and mile.*

From previous work $1 \text{ m.} = 1{\cdot}094 \text{ yd.}$

$\therefore \quad 1 \text{ Km.} = 1094 \text{ yd.}$

i.e., 1 Km. is about $\frac{5}{8}$ of a mile.

Examples on changing miles to kilometres and *vice versa* can be done if desired, but they should have reference to interesting topics such as races and speeds.

VI. *Metric money.*—Metric money is of interest if used in conjunction with projects, plans for journeys, etc.

STAGE 4. DECIMAL MONEY

Aim.—To teach decimals of £1 in preparation for work in percentages, profit and loss, interest, etc., where it is easier to work in decimals of £1 than in shillings or pence or in vulgar fractions.

This should be made as simple and as clear-cut as possible. The children should construct a ready reckoner:

£·1=2*s.*	2*s.*=£·1
£·2=4*s.*	1*s.*=£·05
£·3=6*s.*	6*d.*=£·025
£·4=8*s.*	3*d.*=£·0125
£·5=10*s.*	1*d.*=£·004
£·6=12*s.*	¼*d.*=£·001
£·7=14*s.*	9*d.*=£·0375
£·8=16*s.*	1*s.* 6*d.*=£·075
£·9=18*s.*	

Examples in changing £ *s. d.* to decimals of £1 and *vice versa* should be given.

Multiplication and division of money should be done by aid of decimalisation.

Examples

1. £2 7*s.* 3*d.*×53
2. £270·16÷18, etc.

VIII. PERCENTAGES

Use and abuse of percentages.—A percentage is another way of stating a fraction. 23% means $\frac{23}{100}$ and has no further meaning unless it is connected with a unit. 23% of £1 means £$\frac{23}{100}$ or £·23.

Percentages are used instead of decimal fractions or vulgar fractions in many practical affairs. Custom has shown their convenience for trade and commerce. Interest, profit and loss, and statistics are stated as percentages. Every child should learn to understand and interpret them. Their meaning is simple and should be obvious, but they can be used in misleading ways and can be made to lead to plausible fallacies.

One of the common misuses of percentages is to quote them apart from their true context. For example, if, in a population of 100,000, there are 20,000 insured workers of whom 16,000 are unemployed, then the percentage unemployed is 80% of the insured workers, or 16% of the population. The street corner orator who wishes to emphasise the seriousness of the problem says, "80 per cent unemployed! 80 per cent of our people out of work! 80 per cent of 100,000; that means 80,000 able men without work!" His political opponent, desiring to minimise the amount of unemployment, says, "16,000 men unemployed, but half of them have exhausted their benefit and are no longer insured workers. Many of these are unfit for employment so, actually, there are only 8,000 unemployed out of a population of 100,000; that is only 8 per cent unemployed." Arguments based upon either 80 per cent or 8 per cent may lead to very erroneous conclusions. Advertisements and newspaper articles as well as political speeches abound in fallacies of this type.

For children, the misuse of percentages may be illustrated by the tale of the rabbit pies.

Rabbit pie was one of the special dishes advertised by a dock-side eating-house. Customers became dissatisfied with the quality and complained, saying that the pies were of horseflesh, not rabbit. This was denied vigorously by the proprietor until, faced with a piece of bone which had not been part of a rabbit, he had to admit, "Some horse." Further pressure drove him to, "Some horse, but 50 per cent rabbit. Yes, there is 50 per cent rabbit." Nothing would move him from that, "50 per cent rabbit, half rabbit—good rabbit pie." But in the end it was found that "50 per cent rabbit, 50 per cent horse" meant "1 rabbit, 1 horse."

Children should be taught always to ask about a percentage, "Of what?"

STAGE 1. MEANING OF %

Aim.—To give a clear idea of the meaning of %.

Mental work dealing with familiar matters.

1. A firm advertised that 5% discount was given for all articles bought for cash; that means £5 for all goods amounting to £100 in value, 5*s.* for 100*s.* in value and 5*d.* for 100*d.* in value. What would be given for goods valued at 300*s.*? For £200? For 600*d.*, etc.?

2. In a school there are 200 children. 50% are girls. How many girls are there? How many boys?

3. In a school of 300, 60 children stay at school for dinner. What percentage is that?

Mental questions of similar types, dealing with complete hundreds, should be given until the children are able to do them easily. These should include questions such as:

4. A man loses 5% of his money. What percentage is left?

5. A breakfast cereal is advertised as 100% food. What does that mean?

STAGE 2. PERCENTAGES AS FRACTIONS

Aim.—To link percentages with fractions.

I. *Percentages expressed as fractions.*—Mental questions such as the following should be given:

1. There are 40 children in a class. 50% of them can swim. How many children can swim?

2. How much is 20% of 10*s.*?

3. A man saves 10% of his wages. If he earns £3 per week, how much does he save?

The above questions require the percentage to be converted into a fraction.

$50\% = \frac{50}{100} = \frac{1}{2}$ $\qquad$ $\frac{1}{2}$ of 40 children = 20 children.

$20\% = \frac{20}{100} = \frac{1}{5}$ $\qquad$ $\frac{1}{5}$ of 10*s.* = 2*s.*

Questions similar to those in Stage 1 can be used, but the total number should not be a round number of hundreds.

A table should be built up and used for reference until the items become memorised:

$50\% = \frac{50}{100} = \cdot 5 = \frac{1}{2}$	$10\% = \frac{10}{100} = \cdot 1 = \frac{1}{10}$
$20\% = \frac{20}{100} = \cdot 2 = \frac{1}{5}$	$25\% = \frac{25}{100} = \cdot 25 = \frac{1}{4}$
$40\% = \frac{40}{100} = \cdot 4 = \frac{2}{5}$	$75\% = \frac{75}{100} = \cdot 75 = \frac{3}{4}$
$80\% = \frac{80}{100} = \cdot 8 = \frac{4}{5}$	$5\% = \frac{5}{100} = \cdot 05 = \frac{1}{20}$

The speed with which this is built up and the number of items taken depend upon the intelligence of the class.

After practice in mental work, written work is required for dealing with larger numbers. The method is the same.

Examples

1. Out of 380 children, 75% pass an examination. How many pass?

$$75\% = \tfrac{3}{4};\quad \frac{3 \times \overset{95}{\cancel{380}}}{\cancel{4}} = 285 \text{ children pass.}$$

2. A school has 225 pupils. 40% have not been absent this year. How many children have not been absent?

3. A rent of £25 is raised 8%. What will it become?

$$\frac{\overset{2}{\cancel{8}}}{\underset{4}{\cancel{100}}} \times \frac{\cancel{25}}{1} = £2.$$ Rent is raised £2 and becomes £27.

II. *Fractions as percentages.*

Mental Examples.

1. What % is $\frac{1}{2}$; $\frac{1}{4}$; $\frac{1}{10}$; etc.?

2. What % is 3*d.* of 6*d.*? Of 1*s.*, etc?

3. What % is 30 marks out of 60?

4. What % is 20 children out of 50?

5. If 8 out of 40 are absent, what % is that?

Written Example.

What % is $\frac{1}{15}$?

$$\frac{1}{\underset{3}{\cancel{15}}} \text{ of } \overset{20}{\cancel{100}} = \frac{20}{3} = 6\tfrac{2}{3}$$

Examples in Conversion of Fraction to %

1. In a class of 50, 38 are present. In another class, 30 out of 40 are present. Which class has the better attendance?

2. A grocer buys tea at 1*s.* 4*d.* per lb. and sells it at 1*s.* 8*d.* What is his profit %?

(The children should be told to take profit as a percentage of cost price.)

3. What % of money is left if $\frac{3}{4}$ has been spent out of $\frac{1}{2}$ of a legacy.

STAGE 3. HARDER APPLICATIONS

Miscellaneous examples of a harder type. In questions dealing with profit and loss, four items are involved; namely, cost price, selling price, profit, % profit. If any two are given, the other two can be found. The easiest type of example gives cost price and selling price, or cost price and profit. The hardest type gives profit and % profit.

Teachers can make their own examples to suit their class. Degree of difficulty depends upon sizes of numbers and the complexity of the fractions involved. Children should be taught to make clear statements and warned about the dangers of not stating of what the % is taken.

Note.—A good "A" class will go through all the stages, doing some examples in Stage 3, in one lesson. An average class will do Stage 1 and part of Stage 2 in one lesson.

The mental examples are found to be much easier than the written, in all stages, and it is possible to teach all stages as part of the mental arithmetic, applying it in written work only as it is needed.

IX. PROPORTION

Proportional numbers and quantities.—Proportion sums can refer to pure number. For example, 3, 12, 9, 36 are four numbers proportional to one another because the ratio of 3 to 12 is the same as the ratio of 9 to 36.

$$\frac{3}{12} = \frac{9}{36}$$

In real life, the sums refer to money, length, weight, time and their relationships with one another. Their difficulty ranges from the very easy to the very difficult. At one end, "If 4 toys cost 1*s.*, what would 2 toys cost?" At the other, a compound proportion introducing several variables, some directly and some inversely proportional. The easiest can be done by a child of 6 or 7 years. The hardest should not come into senior school work because it is academic and rarely comes into real life.

"Fractional" and "unitary" methods.—The most satisfactory way of solving questions in proportion is the ratio (or fractional) method.

Example: If 4 toys cost 1*s.*, what would 2 toys cost? 2 toys are half of 4 toys, so they cost half as much Half of 1*s.* is 6*d.* Therefore 2 toys cost 6*d.*

As long as the ratios are easy, no difficulty is involved. If the question asked for the cost of 7 toys or even 3 toys, children would not be able to do it by the ratio method, until they had had much training. The quicker ones would suggest, "4 toys cost 1*s.*; that is, one toy costs 3*d.* 7 would cost 21*d.*; that is, 1*s.* 9*d.*"

Children do discover the unitary method for themselves and feel confidence in using it. The weaker children will never use any other, but the better ones should be led to use the fractional. Most of the "A" stream and some of the "B" will wish to do so.

Proportion in the senior school.—The work is graded: "C" children can cover the first stages. "A" children can cover all and will spend little time over the earliest.

STAGE 1. PREPARATORY

For some time before beginning the formal treatment of the subject, easy questions should regularly be introduced into mental work, so that the children become familiar with them.

These should range from very easy—"6 books cost 3*s*. What would 12 cost? What would 3 books cost?"—to harder—"10 books cost 9*s*. 6*d*. What would 2 books cost? What would 20 books cost?"

The teacher can make examples to suit the class. The topics dealt with should be of interest to children:—Toys: tops; marbles; dolls; engines. Eatables: sweets; cakes; apples; oranges; Easter eggs. Books; pens; pencils.

The ratio should be confined to $\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{3}$, $\frac{1}{6}$, $\frac{2}{1}$, $\frac{4}{1}$, $\frac{3}{1}$ and $\frac{6}{1}$. In some cases the question should be asked in another form. Instead of saying, "If 6 cakes cost 1*s*. 6*d*., what would 3 cakes (or 12 cakes) cost?" ask, "What would be the cost of 3 cakes if 6 cakes cost 1*s*. 6*d*.?" or, "If 1*s*. 6*d*. is the cost of 6 cakes, what would be the cost of 3 cakes?"

After the children have found the right answer, they should be asked to explain how they arrived at it. It is a valuable exercise in clear, orderly expression if the children are trained to say:

"We are asked to find the cost of 3 cakes."
"We are told that 6 cakes cost 1*s*. 6*d*."
"3 cakes are half of 6 cakes."
"They will cost half as much."
"Half of 1*s*. 6*d*. is 9*d*."
"*3 cakes cost 9d.*"

To make a full statement for every example would be boring. By spreading the work over a number of weeks, everyone in the class can be given practice in stating solutions.

Non-proportion questions should be included occasionally. They amuse the children and keep them alert. The best known types are:

1. If it takes 3 mins. to boil 1 egg, how long will it take to boil 2?

2. If 1 peacock wakens 3 men, how many peacocks would be needed to waken 12 men?

3. If Henry VIII had 7 wives, how many had Henry IV?

4. *Tom is 4 ft. high when he is 10 years* old. How tall will he be when he is 20 years old?

A different type is illustrated by a story from Berwick-on-Tweed, where much salmon fishing is done. A visiting inspector hoped to gain a better response to his questions by making them topical. He asked, "If 2 lb. of salmon are sold for 8*d*., what would 7 lb. be worth?" "Nawt," replied the boy, who had good practical knowledge about the values of salmon.

The teacher can make examples based on these types.

Inverse proportion should be avoided at this stage.

STAGE 2. WRITTEN EXAMPLES

Aim.—To introduce written work. Mental examples are taken first.

1. 6 engines cost 4*s*. What would 3 cost? 12 cost?

2. 12 pencils cost 1*s*. 6*d*. What would 4 pencils cost? 36 cost?

3. 8 cwt. of coal cost 16*s*. What would 2 cwt. cost? 32 cwt.? 40 cwt.?

4. 3 pails hold 6 gallons. How much would 5 pails hold?

This and similar examples would be worked, mentally, by unitary method.

The degree of difficulty that requires written work depends upon the intelligence of the class. Even with a very good class, the first written example should be fairly simple. The method of writing down has to be learnt:

If 4 pails hold 3 gallons, how much will 7 pails hold?

4 pails hold 3 gallons.
1 pail holds $\frac{3}{4}$,,
7 pails hold $\frac{3\times7}{4}$,, $= 5\frac{1}{4}$ gallons.

Children who are able to do so, realise that the middle line could be omitted. The difficulty is that $\frac{7}{4}$ is an unfamiliar ratio. Children should be taught the unitary method and encouraged to omit the middle line when they feel it unnecessary.

Many examples should be given so that the children gain confidence. Freedom should be allowed in the handling of the last step. Sometimes it is wise to work out the value for the middle line; more often it is wise to postpone the working out until the last line.

Examples.

(*a*) If 7 lb. of sweets cost 18*s.* 8*d.*, what would 5 lb. cost?

7 lb. cost 18*s.* 8*d.*

1 lb. cost $\frac{18s.\ 8d.}{7} = 2s.\ 8d.$

5 lb. cost $5 \times 2s.\ 8d. = 13s.\ 4d.$

In the above, the sum would become more cumbersome if the third line were written:

5 lb. cost $18s.\ 8d. \times \frac{5}{7}$ or $\frac{18s.\ 8d.}{7} \times 5.$

(*b*) If 4 lb. of sugar cost 10*d.*, what would 18 lb. cost?

4 lb. cost 10*d.*

1 lb. cost $\frac{10}{4}d.$

18 lb. cost $\frac{\overset{5}{\cancel{10}} \times \overset{9}{\cancel{18}}}{\cancel{4}} = 45d.$

In this sum it is better to postpone working out until the last line.

The slower children find it more difficult to exercise discretion and prefer to follow an exact routine. They should be kept to easy examples and may follow the unitary method always. They often find difficulty in choosing the first statement. For example, a question which begins by stating that "30 oranges cost 4*s.*" may go on to ask, "How many would be bought for 14*s.*?"

The simplest (unitary) method of working this is:

4*s.* buys 30 oranges

1*s.* „ $\frac{30}{4}$ „

14*s.* „ $\frac{\overset{15}{\cancel{30}} \times \overset{7}{\cancel{14}}}{\cancel{4}} = 15 \times 7 = 105$

Here the first statement is not identical with the one made in the question. If the children need a "crutch" they may be told to ask themselves, "What is wanted, money or oranges?" In this case, oranges. Then "oranges" must be written on the right of the first statement. The thing that is wanted always comes on the right hand side of the first statement.

Note.—The differences in ability are brought out very clearly by "proportion" sums. Once the preliminary stages are mastered the best children progress easily to harder examples and can be given freedom to find the shortest method. Facility in fractions is essential before going on to harder examples. The weaker children can do easy examples by the routine method. On the whole, harder examples are harmful to the weak child. They result in confusion of mind and a feeling of incapacity.

STAGE 3. INVERSE PROPORTION

Aim.—To introduce inverse proportion.

I. The following are mental examples of a practical type.

Examples

1. Library books are carried upstairs by 2 boys in 20 minutes. How long would it have taken 4 boys? 1 boy?

2. The journey from A to B takes 3 hours if the train travels at 30 miles per hour. How long would it take if the speed were 60 miles per hour?

3. I have enough money to buy 6*d.* presents for 15 children. If I wish to give presents to 30 children, how much can I spend on each present?

4. I have enough ribbon for 12 badges if I put 8 in. into each. How many can I make if 4 in. are put into each badge?

II. Written work is required when the ratios are not as easy as the foregoing. The first written ones should be simple.

(*a*) If 2 boys take 20 mins. to move books upstairs, how long would it take 5 boys?

2 boys take 20 mins.

1 boy would take 40 mins.

5 boys „ „ $\frac{40}{5} = 8$ mins.

(*b*) A journey takes 3 hrs. at 30 miles per hour. How long would it take at 40 miles per hour?

At 30 mls. per hr. it takes 3 hrs.

„ 1 „ „ „ 3×30 hrs.

„ 40 „ „ „ $\frac{3\times 3\cancel{0}}{4\cancel{0}} = 2\frac{1}{4}$ hrs.

Using the fractional method, the child would say, "It will take less than 3 hours. It will take $\frac{30}{40}$ of 3 hours; that is, $2\frac{1}{4}$ hours.

That is, the middle line is omitted and the sum stands:

At 30 m.p.h. the journey takes 3 hours

„ 40 „ „ $\frac{3\times 3\cancel{0}}{4\cancel{0}} = 2\frac{1}{4}$ hrs.

(*c*) I have enough ribbon for 32 badges if I put 10 in. into each. I want 40 badges. How much ribbon can I put into each?

32 badges with 10 in. in each.

40 „ „ $\frac{10\times 32}{40} = 8$ in. in each.

(*d*) A camp has enough food for 4 men for 12 days. How long will it last if 2 more men join the party?

4 men for 12 days.

1 man for 48 days.

6 men for 8 days.

Or:

4 men for 12 days.

6 men for $\frac{4}{6}$ of 12 days=8 days.

Examples on inverse proportion should be chosen with care. Many of those given in the older books are pedantic and have no relation with the real world.

STAGE 4. COMPOUND PROPORTION

Compound proportion, if it is desired, may be done here. It is not easy to get simple, convincing examples, and the topic may be omitted. Variation and joint variation can be done by the best children and are dealt with under *algebra*.

Examples

1. If 1 ton of coal lasts a household 2 months when 4 fires are kept alight 9 hours per day, how long would it last if 6 fires were kept alight for 12 hours per day?

It would last $\frac{4}{6}\times\frac{9}{12}$ as long.

$\frac{4}{6}\times\frac{9}{12}\times 2 = 1$ month.

2. If by walking 4 miles an hour I can cover a given distance in 35 mins., how long should I take to travel three times the distance at $3\frac{1}{2}$ miles an hour?

3. If 500 tiles are used for paving a court-yard, how many will be needed for one twice as long and $\frac{4}{5}$ of the width?

4. If a 4 lb. loaf of bread costs 10*d.* when wheat is 70*s.* a quarter, what should be the price of bread per lb. when wheat is 63*s.* a quarter?

5. A road 220 yd. long and 15 yd. wide is constructed by 20 men in 14 days. How long would it take 35 men to construct a similar road 330 yd. long and 20 yd. wide?

STAGE 5. PROPORTIONAL DIVISION

Aim.—To teach proportional division.

I. Introduction by mental questions.

Example: Divide 1*s.* between 2 boys so that one gets twice as much as the other.

This can be illustrated in concretes or by diagram:

oo	oo	oo	oo	8
o	o	o	o	4

In words: When 1 boy gets 1*d.*, the other gets 2*d.* That makes 3*d.* We can take 3 pennies 4 times from 1*s.* That means that 1 boy gets 4 times 1 penny and the other 4 times 2 pennies.

After practice, the children see that 1 boy gets $\frac{1}{3}$ and the other $\frac{2}{3}$ of the whole.

Similar examples dealing with division in ratio 1 to 3; 1 to 4; 2 to 3; 3 to 4; are suitable for this preliminary mental work.

II. Written questions, dealing with more difficult ratios, larger numbers, division among three or four. Suitable topics are division of profits, division of rent, composition of alloys and other mixtures.

(*a*) A provides £500 capital, B provides £300 and C provides £200. How should they share a profit of £120?

$$\text{A gets } \frac{500}{1000} \text{ of } £120 = £60.$$

$$\text{B gets } \frac{300}{1000} \text{ of } £120 = £36.$$

$$\text{C gets } \frac{200}{1000} \text{ of } £120 = £24.$$

(*b*) Tea is mixed in the proportions 1 lb. of a good quality tea to 5 lb. of a cheap quality. What weight of the good quality tea will there be in 1 cwt. of the mixture? Problems on price can be based on the above sum.

STAGE 6. GEOMETRICAL REPRESENTATION

Aim.—To show geometric applications and illustrations.

1. The children draw two lines meeting at a point at any angle. Along one they mark off $\frac{1}{2}$ inches and along the other $\frac{3}{4}$ inches. They join the points in pairs, and discover that the lines obtained are parallel to one another, Fig. 1.

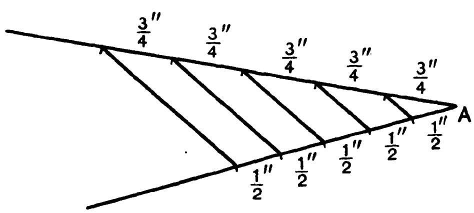


FIG. 1. PARALLEL LINES

Repeat, marking off equal lengths with compasses along AB, and equal divisions of a different length along AC. Join the points in pairs.

The children will all use different lengths for the divisions along AB and AC, but all will find the cross lines parallel to one another.

2. The use of this for division of a given line into any required number of parts.

Let AB be the given line to be divided into 5 parts. Draw another line through A, making an angle of convenient size with AB. Along this mark off 5 equal distances, lettering the 5 points, C, D, E, F, G. Join BG. Through C, D, E, F draw lines parallel to BG, cutting the line AB into 5 equal parts, Fig. 2.

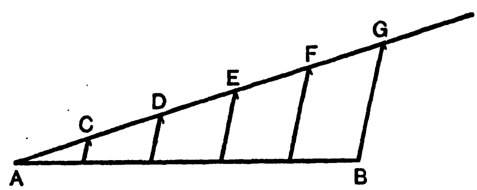


FIG. 2. DIVIDING A B INTO EQUAL PARTS

3. Dividing a line into parts which are in a given proportion.

Example: To divide a line AB into 2 parts so that their lengths are in the ratio 2 to 3.

Through A draw another line at any convenient angle. Along this mark off 5 equal divisions. Join the end point G to B. Through D draw a line parallel to BG. This line divides AB into 2 parts which are in the ratio 2 to 3, Fig. 3.

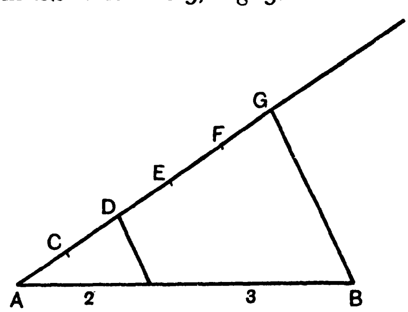


Fig. 3. LINE A B DIVIDED INTO PROPORTIONS OF 2 : 3

X. GEOMETRY

History of the teaching of geometry.—Geometry studies spacial relations; it has to do with distances, positions, shapes, forms, of solids as well as plane figures. It gives us acquaintance with our environment, in the skies as well as on the earth. Mankind studies geometry from the days of infancy when he handles all things within reach to discover their shapes, sizes and feel, to the years of maturity when he builds houses, bridges, ships, canals, aeroplanes. By studying the geometry of the heavens he discovered how to make maps of the earth, how to direct his voyagings abroad, how to make a calendar. As a topic, geometry is as all pervasive as number, yet in elementary education it has been almost neglected. This is largely because geometry has been identified with Euclid. Admirable as his structure of deductive reasoning may have been for the philosophers of his own day, B.C. 350, it is not suited to children. It is told that the fellow townsmen of Pythagoras fired the college where he taught because they felt so incensed by the aloof superiority of his teaching and his students. To-day, the man in the street feels that he has little use for geometry and doubts whether it should be taught. Yet the theorem of Pythagoras states a truth that is used in almost every enterprise undertaken by men, and none of our modern progress could have been achieved without geometry.

The study of geometry should be part of the education of every child. A child once wrote, "There are three postulates. First, things that are equal to the same thing are equal to one another. Second, things that are greater than the same thing are greater than one another. Third, things that are less than the same thing are less than one another." "Howlers" of this type illustrate the fact that the axioms and postulates of Euclid are not obvious to a child's mind. His methods of proof are not a child's methods and require powers that a child has not yet developed. Despite this, Euclid was the current text book of geometry in the schools of Europe and America until the beginning of the twentieth century. The developments during the past seventy to eighty years have been revolutionary and Euclid is rarely found in any school of to-day.

The revolt against Euclid arose among educationalists and practical teachers. One of the first protests was made in Germany towards the end of the seventeenth century by Leibnitz, who said that he did not think that the *Elements of Euclid* was a satisfactory text book for children. It was the next century that saw widespread developments in educational thought. The great pedagogues of the nineteenth century, Pestalozzi, Herbart and Fröebel, influenced the teaching methods of all subjects. They aimed at leading the children from empirical observation to thought. They believed in starting from concrete facts, in giving practical work that involved independent investigations on the part of the children. They said that by these activities and by play, children learnt and became able to think, but the reasoning was to be largely inductive and suited to the child's stage of development. The first effects were the appearance of many new school books, artistically produced and attractive to children, but the system of Euclid remained. There was less abstraction, less formalism, less pedantry, but essentially the same Euclid. Those interested in the development of geometry in Germany can find an account of it in the *Mathematical Gazette* for May, 1937. From the point of view of the senior schools, the story of progress in England is of more importance. In his presidential address to the Mathematical Association in 1936[1], Mr. A. W. Siddons gave an interesting account of what has been done by the teachers of mathematics in this country during the past eighty years. The revolt against Euclid began about 1860 and in 1868 a Schools Inquiry Commission published a report which made it plain that "time was being wasted over Euclid; that boys might have worked for years at Euclid and even known Euclid perfectly and yet known next to nothing of the spirit or method or results of geometry."

The formation of an Anti-Euclid Association was proposed in 1870 and in 1871 the first meeting was held of the Association for the Improvement of Geometrical Teaching. Of the sixty-one members at that time, fifty-two were schoolmasters. Much work was done by the A.I.G.T.; methods of teaching were discussed; syllabuses were drawn up and published in 1875; a text book was produced and published in 1881. Some of the leading reforms advocated were:

1. That practical geometry should precede theoretical.
2. That numerical examples should be introduced in illustration.
3. That the notion of rotation should be introduced into the definition of an angle.
4. That the axiom known as Playfair's respecting parallels should be substituted for Euclid's.
5. That problems should be separated from theorems.

Mr. Siddons tells many details of this campaign waged by schoolmasters for a more educational course in geometry. Progress was slow, strong opposition came from examining bodies and from the universities. After sixteen years of work, in 1887, concessions were won from Oxford and Cambridge. Both universities passed regulations that allowed "proofs other than Euclid's, provided that Euclid's order was not violated." There the matter rested until the present century. The Mathematics Association was organised in 1897 and played a large part in the campaign for better teaching of geometry. Early in the twentieth century the results of thirty years of spade work began to appear. In 1903 both Oxford and Cambridge accepted as examination regulations, "Any proof of a proposition shall be accepted which appears to the examiners to form part of a systematic treatment of the subject." "Proofs which are only applicable to commensurable magnitudes shall be accepted." In Rome, in 1908, an International Commission on the teaching of mathematics demanded of geometry, "The strengthening of space perception and the experimental, practical, application." In 1909 the Board of Education published circular 711 on *The Teaching of Geometry and Graphical Algebra.* This circular became famous because it gathered up all the conclusions arrived at by the new movement. It marked the complete break from Euclid and the adoption of the new methods. It stated that in geometrical education the method should consist of three stages:

1. In the first stage, the pupil should be introduced through observation and experiment and a minimum of explanations into the language and the concepts of geometry. No mention of axioms and postulates should be made.
2. Then follows the second stage of the discovery of the properties of figures. The pupil learns certain propositions by means of drawing, measuring, paper-folding and other investigations. Construction problems should be avoided. Parallels should be introduced through the notion of direction.
3. Finally, in the third stage, construction problems and propositions should be worked on, not as mental acrobatics but by means of a good mixture of observation and thinking, deductive reasoning being introduced.

These ideas were quickly adopted not only in the public schools and grammar schools, where the movement had originated, but also by the new secondary schools. As

[1] vide *Mathematical Gazette*, February, 1936.

always, the pendulum tended to swing to the other extreme. Freedom from the bondage of Euclid tended to be abused.

Speaking on this topic at the British Association in 1910, Professor Hobson said: "There are at the present time some signs of reaction against the recent movement of reform in the teaching of geometry. It is found that the lack of a regular order in the sequence of propositions increases the difficulty of the examiner in appraising the performance of the candidates, and in standardising the results of examinations. That this is true may well be believed, and it was indeed foreseen by many of those who took part in bringing about the dethronement of Euclid as a textbook. From the point of view of the examiner it is without doubt an enormous simplification if all the students have learned the subject in the same order, and have studied the same textbook, but, admitting this fact, ought decisive weight to be allowed to it? I am decidedly of opinion that it ought not. I think the convenience of the examiner, and even precision in the results of examinations, ought unhesitatingly to be sacrificed when they are in conflict—as I believe they are in this case—with the vastly more important interests of education. Of the many evils which our examination system has inflicted upon us, the central one has consisted in forcing our school and university teaching into moulds determined, not by the true interests of education, but by the mechanical exigencies of the examination syllabus. The examiner has thus exercised a potent influence in discouraging initiative and individuality of method on the part of the teacher; he has robbed the teacher of that freedom which is essential for any high degree of efficiency."

The freedom was won and the tale of its coming may seem like a story of battles long ago. Nevertheless, the senior school work will profit if its teachers know something of the history of the teaching of geometry and see their work in perspective as part of a greater whole. The anti-Euclid campaign was fought in schools working up to, and beyond, matriculation standard. The senior school syllabus covers a smaller range. It is different in type, not being a shortened, watered-down secondary school course, but its teaching problems are not different in nature. The senior schools are fortunate in being free from external examinations, free to experiment and to work out their own salvation. In developing schemes for geometry for the average child and for those below average, teachers are carrying forward a progress begun in 1860.

The "father" of the A.I.G.T. was Rowland. In 1902 his advice was sought on some suggested reforms. It is interesting to read part of his reply, as quoted by Mr. Siddons:

"I care not a rush whether boys use an *x* or not in working an arithmetical problem; if it helps them to think, then good; if it is a symbol used mechanically, then bad, very bad.

"I trust that in the new reforms you will aim at giving freedom to the teacher; my present position with regard to reform might perhaps be summed up in the following resolutions:

1. That it is desirable that every schoolmaster should be intelligent, zealous and stimulating.
2. That good schoolmasters should be well paid in cash and in repute, and that bad ones should be requested to find other occupation.
3. That a good schoolmaster should be allowed to do what he liked.
4. That examiners should go to the devil."[1]

Sequence of geometry for the senior school.—It would be difficult, if not impossible, to plan a detailed syllabus suited to all children and to the circumstances of all schools. The following sequence is divided into stages which follow the order of development of a child's powers. Some notes on teaching

[1] *Mathematical Gazette*, February, 1936.

method are given for each stage. The time given to it depends upon many factors and must be left to the discretion of the teacher.

"A" stream children will cover the ground quickly and do each stage fully. "B" and "C" will work through the same stages but they work more slowly, need more practical work and do less work within each stage; that is, they make fewer applications. In the end they will have covered fewer stages, but it is possible to work with a class containing children of different capacities, *as a class*. All work at the same stage, but some do more varied examples than others and make more difficult applications.

The later stages cannot be done without the preparatory work of the earlier ones. Books of examples are desirable because an abundant supply must be available.

It is a good thing if the children keep their own geometry note books. Into these they put sufficient notes to remind them of the most important things they have learnt at each stage.

Junior school work.—The children coming into a senior school have very varied attainments in geometry. What may be hoped for are:

1. Ability to measure and to draw straight lines accurately to $\frac{1}{10}$ in.
2. Ability to construct right angles, squares and rectangles.
3. Ability to draw and to interpret simple drawings to scale and to understand very simple maps and plans.
4. Some idea of direction and the points of the compass.

Importance of fundamental ideas.—There are sure to be some members of the class who have not covered the whole of this in a satisfactory way, and the teacher's first problem is to devise work which will give profitable revision and application for all; make vague ideas clear and definite; develop skill and accuracy. It is rarely necessary to divide the class into sections because any topic in geometry provides a wide range of applications with varied degrees of difficulty. By preparing sufficient examples for each topic, the teacher can provide occupation for every child suited to his needs and speed of work. Some suggestions follow for the treatment of this preliminary work. It must not be disparaged as too easy for a senior school, for it gives the foundations for all the later work. Many of the difficulties encountered in teaching geometry are due to confused ideas about fundamental matters.

This is often illustrated in connection with angles. For example, a class was folding squares diagonally so as to make right angled triangles. The squares were of different sizes and one child had folded a 3 in. square and a 1 in. square. She held them up and said, "This half right angle (showing the triangle from the 3 in. square) is far bigger than this half right angle (showing the angle of the triangle formed from the 1 in. square)."

During a practical lesson a boy twelve years of age wished to draw, to scale, a right-angled triangle with one side representing a base line 60 ft. long and one angle representing an angle of elevation of 25°. He came to his teacher and said, "I am going to use a scale of 10 ft. to 1 in. How do I draw the angle to scale. Do I take so many degrees to 1 in.? How can I do it?"

Another example of confused thought is provided in the "howler"—"An angle is a triangle with only two sides and one side missing." A child should not be asked to define an angle, but it is well for a teacher to consider what is meant by the size of an angle before beginning to teach about angles.

Children have to begin by studying corners of figures, drawing them, feeling them, comparing them. Along with this they should turn through angles—at first, right angles—and talk about hands of clock turning through angles. The right angle is used as unit of measurement in the first lessons. When the children feel the need for a smaller unit, they can be introduced to degrees.

Suggestions follow for lessons suitable for children during their first year. These aim at revising and extending knowledge and preparing the way for later work.

STAGE 1. TEACHING AND REVISION OF RIGHT ANGLES

Introduce as a name for corners of squares and rectangles; get the children to discover right angles in the classroom; let them fold a straight edge of paper so as to make a right angle; fold paper so as to make a right angle; fold paper twice so as to get creases at right angles; fold a square diagonally so as to get a triangle with one corner a right angle.

When the children are familiar with right angles, they are ready to draw them.

It is desirable that set squares should be available for all. If this is not the case, paper set squares can be made by taking a piece of stout paper about 8 in. square, folding carefully so as to get the folded edge forming one arm of a right angle. This fold is sufficiently strong for a pencil to be run along it and, with care, the paper set square (rectangular in shape) can be used successfully.

Drawing Exercises

1. Free drawing of right angles in any position to give facility in handling a set square.

2. Drawing lines at right angles to a given line through any points on it.

(At this stage it is wiser not to use a ruler with the set square. One side of the set square is laid along the given line, the set square held steadily with the left hand while the line at right angles is drawn.)

3. Drawing lines at right angles to a given line through given points.

The children draw a line across the bottom of their paper and mark points along it ½ in. apart. They then draw lines, about 3 in. long, at right angles at each point.

When the quicker children have finished this, the next step can be introduced. Measure ½ in. up the end lines; make a dot on each and join the two dots. The slower children will have only one or two squares but the whole class can discuss what they have made—the lengths of the sides; the kind of angles; the number of squares and right angles.

The children then continue, each at his own rate, marking off ½ in. on the end uprights and joining. This is a good exercise because all get practice at their own speed of work. It is easy to see whether the drawing has been done accurately or not. The children can see where they have made mistakes and how to avoid them. They can start over again, make attempts until they are satisfied, Fig. 4.

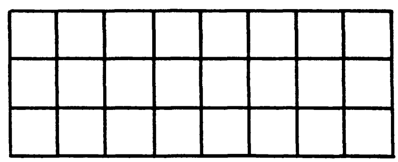


FIG. 4. EXERCISE FOR DRAWING PRACTICE

4. Drawing squares of given size. The best apparent results are obtained by dividing the construction into stages, demonstrating each step on the board and making the class work together, the quick waiting for the slow to complete each step before going on to the next. This may produce good squares, but it is not a good method of teaching. It does not leave enough to the child's own initiative, it bores the good children and is unnecessary if adequate practice has been given in Exercise 3.

It is better for the children to discover by making mistakes. If necessary, the teacher can demonstrate how to draw a square. This exercise can be extended for quicker members, and interest added, if the children draw a group of squares of varying sizes; e.g., 3 in., 2 in., 1 in., ½ in., and find out how many small squares would fit into a large one.

5. The children draw a square, mark midpoints of sides, join them, and study the new figure that has been drawn.

This exercise gives practice in drawing

but much more value can be obtained. The children all say that they have made another square. The teacher asks, "Are you sure it is a square? How can you make sure?" This introduces the testing of a conclusion and the critical attitude.

The exercise can be made the basis for simple inductive reasoning. If every child chooses the size of square he will draw and the quicker children do several squares, then the class results can be considered by the class. One child reports, "I drew a 3 in. square. I joined the middle points of its sides and I got another square." Every child gives similar evidence about his own work. Many squares have been drawn of many sizes, and the class conclusion will be that, "If a square is drawn and the middle points of its sides joined, a new square is obtained."

When a child repeats the result of his work, he obtains exercise in English. Thought and expression in words go together and this part of the lesson should not be hurried even though the children spent much time fumbling for words. The weaker children may not be able to draw the general conclusion in terms of "any" square but they can state their own results or say, "Everyone in the class has made a new square." By doing this they take the first step towards reasoning inductively.

6. Drawing geometrical designs involving right angles gives further practice in careful accurate drawing. Some children find great satisfaction in this kind of work. Weaker children may be helped by using squared paper.

STAGE 2. TEACHING AND REVISION OF "DIRECTION," TURNING THROUGH RIGHT ANGLES; SIMPLE SCALE DRAWING

The introductory work consists of:

I. Turning through right angles, one, two, three or four; the points of the compass, in classroom and in school yard. Practice in facing north (S., E. and W.) and saying what direction is behind, on right, on left. Practice in standing N., S., E. or W., of a given point or person. Practice in deciding whether Tom is N., S., E. or W. of John.

II. Questions about the turning of the hands of the clock; e.g., Through how many right angles does the minute hand turn in half an hour? In 1 hour? etc. (This can be linked with teaching about Time.)

III. Measuring and making scale drawings of classroom, cupboard doors, hall, rectangular school yard, playing field, etc.

This introductory work is done most successfully in short lessons. It requires frequent repetition and can be revised by questions given as part of the "mental" work.

Drawing Exercises

1. The teacher draws a 2 ft. square on the blackboard and says, "This is the plan of a garden. What can you tell me about it? The scale is, 1 ft. stands for 100 ft.; how big is the garden? In one corner there is a seat; in another a tree; in another, a flag; in the fourth, a pond." These are entered as they are mentioned and the children draw a copy on their own papers, scale 1 in.=100 ft., Fig. 5.

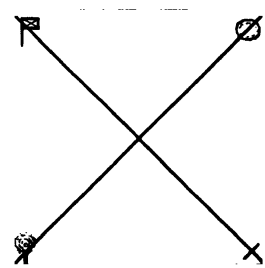


FIG. 5. PLAN OF GARDEN

The question is asked, "If you walked from seat to flag, along the edge of the garden, how far would it be? Which is the shortest way? Draw a line across and measure it. Draw a line joining the other two corners. How far is the pond from the tree?"

"The two lines cross at the middle of the garden. If you stood there, looking towards the flag, what would be behind you? On your right? On your left? If you turned through a right angle to your left, what would you be looking at? etc."

"If you walked from the flag to the middle of the garden, turned through a right angle to your right, which corner would you get to? etc."

2. The teacher draws a rectangle on the board to represent a field 200 yd. by 300 yd. The children copy it to a suitable scale and mark in the corners a small pond, an oak tree, a tent, an ash tree. (Marking the trees O and A is an introduction to the use of letters.)

A tale of buried treasure is told to the class. Four men share the secret; each one knows part of the clues. One says, "I have the first clue; it says, begin from the oak tree and go 100 yd. towards the ash." Another says, "I have the second clue; turn to the right through a right angle and walk 50 yd." The third says, "I have the third clue; turn to the left, at right angles, and walk 100 yd." The fourth man says, "Turn left again at right angles and walk 150 yd," Fig. 6.

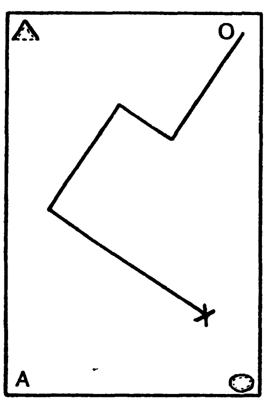


FIG. 6. PLAN OF TREASURE FIELD

The children can enter each clue as it is given, the class working together and the teacher entering on the board after they have tried. This enables them to check work.

Another treasure trail can be given to the children to work out for themselves. Fun is added if the trail leads to a point just outside the field. Incidentally, this makes easy checking of the accuracy of the children's drawings!

For both (1) and (2) it is helpful to have a small doll, mounted on a strong pin, which can be fixed into the blackboard and turned to face in any direction, as required. This is particularly good for the children who are slow to develop a sense of direction. It adds interest for all. A suitable doll is easily made out of a strong pin, about 6 in. long, lengths of pipe cleaners and crinkled tissue paper. One side of the head is darkened, to represent hair and so distinguish back from front. If necessary, a handkerchief can be carried in the right hand, Fig. 7.

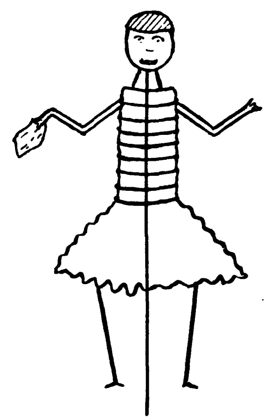


FIG. 7. SIMPLE FORM OF DOLL

STAGE 3. TEACHING OF SQUARE MEASURE

This stage includes revision work for some:

I. *Square inch.*—(*a*) This is introduced by questions which show the difference between "edges" and "surfaces." For example, "Show the edges of your paper, or desk. How long are they? If you were to paint the paper, or desk, show with your hands what you would paint. Can you measure that in inches?" The children usually suggest that they could say, "So many inches long and so many inches wide." The teacher's aim in this talk is to get the children to realise the meaning of "surface." Some children need much illustration before they grasp it.

(*b*) Envelopes containing square inches, cut out of thin card, are distributed. One envelope, of a size which does not involve fractions of an inch—say 6 in. by 4 in., or 5 in. by 3 in., containing 24 to 30 sq. in.—should be supplied for every two children. The children take out the squares, observe the size and shape and discuss the suitability of the name "square inch." They then use the square inches to measure the size of the envelope. They report their results in the form, "6 sq. in. in a row, and 4 rows. That is, 24 sq. in." (Note that this avoids the incorrect statement, "6 in. multiplied by 4 in. is 24 sq. in.") The word "area" should be introduced.

(*c*) The children draw rectangles of given sizes and find their areas. For slow children, it is best to let them lay on the square inches, then draw in the square inches, then imagine themselves doing it, then discover how to get the area by multiplying the number of inches in the breadth by the number of inches in the length. The quicker children will spend little time over this stage of the lesson and can be occupied in drawing and comparing sizes of rectangles 2 in. by 6 in., and 3 in. by 4 in.; a 4 in. square; and a rectangle 2 in. by 8 in.

(*d*) The *statement* of the rule is the logical conclusion of the lesson, but it is a more difficult step and may be reserved until the children have had more practice in using it. The teacher is always tempted to wind up the lesson quickly with the statement, "Area equals length multiplied by breadth," or even, "$A=L\times B$." As a rule this is not wise, for the children may not be ready for this degree of generalisation. When asked for the area of a desk 10 in. by 12 in., the children should say, "There will be 12 sq. in. in a row and 10 rows, that is 120 sq. in." From this they generalise, when they are ready, "Take the number of inches in the length and multiply by the number of inches in the breadth and you get the area in square inches."

(*e*) Further applications, not involving fractions.

II. *Square foot.*—(*a*) The teacher shows a square foot, divided up into square inches, and discusses it with the children.

(*b*) Measurements are made of suitable objects and their areas found in square feet. If the classroom is not an exact number of feet in length and breadth, its area can be found up to a certain line.

This work should be linked with scale drawing and applications to carpets, gardens, playing fields, etc. The examples should be simple and straightforward.

III. *Square yard.*—This is treated in a similar way.

IV. Simple examples in addition, subtraction, multiplication, division and reduction of square measure up to square yards should be given in connection with this work.

STAGE 4. RIGHT-ANGLED TRIANGLES AND HALF RIGHT ANGLES

I. (*a*) Introduce by folding squares. The children observe and describe the triangle formed. Two angles can be described as "half right angles" because the right angle was folded in half.

(*b*) Turning through half a right angle. The children turn the hands of a clock, turn themselves, turn their arms, connect with N.E., N.W., etc.

(*c*) The children draw, to scale, a triangular field, right-angled, isosceles. They imagine themselves walking round its edges and talk about the turns they would have to make. The doll and a blackboard diagram would help the children to realise this.

(*d*) The children draw the same field on a different scale and compare the sizes of the sides and the angles of the two triangles.

(*e*) The children fold diagonally, squares of different sizes and compare the resulting triangles. The triangles can be re-folded so as to get a series of right-angled, isosceles triangles of diminishing size.

(*f*) The children tear or cut the triangle into two, place the two angles together and see that they make one right angle.

(*g*) The children notice that the diagonals of a square are equal and bisect one another at right angles.

The children do more practical work, though some of them may not get beyond (*c*).

II. *Work on other right-angled triangles.*—(*a*) The children fold a paper rectangle diagonally, observe and describe the triangle formed.

(*b*) They mark the two smaller angles, tear them off, fit them together and find that they make a right angle.

(*c*) They note that the diagonals of a rectangle are equal and bisect one another, but not at right angles.

STAGE 5. CIRCLE AND PREPARATION FOR MEASURING ANGLES

I. *Introduction.*—The children enjoy "playing with" compasses when they are about ten or eleven years old. It is good for them to attain the manual dexterity required to draw a good circle. They have all been familiar with rings, balls and wheels for many years, but they have to be introduced to the method of drawing a circle. This should be done without compasses at first. The children should make loops at the ends of a short length of cotton. One loop is placed round a pin stuck firmly in the paper; the other loop is placed round the pencil point, which is moved around, keeping the cotton tightly stretched. A similar method can be used with fine string and chalk on the blackboard and with string and chalk on the floor or yard. When doing this the names centre, radius, circumference, diameter, can be given. The children will not be able to define a circle but they will have discovered the idea and should be allowed to practise drawing circles with compasses and making designs with them, at their own pleasure.

II. *Exercises in drawing circles according to instructions.*—Teachers can make many examples, at first giving the radius only and expecting clear finely drawn circles. Later, concentric circles and circles touching one another can be introduced.

III. The children cut out a circle, folded in half twice, and examine the creases at the centre. They are seen to be at right angles and there are four right angles at the centre of the circle. This should be compared with the hands of a clock turning through four right angles every time they make a complete turn.

The circle is now folded a third time, creased, unfolded and the creases examined. There are now eight half right angles. This should be compared with the points of the compass.

IV. The child is now ready to learn about the division of the circle into 360°.

It is of interest that this division into 360° was first used by the Babylonians earlier than 2000 B.C.; that it has been used ever since and is employed by all nations to-day.

In the first lesson, the children should become familiar with 90°, 180°, 45° and should apply them to the points of the compass; e.g., facing E. and turning to face N.E. means turning through 45°.

V. The study of the protractor and its use for measuring and for drawing angles. This will probably occupy several lessons. At first only easy angles should be dealt with. Measuring angles where two lines cross and finding that the opposite angles are equal is a useful exercise with the protractor.

Note.—When angles are taught in this way, by the amount of turning, the angle 180° presents no difficulties.

STAGE 6. EQUILATERAL TRIANGLES

I. Construction of an equilateral triangle by using compasses. The children should practise making accurate triangles.

II. The children investigate the angles of the equilateral triangles they have drawn and discover for themselves that all the angles are equal and measure 60°.

If protractors are not available, they can cut off the angles (after marking them), put them together and see that the three equal angles make 180°.

STAGE 7. ISOSCELES TRIANGLES

The teacher shows an isosceles triangle and gives the name "base."

I. The children construct a triangle on a base of 1 in., both the other sides being $1\frac{1}{2}$ in. If the question is given in this form, most of the children will be able to find out how to do the construction, using compasses. Other isosceles triangles should be drawn.

(It is not necessary to give the name "isosceles." "A triangle with two sides equal" is simpler, but more cumbersome.)

II. The children cut out the triangles and fold the equal sides together, thus showing that the angles are equal. Because triangles of different sizes have been used, the class conclusion, by inductive reasoning, is that all isosceles triangles have equal angles, opposite the equal sides.

III. The children should also discover that the crease in (2) is at right angles to the base of the triangle.

IV. Construction for bisection of a line, AB. The teacher shows the construction and the children practise using it, Fig. 8.

Having done the previous work, they see intuitively that the construction does give the bisector of the line and that is at right angles to the line. No formal proof should be attempted.

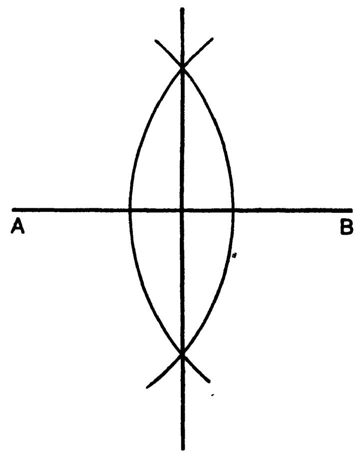


FIG. 8. BISECTION OF A LINE

STAGE 8. OTHER SCALENE TRIANGLES

The following problems can be tackled by most of the children who have covered the previous work:

1. Draw a base $1\frac{1}{2}$ in. long. Make a triangle on it with one side 1 in. long and the other $1\frac{1}{4}$ in. long, using compasses.

2. Find out whether its angles are equal. Measure them and add them together; or cut them out and place them together.

3. Imagine that the triangle is the plan of a field and that you are walking round it. Through what angles would you turn at the corners? How far would you have turned altogether by the time you got back to your starting point?

4. Draw triangles with sides $2\frac{1}{2}$ in., 2 in., 1 in.; and 3 in., $2\frac{1}{2}$ in., 1 in. Find out all you can about their angles. Taken along with previous work, this leads to a class conclusion that the sum of the angles of a triangle is always 180°.

5. Try to draw a triangle whose sides are 3 in., 2 in., $\frac{1}{2}$ in. What length could be given instead of $\frac{1}{2}$ in., so as to make it possible to draw a triangle? By working with different measurements and by skilful questioning, the children can be led to conclude, not told, that any two sides of a triangle are bigger than the third side. The fact is fairly obvious but its expression in words is not.

Other examples on triangles may follow, in particular those leading to the fact that the exterior angle of a triangle is equal to the sum of the two interior opposite angles.

This may be deduced from facts already known as well as discovered by measurement.

STAGE 9. 3, 4, 5 RIGHT-ANGLED TRIANGLES

The children construct a triangle whose sides are $1\frac{1}{2}$ in., 2 in. and $2\frac{1}{2}$ in. They examine its angles and find that the largest is a right angle. They repeat with lengths of sides 3 in., 4 in. and 5 in. As many as possible, repeat, using feet instead of inches and working on the blackboard, the floor or the school yard.

The teacher tells that the triangle with sides 3, 4 and 5 units long was used for constructing right angles in ancient days. In Ancient Egypt it was used when boundaries of fields had to be marked after the annual Nile floods had subsided. To-day it is used when marking out tennis courts and playing fields.

The teacher can demonstrate the method on the blackboard by using a piece of string. Three knots are made in the string at distances $1\frac{1}{2}$ ft. and $2\frac{1}{2}$ ft. apart. A line 2 ft. long is drawn on the board. The end knots are held on the ends of the line, by pins or by children, and the middle knot held as high as possible so that the string is quite taut, Fig. 9.

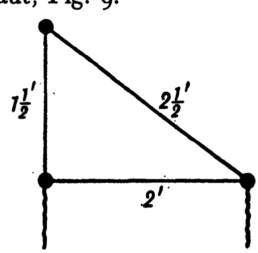


FIG. 9. USING STRING TO CONSTRUCT RIGHT-ANGLED TRIANGLE

The children, working in threes, can lay out right angles on the floor or in the school yard. If work is done in a garden or on grass, the end knots can be pegged down. Where space is adequate, the knots should be 3 ft. and 5 ft. apart and the points on the line 2 ft. apart.

STAGE 10. PARALLEL LINES AND PARALLELOGRAMS

I. The children are familiar with parallel lines in their exercise books, parallel lines in railway and tram tracks. The name and spelling should be given and the following points brought out in discussion:

(*a*) Lines which go in the same direction are said to be parallel.

(*b*) They do not meet, however far we produce them.

(*c*) The distance between them always remains the same.

(No subtleties arise at senior school stage about the definition of parallel lines!)

II. The children are shown how to draw parallel lines by the use of ruler and set square. They practise drawing sets of parallel lines and also drawing a line parallel to a given line through a given point.

III. The children draw a pencil line across the ruled parallel lines on a page of their exercise books. They look for equal angles and mark them. The name "alternate angles" may be given—angles on alternate sides of the line—but other names are not of value at this stage, Fig. 10.

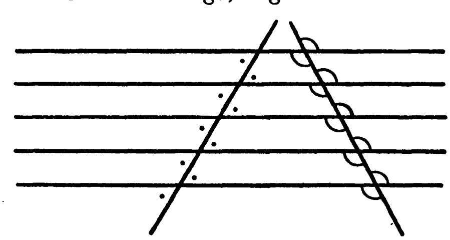


FIG. 10. ANGLES AND PARALLEL LINES

IV. The children cut rectangles across, in a slanting direction, and compare angles, Fig. 11.

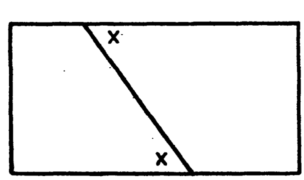


FIG. 11. ALTERNATE ANGLES

V. The children draw sets of crossing parallel lines and so discover parallelograms, Fig. 12. If desired, this can be followed up by a study of the parallelogram and of the rhombus.

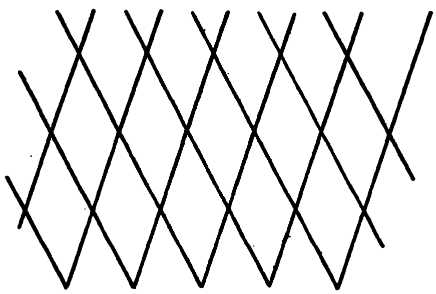


FIG. 12. MAKING PARALLELOGRAMS

The children draw many parallelograms and discover that the opposite sides are always equal; that the opposite angles are equal; that the sum of two adjacent angles is 180°; that the diagonals bisect one another. (All these can be illustrated with meccano strips.)

STAGE 11. CUBE AND RECTANGULAR PRISM; CUBIC INCH

I. The teacher can show a cubic inch and, after discussion, ask the children to try to find out how to make one. Some suggestions and advice will be needed by many, but it is good for the children to wrestle with the task for themselves.

After a number of cubic inches have been made, they can be used as a basis for a lesson on measuring volumes in cubic inches.

II. The children should also make rectangular prisms from paper and find their volumes.

III. Applications to packing goods in cases; e.g., bars of soap, packets of cereals, etc.

Questions on volume of air in a room, cubic feet and cubic yards should be introduced in connection with these.

STAGE 12. AREA (continued)

I. An earlier stage dealt with areas of squares and rectangles without introducing any fractions. This stage introduces fractions and requires knowledge of fractions as a background.

The following exercises form a useful introduction:

1. By drawing in square inches, find the area of a rectangle 4 in. by $2\frac{1}{2}$ in., Fig. 13.

8 sq. in.
4 half sq. in.
Area = 10 sq. in.

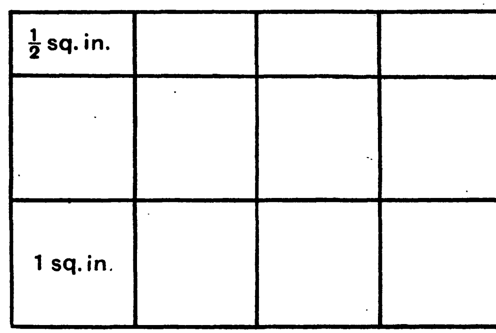


FIG. 13. SHOWING AREA OF RECTANGLE

2. By drawing in square inches, find the area of a $2\frac{1}{2}$ in. square, Fig. 14.

4 sq. in.
4 half sq. in. = 2 sq. in.
$\frac{1}{4}$ of a sq. in.
Area = $6\frac{1}{4}$ sq. in.

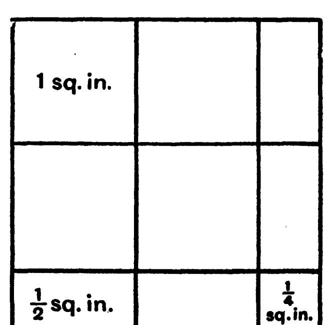


FIG. 14. AREA OF $2\frac{1}{2}$ IN. SQUARE

3. Repeat for a rectangle 2½ in. by 4½ in., Fig. 15.

11¼ sq. in.

2½×4½

$$= \frac{5}{2} \times \frac{9}{2} = \frac{45}{4}$$

=11¼

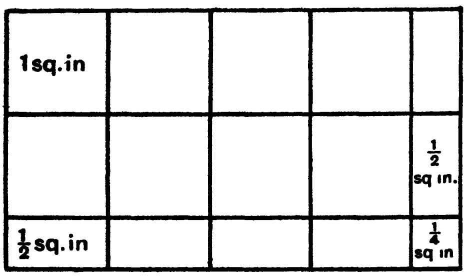


FIG. 15. AREA OF RECTANGLE 2½ IN x 4½ IN

From these and other similar examples the children come to an understanding of the rule. Once this is attained, they should be encouraged to write it A=L×B.

If the children can use fractions, the rule is mastered quickly and it should be applied to many practical questions. The examples should be simple, useful, straightforward and of interest to the children. As a rule, a diagram should accompany the answer Abundant examples are found in most of the text books; teachers can make their own examples to suit the needs of the class.

An extension of the table to:

4840 sq. yd.= 1 acre.

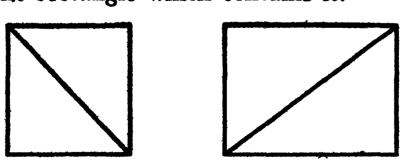
640 acres= 1 sq. mile

and examples using these facts.

II. *Areas of triangles.*

(*a*) Areas of right-angled triangles which are halves of squares or rectangles, Fig. 16.

(*b*) Area of a triangle compared with area of the rectangle which contains it.



1 in. Square   Rectangle 1½″×1″

FIG. 16. RIGHT-ANGLED TRIANGLES

The children draw any triangle, construct the rectangle, cut out the parts and show that the triangle is half of the rectangle. The use of letters to indicate the corners of the triangle should be introduced here, because they are needed. The children realise that the height of the rectangle is equal to the perpendicular from A to the base BC. Triangles of varied sizes have been drawn in the class and the conclusion can be drawn that the area of a triangle equals ½ base × perpendicular height.

(*c*) Applications of this can be made in connection with surveying of land and buildings. If possible, this should be done as practical work (see Section XIII).

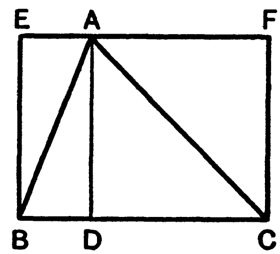


FIG. 17.

III. *Areas of parallelograms.*—By drawing and cutting out, the children show that the triangle ABE fits into the space DCF and that the area of the parallelogram=base × perpendicular height, Fig. 18.

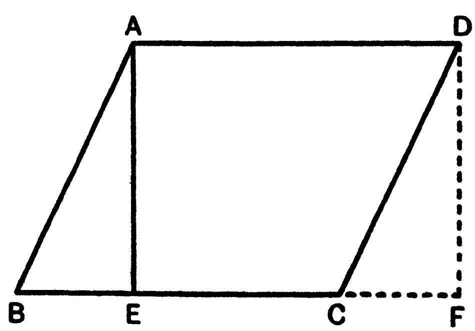


FIG. 18.

IV. *Area of trapezium.*—This can be treated in a similar way.

Triangle ABC fits into space DEF, Fig. 19.

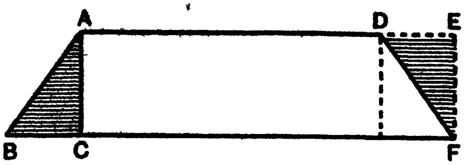


FIG. 19. AREA OF A TRAPEZIUM

Area of trapezium $= CF \times AC$; i.e., $\frac{1}{2}(BF + AD) \times AC$.

Applications are found in roofs.

The irregular trapezium, met with in sheds, verandahs and other buildings, is dealt with by treating as a rectangle + a triangle, Fig. 20.

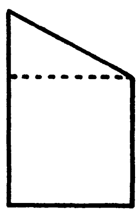


FIG 20 IRREGULAR TRAPEZIUM

Applications deal with amount of wood or glass, to construct; or paint or linoleum to cover such an area.

V. *Areas of irregular spaces such as gardens, fields, estates*—These have to be divided into rectangles and triangles. It is usually possible to obtain access to a piece of land that can be surveyed, drawn to scale and measured for area. If the work is properly organised and is neither too easy nor too difficult, this proves a valuable and enjoyable exercise.

Finding the area of an irregular school yard may form a good exercise.

STAGE 13. MEASUREMENTS NEEDED TO COPY TRIANGLES

I. The children draw a triangle on their paper and are asked to think out a way by which they could make an exact copy of it. The easiest way is by measuring the three sides and using ruler and compasses. This is the method which will be suggested, but interest can be aroused in finding other ways and the class can be led to formulate the three methods:

(*a*) Measure the three sides.

(*b*) Measure one side and two angles.

(*c*) Measure two sides and the angle between them.

II. Application of this in the surveying of triangular fields or parts of an area.

STAGE 14. CIRCLES: RATIO OF CIRCUMFERENCE TO DIAMETER

Finding the ratio of the circumference of a circle to its diameter, or, as the children may say, finding how many times the diameter goes into the circumference. The ancient geometers wrestled with this problem in the form, "Find a square which is equal in area to a given circle." Their task of "squaring the circle" could not be done exactly because the ratio of diameter to circumference cannot be represented exactly, as the ratio of two whole numbers. It is for this reason that it is represented by the Greek letter π. But for everyday work, an exact value is not required. $\frac{22}{7}$ is sufficiently accurate for most purposes. If a greater degree of accuracy is needed, $3 \cdot 1416$ may be used. In any case, the senior school child does not need π, for many, it introduces a needless perplexity, there is no need to mention it to children.

I. The lesson should be practical and should introduce as many methods of measuring diameter and circumference as possible. The children can bring circular tins of varied size. They can measure the circumference by rolling along a line; by wrapping a strip of paper round, pricking through the overlapping ends and measuring the distance between the pricks when the paper is unrolled and laid flat; by wrapping cotton around the tin once, twice or thrice, and measuring.

The diameter is measured best by holding the tin between two set squares or other uprights and measuring their distance apart.

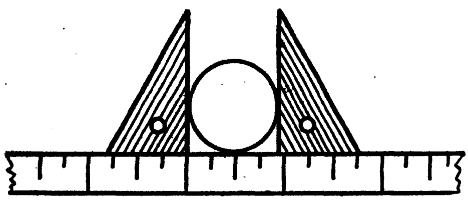


FIG. 21.

A large circle on the floor or blackboard can be measured by stepping thread around it. A still larger one in the yard can be measured by using a child's foot as unit. The child steps round the circumference and across the diameter, finding how many of his own foot lengths are contained in each.

Each child can draw a circle (preferably a large circle) on his own paper, note its diameter and measure its circumference by stepping cotton around it.

In all experiments, the ratio $\frac{\text{circumference}}{\text{diameter}}$ should be worked out to the first decimal place. Some children will do several experiments, others may do only one. All should be encouraged to consider the degree of accuracy of their work and to make it as high as possible. From the collected results the conclusion can be drawn that "whatever the size of the circle, the circumference is between 3·1 and 3·2 times as long as the diameter."

The teacher tells the class that by other methods the value has been found more accurately and that it is 3·1416. For most practical purposes, 3·14 or $\frac{22}{7}$ is sufficiently accurate. At the teacher's discretion, something may be said about π. The "A" stream children often enjoy it. A more important matter is to get some understanding of degree of accuracy.

II. Many applications should be made. The first, of the simplest type; e.g., find the circumference of a circle whose diameter is given, or find the diameter of a circle whose circumference is given.

Then examples dealing with practical affairs should be given. These can be made by the teacher to suit the class.

The following topics are suitable:

Find the circumference of a wheel of given radius. Find how often it turns in going a mile. Link this with cyclometers.

Find the circumference of a garden bed of given radius. How many plants would be needed if they were to be placed 6 in. apart around the bed, 6 in. from its edge?

Find the circumference of a racing track of given diameter. Find how much longer the outer edge is than the inner, given the width of the track and diameter of outer circumference.

Find the length of string required to "wind" the circular handle of a hockey stick, or a bat for a given length, given the radius of the handle and diameter of string. A similar question is that about length of wire needed for a single electric coil.

Find the length of cotton on a reel, or wire in a coil, given the radii of inside and outside layers and the diameter of cotton, or wire. This is a more difficult example because the average of the radii of inside and outside layers has to be used.

STAGE 15. RIGHT-ANGLED TRIANGLES AND THE SQUARES ON THEIR SIDES

I. (*a*) The children draw a 3, 4, 5, right-angled triangle (see Stage 9). Centimetres may be used instead of inches if large sheets of paper are not available. A sheet 11 in. long at least is required for the diagram if inches are used.

Squares are constructed on each side and the children note that $5^2=3^2+4^2$ or, if they have not learnt this notation, $25=9+16$.

The devices for cutting up the squares, fitting together the pieces and so demonstrating the equality is apt to take far more time than it is worth. The divisions are shown in the diagram. O is the middle point of the square BCDE. KL and MN are drawn parallel to AC and at right angles to it respectively. The square BCDE is cut along the lines KL and MN and the pieces along with the square ABGF are fitted into the square HACI, as indicated, Fig. 22.

(*b*) Much more profit is gained by the following type of exercise. The children draw a right-angled triangle with the shorter sides 1 in. and 2 in., or any other exact number of inches, and measure the hypotenuse (this name should be given). They then test by squaring and find that in every case the square on the hypotenuse is equal to the sum of the squares on the other two sides.

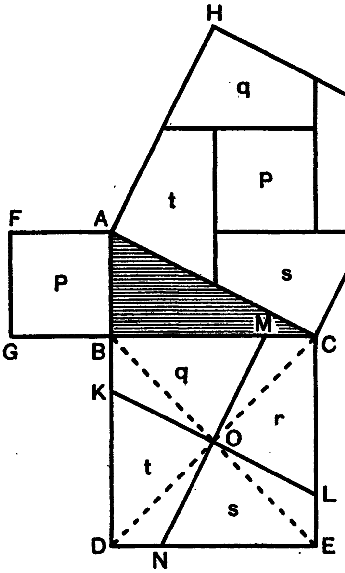


FIG. 22. SQUARES ON SIDES OF RIGHT-ANGLED TRIANGLE

II. The children use this fact for working examples, such as:

1. A ship sails 20 miles east and then 30 miles south. How far is it from its starting point?

2. What length of wire is needed to stretch from a window sill 20 ft. high to a point on the ground 10 ft. from the wall of the house?

3. An aërial is to be stretched from the top of a 15 ft. post to that of a 10 ft. post, 12 ft. away. What length of wire is needed?

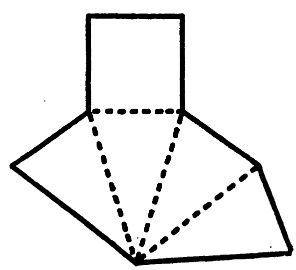
STAGE 16. PYRAMIDS

I. *The square pyramid.*—(*a*) The children should examine, measure, describe and make drawings of a pyramid.

(*b*) The children find out how to make a pyramid from paper. They make one, of given size.

The easiest case is when the lengths of the sides of the base, and of the slant edges, are given. Slightly more difficult is the case when lengths of the sides of the base and of the slant heights are given. When vertical height is given in addition to the side of the base, a much more difficult case is involved, for a calculation has to be made to find either slant height or slant edge before the drawing can be made.

"A" stream children can do all three cases; "B" can do the first two. If some children require help they may be shown a finished diagram and aided by suggestions as to how it can be drawn. After the children have made the drawing they should plan the making of flaps by which the pyramid can be held together.



Square Pyramid

FIG. 23.

(*c*) Exercises applying what has been learnt; e.g., A tent is made in the shape of a cube, each side 8 ft., surmounted by a pyramid. The height of the centre pole is 12 ft. Find the area of canvas required to make the tent.

Tents, roofs and tops of towers provide applications that are practical.

(*d*) Volume of pyramid. Comparison should be made with the square prism and the children told that the volume of the pyramid is $\frac{1}{3}$ the volume of a prism with the same base and the same vertical height.

It is possible to illustrate this by measuring. The pyramid and the companion square prism are made from strong paper or thin card, the joints being very carefully made. The prism is left with one side open—one of the smaller sides. An opening to the pyramid is kept by leaving unfastened the top of one of the sloping faces. It is possible to fill the pyramid with sand and find that three pyramidfuls are needed to fill the prism. Alternatively, the pyramid may be made without a base, held upside down and filled with sand. In either case it is not an experiment to be undertaken by the whole class in an ordinary classroom!

(*e*) Exercises utilising the formula:

Volume of pyramid $= \frac{1}{3}$ area of base $\times$ height,

are chiefly those connected with volume of air in tents and rooms with pyramid-shaped roofs.

II. *Method of teaching the square pyramid to "C" stream children.*—As with "A" and "B" streams, the children examine, measure, describe and draw, but they need much more guidance. The following questions show the type that should be used and how the lesson should run. If possible, each child should have a pyramid of wood or paper.

EXAMPLES

1. How many sides has the pyramid?

2. What shapes are they?

3. Are any of them the same?

4. How many corners has the base?

5. How many corners have the slanting faces?

6. Measure the sides of the base. How long are they?

7. Measure the slanting faces. How long are their sides?

8. Set the pyramid on a sheet of paper and draw round its base. What figure do you get?

9. Lay the pyramid on its side and draw round it. What figure do you get?

10. Cut out the square and four triangles that would fit the faces of the pyramid. Could you make a paper pyramid by holding them together?

11. By looking at the 5 pieces, find out whether you could cut 1 piece of paper that could be folded into a pyramid. Arrange the pieces to show what it would be like.

12. Draw and cut out the required piece. Fold it. Where could flaps be made so as to stick it together?

13. Draw another figure and draw in the flaps. Cut out and make up the pyramid.

The children can make pyramids of required sizes if detailed instructions are given as to how the figures are to be drawn, but they would be more profitably employed in doing easier work in which they could use more of their own initiative. Work which is purely copying or following detailed instructions is of less value.

III. *Pyramids of other shapes.*—These can be treated in a similar way.

(*a*) The rectangular pyramid.

(*b*) The pyramid with base an equilateral triangle.

(*c*) The pyramid with base a hexagon.

(*d*) The regular tetrahedron. This is an entertaining solid—"The Joker" among pyramids.

This work gives practice in careful, accurate drawing, and skill in making models. It gives insight into geometrical principles. The value gained depends upon the methods used in teaching, the questioning employed and the stimulus given to initiative. The time spent over this stage and the amount of work attempted must be left to the discretion of the teacher. The extent to which the children enjoy the work and gain satisfaction from it is one measure of its value to them.

STAGE 17. EQUALITY OF TRIANGLES

This stage follows up work done in Stage 13 and is a more formal treatment of identically equal triangles. It is not desirable that deductive proofs should be given, or the formal statement of proof by super-position, but the children should have practice in finding equal triangles and in saying how they know that the triangles are equal. At first it is permissible to allow them to point, saying, "This side equals this; that side equals that; this angle between equals that angle between; therefore the triangles are exactly equal," etc. Naming of sides by letters should be introduced early. Naming of angles by three letters presents more difficulty and the angles may be named in some other way; e.g., angle 1, angle 2, angle 3; the dot angle, the cross angle, the bar angle.

STAGE 18. INSCRIBED AND CIRCUMSCRIBED FIGURES

This stage introduces deductive proofs.

I. If the children are asked to find out how to draw a square in a circle, they will find it a difficult problem. If they are given the instructions, "Draw 2 diameters at right angles to one another. Join the ends of these 2 diameters. Say what figure you have made," they will draw, and say, "A square." If the teacher now asks, "How do you know it is a square?" the class is on the way to deductive reasoning. By suitable guidance the children can build up a proof that, in the triangles formed, the sides are equal and the angles right angles, Fig. 24.

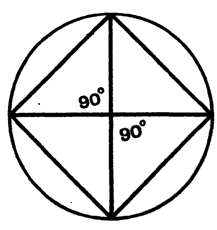


FIG. 24. INSCRIBED SQUARE

II. Similarly, the following instructions are given: "Draw a radius AO, O being the centre of the circle. Make an angle AOB=120° and another angle AOC=120°. Join AB, BC and AC. Tell all you can about the triangle ABC."

The children quickly say, "Its sides are all equal." Some will add, "And its angles are all 60°." The teacher asks, "How do you know that?" and assists the children as far as help is necessary to build up a proof. In this case letters are not needed. There are three little triangles. In each of them two sides are radii of the circle and the angle between them is 120°. Therefore the three triangles are equal. One angle is 120°, therefore the sum of the other two is 60°. The sides opposite them are equal, therefore the angles are equal and each is 30°. The angles of the big triangle are equal to 30°+30°; i.e., 60°, Fig. 25.

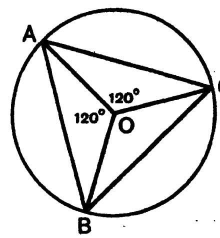


FIG. 25. INSCRIBING A TRIANGLE

Putting in letters and making a more formal proof is a hindrance rather than a help to children.

III. Similarly, a hexagon may be constructed with angles of 60° at the centre, and an octagon with angles of 45° at the centre.

IV. Instructions are given: "Draw a circle and 2 diameters, AB and CD, at right angles to one another. Through A and B draw lines parallel to CD. Through C and D draw lines parallel to AB."

The children draw, say what they have made and give reasons. In this case they refer back to Stage 10 on parallel lines.

V. A circumscribed equilateral triangle, hexagon and octagon can be constructed, but the proofs are more difficult, Fig. 26.

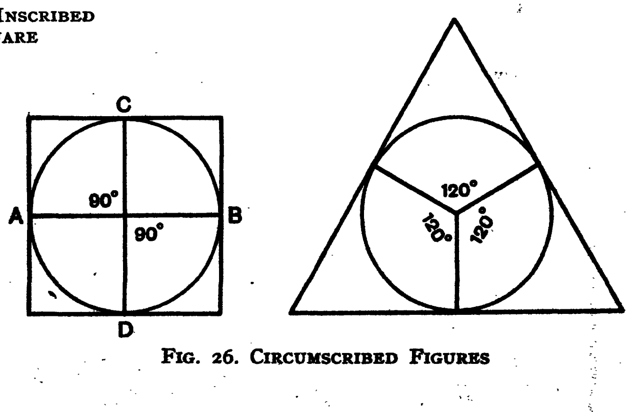


FIG. 26. CIRCUMSCRIBED FIGURES

STAGE 19. AREA OF CIRCLE AND CIRCULAR RINGS

Before beginning this, Stage 14 should be revised and the symbol π introduced as standing for the exact value of circumference divided by diameter.

I. The children cut out a circle—2 in. or 3 in. radii are suitable sizes; 1 in. is rather too small—fold it three times, thus getting creases at 45° to one another at the centre. They then cut along the creases, so dividing the circle into eight equal parts. These are arranged so as to approximate to a parallelogram in shape. The height of the parallelogram approximates to the length of a radius and its length to πr. Therefore the area of the circle approximates to πr^2. The teacher tells the class that it can be proved, by other methods, that the area of a circle is exactly equal to πr^2.

If coloured gummed paper is used, interest is added; the children can stick the pieces into their geometry note books and record the result, Fig. 27.

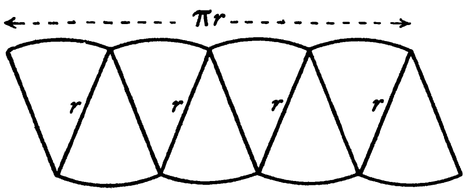


FIG. 27. SHEWING THE AREA OF A CIRCLE

Dividing the circle into sixteen gives a more convincing parallelogram, but it takes much more time.

II. Examples employing the formula:

Areas of circular lawns, garden beds, discs of wood and metal, given the radius or diameter, are the most straightforward.

Weights of circular discs, given radius and weight of unit area.

Areas of flat rings; e.g., a circular racing track, a metal washer; given internal and external diameters.

STAGE 20. SECTORS OF CIRCLES; ARCS; ANGLES AT CENTRE; AREAS

I. In Stage 5 the children studied angles at the centre of a circle.

The names sector and arc should be given; revision of Stage 5, with practical work in folding circles, and drawing sectors of a given angle lead to many statements of the type: in $\frac{1}{4}$ of the circle the arc is $\frac{1}{4}$ of the circumference and the angle at the centre is $\frac{1}{4}$ of 360°.

II. Applications to (*a*) finding the length of the arc, given radius and angle; (*b*) finding the angle, given arc and radius; (*c*) finding areas of sectors.

The fractions should be simple: $\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{4}$, $\frac{1}{5}$, $\frac{1}{6}$, $\frac{1}{8}$, $\frac{1}{9}$, $\frac{1}{12}$. The examples can be made practical by applying them to circular race tracks, circular garden beds.

III. The general statement can be arrived at:

$$\frac{\text{area of sector}}{\text{area of circle}} = \frac{\text{arc}}{\text{circumference}} = \frac{\text{angle at centre}}{360°}$$

Examples of further applications, should be given.

Note.—The best children will cover all the work. The "C" children can do (I) and (II) using the fractions $\frac{1}{2}$, $\frac{1}{4}$, and perhaps $\frac{1}{8}$, $\frac{1}{3}$, $\frac{1}{6}$, because these can be illustrated practically by the children themselves.

IV. If the children have begun to make formulae they can work out:

$$\text{area of sector} = \frac{\text{arc}}{\text{circumference}} \times \pi r^2$$

$$= \frac{a}{2\pi r} \times \pi r^2 = \tfrac{1}{2}ar$$

Exercises in the use of this formula concern flower beds, parts of a machine, etc. One of the best applications arises when the cone is studied (Stage 22).

EXAMPLES

The following are numerical examples on areas of sectors of a circle:

1. A goat is tethered to the corner of a field by a rope 15 ft. long. If the angle of the corner of the field is 80°, over what area of grass can the goat graze? Fig. 28.

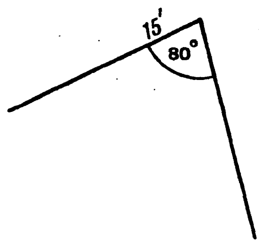


FIG. 28. AREA GRAZED BY GOAT

2. A flower bed is in the form of a sector of a circle. The radius of the circle is 6 ft. and the angle of the sector is 60°, Fig. 29.

(*a*) Find the length of the curved edge of the bed.

(*b*) Find the area of the bed by two methods. ($\frac{1}{6}\pi r^2$; $\frac{1}{2}$ arc × radius.)

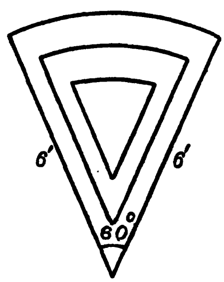


FIG. 29. FLOWER BED

3. The design for a stained glass window includes sectors of circles. If the angle of a sector is 60° and the length of the straight sides is 6 ft., find the area of glass in the six sectors, Fig. 30.

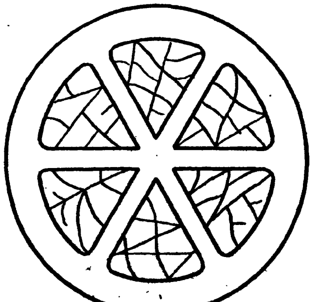


FIG. 30. SECTORS OF STAINED GLASS WINDOW

4. From a sheet of lead, a sector of a circle of radius 6 in. is cut. If the curved edge of the sector is 10 in., find its weight. (The weight of the sheet is $4\frac{1}{2}$ lb. to the square foot.)

5. A hopper window, 3 ft. by 18 in., swings inward about its lower edge, CD. If the angle is 40°, find the length of the arc AB and the area of glass in the side cheek ABC, Fig. 31. (The side openings are protected by glass screens.)

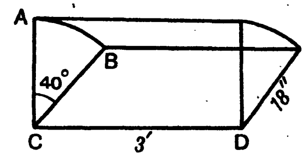


FIG. 31. HOPPER WINDOW

STAGE 21. THE CYLINDER

I. *The area of a cylinder.*—The children should come provided with cylindrical tins and should discover how they are made from two circles and a rectangle. They make a paper cylinder of given size, deciding for themselves how much to allow for overlap.

Examples on surface areas of cylinders and amount of material required to make them should be given.

EXAMPLES

1. Find how much sheet iron would be needed to make a tube 8 ft. long, with diameter 2 ft., both ends open.

2. Find cost of painting a column 12 ft. high, diameter 4 ft., at 2*d*. per sq. ft.

3. A garden roller in making 350 revolutions traverses an area of 1375 sq. yd. If it is 4 ft. 6 in. long, what is its diameter?

4. How much will it cost to paint a pole 35 ft. high and 15 in. diameter at 3*d*. per sq. ft.?

II. *The volume of a cylinder.*—The children are reminded that the volume of a prism is given by area of base × height, and told that the volume of a cylinder is given by the same formula.

Various experiments may be done to illustrate this. One of the most easily managed is to fill a cylinder with clean, dry sand, pour the sand into a rectangular box and measure the depth to which the sand fills the box. By measuring the length and breadth of the box the volume of the sand can be found and compared with the volume of the cylinder given by the formula $\pi r^2 h$.

(*a*) The measuring cylinder should be shown and used for measuring the volumes of small cylindrical bodies and other solids. This opens the way to much practical work which can be done in connection with science (see Section XII).

(*b*) Applications of this work are numerous and deal with pipes, boilers, tanks, tunnels.

Examples

1. The diameter of the end of a cylindrical tank measures 10 ft. What volume of water does it contain when the depth of the water is 4 ft?

2. A water main is 14 in. in diameter. Find the volume of water in 100 yd. of such a pipe.

3. A boiler contains $2887\frac{1}{2}$ galls. of water. If it is 12 ft. long, what is its diameter? (1 cu. ft. of water = $6\frac{1}{4}$ galls.)

4. What would it cost to sink a well 35 ft. deep and 5 ft. in diameter at 6*s.* 9*d.* for every cu. ft. of material excavated?

5. A cylindrical tunnel 35 ft. in diameter is bored for half a mile. What would be the cost at 14*s.* 6*d.* for every cu. yd. of material taken out? (Answer to nearest £.)

STAGE 22. CONE

I. Children enjoy making cones from sectors of circles and exploring the possibilities of getting low, flat cones; high, narrow ones; and well-proportioned tents. Much experimental work is required to lead up to the next step.

II. The children work out, for themselves, the connections between slant height of cone, circumference and diameter of base, vertical height, area of curved surface, radius of the original circle, and angle of sector used. These relationships afford excellent practice in the making of formulae and the manipulation of equations.

All children can do (1); most of them can deal with the easiest points in (2) but only the best can cover all of (3).

If r=radius of base l=slant height
h=vertical height a=arc
θ=angle of sector

1. $\dfrac{a}{2\pi l} = \dfrac{\theta}{360°}$
$a = 2\pi r$

2. $h^2 + r^2 = l^2$

3. Area of curved surface$=\frac{1}{2}a \times l = \pi r l$ (cf. Stage 20.)

(Expansion of proof of formula for teachers' reference.)

Fig. 32*e*. Sector from which cone is made. Arc$=a$; $A\hat{O}B=\theta$.

The radius, l, becomes the slant height of the cone.

The arc becomes the circumference of the base of the cone.

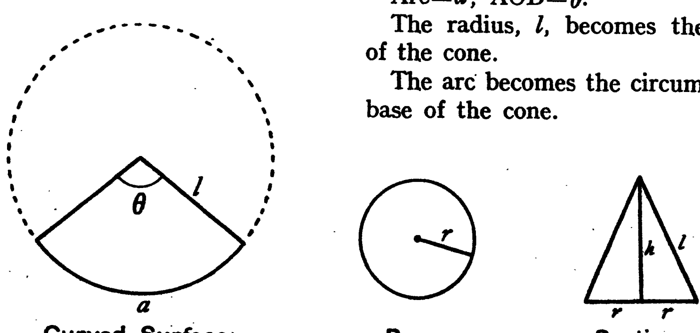


Fig. e Fig. f

FIG. 32. DIAGRAMS SHOWING AREA OF A CONE

Fig. 32*f*. Section of cone.

Circumference of base of cone $=2\pi r$.

This was the arc of the sector.

Slant height, l, was radius of the original circle; h is vertical height of cone.

From Fig. 32*f* we get: $h^2+r^2=l^2$

From Fig. 32*e* we get: $a=2\pi r$

$$\frac{a}{2\pi l}=\frac{\theta}{360}$$

To find the area of the curved surface of the cone, the area of the sector of the circle (Fig. 32*e*) must be considered.

The sector is a fraction, $\frac{\theta}{360}$, of the whole circle; whole radius is l

Therefore its area is $\frac{\theta}{360}$ of πl^2 . . . . . (1)

When θ and l are given, this formula should be used.

Alternatively, the sector is a fraction, $\frac{a}{2\pi l}$, of the whole circle. (Note $\frac{\theta}{360}=\frac{a}{2\pi l}$.)

Therefore its area is $\frac{a}{2\pi l}$ of πl^2.

$=\frac{1}{2}al$ . . . . (2)

$=\frac{1}{2}\times 2\pi r\times l=\pi rl$ . . . . (3)

Of these three formulae for the area of the curved surface of a cone, (3) is the most useful because r and l are given more often than θ or a.

III. Applications to questions concerning tents, funnels, cones in buildings, lamp shades.

Examples

1. A military tent has a base diameter of 5 ft. 6 in. and a height of 7 ft. How many men can use the tent if each is supposed to have 9 cu. ft. of air at least?

2. A conical spire with a base diameter of 10ft. 6 in. and slanting side 35 ft. long is covered with lead costing 1*s*. 3*d*. per sq. ft. Find the cost of the lead.

3. 5 cones of lead, each of diameter 15 in. and height 21 in., are melted and cast into a cylinder of diameter 28 in. What will be the height of the cylinder?

4. How much canvas will be required to construct a conical tent with a base diameter of 8 ft. and a sloping side measuring 10 ft.?

5. A stone column is in the form of a cylinder surmounted by a cone. The diameter of the column is 2 ft. 11 in., the height of the cylinder 11 ft., and the height of the cone 2 ft. 9 in. Find the volume of the stone in the column.

6. A conical tent is to have radius of base 6 ft. and vertical height 8 ft. What will the slant height be? What area of canvas would be required for the tent?

7. The vertical height of a conical hat is 12 in. and its slant height is 14 in. What is the circumference of its base? What circumference would be needed for a hat for yourself? Work out suitable dimensions for the hat and describe how you could make it.

8. What area of tin would be needed to make the top portion of a funnel, 8 in. across the top and 10 in. deep?

STAGE 23. ANGLES IN A CIRCLE

I. The children draw a circle and one diameter AB. They choose any other point on the circle, call it C; join AC and BC, and measure the angle ACB. Everyone in the class finds that it is a right angle; all the quicker workers can make further tests and the inductive conclusion is that the angle in a semicircle is a right angle.

(Note that the need for naming angles by letters has now arisen.)

II. The children draw a right angle AOB at the centre, choose any point C on the major arc, join AC and BC, and by a similar method arrive at the conclusion that angle ACB is 45°.

III. The children draw any angle AOB at the centre. Choose any point C, join AC and BC. Measure the angles AOB and ACB. All find that $A\hat{C}B$ is half of $A\hat{O}B$. They can generalise, by inductive reasoning, that the angle at the centre is twice as big as the angle at the circumference, standing on the same arc, Fig. 33.

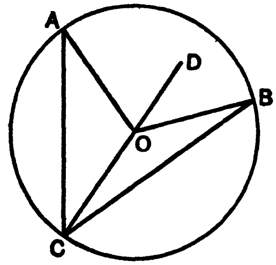


FIG. 33. ANGLES IN A CIRCLE

IV. An opportunity arises for the introduction of deductive reasoning. In stage 7 the children learnt that the angles at the base of an isosceles triangle are equal. In Stage 8 they learnt that the external angle of a triangle is equal to the sum of the opposite interior angles. Hence they are ready for the usual proof.

(Note that it is not necessary to introduce the word "segment," or to speak of angles as "standing on chords.")

$$A\hat{O}D = O\hat{A}C + O\hat{C}A = 2O\hat{C}A$$
$$B\hat{O}D = O\hat{B}C + O\hat{C}B = 2O\hat{C}B$$
$$\therefore\ A\hat{O}D + B\hat{O}D = A\hat{O}B = 2A\hat{C}B$$

V. Angles at the circumference, standing on the same arc, are equal.

This deduction from (III) can be made by almost everyone.

VI. Sum of opposite angles of a quadrilateral in a circle.

The children draw a circle, inscribe any four-sided figure, measure its angles and find the sum of opposite angles.

The class concludes, by inductive reasoning, that the sum is equal to two right angles.

Deductive proof can be taken with the children who are ready for it, by the usual method. It should be kept informal.

VII. Numerical examples (I) to (VI) are as follows:

EXAMPLES

1. O is the centre of a circle ABCD, and BOD is a straight line, Fig. 34.

If $B\hat{A}C$ is 50°, find:

(*a*) $C\hat{A}D$

(*b*) $B\hat{O}C$

(*c*) $B\hat{D}C$

Give your reasons.

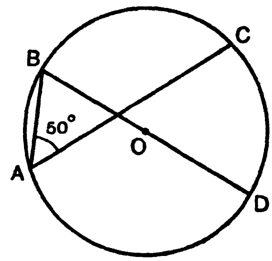


FIG. 34. DIAGRAM FOR EXAMPLE 1

2. PQ and RS are two chords of a circle which meet at O when they are produced. If $O\hat{P}S = 20°$, and $P\hat{O}S = 30°$, find $O\hat{Q}R$.

3. A point P is 10 in. from the centre of a circle of radius 6 in. A tangent is drawn from P to the circle, touching it at N. Find the length of the tangent PN.

4. Draw a semicircle of radius 3 in. Place in it a right angle, one arm of which measures 2 in. Measure the other arm and check your result by calculation.

5. ABC is a triangle inscribed in a circle of centre O. The angle AOC° = 120. The angle BOC° = 160. Find the angle ACB.

6. Draw a circle with centre O and diameter AB. Make an angle ABC equal to 40°, and, on the other side of AB, an angle ABD equal to 30°. Join OC and OD, Fig. 35. Write down the sizes of all the angles in your figure. Check by measuring them. Join AC and AD. Write down the sizes of the new angles you have made and check by measurement.

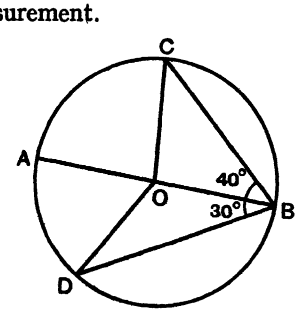


FIG. 35. DIAGRAM FOR EXAMPLE 6

VIII. Easy deductive riders can be done on this work. They must be sufficiently easy for the children to enjoy doing them. There is little value in the rider which has to be "shown" to the child. He may "see" each step as it is shown but may not be any nearer being able to do a rider for himself. Examples of the above are as follows:

1. A line ABCD cuts two concentric circles at A, D and B, C. Prove that AB=CD.

2. Two lines ABC and ADE cut a circle at B, C and D, E. Prove that angle ABE= angle ADC.

3. Two circles cut at a point A. BC is a diameter of one of the circles. AB and AC, produced if necessary, cut the other circle in D and E. Prove that DE is a diameter of this circle.

4. PQRS is a cyclic quadrilateral. If PR bisects the angles at P and R, prove that $P\hat{Q}R$ is a right angle.

STAGE 24. CHORDS AND THEIR DISTANCES FROM THE CENTRE

I. The children draw a circle and any chord in it. They join the centre of the circle to the mid-point of the chord and discover that OC is at right angles to AB, Fig. 36.

By inductive reasoning they conclude that any line joining the centre of a circle to the mid-point of a chord is at right angles to the chord.

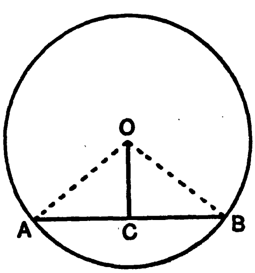


FIG. 36. OC AT RIGHT ANGLES TO CORD AB

II. A deductive proof is easily obtained by considering the triangles OAC and OBC which have three sides of one equal to three sides of the other.

III. The children drop a perpendicular from the centre of a circle to any chord and find that the chord is bisected. By inductive reasoning they conclude that a perpendicular from the centre of a circle to a chord bisects the chord.

IV. A deductive proof is obtained by considering the triangles.

Triangle OAB is isosceles, therefore $\hat{A}=\hat{B}$.

The two triangles OAC and OBC have three angles of one equal to three angles of the other, and two sides of one equal to two sides of the other; i.e., more than enough evidence to prove them equal.

V. Formulae connecting radius of circle, length of chord and distance from the centre are obtained by theorem of Pythagoras. Numerical examples can be obtained from a modern geometry.

STAGE 25. TANGENTS TO CIRCLES

I. The children draw a circle and place in it a number of parallel chords. They mark the mid-points of the chords and notice that the line joining these middle points is a diameter at right angles to the chords, Fig. 37. This is linked up with Stage 24.

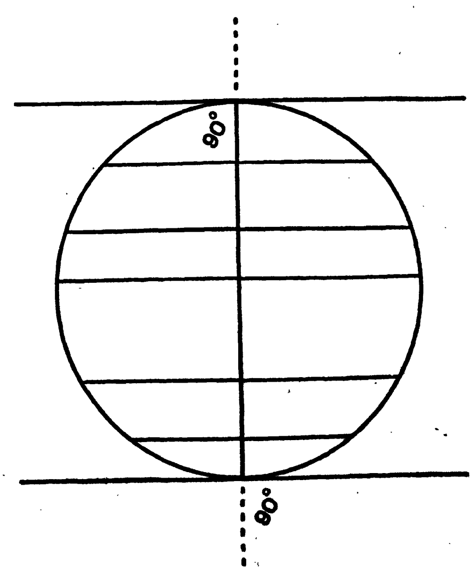


FIG. 37. PARALLEL CHORDS, DIAMETER AND TANGENTS

II. Through the ends of the diameter the children draw lines parallel to the chords and so get tangents to the circle. They notice that the tangent is at right angles to the diameter or radius through the point of contact.

STAGE 26. SPHERE

I. Volume of sphere $= \frac{4}{3} \pi r^3$

Surface area $= 4 \pi r^2$

These facts can be applied in examples such as:

1. Find the volume of a spherical lead bullet of diameter $\frac{1}{4}$ in. If a cubic inch of lead weighs $6\frac{1}{2}$ oz., how many of these bullets will go to the pound?

2. A hemispherical basin is 18 in. in diameter. How much water will it hold?

3. The diagram (Fig. 38) shows a cylindrical boiler with hemispherical ends. Find its volume.

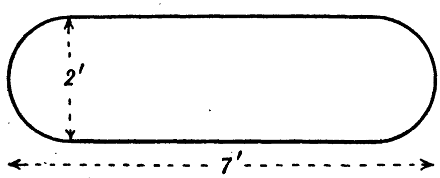


FIG. 38. PLAN OF CYLINDRICAL BOILER

II. *Latitude.*

Any plane section of a sphere is a circle. If it passes through the centre of the sphere it is called a great circle, and its diameter is equal to the diameter of the sphere. If it does not pass through the centre of the sphere, its diameter is less than that of the sphere and it is called a small circle. In the earth, which is approximately spherical, the equator is a great circle. The meridians are great circles passing through the north and south poles. The lines of latitude are small circles.

In Fig. 39, the angle AOB is the latitude of the place A; i.e., the angle at the centre of the earth, subtended by that arc of the meridian through A, which lies between A and the equator.

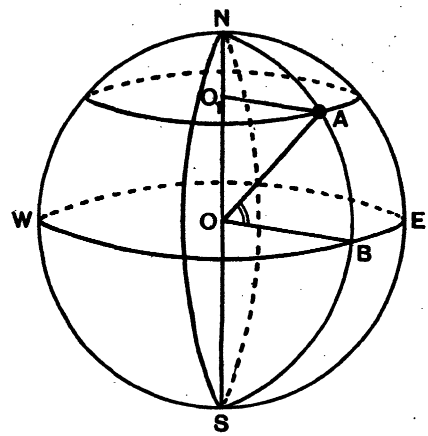


FIG. 39. DIAGRAM FOR DETERMINING LATITUDE

Questions based upon this may be of the following types:

1. What is the length of the circumference of the parallel of latitude 50°. (Take 8,000 miles as the diameter of the earth.)

Methods of working examples.—Fig. 40 shows a section of the earth, passing through a place B in latitude 50°N.

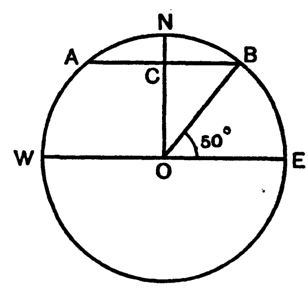


FIG. 40. DIAGRAM FOR EXAMPLE 1

WE is the diameter of the equator.

AB is the diameter of the circle that forms the parallel of latitude 50°N.

N is the north pole and C the centre of the circle that forms the parallel of latitude 50°.

In the triangle BCO, CB=OB sin 40° or OB cos 50°.

If the children have not learnt the trigonometrical ratios, they draw the triangle to scale and so find the length of CB. Otherwise,

sine 40° = ·6428
CB = 4,000 × ·6428
= 2571·2

∴ circumference of parallel 50°N.
$= 2\,\pi \times 2571{\cdot}2$
$= 6{\cdot}18 \times 2571{\cdot}2$
= 16,147 miles.

Using logarithms is neater:

Circumference $= 2\,\pi \times CB$
$= 2\,\pi \times 4{,}000 \times \sin 40°$
= 16,160 miles.

Logarithms.

log 2 π = ·7982
log 4000 = 3·6021
log sin 40 = $\bar{1}{\cdot}8081$

4·2084

Note.—In Lat. 50°, one degree of longitude measures $\frac{16160}{360}$ miles; i.e., 44·9 miles. Examples, finding the distance between two places lying on the same latitude can follow.

2. If an aeroplane starts from Moscow (55° 45′N.; 37° 40′E.), flies straight N., turns when over the north pole and flies S. to San Francisco (37° 40′N.; 122° 35′W.), what distance will it have covered?

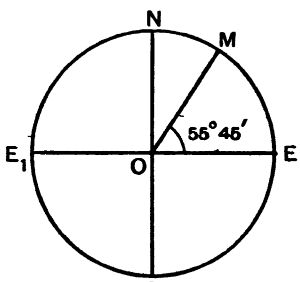


FIG. 41A DIAGRAM FOR EXAMPLE 2

Fig. 41A, shows the circle of longitude through Moscow 37° 40′E.

M is Moscow, latitude 55° 45′N.

N is the north pole.

O is the centre of the earth.

E_1 and E are points on the equator.

The aeroplane flies over the arc MN as it goes from Moscow to the north pole.

Taking the radius of the earth as 4,000 m.,

$$\frac{MN}{\pi \times 4{,}000} = \frac{90° - 55°\,45'}{180°} = \frac{34°\,15'}{180°}\text{[1]}$$

$$\therefore MN = \frac{\pi \times 4{,}000 \times 137}{4 \times 180} = \frac{\pi \times 50 \times 137}{9}$$

The degree of accuracy does not justify a closer approximation to π than 3·14.

$$\therefore MN = \frac{3{\cdot}14 \times 50 \times 137}{9} = \frac{314 \times 137}{18} =$$

2,390 miles.

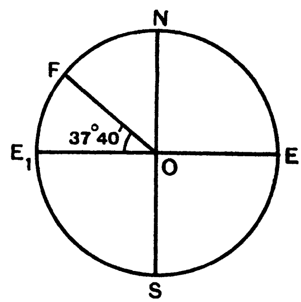


FIG. 41B DIAGRAM FOR EXAMPLE 2

Fig. 41B, shows the circle of longitude passing through San Francisco, 122° 35′W.

F is San Francisco, latitude 37° 40′N.

N is the north pole.

O is the centre of the earth.

E_1 and E are points on the equator.

The aeroplane flies over the arc NF as it goes from the north pole to San Francisco.

$$\frac{NF}{\pi 4{,}000} = \frac{90° - 37°\,40'}{180°} = \frac{52°\,20'}{180}$$

$$\therefore NF = \frac{3{\cdot}14 \times 4{,}000 \times 157}{180 \times 3} = 3652 \text{ miles.}$$

Total distance flown = 2,390 + 3,652 = 6,042 miles.

(Height at which the aeroplane flew does not make any appreciable difference. A height of 1 mile would make a difference of $\frac{1}{4000}$ but other factors cause much more divergence.)

Note.—Russian aviators made this flight in the summer of 1937. In going non-stop from Moscow to San Francisco, via the north pole, they set up a new record for a long dis-

[1] Logarithms can be used with advantage from this point.

tance flight. Between the north pole and San Francisco they flew over the meridian, but between Moscow and the north pole they did not keep to the meridian and their distance was longer than that given by this calculation. 11,500 kms. was the distance claimed.

3. Find the shortest distance between Liverpool (53° 26′N.; 3°W.) and Newport, Mon. (51° 37′N.; 3°W.).

III. Lines of longitude are great circles passing through the poles. Types of questions are:

1. When the time is midday in London, what is the hour in New York? (Longitude 73° 57′W.)

2. New Romney, in Kent, and Torrington, in Devon, both lie on latitude 51°. Their longitudes are 1°E. and 4° 9′W. What is the shortest distance between them?

XI. GRAPHS

Graphs, their use and misuse.—Graphs should not be spoken about as though they were a separate branch of school mathematics. Books are published about them, as though they were a subject in themselves, but graphs are merely one method of representation of facts and relationships. They are a very effective method because we realise things in pictures more quickly than in words. Graphs are easier to grasp than lists of figures; they are clearer than words, and they give a bird's eye view of a situation. They enable us to pick out the main points quickly and to see the general trend amid the details. For these reasons, they are being used increasingly in present day life. Commercial newspapers use them freely; unemployment figures, road accidents, Ministry of Health figures are shown as graphs in the daily press; election posters display the facts that the contending parties wish to emphasise, in the form of graphs; advertisers exhibit the virtues of their goods by graphs.

Graphs are easy to read; conclusions can easily be drawn from them. Because of this ease they often mislead; graphs used for advertisement or propaganda should be carefully scrutinised. The graphs I, II and III, (Fig. 42), illustrate different ways of showing the same figures. All three represent percentages of insured persons, unemployed in the years 1921 to 1935. The horizontal scale is the same in all three. In I, the vertical scale is small and the variations during the years do not appear to be great. In II, a suitable vertical scale is used and the graph gives a fair representation of the situation during the fifteen years. In III, two devices are used to exaggerate the variations; the vertical scale is twice as large as in II; the horizontal axis represents, not 0, but 9. The result is a graph which demonstrates clearly the dire results of the slump in 1929 to 1931, and the remarkable recovery during the years 1932 to 1935.

The three graphs are accurate and a careful examination would prevent unjustifiable conclusions from being drawn, but a hurried perfunctory view would mislead.

It is therefore important that children should learn how to read graphs intelligently and how to use them as methods of representation.

Teaching of graphs.—The technique of graphs has to be taught in a series of lessons. The following notes suggest a sequence of lessons in which the children learn how to use graphs. Afterwards they should use them where they are of value for exhibiting data, showing relationship, or discovering laws. Once the technique is grasped, graphs should not be drawn for the sake of drawing graphs. Graphs can be used in the lower classes for illustrating special topics at school; e.g., temperature, attendances, results of games, but the detailed study of them is best done in the last years.

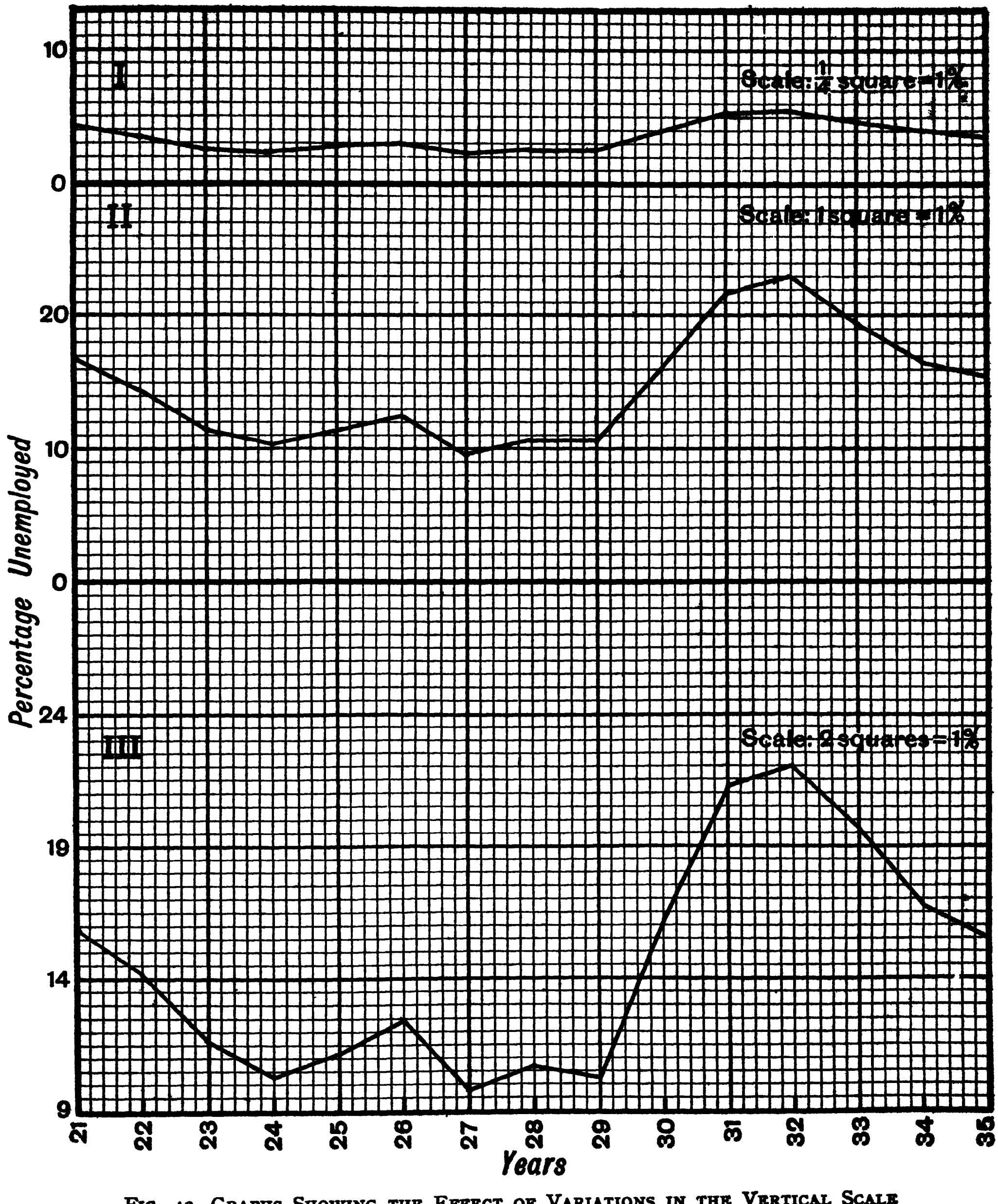


FIG. 42. GRAPHS SHOWING THE EFFECT OF VARIATIONS IN THE VERTICAL SCALE

STAGE 1. CONTINUOUS GRAPHS

I. *Introduction of graphs.*—This should be done by means of a continuous graph that is of interest to the children. One successful and profitable topic is the height of petrol in the petrol gauge of a motor car during the day. It is successful because it is of deep interest to the average child. It is profitable because it can be varied in so many ways. It may be used for a straightforward journey at uniform speed; or, the journey may be partly on roads where speed is limited and partly on roads which permit of high speeds. The journey may include stops of varied lengths, and refills of petrol. The speed of travel is found from the amount of petrol used in a given time, and is shown in the graph by the gradient of the line. Some notes of a first lesson, to a good class, are given because the first lesson is of great importance.

II. *Preparation.*—A finished graph of an easily read type is shown. It should deal with something familiar to the class; e.g., games results, number of yards swum by a learner in successive visits to the baths, or some effort being made by the class or school. This graph is discussed so that the children get an idea of how a graph is drawn.

III. *Presentation.*—Squared paper is distributed and the class is told that a graph is to be made showing the amount of petrol a man has in the tank of his motor car during a journey. The journey lasts from 9 a.m. to 4 p.m. The tank holds 6 gallons and the car gives 30 miles to the gallon.

The scales to be used are discussed—times in hours, horizontally; and gallons, vertically.

The journey is then described in sections. Each section is entered by the children as it is described. They should enter the points for themselves, not copy from the blackboard, but the teacher enters points on the board and draws the line, Fig. 43. This allows the children to check their work and helps the weaker ones.

After each section is completed, interesting points are discussed.

The following sections and points of interest are taken:

At 9 a.m. there were 6 gallons in the tank.

At 10 a.m. the indicator showed 5 gallons.

At 12 noon there were 2 gallons.

After the children have entered these, they are asked what they notice about the journey. "He used 1 gallon in the first hour and 3 in the next 2 hours." "He must have travelled farther between 10 and 11 and between 11 and 12 than he did between 9 and 10." "He must have travelled faster between 10 and 12." "If he got 30 miles to the gallon he went 30 miles between 9 and 10 and 90 miles between 10 and 12." "The graph slopes more steeply between 10 and 12 when he was going faster."

These answers are obtained from good children. The less intelligent get the first two and perhaps the third.

At 1 p.m. there are still 2 gallons.

What has the man been doing? How shall we enter that? How steep is the slope of this section?

There is no difficulty about this, even for the slower children.

At 2 p.m. there is 1 gallon.

How far has the car travelled? How fast? Compare with morning periods with regard to speed and slope of line.

At 2 the tank was refilled, 5 gallons being added.

How can that be shown?

At 3 there were 4 gallons.

What can you tell about the journey between 2 and 3? "2 gallons used." "Must have gone 60 miles." "Speed is 60 miles per hour." "Roads must have been good and clear of traffic." "Slope is steeper than in any other part."

The slower children begin to realise more and at this stage they may give the first three or four points.

At 4 p.m. there are $3\frac{1}{2}$ gallons.

"Half a gallon used in an hour." "Only 15 miles travelled in the hour." "Something

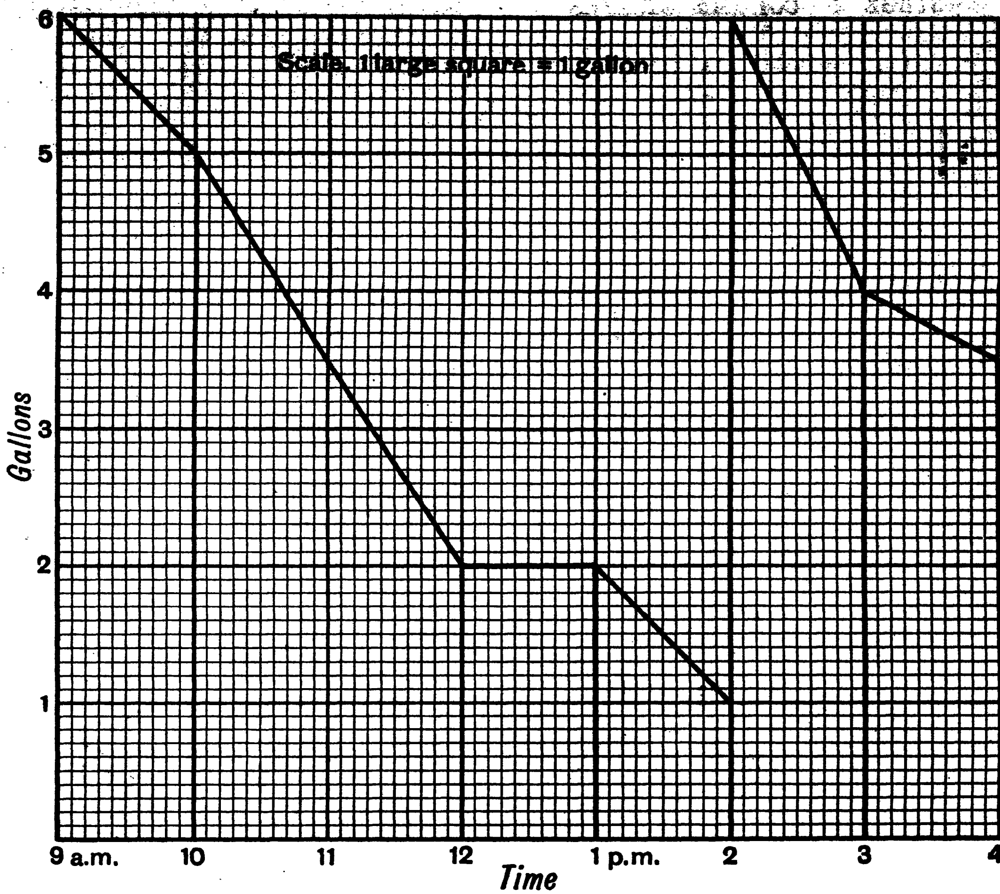


FIG 43. CONTINUOUS GRAPH

made speed slow or there were stops." "Slope of line is slight."

The name "graph of petrol supplies in a car" and the scales used—10 squares=1 hour; 10 squares=1 gallon—are entered. Fig. 43 shows the result.

IV. *Application.*—The children make for themselves the graph of a similar journey in the same car.

2	p.m.	there	were	5	gallons
3	"	"	"	4	"
4	"	"	"	2	"
5	"	"	"	2	"
6	"	"	"	0	"
6	"	"	"	6	"
7	"	"	"	5	"

After the graphs have been drawn the children discuss them.

After this first lesson, practice is given in drawing graphs as applied to different subjects. They should all be continuous graphs and should give practice in choosing scales. The children should read as much as possible from them. Suitable topics are:—number of unemployed in successive weeks; height of barometer; growth of a child in height and in weight; growth of a plant; temperature of a hot body as it cools; travelgraphs. Many other topics will suggest themselves. The most valuable are the ones for which the children obtain the data by their own observations.

STAGE 2. COLUMN GRAPHS

This stage includes the introduction of column graphs; comparison of continuous and discontinuous graphs; and interpolation.

I. *Introduction.*—The difference between continuous and discontinuous, or non-continuous, graphs is a source of confusion unless they are taught apart and then compared.

One of the best introductions to column graphs is their use for recording rainfall. In this there is no temptation to join up the tops of the columns and the difference between column graphs (discontinuous) and continuous graphs is clear. Other column graphs should be drawn—the goals scored in successive matches; the number absent from school in successive weeks or months; the output of a firm in successive years; maximum and minimum temperatures on successive days of the week; these and other topics can be used.

II. *Comparison of continuous and non-continuous graphs.*—The children should compare the truly continuous graph, of which the best example is the self-recording barometer

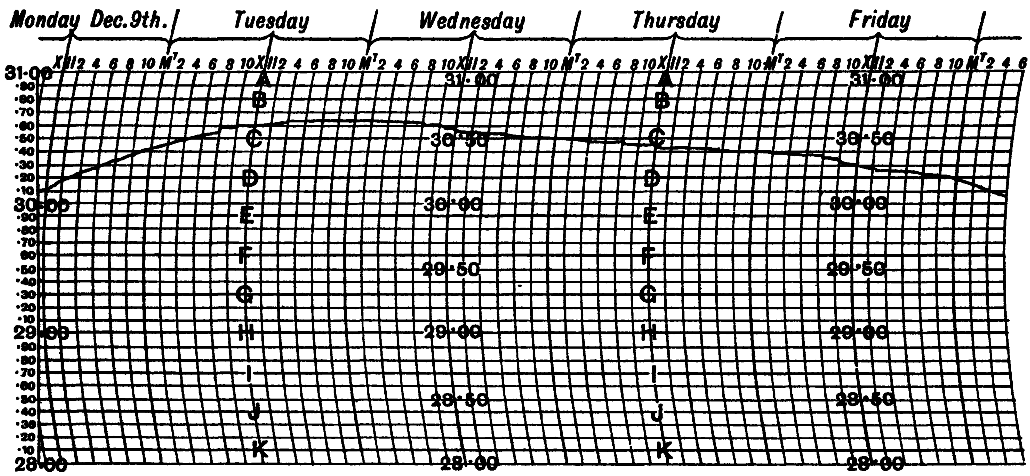


FIG. 44. TAKEN FROM SELF-RECORDING BAROMETER

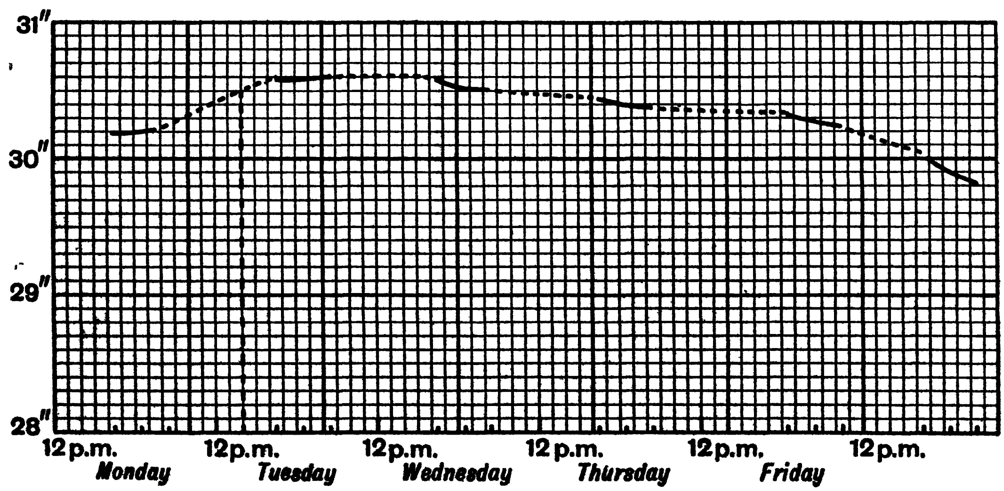


FIG. 45. CHILD'S BAROMETRIC GRAPH

(Figs. 44 and 46), with the column graph. They should discuss the number of readings each day required for making a barometric graph of their own. When the mercury records its own height, there are no gaps in the record. The height of the mercury does not change quickly and therefore gaps between the readings are permissible. If the height is read three times a day, the graph obtained is sufficiently accurate for school purposes. If the height at intermediate times is required, it can be found by "interpolation." In Fig. 45, the observations were taken at 9 a.m., 1 p.m. and 5 p.m. The height at 4 a.m. on Tuesday is found by drawing a perpendicular at the point 4 a.m. It indicates that the barometer height was approximately 30·5°.

The children should discuss the frequency with which observations should be made if graphs were required for temperature of a room; outdoor temperatures; height of a child; strength of the wind.

Graphs as in Figs. 44 and 45; 46 and 47, should be compared. Graphs should be drawn and exercises in interpolation given.

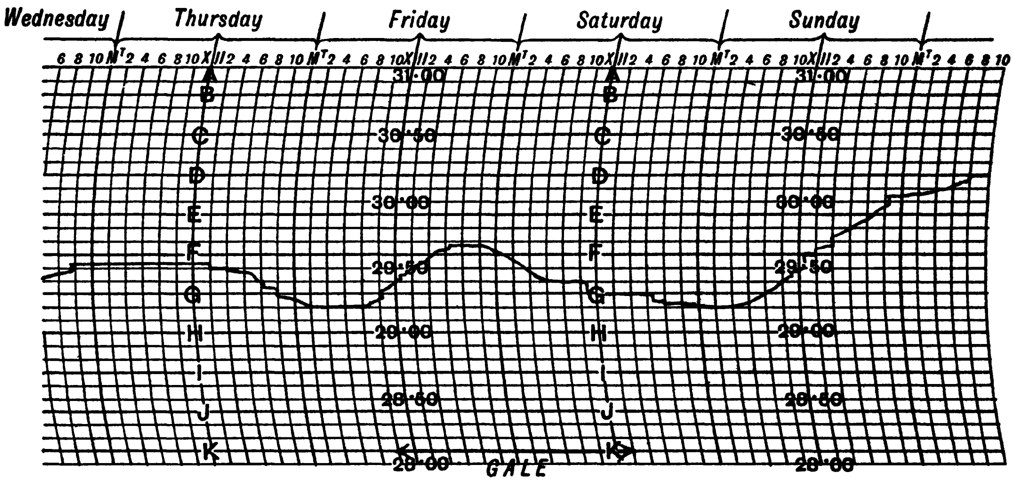


FIG. 46. BAROMETRIC (MECHANICAL)

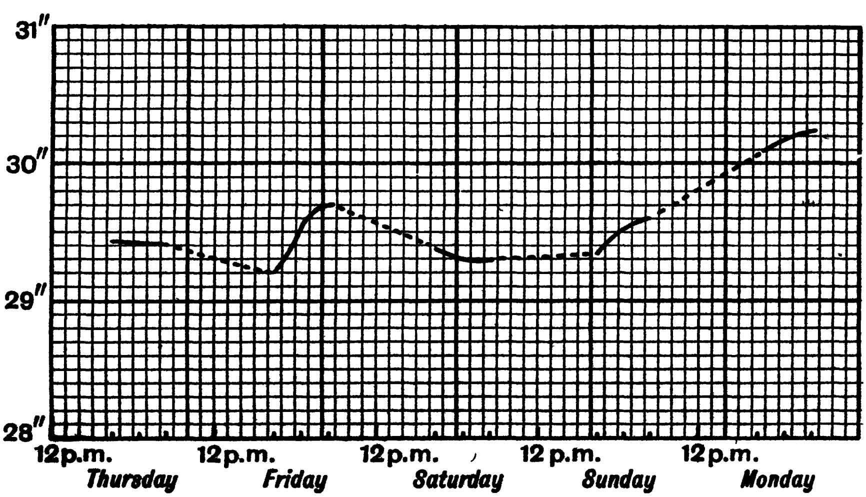


FIG. 47. BAROMETRIC (CHILD)

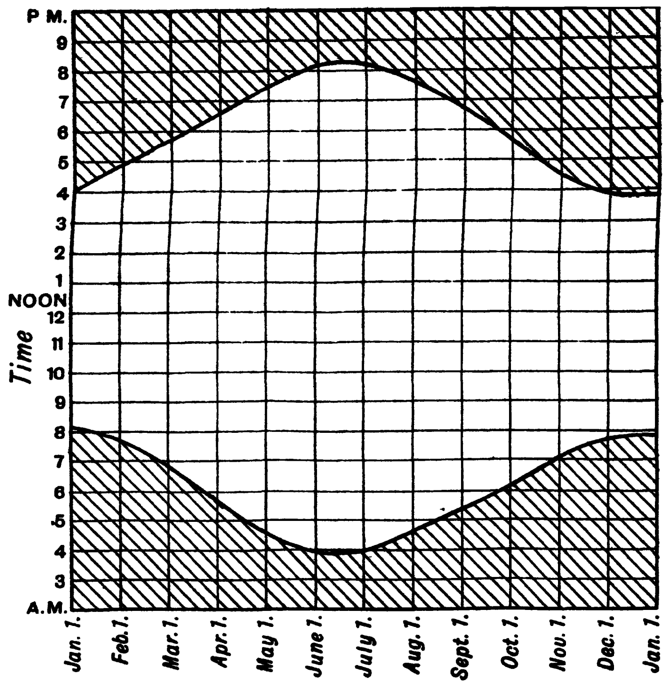


FIG. 48. SHOWING TIMES OF SUNRISE AND SUNSET

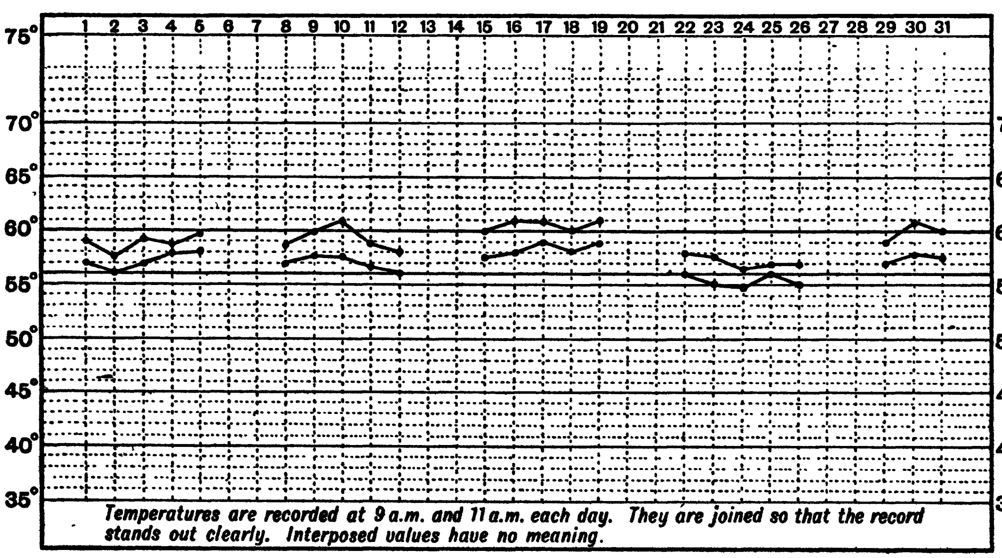


FIG. 49. RECORDING TEMPERATURES

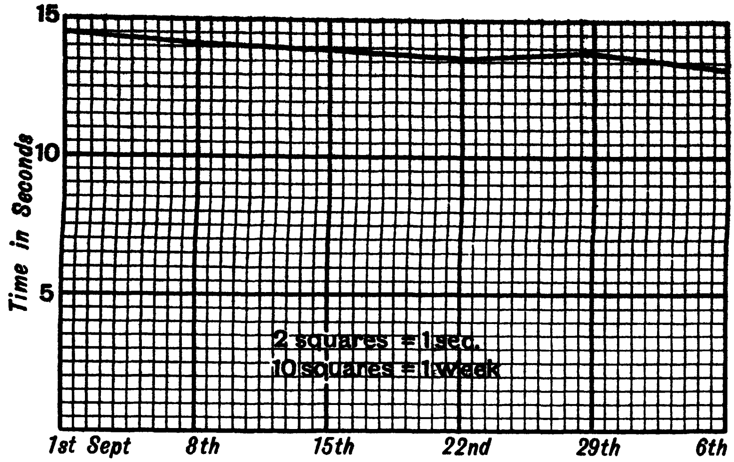


FIG 50 RECORDING TIMES FOR RUNNING

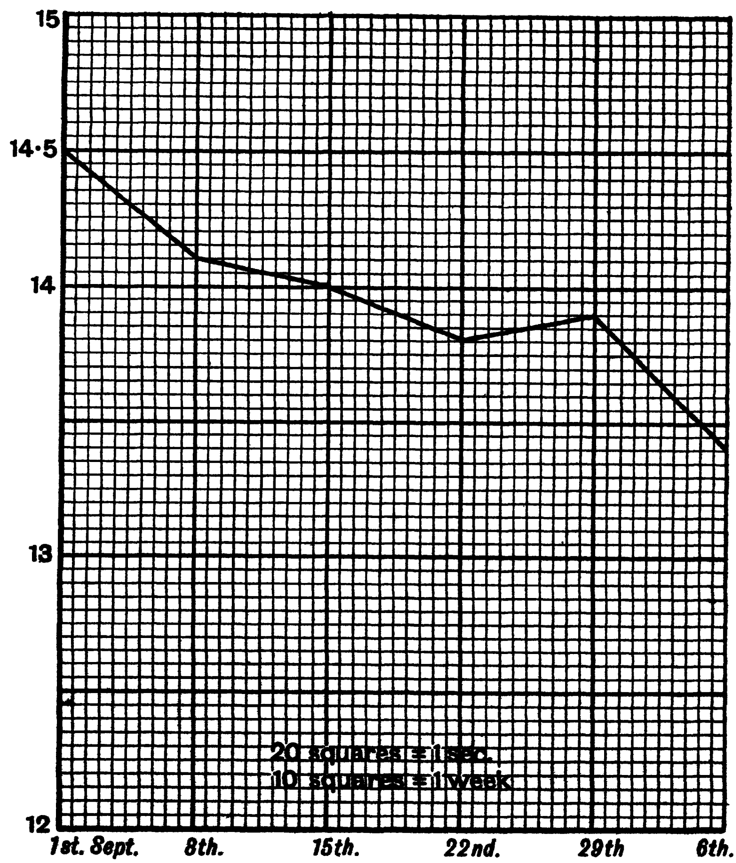


FIG. 51. RECORDING RUNNING, SHOWING MORE SUITABLE VERTICAL SCALE

III. *Discussion of other graphs and their uses.*—Some column graphs are drawn as though they were continuous graphs. The midday altitude of the sun can be recorded on successive days and a graph drawn. Strictly speaking, this should be shown as a column graph. The horizontal axis represents time; half-way between two middays there is a midnight when the sun has no altitude. Therefore columns should be shown for each midday, not a continuous curve. But the practice of entering the points for each midday and joining them by a curve has a value. It shows the rate of change in midday altitude more clearly than any other method.

Similarly, the times of sunrise and sunset throughout the year can be exhibited effectively in the form of a graph, Fig. 48. Average *monthly temperatures, annual imports and* exports, national debt over a series of years and many other topics can be used as examples. The classroom temperature chart affords useful material for discussion. A common practice is to record temperatures on squared paper at 9 a.m., 12 p.m. and 3 or 4 p.m. The 9 o'clock readings are joined up by lines. The 12 o'clock readings and the 3 o'clock readings are joined; so that the record for the month shows three lines across the squared paper, Fig. 49. From the mathematical point of view, this is a deplorable custom and causes confusion of mind among children, yet it serves a useful purpose. The efficiency of the school heating arrangements can be checked off by a quick glance at these classroom temperature charts.

Data for graphs in Figs. 50 *and* 51.

1. A boy is training for the 100 yards race. His times during six successive weeks are 14·5 secs., 14·2 secs., 14 secs., 13·7 secs., 13·8 secs., 13·4 secs. The graph is drawn to show his progress.

Exercise of a similar type:

2. A boy of 17 is training for high jump. His heights in six successive weeks are:

4 ft. 9 in.	4 ft. 11½ in.
4 ft. 10 in.	5 ft. 0 in.
4 ft. 11 in.	5 ft. 0½ in.

Find a suitable scale and draw a graph to exhibit these figures effectively.

STAGE 3. EFFECTS OF CHANGE OF SCALE

The children should experiment with various scales until they realise the points illustrated in Figs. 42, 50 and 51. This stage should be linked with the children's own experimental work in science or geography. Results should be expressed in graphs and the scales should be chosen so as to emphasise the essential points.

STAGE 4. GRAPHS OF SIMPLE FUNCTIONS

I. The straight line graph can be taught *in connection with proportion and used as* a "ready reckoner" for prices, percentages, wages, etc. Apart from these practical uses, it has little value for the majority of the children.

II. Those who learn how to express proportion algebraically (see Section XV, Stage 3) should also express it geometrically as a graph. Examples in travel graphs can lead to the discoveries:

That the graph of $y=kx$ passes through the origin; slopes upward; its steepness depending on the value of k.

That the graph of $y=kx+b$ does not pass through the origin; that its slope depends upon the value of k.

That the graph of $y=b-kx$ begins at the point O,b and slopes downward, its steepness depending upon k.

An example leading to the last discovery is:

Newcastle-on-Tyne is 273 miles north of London. An express train averages 60 miles an hour. Make an equation connecting its distance north of London, y, with the time since it left Newcastle, x, and draw a graph for x and y, Fig. 52. If the train leaves Newcastle at noon, when will it arrive in London?

Equation is $y=273-60x$.

The train reaches London at 4.33 p.m. (approx.).

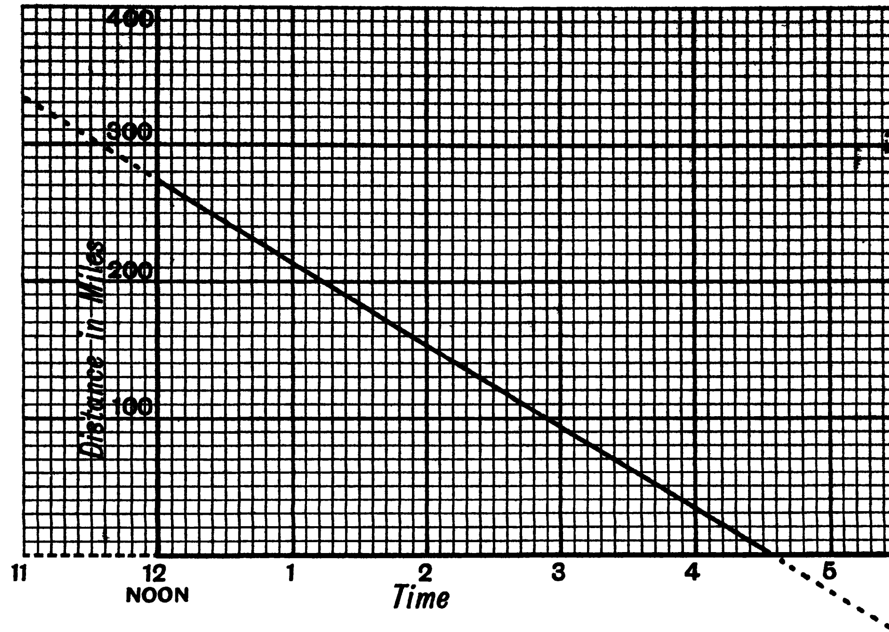


FIG 52. PROPORTION EXPRESSED AS A GRAPH

Note—Negative numbers can be introduced from this example (see Algebra, Stage 4). Proportion, Stage 6, and practical work on sun shadows and the measurement of heights should be linked up with these straight line graphs.

III. Other algebraic graphs can be explored, e g, the curve of squares; square roots, $y=10^x$ (in connection with logarithms); $xy=k$ (in connection with inverse proportion).

The time given to this should be strictly limited except for specially gifted children.

XII. APPLICATIONS TO EVERYDAY LIFE

Aims of the section.—This work is intended for children in their last year of school life. Isolated parts of it will have been done as applications of percentages, proportion and other sections of arithmetic, but the present aim is to give a wide survey of applications in everyday life so as to prepare the children to take their places as citizens and workers. In more detail the aims are:

1. To train the children in the understanding of English, the following of instructions and comprehension of what they read.

2. To develop in them the habit of looking at all sides of a question or problem; not jumping to conclusions or generalising from inadequate data; to give them practice in applying intelligence to the affairs of life.

3. To give opportunity for planning and organising projects such as schemes for a holiday or camp; for a group, at home or abroad; running a house or a business; organising a club; arranging a picnic or sports or a party. Such projects can be very simple so as to suit the slowest, or sufficiently difficult to satisfy the most gifted. Whatever the project, it must be carried out thoroughly,

planned in detail, fully reported, discussed and criticised so that full value is obtained from it.

4. *To give practical information about the* affairs summarised below so that the children may be able to deal with them, in a business-like way after they leave school.

Topics.—Selection from the following topics should be made to suit the particular children who are being taught. It is desirable to cover as many as possible, even when time is limited and little can be done in each topic. Girls and boys will differ in the emphasis placed upon particular topics, but men and women are concerned with all of them. An abundant supply of good examples of varied difficulty is essential. These can be obtained in many modern books or made by the teacher.

I. Post office.—Postage rates for letters, newspapers, parcels, to destinations in United Kingdom, British possessions and other countries.

Examples should be real and practical, such as the following:

Mr. Arthur Brown left London (or local town) and is now in America, at 263, West Avenue, New York. Wrap up a local paper, address it to him, weigh it and find out what postage is necessary.

A model post office should be made in a corner of the classroom and scales for weighing letters and parcels should be available. Lists showing postages; particulars about telegrams, telephones, postal orders, money orders; should be posted up. Telegraph forms should be available. These can easily be made by the children. Used stamps can be collected and "sold" from the class post office. A model "telephone" can be established and used for speech training as well as other purposes. Cost of call, length of call, and quarterly account all give material for questions.

EXAMPLES

Parcels.

1. Weigh a book that you wish to send as a present to Tom Jones, 4, Stanley Place, Plymouth. Find out what it would cost (*a*) by letter post; (*b*) by parcel post. Which would be the better method of sending the book?

Telegrams.

2. Mary was going to spend a holiday with her aunt who lived in the country. She was expected by a train arriving at midday on June 10th, but she was ill in the morning and could not start. Write the telegram to be sent to Mary's aunt and find out the cost.

Postal orders.

3. Jack Smith wishes to send 21*s.* 6*d.* to his mother, Mrs. T. B. Smith. Make out a copy of the postal order he would send. What would it cost him? What would it have cost if he had sent a Treasury note and 1*s.* 6*d.* in stamps, by registered post?

Telephones.

4. How much extra does it cost a man if he instals a telephone, his average number of local calls being 200 per quarter? the quarterly rental being £1 12*s.*

The difficulty of the questions can be adjusted to suit the children.

Project work connected with the post office has proved effective in stimulating very backward children.

Saving money.—In most schools there is some form of savings bank. Commonly this is run in connection with the Post Office Savings Bank. This can be made the basis of the lessons on saving and lead up to other methods of saving; e.g., paying into a deposit account at a bank, paying into an endowment insurance policy.

It is the saving of pence that is of greatest interest to a child, and Post Office arrangements make this possible. A money box called a home safe may be obtained from any post office for 1*s.*, which is repayable when the safe is no longer required. Small coins may be put into the safe or stamps may be bought and attached to books obtained from the post office.

Post Office Savings Bank.—In the Post Office Savings Bank interest is at 2½ per cent per annum; i.e., ½*d.* per £1 per month.

Interest is counted from the first day of the next month after the money is paid in. No *interest is paid on fractions of £1*. Single halfpennies are not counted.

Books and forms are available for saving by 1*d*. or 6*d*. stamps, for deposit in the savings bank or for purchase of National Savings Certificates.

Examples

1. Find how much interest is due on December 31 on the following account. The figures give the amount paid in and the date:

		£	s.	d.
Feb. 20	Two pounds, ten shillings	2	10	0
Apr. 10	Fifteen shillings		15	0
June 28	One pound, twelve shillings	1	12	0
Aug. 15	One pound, eleven shillings	1	11	0
Nov. 28	One pound, seventeen shillings	1	17	0

The working of this should be set out as follows:

Dates	Months	£ (complete)	Interest £ s. d.
Mar. 1—Apr. 30	2	2	2
May 1—June 30	2	3	3
July 1—Aug. 31	2	4	4
Sept. 1—Nov. 30	3	6	9
Dec. 1—Dec. 31	1	8	4
			1 10
	Interest = 1*s*. 10*d*.		

2. This is a copy of a page of a Post Office Bank book:

Date of Deposit or Warrant, etc.	Amount of Deposit in words or Number of Warrant in Figures	Amount of Deposit £ s. d.	Amount of Withdrawal £ s. d.
	Brought forward		
1937			
Mar. 12	One pound, ten shillings	1 10 0	
May 24	One pound, five shillings	1 5 0	
July 1			2 0 0
Oct. 19	Fifteen shillings	15 0	
Nov. 10	One pound, five shillings	1 5 0	
Dec. 15			2 0 0
	Carried forward	4 15 0	4 0 0

How much interest will be due on December 31?

How much would have been due if no withdrawals had been made?

3. A boy saves 15*s*. a month from his wages and pays it into a Post Office Savings Bank. How much will it amount to by December 31 if his first payment was made on August 31 and subsequent payments on the last day of each month?

National Savings Certificates.—These are a form of government security suitable when money is to be left to accumulate interest over a number of years. A certificate of the present issue (sixth) costs 15*s.* and becomes worth 20*s.* in ten years at the following rate of growth:

At the end of the first year, 3*d.* interest is added; during the second ½*d.* is added at the end of every completed period of 2 months; thereafter ½*d.* is added at the end of every completed period of 1 month up to the end of the tenth year. A bonus of 3*d.* is added at the end of the fifth year and a further bonus of 3*d.* at the end of the tenth year.

This represents a rate of interest of £2 18*s.* 4*d.* per cent per annum over the whole period of ten years.

No income tax is charged upon the interest on National Savings Certificates. The money invested in certificates may be withdrawn at any time together with any interest that may be due, provided that the holder is not under seven years of age.

Examples about National Savings Certificates are exercises in the understanding of English as much as they are exercises in calculations.

Examples

1. A man bought one certificate every two months for a year, beginning on June 21, 1936. How much would his holding be worth at the end of the third year, June 21, 1939?

2. A man wished to buy certificates so that at the end of 5 years they would be worth at least £200. How much money would he have to invest now?

Government annuities.—These may be obtained through the Post Office. The cost depends upon the age and sex of the annuitant and on the current price of 2½ per cent Consols.

Full details may be obtained from any post office, upon which questions such as the following may be based.

Examples

1. How much would a man of 55 have to pay, in a lump sum, for an annuity of £100 per annum?

2. If he lived until the age of 70, how much money would he have gained?

3. If he died when he was 60, how much money would he have lost?

II. Insurance.—(1) Life assurance; (2) endowment assurance; (3) annuities.

Another form of saving is to make regular payments towards the cost of an annuity, or of a lump sum paid to the holder when he reaches a certain age, or to his dependants if he dies before reaching this age.

A life assurance agrees to pay a certain *fixed sum of money on the death of the* person assured.

An endowment policy agrees to pay a certain fixed sum of money at the end of a given number of years or at death if it occurs before this time has elapsed.

An annuity pays a certain amount annually after a certain age has been reached. In the case of all three, payments may be paid weekly, monthly or annually. This form of saving is really an insurance. Various insurance companies have various arrangements and terms.

Particulars upon which questions may be based can be obtained from any company. The reading of an insurance company's prospectus affords good training but easily becomes tedious and boring.

Examples

1. A man aged 30 wishes to take out an endowment policy for £500 in 25 years. Look up the tables and find out how much he must pay per annum. If he dies a week after his fiftieth birthday, how much will he have paid altogether? If he had invested the amount of his premium each year, what would it have amounted to without any interest?

2. This is the same question applied to life assurance. What difference would it have made to have had a life assurance instead of an endowment assurance?

3. A man of 25 takes out an endowment policy for £200 payable in 25 years. How much must he save per week to pay his annual premium?

SIMPLIFIED TABLE SHOWING ANNUAL PREMIUMS FOR LIFE ASSURANCE POLICY AND PREMIUMS FOR ENDOWMENT POLICY, TO INSURE £100 (OTHER AMOUNTS PROPORTIONAL)

Age next birthday	Life Assurance (payable through life)	Endowment Assurance Payable at Death or in 15 years	20 years	25 years
	£ s. d.	£ s. d.	£ s. d.	£ s. d.
20	1 0 5	2 10 0	2 0 9	1 15 4
25	1 8 5	2 14 10	2 4 9	1 18 10
30	1 12 10	3 0 8	2 9 6	2 3 2
35	1 18 7	3 7 8	2 15 5	2 8 6
40	2 6 0	3 16 0	3 2 7	2 15 2

Insurances in general.—This is a topic as wide as life itself, for all things can be insured:

A house against fire.

Books, clothes, jewels, against theft, loss or damage.

A motor car against accidents.

A dancer's legs and a pianist's fingers against injury. (In 1937 Sonia Henje, the famous skater, insured her legs for £20,000)

A summer holiday against bad weather.

An individual against ill health or accident.

A ship against damage or loss.

Greenhouses against breakage by storm or hail.

Shop windows against breakage.

The subject is so large that teachers can give only the general principles underlying "insurance" and select particular examples for detailed study.

One of the best introductions to the subject is afforded by insurance against fire. Any householder may have to face the emergency of having house and furnishings destroyed by fire. Having to replace the lost property is a heavy expense and many would be unable to afford it. Therefore, householders combine together so as to provide against the danger of fire. All pay a small sum every year into a common fund, on condition that out of this common fund money shall be provided for rebuilding of property and replacement of furnishings damaged by fire. Those who own expensive property should obviously pay more per annum than those who own less expensive property. The premium to be paid is usually taken as so much per cent of the value of the property insured.

Properties more liable to damage by fire—e g , wooden buildings, cinemas, explosives factories—pay premiums at a higher rate because of their greater danger. The premiums are decided by study of the average risk; e g , if figures show that during a number of years the average damage by fire to 100,000 small houses, of average worth £500 each, was £25,000, it would mean that on the average £25,000 worth of damage was done, by fire, to £500 × 100,000 worth of property. Therefore, every householder should pay $\frac{\pounds\ 25{,}000}{500 \times 100{,}000}$ as premium on every £1 worth of property; that is, $\frac{1}{100}$s. per £1.

On a house worth £500, this would mean an annual premium of 5*s*.

An insurance company manages the affairs of the group of householders, collects average figures, finds the premium that should be paid for each type of property, collects the premiums, investigates the damage done by fires and pays out what is due.

Each insurer has responsibilities to his group. He must take reasonable precautions against fire. He must return true values for his property. Fraudulent fires have been staged by unscrupulous people for the purpose of gaining unfair benefits. Insurance company valuers have been bribed to return untrue values of the property damaged and its contents. In recent years, several men have been sent to prison for offences of this type. Insurance frauds should not be overemphasised but children should realise the responsibilities of the insured and the importance of "playing the game".

The insurance policy is the agreement which sets out what is to be insured, the risks against which it is insured and the premium to be paid. Disputes often arise out of misunderstanding of the conditions set out in the policy. The ordinary policy is too difficult to be of use for school purposes but children can be given practice in reading simplified statements.

Examples

1. The premium on a house for insurance against fire is 6*s.* 6*d.* per cent. of its value and, on its furnishing, 5*s.* per cent. What annual premium would be paid for a house valued at £500 with contents valued at £250?

2. How much would be paid to an insurance company on 100 houses like this, in 20 years?

3. A public building is valued at £25,000. What will be the annual premium paid for fire insurance at the rate of 9*d.* per cent?

Insurance of the luggage of railway passengers.—This affords a good example of the way in which premiums vary according to the risk and to the period covered by the policy and value of the goods insured.

RATES FOR PASSENGER LUGGAGE
(covering travel in Great Britain, Ireland and Channel Islands)

Period	Amount Insured				
	£20	£40	£60	£80	£100
15 days	1*s.*	2*s.*	3*s.*	4*s.*	5*s.*
3 weeks	1*s.* 9*d.*	3*s.* 6*d.*	5*s.* 3*d.*	7*s.*	8*s.* 9*d.*
1 cal. month	2*s.* 6*d.*	5*s.*	7*s.* 6*d.*	10*s.*	12*s.* 6*d.*

RATES OF PREMIUM FOR WORLD-WIDE INSURANCE

Period	Amount Insured			
	£25	£50	£75	£100
15 days	2*s.*	4*s.*	6*s.*	8*s.*
3 weeks	3*s.*	6*s.*	9*s.*	12*s.*
1 month	4*s.*	8*s.*	12*s.*	16*s.*
2 months	5*s.*	10*s.*	15*s.*	20*s.*

Examples on luggage insurance are of a simple, straightforward type; e.g.,

What would it cost to insure £120 worth of personal luggage for a month's holiday in Great Britain? How much more would it cost for a holiday abroad?

Terms and conditions can be obtained from any railway office if desired.

The composition of a letter to the insurance company, making claim on account of loss, is a good exercise in English.

Motor car insurance.—Insurance against the various motor mischances are the concern of everyone to-day. The conditions set out in the policies are of great importance to owners, drivers and passengers. Children at school cannot be instructed in all of these but they can learn to read intelligently. A class discussion on the risks against which a motorist should be insured is interesting and valuable. The importance of insurance against "third party risks" can be emphasised.

Examples can be based on extracts from the prospectus of an insurance company. The complete prospectus is too complicated for school use but the following is an example of a selected statement.

PRIVATE CAR POLICY

This covers:

(*a*) Third party indemnity.
(*b*) Legal defence (if required).
(*c*) Emergency treatment (after an accident).
(*d*) Loss of, or damage to, the insured car.
(*e*) Accidents to the insured in connection with the car.

The premium to be paid depends upon the car's value, its horse power and the purposes for which it is used.

Cars are divided into three classes:

Class I. Used for pleasure purposes only.

Class II. Used for pleasure and certain business purposes.

Class III. Used for any purpose except hiring, racing or pace making.

The table gives the annual premiums to be paid.

H P.	Class	Full Value of Car, not exceeding:			
		£200	£300	£400	£500
		£ s. d.	£ s. d.	£ s. d.	£ s. d.
9	I	12 2 6	12 7 6	12 17 6	13 12 6
	II	15 3 0	15 9 3	16 1 9	17 0 6
	III	18 3 9	18 11 3	19 6 3	20 8 9
12	I	12 12 6	12 17 6	13 2 6	14 1 3
	II	15 15 6	16 1 9	16 8 0	17 11 6
	III	18 18 9	19 6 3	19 13 9	21 1 9
15	I	15 7 6	15 12 6	15 17 6	16 2 6
	II	19 4 3	19 10 6	19 16 9	20 3 0
	III	23 1 3	23 8 9	23 16 3	24 3 9

EXAMPLES

1. Find the premiums on the following cars, for values stated:

(*a*) Standard; 9; Class II; £150.
(*b*) Vauxhall; 14; Class I; £200.
(*c*) Morris; 12; Class III; £200.

2. A bonus of 16 per cent is allowed if no claim has arisen during the preceding year. What premium would have to be paid for a 12 h.p. car worth £400, in Class I, if no claim had been made in the previous year?

A bonus of 15 per cent is allowed if no claim has been made in the preceding 2 years. What would this amount to for the above car?

3. A car, 15 h.p., valued at £500, in Class III, is laid up for 3 months in the winter. Because of this, the premium for insurance is reduced by $7\frac{1}{2}$ per cent. What would have to be paid?

4. If the person insured is prepared to bear the first £5 of damage, the premium is reduced by $12\frac{1}{2}$ per cent. Find the premium for a 12 h.p. car, in Class II, valued at £350, under this condition.

5. If an owner has two cars, the premiums for insurance are reduced by 15 per cent. What would be paid for the following two cars, both in Class I?

A 15 h.p. car valued at £450.

A 9 h.p. car valued at £200.

Policies for householders.—A domestic or "all-in" policy can be obtained to cover many other risks besides fire and is a very convenient form of policy for the average householder.

An "all-in" policy insures against:—Fire; explosion; lightning; thunderbolt; earthquake; burglary; theft; bursting pipes; riots; storm; flood; tempests; liabilities for accidents to servants, and other risks.

Premiums are based upon the value of the house and its contents. The usual rate is 5*s.* per £100.

A policy for house-owners, inclusive premium 1*s.* 6*d.* per £100, insures against most of the risks involved in owning house property.

Particulars can be obtained from an insurance company and from them examples made about the premium due in particular cases.

Insurance against bad weather.—This insurance is for holidays and open air functions.

These policies provide compensation in money for a holiday spoilt by rain; for losses suffered by caterers, exhibitions, festivals on account of rain.

The premiums depend upon the risks, and these vary, depending upon the season of the year; the number of hours per day for which insurance is required; the average rainfall of the place for which insurance is to be given.

The study of a prospectus for weather insurance makes an interesting lesson and examples can be based upon it.

National Health Insurance and Unemployment Insurance.—These are the concern of every worker of every age. As soon as children become "workers" they come under both Health and Unemployment Insurance. It is important that they should have a sense of responsibility with regard to them. School discussions can do much to develop the right attitude.

The current tables for both National Health and Unemployment Insurances should be obtained and used in the classroom. Examples on premiums to be paid and benefits received can be set in respect of a man or woman of any age.

Examples

1. A man has been employed for 4 years. How much will he have paid for health insurance in this time? How much will his employers have paid? If he then claims sickness benefit for 24 weeks, how much will he receive?

2. A boy aged 15 gets work and pays unemployment insurance for 1 year. How much will he have paid? How much will his employer have paid? If he is unemployed from 16 to 17, how much will he have drawn in benefit?

3. An employer has working for him 20 men; 8 boys; 10 girls (16–18); 5 women. How much will he have to pay for their unemployment insurance per week? How much will they pay per week altogether? How much would the employer pay per annum? How much would the employees pay per annum?

III. Wages and the laying out of money.

(*a*) Payment for work done is made in various ways; wages may be paid weekly or monthly; salaries are counted by the month or year; some workers are paid by the "piece"; some by commission on sales; some by a share of profits.

A first charge for most workers is insurances—health and unemployment. These provide material for many examples, easy and difficult.

Examples

1. Tom earns 12*s.* 6*d.* per week and is 15 years old. How much is left per week after unemployment and health insurance have been paid? How much does that come to in a year?

2. A man is paid £150 a year and 2 per cent commission on sales. He is paid monthly. How much would he get for a month during which he had sold £300 worth of goods?

(*b*) The laying out of money provides examples to interest all children. The sharing of expenses; the obtaining of discount; dividend at the co-operative stores; the keeping of accounts. Examples should be made to involve these matters; they should be applicable to the lives of the children.

Examples

1. Mary and Jean go to the seaside for a day together. They both take sandwiches. Mary buys the tickets for the train, 11*d.* each; Jean spends 6*d.* on fruit and 4*d.* on sweets and pays for tea, 5*d.* for each. How should they settle their accounts so that they pay equal amounts for their outing?

2. Mrs. Brown bought draperies costing £5 7*s.* 6*d.* from the co-operative stores, during three months. The dividend for that quarter was 2*s.* in the £. How much dividend did she get on her draperies? If she had bought the same things at Wilson's shop they would have cost £5 5*s.* and she would have got a discount of 1*s.* in the £. Did she lose or save by going to the stores?

3. A club of 240 members holds a special meeting. Notices are sent to all the members. 160 of them attend and pay 6*d.* each towards expenses. The hall costs 10*s.* for the evening. Refreshments are provided by a caterer at 4*d.* a head, for those actually present. The other expenses were postage, ½*d.* each for the notices; stationery and typing, 5*s.* 6*d.* Draw up a balance sheet showing the accounts for the meeting.

IV. Housekeeping expenses.—Household accounts; receipts and costs of food; buying in quantity; comparison of costs of home made and bought bread, cakes, pies, etc.

This section is well suited to girls who can get receipts from home or school, find out the current prices, work out costs of home-made foods and compare with costs of ready-made foods.

Household accounts can also be drawn up. This work should be done in co-operation with the domestic science teacher. Laundry and home washing can be compared; the examples are obtained from the home experiences of the girls and can be collected by them.

V. Heating a house and producing supplies of hot water.—This is of interest to both boys and girls.

Gas and the gas meter.—The reading of a gas meter and examples on the cost of gas can be used as a basis for a number of questions. The gas supplied is measured in cubic feet as it passes through the gas meter.

The meter has three or more dials, as shown in Fig. 53. The dial on the right indicates hundreds of cubic feet of gas. One revolution of the pointer records 1,000 cu. ft. The dial in the centre indicates thousands of cubic feet. One revolution of the pointer records 10,000 cu. ft. (The pointer moves in the opposite direction to the pointer of the

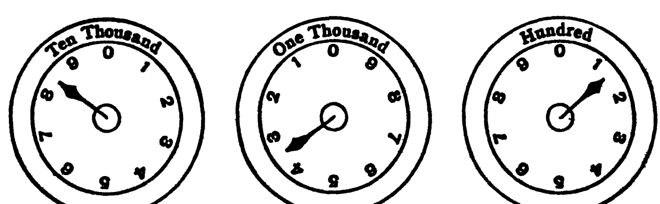


FIG. 53. DIALS OF THE GAS METER

former dial because its movement is produced by interlocking of cogs on the two wheels to which the pointers are attached. For this reason, the figures on the middle dial are reversed.) The dial on the left indicates ten thousands of cubic feet of gas. One revolution of the pointer records 100,000 cu. ft.

The reading as shown in the diagram is 83,100 cu. ft. Unless the pointer stands exactly opposite the number, the next lower number is taken.

Questions can be given on the reading of a meter or asking for a sketch of the meter to correspond with a given reading.

Examples of the following type can be worked:

If a gas company charges 3*s.* 8*d.* per 1,000 cu. ft., what would be the account for 25,400 cu. ft.? How much gas would be supplied for 1*s.* in a shilling-in-the-slot meter?

In practice, gas companies charge by another unit, the therm. This unit measures the heat value of the gas, so that customers pay for the heating value of the gas they get instead of paying for its volume.

A British thermal unit is the amount of heat required to raise the temperature of 1 lb. of water through 1° Fahrenheit. 100,000 of these units form 1 therm.

Gas is tested in order to find its heat value per thousand cubic feet. The calculation of the gas bill on this basis gives examples of greater difficulty than those given earlier.

Examples

1. Gas gives 5 therms per 1,000 cu. ft. and is charged at 7*s.* 8*d.* per therm. Find the amount to be paid for 80,000 cu. ft. of gas.

2. If a householder is allowed a cheaper rate (6*d.* per therm) for all gas in excess of 500 therms, and a discount of 10 per cent for early payment, what should be paid for a quarter in which 105,000 cu. ft. of gas were consumed?

Most gas companies have a domestic tariff on which their charges are based. This tariff sets out the number of therms for which full price has to be paid in houses of various sizes. Therms in excess of this basic number are charged at a much lower rate. Winter and summer have different tariffs. For example, in one town a house of 5 rooms has its first 40 therms at 7*s.* 8*d.* per therm, its next 40 at 6*d.* and all therms in excess at 3*s.* 4*d.* during the quarters ending in March and December. For the quarters ending in June and September, the number of therms at each price is 25.

Full details are given on the back of the gas account and this suggests examples of a third degree of difficulty. The teacher writes up a copy of the local gas company's tariff, so that all children can refer to it, and then makes questions such as the following:

A house has 6 rooms, excluding sculleries, bath rooms, lavatories and unfurnished attics. The meter shows that 170,000 cu. ft. of gas had been used in the quarter ending December 31. Read the domestic tariff and make up the account.

This third degree of difficulty gives exercise in the reading of forms.

Electricity and the electric meter.—Electricity is usually measured in watts; 1,000 watts is called a Kilowatt. The current used is charged at so much "per unit" and the unit is one Kilowatt. An electric meter measures the number of units used and indicates the total on dials.

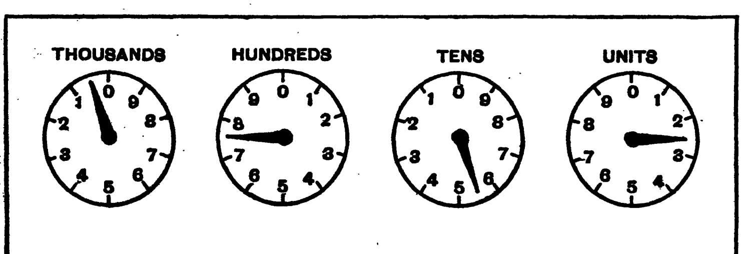


Fig. 54. Dials of the Electric Meter

The reading of the dials shown in Fig. 54 is 752 units.

Examples can deal with the costs for

electricity. The rate of charge for heating and power is always lower than the rate for lighting. There are two methods of charging:

(*a*) A "flat rate" of, say, 5*d*. per unit for lighting and, say, $\frac{3}{4}$*d*. for other purposes.

(*b*) An "all-in" tariff of so much per unit, say, $\frac{3}{4}$*d*., plus a fixed percentage on the rateable value of the property.

If the first method is used, two meters are installed.

EXAMPLES

1. Suppose a householder uses 120 units for lighting and 340 for other purposes, what would his quarterly bill be if 5*d*. per unit were charged for lighting and $\frac{3}{4}$*d*. for other purposes?

$$\left(\frac{120\times5}{12}+\frac{340\times3}{4\times12}\right)s. = 50+21\tfrac{1}{4} = 71s.\ 3d.$$

2. What would his bill have been if he had been charged on an "all in" tariff which charged $\frac{3}{4}$*d*. per unit and an annual charge of 10 per cent of the rateable value of his house, which was £80?

The various methods of heating can be made a basis for many projects.

Coal, gas, oil, electricity can be used in many forms of stoves, heaters, ovens and boilers. Information can be collected about methods used in the locality and relative costs worked out.

EXAMPLES

1. Central heating is installed in a house of 7 rooms. The boiler also provides hot water for the bathroom and kitchen. Coke for the stove costs 27*s*. 6*d*. a ton and 3 cwt. are burned per week during the winter. This heating system replaces 4 fires which burned a ton of coals (at 38*s*. per ton) in 6 weeks and a gas fire which was used for 2 hours per day and cost 1$\frac{1}{2}$*d*. an hour. How much would be saved per week by the new installation?

2. Is it cheaper to have gas from a shilling-in-the-slot meter or to pay by the quarter?

VI. House furnishings and decorations.—Decorations for walls:—Wall papers; friezes; borders; panels; ceilings; paintings.

Floor coverings:—Carpets; linoleums; borders; staining.

Furniture:—Loose covers; curtains; cushions; bedding.

Many textbooks use "carpets" and "wall paper" to illustrate "area," but that puts the emphasis in the wrong place. Children prefer to use area in the course of doing something else. Many short questions can be made on these topics but the most popular treatment is to base a project upon them. Girls thoroughly enjoy planning a house and working out sizes and costs for everything.

First, the plans of a house—ground floor and first floor—are to be drawn to scale. Then on a larger scale plans of all the rooms are drawn, showing how the floors are to be covered. If linoleum is to be used, its pattern, colour, size and quality are chosen from a catalogue or from the stock exhibited in a store. The method of laying it in each room is schemed and shown in the plan. If a carpet is to be placed in a room, it should be entered on the plan, the area of the "surround" and its treatment being then determined.

The paper for walls and ceiling can be chosen from a book of patterns. House decorators are willing to give to a school a discarded book of patterns of wall paper. This adds very much satisfaction to the girls in their project. Full particulars about each room and its costs should be written in a special note book.

A small sample of the papers selected may be cut from the pattern book and fastened into the notes about the room, with particulars about length required, its cost and cost of hanging. The colour of the paintings and their costs should also be given. Furniture for every room can be selected from old catalogues. The arrangement of the chief articles of furniture can be shown in the plans of the rooms. A list of the furniture and furnishings, and their costs, should be made for each room.

The scope of this project may be extended almost indefinitely.

The "hire purchase" plan for buying furniture can be discussed in connection with this project. When the girls are collecting particulars about furniture, they will get "cash" prices and "deferred payment" prices.

Examples:

A bedroom suite: cash price, 15½ guineas; deferred payments, 16½ guineas by 10*s*. monthly.

Dining room furniture: cash price, £7 19*s*. 6*d*.; deferred payments, £8 12*s*. 6*d*. by 5*s*. monthly.

Carpet: cash price, £5 9*s*. 6*d*.; deferred payments, £5 17*s*. 6*d*. by 5*s*. monthly.

Pianoforte: cash price, 38 guineas; or 38 monthly payments of 23*s*.

Questions about one or more articles can take the forms:

1. How much more is paid on the deferred payment plan?

2. How much per cent more than the cash price is paid on the deferred payments plan?

3. How much has to be paid each week?

4. If a man pays 12*s*. per week to a building society for the house he is buying through it, and 36*s*. per month for hire purchase of furniture, and 3*s*. a week for insurances, how much is left out of a weekly wage of £4?

The advantage and disadvantage of hire purchase schemes should be discussed as well as the importance of knowing the exact terms on which the goods are being supplied.

This project offers opportunity for discussions about many things besides quantities, qualities and costs, while at the same time it gives exercise in the use of mathematics when properly carried out.

VII. Buying houses.—The work of building societies and the benefits of owning the house one lives in should be discussed. Rents; freehold and leashold property; mortgages; ground rent; all these can be explained to the most intelligent children.

The most useful examples are those connected with building societies.

EXAMPLES

1. If a Building Society will advance 80 per cent of the value of a house, how much deposit will Mr. Brown have to pay for a house valued at £750?

2. A house whose advertised price is £600 can be bought by paying a deposit of £50 and a monthly instalment of £3 8*s*. 0*d*. for 20 years. How much will have been paid by the end of 10 years? By the end of 20 years? How much would the purchaser have saved by buying outright? What rate of interest (simple) has the Building Society received on its money?

3. A man bought 4 houses at £300 each. They were all let at rents of £18 per annum, exclusive of rates and taxes. If repairs averaged £5 10*s*. per annum on each house, how much did he get per annum? If he had been getting 3 per cent per annum on his money before he bought the houses, how much has his income been altered by the change?

VIII. Partnerships and companies.—Easy examples on these give practice in the comprehension of English and in working with percentages. They should deal with practical affairs of real life without the complexities of the Stock Exchange. The following is a suitable example:

Brown and Peel are partners in a grocery business. Brown provided £1,600 and Peel provided £2,000 of the capital. In the first year their profits were £950. They had to pay £120 in rent and rates; £12 for lighting; £20 for coal and coke; £90 for an assistant and £20 for other expenses. How much would each get if they allowed themselves salaries of £200 and shared the rest in proportion to their capital?

IX. Rates.—The meaning of rateable value should be given and the purpose for which rates are levied should be discussed. This is best done in connection with a course on civics. The arithmetic is straightforward.

EXAMPLES

1. If the rateable value of a house is £35 and the rates are 14s. in the £ per annum, what is the half-yearly rate?

2. From the statement given on the back of the rates notice, or in local reports, find how much your father, or landlord, paid towards Education last year.

X. Income tax.—*Income tax provides* examples in the understanding of English and applying it in examples. The official forms are not suitable, but examples can be made from them. The topic should be taken in connection with civics or history. The following is a suitable example:

A married man earns £400 per annum. A personal allowance of £180 is made in respect of him and his wife; i.e., there is no tax on the first £180. He has two children and is allowed a deduction of tax on £60 in respect of each. *How much tax will he have* to pay if income tax is 1*s*. 8*d*. in the £ on the first £135, and 5*s*. in the £ on the rest?

XIII. PRACTICAL WORK OUT OF DOORS

Topics and general points.—Outdoor exercises are of great interest and value. Most of them are concerned with geometry and mensuration. Suitable topics are:

Surveying—by chain; traverse surveying; triangulation; width of river and other distances.

Observations of sun and shadows; latitude and longitude; navigation and compass bearings.

Measurement of heights—accessible and inaccessible; contouring.

This work is seasonal; that is, it is best done during the part of the year when fine weather may be expected and should be planned for the summer months. It can occupy as much time as is available and care has to be taken lest time is wasted over it. The value gained from it is measured by the enthusiasm of the children, the quality of the work produced and the amount of initiative developed. The amount of time given has to be determined by each school to suit its own needs and environment.

Each topic provides problems of varied difficulty and affords interest to children of different abilities. "C" children can do some of the easy work in each topic and gain benefit from it.

Much of the work might be called practical geography. Its links with map making and map reading are obvious and it should be done in conjunction with geography. Most of the required instruments can be made in woodwork or handwork lessons. The previous knowledge required is ability to draw to scale and to measure and construct angles. Some of the later work should not be attempted until the children have learnt to make and use algebraic formulae.

Plane table.—Work in surveying often requires a flat, level table which can be placed at a suitable height, even on rough ground. The plane table provides this in a convenient form. The extending legs of a camera tripod are the base. The legs can be adjusted to any length between 2 ft. 3 in. and 4 ft. 6 in.—larger or smaller sizes can be obtained; they can be packed up into a compact package for carrying. A drawing board is fitted with a screw at the centre of one side, so that it can be fixed on to the top of the tripod, Fig. 55. The setting up of the table requires method and care. Instructions follow:

1. Extend the legs so that the height of the table will suit the observer.

2. Place the feet, roughly, at the corners of an equilateral triangle, so that the table is approximately level.

3. Affix drawing paper to the top of the table.

4. To level the table, loosen the screw which holds the board in place. Turn the board until the edge AB is parallel to

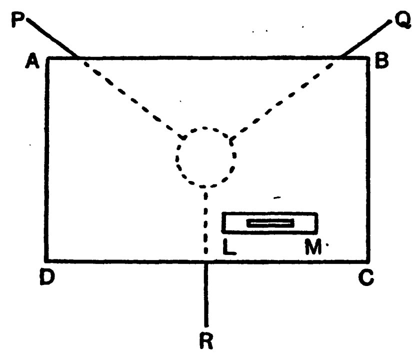


FIG. 55. PLAN OF PLANE TABLE

the line joining the feet P and Q. Place the spirit level, LM, parallel to this line (see diagram). Level the table from side to side in this direction. If L is higher than M, move the foot P further away from the foot Q, keeping it in the same straight line. Adjust the distance of P from Q until the bubble of the spirit level is in its central position. The table is now level in the direction AB; i.e., the edge AD is at the same height as the edge BC.

5. Turn the spirit level until it is parallel with the edge BC and the third leg. If B is higher than C, move R, the foot of the third leg, nearer the line PQ. Adjust the position of R until the bubble of the spirit level is in its central position. The table is now level in the direction BC.

6. Move the spirit level back to the direction of AB and check the level in this direction. The board is now level in all directions, having been levelled in two directions at right angles to one another.

In some plane tables, a spirit level (circular) is inset near one edge of the board. The same method of levelling, in two directions at right angles, can be performed.

SURVEYING

I. *Rectangular areas.*—The simplest piece of surveying is the measurement of a rectangular area or a space that can be divided into two or more rectangles. This can be done by the use of tape measures, 60 in. measures if longer ones are not available. School yards and recreation grounds provide suitable areas. Scale drawings should be made.

This work should be done in the first year.

II. *Surveying by survey lines and offsets—Introductory.*—It is best to begin with a very easy task, the aim being to establish an idea of the method; to show how to get a straight survey line; how to get suitable offsets, at right angles to the survey line; how to make a record of the figures.

Measurements may be made roughly by pacing, but for accurate work a long tape measure or a chain is needed. If paces are used, they should be the child's ordinary swinging step. Effort should be directed to keeping a uniform step, not to taking 1 yd. strides. The pace can be used as the unit throughout and the scale drawing made as so many paces=1 in. It is a good exercise to judge distances and then test by pacing them; the length of the pace having been measured.

The easy task may be mapping the side of a garden, or park, or the course of a stream or hedge. It should not extend for more than a short distance, nor involve more than three or four offsets. If the course of a stream is being mapped, offsets are taken at regular intervals along the survey line.

Laying out the survey line.—The beginning and the end of the survey line are called stations, and the line must lie straight from one to the other. To ensure this, poles are used. Any straight stick or bamboo 5 ft. to 6 ft. long will serve the purpose, but it is much more interesting to use proper ranging rods. These are 6 ft. high and alternate feet (or links) are painted black and white. A

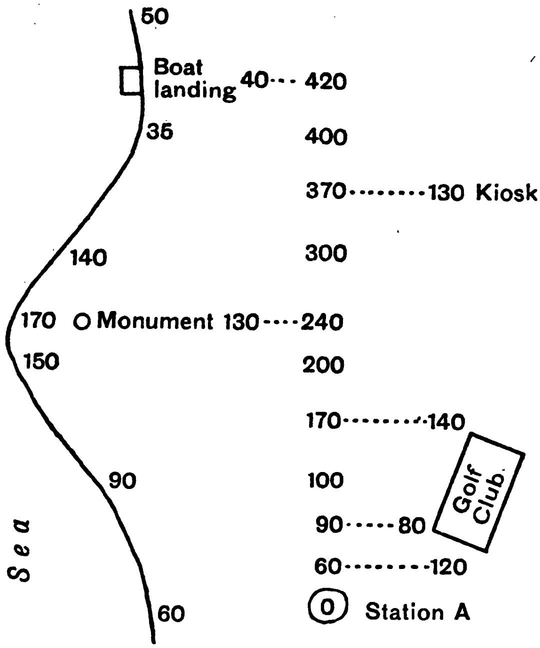


FIG. 56. MORE DETAILED SURVEYING, FIELD BOOK RECORD, WITH ROUGH SKETCH OF SHORE LINE

pole is held at the first station and another at the approximate position of the second station. One boy stands behind the first pole and directs the movements of another boy who carries out the end of the tape measure along the survey line. When the measure is stretched to its full extent, from the first station, along the survey line, a peg or arrow is placed to mark the point reached. The measure is left on the ground, lying straight while the necessary offsets are taken. The process is then repeated as often as is necessary. The work should be organised so that each child has a definite piece of work. The final position of the second station should be taken so as to get a convenient total length.

Taking the offsets.—All offsets are at right angles to the survey line; i.e., they are the shortest distance from the object to the line. They may be measured by a tape measure or a pole.

Entering the record in the field book.—Entries usually run from the bottom of the page upwards. Distances at which offsets are taken are marked in the centre column. Lengths of offsets are placed at the side and any desired note or sketch is added.

		End of line
		180
Statue	40	130
Band stand	24	90
Corner of courts	10	60
Corner of courts	20	10
		0
		Beginning of line

The children should make several simple surveys of interesting things in their neighbourhood.

III. *More elaborate surveying—Working on both sides of the survey line.*—The methods are the same. Longer distances can be undertaken gradually. Offsets should be exactly at right angles to survey lines and should be tested by the 3, 4, 5 triangle method, Fig. 56.

The above gives an example of field book entries. For older children working at this stage it is desirable to have a chain.

The chain is 22 yds. long. 10 sq. chains = 1 acre. It is composed of 100 parts called links. 1 link = ·66 ft., Fig. 57.

Every tenth link is marked by a triangular tablet of brass except the fiftieth, which carries a rounded tablet. The tablets bear points to indicate their distance from the end of the chain. The first and ninth have

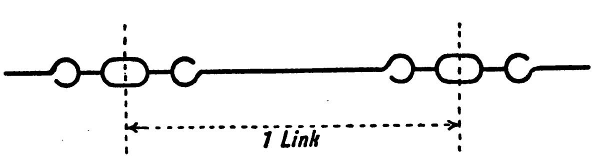


FIG. 57. SECTION OF A CHAIN, SHEWING ONE LINK

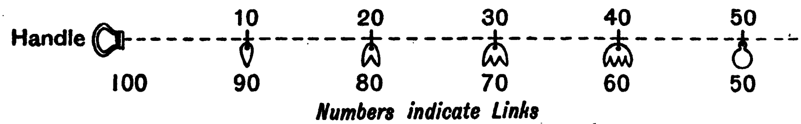


FIG. 58. TABLETS USED IN A COMPLETE CHAIN

one point; the second and eighth, two points, etc., Fig. 58.

Some preliminary practice is required in the handling of a chain. Properly "rolled up" and skilfully managed, it gives no trouble but endless tangles can arise if the chain is treated carelessly.

The survey of a triangular field is a good exercise.

Survey lines AB, BC and CA are laid down. Their lengths are found and this gives data for the construction of the triangle. DE is measured and used as a check line, Fig. 59. Sufficient offsets are made from AB, BC and CA to enable the actual outline of the field to be sketched in.

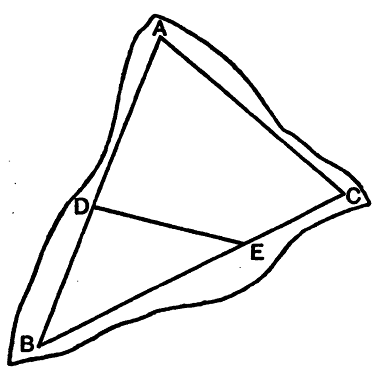


FIG. 59. SURVEYING A TRIANGULAR FIELD

IV. *Measurement of area.* (*a*) This can be done by drawing the plan on squared paper and counting the squares. An estimate can be made of the mutilated squares around the boundary. This method is tedious and care has to be taken about the units used, and the scale.

(*b*) *The method of mean ordinates* is usually better for an irregular piece of land.

The plan is divided into a number of vertical strips of equal width. The greater the number of strips the more accurate the result. The mid-line of each strip is dotted in and measured. The average length of these mid-lines is found and converted into yards or chains. This is multiplied by the width of the figure, in the same units.

(*c*) *By division into triangles.*—The area is divided into triangles, care being taken to place the lines so that any area left outside the triangles is, as nearly as possible, equal to the extra area included in them, Fig. 60.

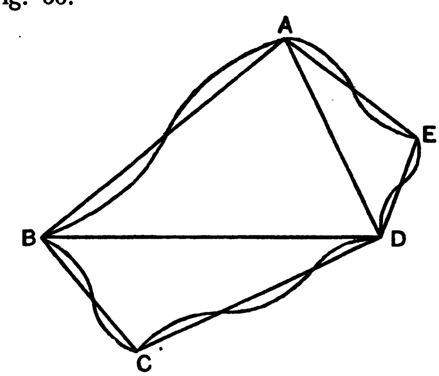


FIG. 60. DIVIDING A FIELD INTO TRIANGLES

Area of each triangle is equal to ½ base × vertical height.

V. *Surveying by plane table.*—The simplest form of plane table is not expensive and is well suited to use by the oldest children. It consists of a drawing board mounted upon a tripod and furnished with spirit level and compass, either as fixtures in the board or loose. Any compass and spirit level may be placed on the drawing board. A "sight" consists of a wooden base graduated in inches and tenth of an inch, or in centimetres and millimetres. At each end is a hinged metal upright which can be folded over when not in use. The front upright is a metal frame across which a fine vertical wire is stretched. The back upright is a metal plate with a narrow vertical slot, Fig. 61. The observer looks through the slot and turns the sight until the wire is seen to coincide with the object being sighted.

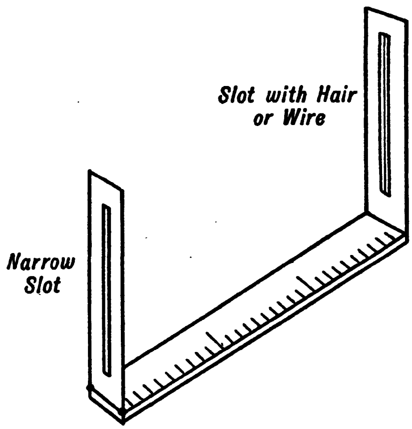


FIG. 61. "SIGHT" OF A PLANE TABLE

The plane table may be used for making a plan of a field or park or garden.

(*a*) A base line AB, of suitable length, is laid down. The plane table is set up over the point A and levelled. Drawing paper is fixed upon it and the compass bearing is marked. A ranging rod is placed at B.

(*b*) A point A is marked on the drawing paper in a suitable position to represent the end A of the base line.

(*c*) The edge of the sight is placed so as to pass through the point A on the paper and the sight turned until the ranging rod at B is sighted. A line is drawn through A in the direction of B. A suitable scale is chosen and the position of B is marked on the paper.

(*d*) Other prominent features of the garden or field are sighted and their direction from A is drawn on the paper. Every line must be carefully marked—"to corner C," "to flag," "to oak tree." Assigning letters to the features that are sighted is a good idea because it simplifies the writing on the plan. Obviously a careful "key" must be kept at hand.

(*e*) The plane table is moved and set over the point B. It is levelled and turned so that the line AB on the paper points towards the station A. (The ranging rod should have been moved from B to A.) Check the position by the compass.

(*f*) All the points previously sighted from A are now sighted from B, with the edge of the "sight" passing through the point B on the paper. Lines are drawn through B to show their directions and each line is carefully labelled.

(*g*) Two lines have been drawn towards C, one showing its direction from A and the other its direction from B. The point of intersection of these lines gives the position of C. All the features that have been sighted may now be marked on the plan by a similar method.

Great care must be taken that the plane table is not moved once its position has been fixed.

The method is interesting, but it is difficult to avoid moving the plane table when sighting and drawing, especially when children are checking one another's readings. It is wise not to attempt to enter many points; four are quite enough at first.

VI. *Survey by angle measurements from a base line.*—This is a variation of the plane table method.

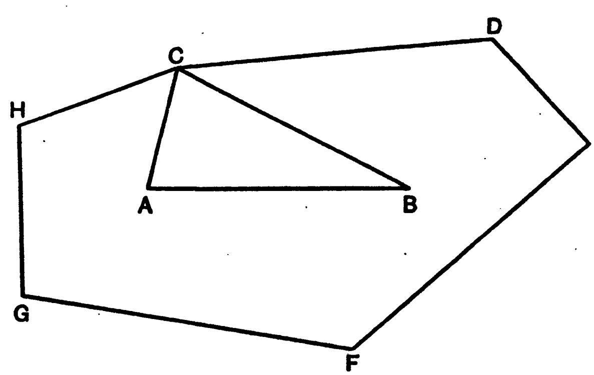


FIG. 62. SUITABLE POSITION OF BASE LINE A B FOR ANGLE MEASUREMENTS

The simplest form of apparatus consists of a large circular protractor, graduated on both sides from 0° to 180°, fixed to the centre of a drawing board which is fitted with a screw underneath, so that it can be mounted on a camera (tripod) stand. The circular protractor may be drawn on thick paper or thin card, and gummed or glued to the board.

The sighting may be done by a "sight" such as is used on the plane table, or by means of a card. A postcard, sufficiently thick to remain flat, serves the purpose.

A base line AB is laid down in a convenient central position, Fig. 62. The table bearing the protractor is erected at A, so that the centre of the protractor is exactly over A. A plumb line, hung from the screw holding the board in position, makes this possible. The table is levelled as described before. The screw holding the board is loosened and the board turned until the zero mark of the protractor points to a ranging rod at B. To do this, two children work together; one holds the card in the vertical plane so that its edge rests along the 0°—180° line of the protractor; the other sights along the surface of the card and turns the table until B is sighted along the card. The edge of the card must continue to lie along the 0°—180° line, the 0° mark pointing towards B; the table must remain level. These two conditions call for very careful co-operation between the two children. Having got the board into the right position, they tighten its screw, test to see that it is level and then begin to sight the points, C, D, E . . ., that are to be mapped. One child holds the card, vertically, with one edge resting on the protractor and passing through its centre, and turns it until he sights C along its surface. The other child watches the position of the edge of the card, making sure that it continues to pass through the centre of the protractor, and reads the angle CAB (PÂO). The children then change over and repeat the observation. Other points are sighted in the same way and careful records of the angles are kept. The board and tripod are then moved to B and the same process of setting up, levelling and sighting is carried out, the zero mark pointing to A.

At B the angle CBA is measured. Full information has now been obtained about the triangle ABC. The length of the base line AB has been measured and the sizes of the angles CAB and CBA. The triangle can be drawn to scale and the distance of C from A (or B) determined.

The other points, D, E, F . . ., are also sighted from B and their angles measured.

At first it is wise to limit the number of points to two or three, on one side of the base line. Practice is required before accurate results can be obtained and it is better to be successful with a few points than to attempt many and get an inaccurate map. After the children have shown themselves capable of managing the table and taking sights, they can attempt a survey similar to the following example. After all the angles have been measured, the magnetic direction of AB is noted and a map drawn from the data.

Results obtained by sighting with a card are reasonably good if great care is taken, but work is more satisfactory if a "sight" is used. The Field Book must be kept with great care. It is wise to draw out a form beforehand, so that the angles can be entered in the appropriate places as they are measured.

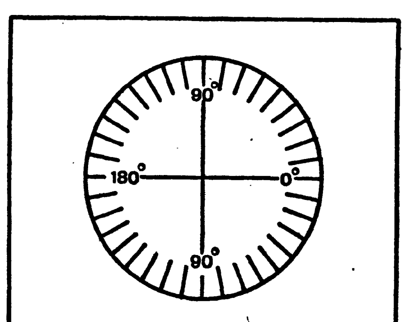


FIG. 63. FORM OF PROTRACTOR

The protractor should be numbered clockwise and anti-clockwise, in degrees, from 0 to 180, Fig. 63. Its centre must be placed at the centre of the drawing board.

The card stands, on edge, along the line AP, A being vertically above the station A and O being the zero mark on the protractor, Fig. 64. If a "sight" is used its central line must pass through A (the centre of the protractor).

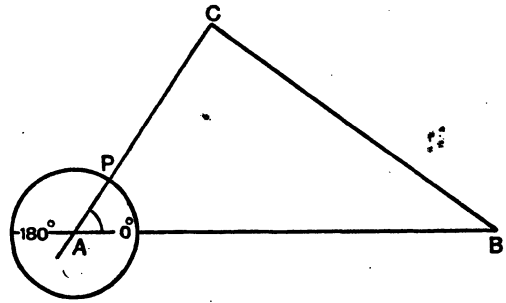


FIG. 64. DIAGRAM TO ASSIST IN USE OF CARD

RECORD IN FIELD BOOK—SURVEY OF PART OF A PARK (FIG. 65)

BASE LINE AB 3 CHAINS	BEARING E. AND W.	
	Angles	
	Sta. A	Sta. B
Points N. of AB		
Band stand	70°	35°
Top of hill	55°	80°
North end of lake	25°	120°
Points S. of AB		
Boat landing	15°	140°
South end of lake	40°	105°
Summer house	65°	60°
Gate of park	115°	20°

VII. *Survey by compass bearing from a base line.*—This is a variation of the last method. Instead of measuring the angles CAB, CBA, by means of a protractor, the compass bearing of C and B from A, and of C and A from B, are determined. From these the required construction is made.

The easiest way to find the bearing of B from A is to place the drawing board over the point A; hold the sighting card so that its edge passes through the centre of the board; sight B; place three dots to indicate the position of the edge of the card; remove the card and join the dots by a line; place the compass with its centre on the line and so determine the direction of the line; i.e., the bearing of B from A.

In similar fashion the bearing of C from A can be found; the plan is drawn on a separate sheet of paper.

The correct method of doing magnetic triangulation is more complicated and is not well suited for school purposes.

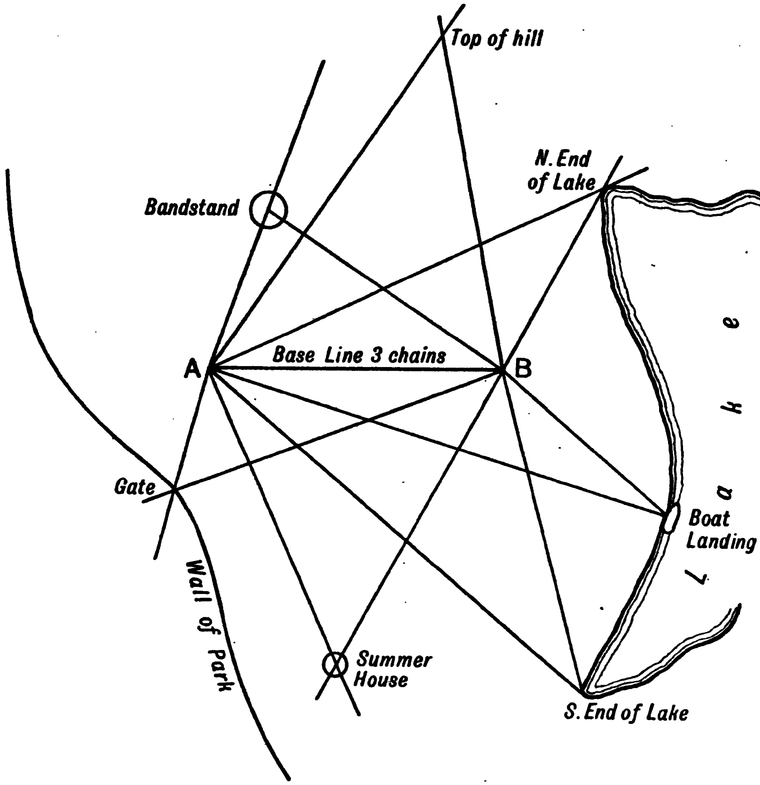


FIG. 65. PLAN OF PARK SURVEYED SHOWING "SIGHTS" TAKEN

VIII. *Measurement of the width of a river.*—It is assumed that the children can work along one bank of the river. A conspicuous point on the opposite side is chosen and called P. A point A immediately opposite, and a few feet from, the water's edge is chosen and a line AC is laid out along the bank. The angle PAC is made a right angle. To do this, a post is erected at A. Another is set up so that the two posts are in a straight line with A. A right angle is set out from the line joining the two posts and this gives the direction of the line AC. Its length is determined in most cases by the space available; about twice the width of the river is a convenient length. In this example, 100 steps are taken.

At the middle point of AC a vertical post B, is erected. At C a line CD is set out at right angles to BC. Posts are set up at C and at D. D is placed so that it is in a straight line with both CD and PB.

CD is equal to PA.

Width of river equals CD less by the distance of A from the edge of the river.

If the space on the bank is limited and does

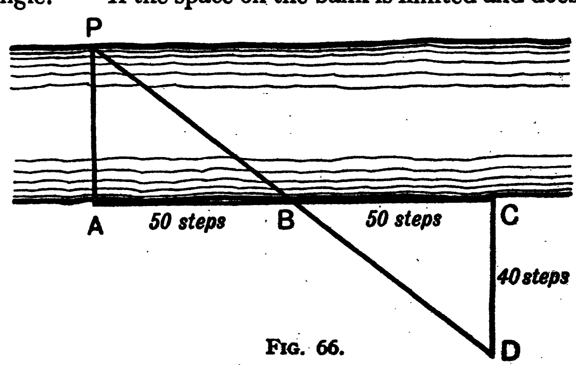


FIG. 66.

not allow D to be far enough back, a modification can be made. B can be placed so that BC is $\frac{1}{3}$ of AC. Then CD=$\frac{1}{3}$ width of river.

A similar method can be used for measuring distances of other inaccessible points.

OBSERVATIONS BY SUN AND SHADOWS

I. *Movements of the sun—Measurement of latitude.*—As a piece of general knowledge children should know something of the apparent movements of the sun and the seasonal changes. Four times in the year observations should be made; on the longest day, the shortest day and at the equinoxes; or as near these dates as possible. By the younger children the record may be made roughly by chalk marks on the school yard or by pegs in the playing field. By the older children the record should be made accurately on a plane table.

In the yard or field, any stationary upright post may be used to cast the shadow as long as it is placed in an open position. Preliminary observations should be made to ensure that the end of the shadow can be marked throughout the day. On the plane table, a short hat pin with a small head gives a good shadow with a clearly marked end.

In both cases, the end of the shadow should be marked every half hour during the day; the direction, length and time of the shortest shadow should be noted; the directions and lengths of the 9 a.m. and 3 p.m. shadows noted; the times of sunrise and sunset should be added to the record. The older children should preserve their plane table records, with the N.–S. line marked upon them.

At the end of the year the four sets of observations should be compared and lessons based upon them. The conclusions drawn by the children depend upon their age and intelligence. If the work has been done in the first year, the children will learn where the sun rises and sets at different seasons; how the length of the day varies; how the sun appears to move in the sky. "A" stream children will enjoy making experiments with a globe and a lamp and discovering the reasons for the season alchanges. "C" stream children will not be interested in the reasons but they are interested in the facts. If the work has been done during the last year, it will have been done on the plane table by the better children. They should verify the reasons for the seasonal changes by working individually with the globe and a lamp. The best children can work out the connection between the angle of elevation of the sun at midday and the latitude of the place of observation. This is easiest at the equinoxes.

At the equinox the sun is vertically overhead at the equator.

$S\hat{P}W$ is midday angle of elevation of sun at P.

$90° - S\hat{P}W = P\hat{O}W =$ latitude of P. (S. represents sun's ray). Fig. 67.

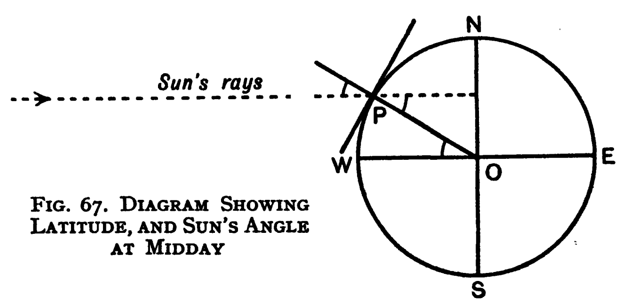


FIG. 67. DIAGRAM SHOWING LATITUDE, AND SUN'S ANGLE AT MIDDAY

At other seasons, the latitude of the places where the sun is overhead at noon has to be added or subtracted. Except at the equinoxes, the situation is too difficult for senior school children unless much time can be given to it.

II. *Time of shortest shadow and longitude.*—The fact that sun time and clock time differ by an hour during the summer months can be dealt with quickly because children know about "altering the clocks." When necessary, this difference of one hour must be corrected. Unless the school is near the Greenwich meridian, the effect of differences in longitude can be shown. In places west of the meridian, the shortest shadow is thrown after 12 o'clock and in places east of the meridian, before 12 o'clock. 360° of longitude correspond to 24 hours; i.e., each degree of longitude means 4 minutes. When the shadow is recorded on a plane table, carefully, the difference of a few minutes is perceptible and longitude can be estimated roughly.

Example.—If the shortest shadow is cast at 12.10, the place is west of Greenwich by $\frac{10}{4}$°; the longitude is W. $2\frac{1}{2}$°.

A difficulty may arise because of the "equation of time." Midday by sun time is the moment when the shadow points due north and is at its shortest. At Greenwich, on the average, sun time and clock time agree; 12 by the clock and midday by the sun are at the same time, but on any particular day this is not exactly so.

Examples.—On June 21st, 1937, the sun rose at 3.42 a.m. and set at 8.21 p.m. at Greenwich (summer times 4.42 a.m. and 9.21 p.m.). It reached its highest altitude at 12.2 p.m. by clock time. The equation of time was 2 minutes.

On March 21, 1937, the sun rose at 6.2 a.m. and set at 6.14 p.m. It reached its highest altitude at 12.8 p.m. clock time. The sun was 8 minutes slow by clock time. Equation of time was 8 minutes.

The difference is never large but it can be disconcerting when the children are doing careful work on the plane table. It is advisable to look up the equation of time in *Whitaker's Almanack* for the date of the experiment. If the difference between sun time and clock time at Greenwich is large enough to produce a perceptible effect on the results, the children should be told that at Greenwich clock time is ahead of sun time for part of the year and behind it for the rest of the year. Hence our "Greenwich mean time."

Another difficulty may arise from the fact that true north is not exactly the same as magnetic north. The angle between the two is called the magnetic declination. It varies slowly from year to year and should be looked up in *Whitaker's Almanack.* When the sun is at its highest point, it is due S., and the shadows point due N. The angle of declination can be read off by placing a compass on the plane table and comparing its direction with the direction of the shortest shadow.

III. *Applications in navigation.*—In some schools it is profitable to follow up this work by its application in navigation and exploration. How to find out when it is noon at any place; how to find the latitude and longitude of a place; these are interesting topics. The principles have been dealt with under the two preceding headings, but the detailed adjustments and precautions and the use of the sextant require special treatment.

IV. *Use of sun shadows for measurement of heights.*—This work is best suited to older children. It is introduced by having a number of vertical sticks whose shadows can be marked on the ground or on a plane table, Fig. 68. The end of the shadow is marked at a definite time for all the sticks and the lengths of the sticks and shadows recorded. The children can work in groups of three or four. It is usually possible to provide sticks or uprights for the whole class. The sticks should be of various lengths, so that each group of children makes its own size of triangle.

Triangles are drawn to scale and their angles measured. The children find that they all get the same angles in their triangles and

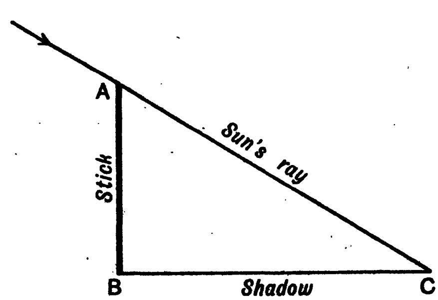


FIG. 68. USE OF A SHADOW TO MEASURE HEIGHT

that the ratio of length of stick to length of shadow is the same in every case.

This is a good method of introducing similar triangles. The children should be told about the measurement of heights by means of shadows in Ancient Egypt. It is a good exercise for them to apply the method, working out the details for themselves, and finding the height of the school or some other building.

V. *Measurements of the size of the earth.*—"A" stream children can be told about the first measurements of the size of the earth, made by Eratosthenes about 200 B.C. Two towns, Syene and Alexandria, were on the same meridian of longitude and therefore had noon at the same moment. On the longest day of summer, when noon shadows were shortest, the angle of elevation of the midday sun was 82½° at Alexandria. At the same moment, at Syene, there was no shadow at all. The midday sun was directly overhead and was reflected in the water of a deep well. The towns were 500 miles apart. Therefore 500 miles is $\frac{7\frac{1}{2}}{360}$ of the earth's circumference, Fig. 69.

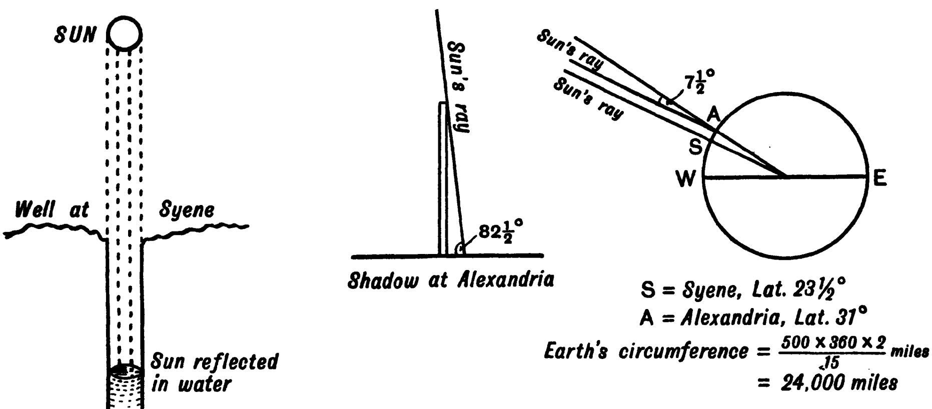


FIG. 69. EXPERIMENT OF ERATOSTHENES

MEASUREMENT OF HEIGHTS

Several methods can be used in schools and a selection should be made according to circumstances. The easiest methods are not necessary as a preparation for the later ones. All depend upon sighting and practice in this is required before good results can be obtained.

I. *Sighting by means of a 45° set square.*—This method is not easy. A point is found from which the angle of elevation of the top of the building is 45°. The height of the building is equal to the distance of this point from the foot of the building. The height of the eye of the observer must be added, Fig. 70.

II. *Sighting by means of a post.*—Two children work together. One stands at a distance from the object to be measured—say, a monument CD. Let AB represent the first child. A second child, directed by the first, places a post or ranging rod, EF, so

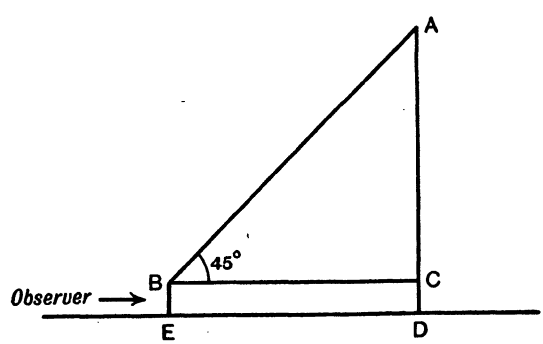


FIG. 70. MEASUREMENT BY 45° SET SQUARE

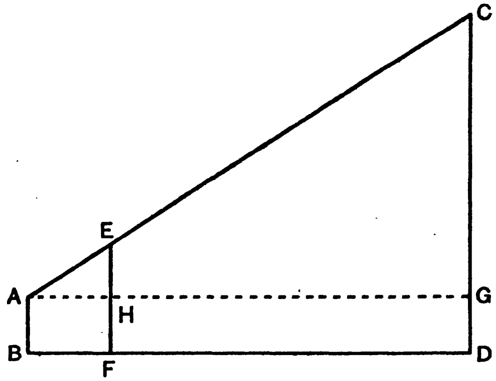


FIG. 71. USING A POST FOR MEASURING HEIGHTS

that F is in a straight line with B and D, and E is in a straight line with A and C. The distances FD and BF are measured and the heights AB and EF. The triangles AEH and ACG are then drawn to scale. CG is measured and AB added, Fig. 71.

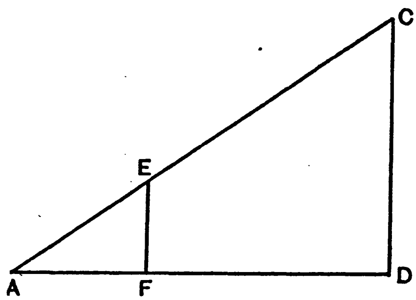


FIG. 72. USING POST AND GROUND LEVEL IN FINDING HEIGHTS

If preferred, the whole diagram can be drawn to scale.

A variation that appeals to small boys is to erect the post and find a point A, on ground level, from which E and C are seen to be in line. The distances of this point from F and D are then measured, Fig. 72.

These methods can be used by children who can draw triangles to scale.

III. *Measurement of accessible heights by means of a clinometer.*

(*a*) For this, the children make their own clinometers. Pieces of card about $4\frac{1}{2}$ in. by 6 in. are required. The card should be sufficiently thick to carry pins for sighting. Each child draws a protractor on his card, marking in every 5°. The diameter should be between 6 in. and 5 in. long, and the lines marking every 10° should be produced beyond the line of the semi-circle.

A plumb line carrying a button or ring or other small weight is hung from the centre O. Ordinary pins are placed at A and B to serve as sights, Fig. 73.

(*b*) The children practise the use of the sights and become accustomed to the movement of the plumb line. They learn to say, "When AB is horizontal, the plumb line hangs over the 90° mark. When AB is

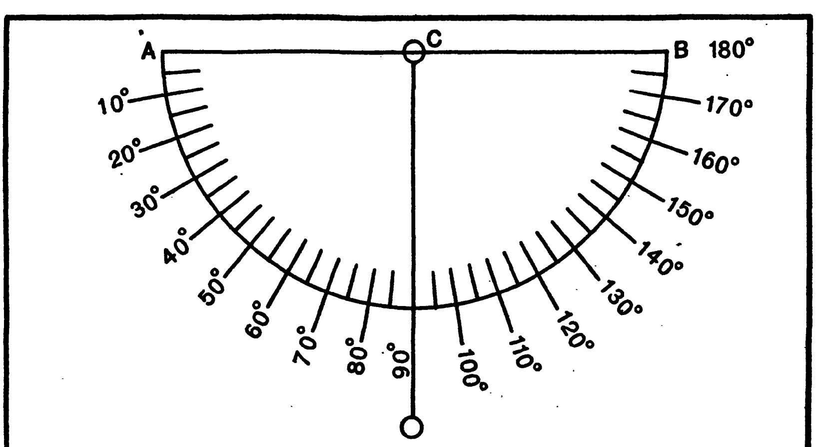


FIG. 73. SIMPLE CLINOMETER

turned through 40°, the 90° mark has turned through 40° so that the plumb line hangs over 50° or 130°."

(*c*) After drill in this, they are ready to discuss the use of the clinometer for measuring heights; e.g., the height of the school, Fig. 74.

If the boy holds AB horizontally, so that the plumb line is over 90°, and sights the school wall, he sees a point C at the same height from the ground as his own eye.

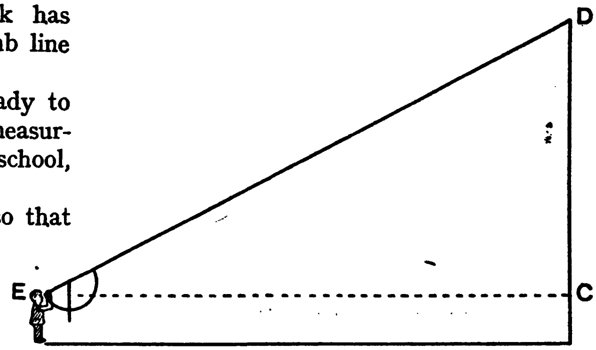


FIG. 74. USING A CLINOMETER

If he turns AB so that it points to D, he has turned it through the angle CED and the size of this angle can be read off from the position of the plumb line.

Having found the size of the angle, he requires only the length of EC, i.e. his distance from the wall. He can draw the triangle DEC to scale and read off the length of DC. The addition of his own height to CD gives the height of D above the ground.

(*d*) Having got the idea of what is to be done, the class should discuss the organisation of the work. The children can work in groups of three. Everyone takes a clinometer; every group takes a note book and pencil and a piece of chalk; the sharing of tape measures is arranged. When the group goes out into the yard, it choses its station, marks it in chalk with a cross and initials. In order to observe the angle, one child sights the top of the school, holding the clinometer steadily; the second child reads the angle; the third child makes a record of the angle; the children change places and repeat. In this way each group makes three readings of the angle and the children check one another's work. The distance between the station and a point on the ground, vertically below the high point sighted, is now measured three times by the group, the children taking turns in measuring and recording. The children should not go out until everyone is clear about what is to be done.

(*e*) The children go into the yard and make their observations. When they have all the data, they return to the classroom, draw the triangles to scale, determine the height of the school and write the result on the blackboard.

(*f*) After all the results are entered, a class discussion is of value. There will be variation, though most of the results will lie within a small range. Figures that are obviously astray should be discarded and the average of the others calculated. This gives the class result. The degree of accuracy should be discussed.

IV. *Measurement of inaccessible heights by means of base line and clinometer.*

(*a*) A base line pointing towards the foot of the inaccessible object should be laid down. A church spire, or monument, separated from the school yard or playing field by lower buildings and roads is a suitable object. The base line should be long, but the teacher should test the angles of elevation beforehand to see that they are of a size suited to the clinometers; e.g., no angle should be less than 15°, Fig. 75.

(*b*) The class should discuss the method in detail and organise the work. Groups of three are convenient but the groups must take turns instead of all going out at the same time, as they did in Method III. The name "angle of elevation" can be given.

(*c*) Groups go out in turn, come back, make their scale drawings and enter the results.

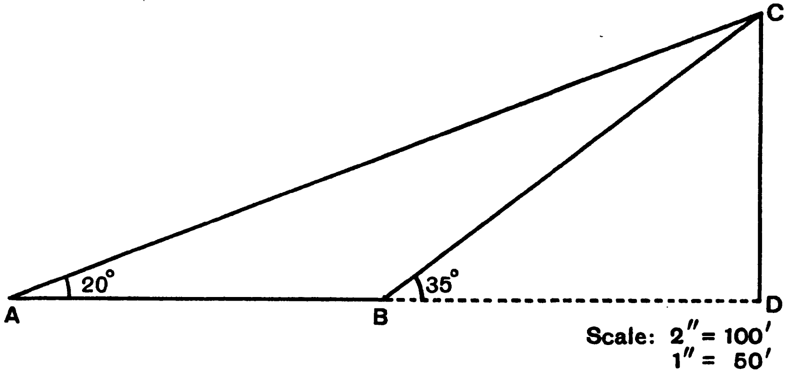


FIG. 75. DIAGRAM SHOWING SIMPLE MEASUREMENT OF INACCESSIBLE HEIGHTS

(*d*) Class discussion of results, average result and degree of accuracy, as in Method III.

Length of AB=100 ft.

Angle of elevation of C from A=20°.

Angle of elevation of C from B=35°.

Length of CD=$1\frac{1}{2}$ in.; i.e., $\frac{100}{2}\times\frac{3}{2}=75$ ft.

A and B are 4 ft. 6 in. above the ground.

∴ Height of C, above level of base line, is 80 ft. (approx.).

V. *Height of cliff measured from the top, or distance of boat, or buoy, at sea.*—Either of these can be obtained, if the other is known, by measuring the angle of depression of the ship from the top of the cliff, Fig. 76.

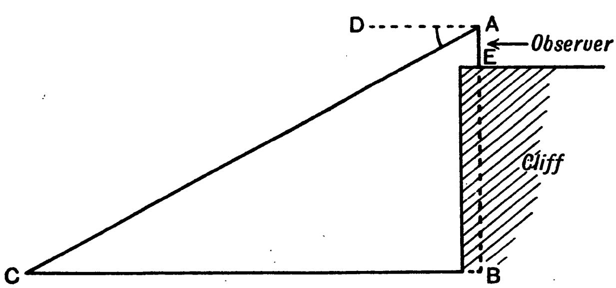


FIG. 76. MEASURING THE ANGLE OF DEPRESSION

DAC is the angle of depression of C, from A.

AB is height of cliff+height of observer.

CB is distance of C from foot of cliff+distance of observer from edge of cliff.

$D\hat{A}C=A\hat{C}B$ and $A\hat{B}C=90°$.

∴ Triangle ACB can be drawn if either height of cliff or distance of boat (C) is known.

LEVELLING AND CONTOURING

Hilly country gives the opportunity of doing this work. It requires much time and is not suited to the average school. On the other hand, it provides interesting practical work for older boys and has an important bearing upon road making; drainage; building estates and similar activities.

I. *Levelling by clinometer.*—The home-made cardboard clinometer is not sufficiently accurate for the work, nor is it sufficiently durable. A satisfactory form can be made by drawing a larger protractor, say 8 in. in diameter, graduating it in degrees and mounting it on wood. Hinged metal sights replace the pins of the simplest cardboard form.

Ranging rods can be used as poles.

A line is laid out across the hill to be measured. Points A, B, C, ... are marked off at equal distances along it and a pole erected at B.

The clinometer is stationed at A and the angle of elevation of B is measured. In order to overcome the difficulty of the observer's eye being above ground level, the following device may be employed. On the pole to be observed a clamp, or other cross piece, is fixed at the height of the observer's eye. The pole is placed at B and the observer, at A, uses the clinometer to sight the cross piece on B. This gives the angle of elevation of B from A.

The difference in height between A and B is obtained by drawing the triangle to scale or by using the sine of the angle.

$$\frac{x}{AB} = \text{sine of angle of elevation.}$$

A section of the hill can then be drawn to scale, and the gradients found between the various points. Gradients are usually given in terms of the horizontal distance between A and B, not in terms of the sloping distance. The gradient between A and B is 3 in 4, not 3 in 5. But gradients as steep as this are very rare except in mountainous country, and when the angle of slope is small the difference between the horizontal distance and the sloping distance is negligible. Boys enjoy finding out this fact for themselves and confirming it by comparison of the sines and the tangents of small angles.

It is interesting to take stations along a hilly road and produce road sections such as are given in road books for cyclists, Fig. 77. The number of stations taken and their distances apart depend upon the nature of the ground and the purpose of the survey. In many cases the stations should not be equidistant from one another.

II. *Contouring.*—For this work, a spirit levelling board is needed. The essential features of this are:—a narrow strip of board about 24 in. × 2 in., or 2½ in. × ¾ in. This is fitted with a circular spirit level on the upper side and on the under side a bolt by which it can be attached to a tripod. Close to the ends are fixed hinged sights AB and CD. These sights are usually 4 in. in height, 1½ in. in width, and about ½ in. thick.

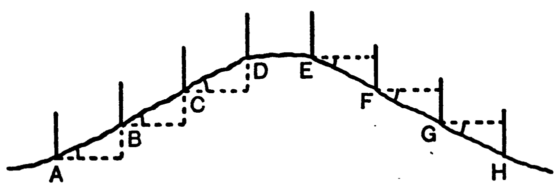


FIG. 77. DIAGRAM SHOWING METHOD OF LEVELLING

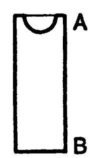


FIG. 79. DIAGRAM OF SIGHT

A semicircular piece, about 1 in. in diameter, is cut from the upper end of the sight and a piece of fine wire stretched taut across.

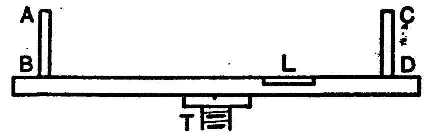


FIG. 78. SPIRIT LEVELLING BOARD

AB and CD are sights hinged at B and D.

L is circular spirit level.

T is top of tripod.

AB and CD (Fig. 78) must be exactly the same height, so that when the board is levelled the line AC is horizontal. Inexpensive sight levelling boards can be bought, but they can be made in the workshop of most schools.

To use the sight levelling board for contouring, it is set up on a slope and levelled. One boy takes a graduated post to a lower level and by following the direction of the observer at the board he finds a position P for the staff where the desired line on the staff is on the same level as AB. The observer at the spirit levelling board signals to the boy with the staff, getting him to move nearer or farther away until the desired line on the staff is seen exactly behind the wires at A and at C, Fig. 80.

The desired line on the staff depends upon the local conditions. It is often convenient

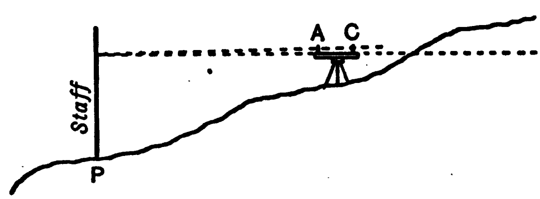


FIG. 80. USING THE LEVELLING BOARD

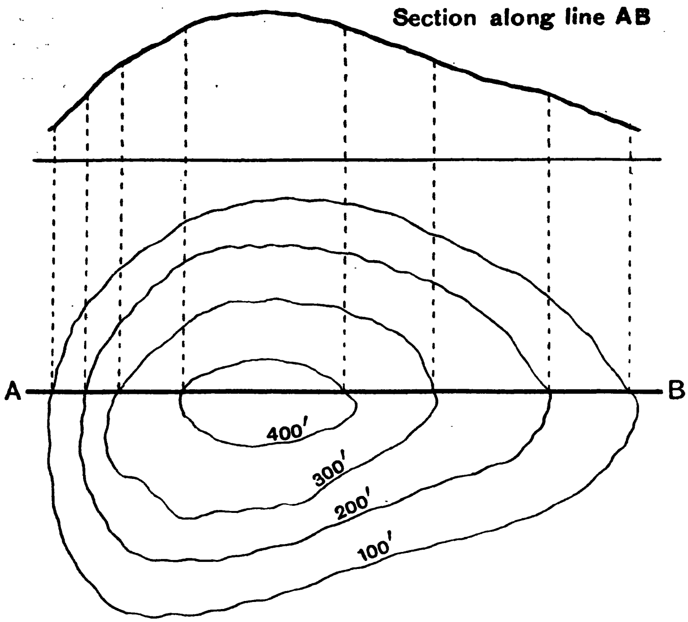


FIG. 81. SECTION PLOTTED FROM ORDNANCE MAP

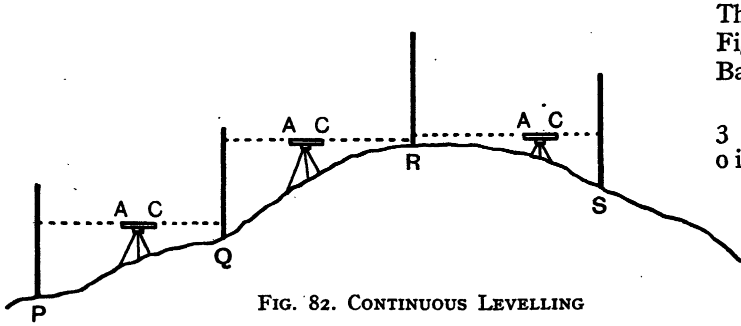


FIG. 82. CONTINUOUS LEVELLING

to make it the height of the levelling board plus 4 ft. Then the position, P, of the staff is 4 ft. below the position of the board. The board is then turned through an angle and other points on the same level as P are found.

The chief value of this work is that it helps the children to appreciate the meaning of contours. As an exercise, a level section should be plotted from an ordnance map, Fig. 81.

III. *Continuous levelling by the spirit levelling board.*—A line is chosen along which levels are to be observed. Graduated staffs are erected at equal intervals along the line. The board is set up and levelled at a point on the line, between the first two posts. The observer looks at the staff along the line AC and reads the height on the staff which coincides with the wires at A and C. He then looks from C to A to the second post and reads the height on it which is on the level CA, Fig. 82. The difference between the two readings gives the height of Q above P.

The board is then placed between Q and R and the difference between their levels read in the same way. This can be continued indefinitely along the line. It gives the differences between the levels at a series of equally placed points on a line across uneven country. The results can be recorded; Fig. 83.

Back-sight to P 8 ft. 3 in.

Rise from P to Q 8 ft. 3 in.—1 ft. 3 in.=7 ft. 0 in.

Fore-sight to Q 1 ft. 3 in.

Back-sight to Q 8 ft. 10 in.

Rise from Q to R 8 ft. 10 in.—0 ft. 8 in.= 8 ft. 2 in.

Fore-sight to R 0 ft. 8 in.

Back-sight to R 1 ft. 6 in.

Fall from R to S 4 ft. 3 in.—1 ft. 6 in.= 2 ft. 9 in.

Fore-sight to S 4 ft. 3 in.

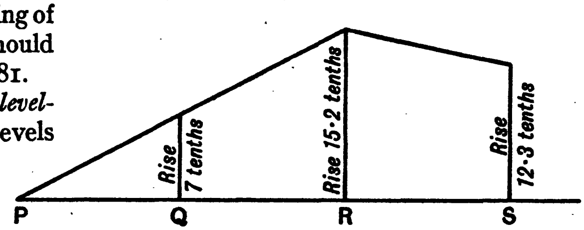


FIG. 83. RESULTS PLOTTED TO SCALE: $\frac{1}{10}$ in.—1 ft.

XIV. EXPERIMENTAL WORK INDOORS

Practical mathematics and physics.—Practical mathematics and physics are so closely related that much of the work done in the laboratory as "science" might appropriately be named practical mathematics. Whatever the name, the work is of benefit to the children, and whatever the division of work among the staff, mathematics is required in every experiment. If one teacher deals with science and mathematics, he can make the necessary correlations. If two teachers are involved, they should consult together and plan so that their syllabuses are adjusted. If there is no physical science being taught in the school, the teacher of mathematics will find that experimental work is well worth while, with "A" and "B" streams. The better the child, the farther he can go. "C" stream children need practical work and can do some of the easiest experiments, but most of the following suggestions are too difficult for "C" children.

Apparatus.

A balance, sufficiently accurate; measuring cylinder, in cubic centimetres; long rulers; regular solids—cube, prism, pyramid, etc; calipers; screw gauge; irregular solids, for specific gravity; stop watch; pulley wheels and pulley blocks; pans for carrying weights; spring balance; levers; inclined plane; screw jack; English weights, ounces to stones.

Apart from the balance, the spring balance and the stop watch, the apparatus is inexpensive and things like levers and inclined plane can be made at school.

Suggested experiments.—The experiments, apart from a laboratory, have to be class experiments but individual children can be given opportunities of doing the experiments for themselves.

The following list gives experiments suitable for classroom use:—Finding volumes of regular solids, including wire, and confirming by measuring cylinder. Finding volumes of irregular solids, heavier and lighter than water, by measuring cylinder. Finding specific gravity of liquids by weighing a bottle full of liquid and finding the volume of the bottle. Experiments leading up to the Principle of Archimedes.

If a sufficiently delicate spring balance is available, the Principle can be shown by hanging a metal rod from the balance, weighing it in air, and then gradually immersing it in water by raising a gas jar of water so as to surround part of the rod. The length immersed and the reduction in weight are noted. The rod must be suspended so that it hangs vertically and the experiment must be tested carefully beforehand.

Many other experiments can be devised to illustrate and make use of the Principle.

The story of the discovery and its use for testing the metal of a crown adds interest and point to the work.

The parallelogram of forces.

Centre of gravity; stable and unstable equilibrium.

Moments of forces.

Levers.

Simple machines:—(*a*) The inclined plane; (*b*) the screw jack; (*c*) pulley blocks.

Coefficient of friction.

Simple pendulum.

All of these topics can be investigated in a simple way. A number of them involve proportional relationships. All require the use of simple algebra and all are helped by graphs.

XV. ALGEBRA

General points—Algebra developing from arithmetic.—"In very few, if any, senior schools should a formal treatment of the subject be given, nor should the subject be made to serve merely as a mental training in the use of abstract quantities."[1]

It is the use of algebraic methods rather than algebra that is desirable and these have to be introduced gradually in connection with simple rules in arithmetic and mensuration. A formula is a piece of shorthand; a neat, concise way of writing a rule. As such, it is welcomed by children as soon as they understand the rule. They do not learn the rule through the formula; the formula is a convenient expression of the rule. The first formula for most children is the one they obtain for area of a rectangle. After practical work with a number of rectangles, they are able to generalise and say, "If we multiply the number of inches in the length by the number of inches in the breadth, we get the area in square inches." Or, generalising further, "Area=length×breadth."

To generalise is a difficult step, but to change from words to letters is easy. Every child prefers to write $A=L\times B$ rather than Area=length×breadth. This formula may be discovered in the junior school; it arises early in the senior school work but is not immediately followed by more formulæ. Other formulæ are taken as they arise in arithmetic, mensuration or geometry. Some of the earliest are:

In connection with a circle:

$$C=\tfrac{22}{7}d \text{ or } C=2\ \pi r$$
$$A=\tfrac{22}{7}r^2 \text{ or } A=\ \pi r^2$$

In connection with a traingle:—$A=\frac{1}{2}\,bh$

In connection with interest:—$I=\dfrac{P}{100}\times rt$

Some senior schools have tried the experiment of taking one lesson each week for algebra and teaching the elementary manipulations (as algebra used to be taught), the rules for addition, subtraction, multiplication, division, including negative quantities; brackets; factors; fractions; equations, simple, simultaneous, and quadratic. It is easy to teach this work for most of it is done by applying mechanical rules. Quickness of eye, careful attention and a good memory enable the children to carry out the operations successfully. The work is easily tested and "good results" are not difficult to obtain from an intelligent class. But teachers who have tried this experiment have not found it satisfactory. They have come to the conclusion that it is not worth the time; that algebra should grow out of real life and its needs; that expression should come before manipulation.

Manipulation should be introduced as it is needed. Children who have learnt $A=L\times B$ do not feel the need for $L=\dfrac{A}{B}$ for some time, but when they are ready for it they find no difficulty in changing the subject of the formula. Changing the subject of $I=\dfrac{Prt}{100}$ is a very different matter. Before coming to it the class should be given practice in making simple formulæ and in substitution of values.

Examples

1. Cocoa is packed in tins which hold $\frac{1}{2}$ lb. If the tin weighs $\frac{1}{2}$ oz., what is the weight of 1 tin of cocoa? Of n tins of cocoa?

If the tin weighed b oz., find an expression for the weight of a tin of cocoa. What would be the weight of 12 tins?

2. A packing case weighs w lb. It holds 144 tins of cocoa. Each tin weighs b oz. and holds $\frac{1}{2}$ lb. cocoa. Find an

[1] *Senior School Mathematics*, Board of Education, No. 101.

expression for the weight of the empty packing case.

If $b=\frac{1}{2}$ oz. and $w=7$ stones $6\frac{1}{2}$ lb., find the weight of the packing case.

Any good modern algebra gives many examples of this type. These should be introduced frequently. They are good exercise in expression, in use of words as well as in symbolisation.

STAGE 1. MAKING OF FORMULÆ

This consists of the making of formulæ and their use. It is done in connection with arithmetic, mensuration and geometry, and is spread over the first years of the senior school course.

STAGE 2. SIMPLE EQUATIONS

Aim.—To teach children how to handle very simple equations so that they may be able to use formulæ more readily.

I. *Hidden numbers.*—Questions on hidden numbers afford the best approach. At first these may be very simple; e.g., "I am thinking of a number. When I subtract 3 from it, I get 9. What is the number?"

The difficulty should be increased as quickly as the children can go. They enjoy making up questions for each other. When more than three or four steps are involved they begin to feel the need for writing down, and this introduces the question of how to write down the question and the use of x.

Questions can be graded; e.g.:

1. $x+2=6 \quad \therefore x=6-2=4$
2. $x-2=8 \quad \therefore x=8+2=10$
3. $2x=10 \quad \therefore x=\frac{10}{2}=5$
4. $2x-3=5 \quad \therefore 2x=5+3=8 \quad \therefore x=4$
5. $\frac{2x}{3}=8 \quad \therefore 2x=8\times 3=24 \quad \therefore x=12$
6. $\frac{3x-4}{4}=2 \quad \therefore 3x-4=2\times 4=8$

$$\therefore 3x=8+4=12$$
$$\therefore x=\frac{12}{3}=4$$

By dealing with examples such as these, the children should be led to discover that the same quantity may be added to, or subtracted from, both sides without destroying their equality. Similarly, both sides may be multiplied or divided by the same quantity.

Brackets may be introduced as they are needed. For example, "A number is multiplied by 3; 4 is added; the new number is multiplied by 5; 2 is taken away and the result is 108. What was the number?"

$5\,(3x+4)-2=108$

Results should always be checked by substitution.

The children should always say what they do. Many teachers wish them to write it. For example, in working the last example:

$5\,(3x+4)-2=108$
Add 2 to each side.
$5\,(3x+4)=110$
Divide both sides by 5.
$3x+4=\frac{110}{5}=22$
Take away 4 from both sides.
$3x=22-4=18$
Divide both sides by 3.
$x=6$

Until the children are sure of what they are doing, this writing in of explanations is useful, but they should outgrow the need very quickly. Quick children will soon arrive at the stage when they say, "Take the 2 over to the other side and change the sign," instead of saying, "Add 2 to both sides," or, "Subtract 2 from both sides."

Short cuts should be encouraged. The last example can be written:

$$\begin{aligned} 5(3x+4)-2&=108 \\ \therefore\ 5(3x+4)&=110 \\ \therefore\ 3x+4&=22 \\ \therefore\ x&=6 \end{aligned}$$

II. *Changing the subject of a formula.*

Example: Area of triangle:—$A=\frac{1}{2}b\times h$

This can be changed by dividing both sides by b and multiplying both sides by 2, into the new form:

$$h=\frac{2A}{b}$$

The formula for simple interest can be rewritten with P, r or n a subject.

$$I = \frac{Prn}{100} \text{ becomes}$$

$$P = \frac{100I}{rn} \text{ or } r = \frac{100I}{Pn} \text{ or } n = \frac{100I}{Pr}$$

These give a quick method for dealing with questions where principal, or rate of interest or number of years are to be found.

III. *Application to problems.*—These should be sufficiently easy to be done by the children and yet sufficiently difficult to be worth while.

EXAMPLES

1. (A hidden number example.) Find a number such that, if 7 be added to it, the result is the same as if 5 were taken from twice the number.

2. When the price of eggs goes up 10 per cent, I pay 1*s.* more for 8 dozen. What was the price at first?

3. (A puzzle question.) A boy's age is 10 and his father's age is 4 times as great. In how many years will the father's age be three times that of the boy?

The following are harder examples, using equations for the solution of problems.

4. In how many years would a sum of £20 double itself if it gained simple interest at 4 per cent per annum?

5. If a stone is dropped from the top of a cliff, the distance, s, that it falls in t seconds is given by the equation $s=16t^2$. Find how far it would fall in 6 seconds. Find how long it would take to fall 144 ft.

6. A firm pays pensions to retired employees on the following plan:

If p is the average pay for the last 3 years' service with the firm, and n is the number of years of service with the firm, and P is the amount of pension,

$$P=\frac{n}{60}\times p$$

Find P for a man who has been with the firm for 20 years and has earned £360 each year for the last 3 years.

7. A greengrocer sells half of his stock of grapefruit at 3 for 1*s.* and the remainder at 5 for 1*s.* If he had sold them all at 4 for 1*s.*, he would have got 2*s.* less. How many grapefruits did he sell?

8. The width of a rectangle is $\frac{4}{5}$ of its length. If the width had been 3 ft. more and the length 3 ft. less, the sides would have been equal. Find the size of the rectangle.

9. In order that an aeroplane of weight W lb. may fly at a velocity of V miles per hour, the area of its wing surface must satisfy the equation $\frac{W}{A}=KV2$. Calculate A if $K=0{\cdot}0025$, $V=60$ and $W=2{,}400$.

IV. *Equations with two hidden numbers.*—The equation $2x-3y+4=0$ has two hidden numbers. If we put 1 instead of x,

$$2-3y+4=0$$
$$\therefore \quad y=2$$

i.e., when $x=1$ and $y=2$, the equation balances.

Similarly, $x=4$ and $y=4$ satisfies the equation. So does $x=7$ and $y=6$, and many other pairs of values of x and y.

If we consider another equation which has two hidden numbers, $4y-2x=6$, we can find many pairs of values of x and y which satisfy it:

$x=1$ and $y=2$
$x=7$ and $y=5$
$x=9$ and $y=6$

all satisfy the equation $4y-2x=6$.

One pair of values satisfies both equations; i.e.,

$x=1, y=2$.

A much quicker way of discovering the values of x and y which satisfy both equations is to combine the equations in such a way that one letter disappears. Placing the equations beside one another, we have:

$$2x-3y+4=0$$
$$4y-2x \quad =6$$

The sum of the two left-hand sides must equal the sum of the two right-hand sides,

$$\therefore 2x-3y+4+4y-2x=0+6$$
$$\therefore y+4 \quad =6$$
$$\therefore y=2$$

Having found the value of y, we can find x from the equation:

$$4y-2x\quad=6$$
$$\therefore\ 4\times2-2x=6$$
$$\therefore\qquad x=1$$

We have found a pair of values for x and y that satisfies both equations: $x=1$; $y=2$. This should be verified by substituting the values in both equations.

Combining the equations so as to get rid of one letter sometimes requires the subtraction of one equation from the other; e.g., if we get:

$$4x+2y=16$$
$$2x+2y=10$$

by subtraction, we get:

$$2x\quad=6\quad\therefore x=3$$

Substituting this in the second equation,

$$6+2y=10\quad\therefore\ y=2$$

Other devices may have to be employed in order to get rid of one letter. These are illustrated in the following examples:

(*a*) $4x+\ y=14$
$2x+2y=10$

Multiply the first equation by 2 and we get:

$$8x+2y=28$$

Subtracting the second equation from this, we get:

$$6x=18\quad\therefore\ x=3$$

Substituting in the second equation, we get:

$$6+2y=10\ \therefore\ y=2$$

(*b*) $2x+5y=29$ . . . . (1)
$3x+4y=26$ . . . . (2)

In this case, we cannot multiply one equation by a number and proceed to add to or subtract from the other equation. Neither letter could be eliminated by such a procedure.

Multiplying the first equation by 3 and the second equation by 2, and subtracting, provides a method.

Equation (1)$\times3$ gives $6x+15y=87$
Equation (2)$\times2$ gives $6x+8y\ =52$
Subtracting, we get $7y\ =35$
$\therefore\quad y=5$
Substituting in (2), we get $x=2$

Examples

1. Find the two hidden numbers in:

(*a*) $x+y=4$
$x-y=2$

(*b*) $2x+3y=12$
$8x-5y=14$

(*c*) $4x+5y=22$
$3x-4y=1$

2. How can a grocer mix tea worth 2*s.* per lb. with tea worth 3*s.* per lb. so as to get 12 lb. of tea worth 2*s.* 3*d.* per lb?

3. A bag contains 24 coins. Some are shillings and some half-crowns. Their total value is £1 11*s.* 6*d.* How many were there of each?

4. 59 eggs are bought, some at 5 for 1*s.* and the rest at 6 for 1*s.* The total cost was 11*s.* How many were bought at each price?

Harder examples arise in connection with the practical work in proportion; e.g., the length of a spring from which a weight is hung.

STAGE 3. INDICES; INDEX LAWS; LOGARITHMS

1. The children will have learned about squares and cubes. They will know that 5^2 means 5×5 and that 5^3 means $5\times5\times5$.

It is a simple step to generalise and say: $x^2=x\times x$ and $x^3=x\times x\times x$; and to extend to larger indices; e.g., $x^5=x\times x\times x\times x\times x$.

The index laws are fairly obvious:

(*a*) $x^2\times x^3=x\times x\times x\times x\times x=x^5$
i.e., $x^2\times x^3=x^{2+3}\qquad=x^5$

When different powers of the same quantity are multiplied together, the indices are added.

(*b*) $x^5\div x^2=\dfrac{x\times x\times x\times x\times x}{x\times x}=x^3$
i.e., $x^5\div x^2=x^{5-2}\qquad=x^3$

When different powers of the same quantity are divided, one index is subtracted from the other.

(*c*) $(x^2)^3=x^2\times x^2\times x^2=x^6$
i.e., $(x^2)^3=x^{2\times3}\ =x^6$

When one power of a quantity is raised to a higher power, the two indices are multiplied together.

(*d*) $x^3 \times x^3 = x^{3+3} = x^6$

$\sqrt{x^6} = x^3$

In order to find the square root of a power of a quantity, we divide the index by 2.

Similarly:

$x^2 \times x^2 \times x^2 = x^{2+2+2} = x^6$

$\sqrt[3]{x^6} = x^2$

In order to find the cube root of a power of a quantity, we divide the index by 3.

Examples

Examples of a simple type should follow; e.g.:

1. What is the value of $x^3 \times 3x^5 \div 12x^{12}$ when $x=2$?

2. What is the value of $\frac{a^2b \times 4ab^3}{12a^3b^2}$ when $a=2$, $b=3$?

Apart from the expression in words of the four index laws, this work is easy.

II. *Finding a meaning for negative indices and a zero index.*

$$\frac{x^2}{x^4} = \frac{1}{x^2}$$

Also, $\frac{x^2}{x^4} = x^{2-4} = x^{-2}$

i.e., $x^{-2} = \frac{1}{x^2}$

Similarly: $x^{-3} = \frac{1}{x^3}$, etc.

$\frac{x^2}{x^2} = 1$; $\frac{x^2}{x^2} = x^{2-2} = x^0$

i.e., $x^0 = 1$

Similarly $a^0 = 1$; $10^0 = 1$; etc.

Examples

1. Find the value of $(a^4)^{-\frac{1}{2}}$

2. Find the value of $x^{\frac{1}{4}} \times x^{-2}$

3. Find the value of $\sqrt[4]{x^{12}y^{-8}z^4}$

III. *Introduction to logarithms.*—The children should first realise that they can write one number as a power of another number.

Example: $16=4^2$; $27=3^3$; $4=16^{\frac{1}{2}}$; $3=27^{\frac{1}{3}}$.

It is then necessary to build up a series of numbers as powers of one base. 10 can be used as base, but it is helpful to use a smaller number first. One does not wish the children to think that 10 is the only possible base. 2 is a convenient base to begin with. The children know that:

$2^{-2}=\frac{1}{4}$	$2^1=2$	$2^4=16$, etc.
$2^{-1}=\frac{1}{2}$	$2^2=4$	
$2^0 =1$	$2^3=8$	

By working out the square root of 2, the children can get $2^{\frac{1}{2}}=1{\cdot}414$; i.e., $2^{\cdot 5}=1{\cdot}414$

By working out the square root of $1{\cdot}414$, they can get $2^{\frac{1}{4}}=1{\cdot}189$; i.e., $2^{\cdot 25}=1{\cdot}189$

From these, by multiplication, they can get:

$2^{\cdot 75}=2^{\cdot 5+\cdot 25}=2^{\cdot 5}\times 2^{\cdot 25}=1{\cdot}414\times 1{\cdot}189=1{\cdot}681$	
$2^{1\cdot 25}=2^{1+\cdot 25}=2\times 2^{\cdot 25}=2\times 1{\cdot}189$	$=2{\cdot}378$
$2^{1\cdot 5}=2^{1+\cdot 5}=2\times 2^{\cdot 5}=2\times 1{\cdot}414$	$=2{\cdot}828$
$2^{1\cdot 75}=2^{1+\cdot 75}=2\times 2^{\cdot 75}=2\times 1{\cdot}681$	$=3{\cdot}362$
2^2	$=4$
$2^{2\cdot 25}=2^{2+\cdot 25}=2^2\times 2^{\cdot 25}=4\times 1{\cdot}189$	$=4{\cdot}756$
$2^{2\cdot 5}=2^{2+\cdot 5}=2^2\times 2^{\cdot 5}=4\times 1{\cdot}414$	$=5{\cdot}656$
$2^{2\cdot 75}=2^{2+\cdot 75}=2^2\times 2^{\cdot 75}=4\times 1{\cdot}681$	$=6{\cdot}724$
2^3	$=8$

Values for the negative indices can be obtained from the values for the positive indices:

$2^{-\cdot 25} = \frac{1}{2^{\cdot 25}} = \frac{1}{1{\cdot}189} = {\cdot}8411$
$2^{-\cdot 5} = \frac{1}{2^{\cdot 5}} = \frac{1}{1{\cdot}414} = {\cdot}7071$
$2^{-\cdot 75} = \frac{1}{2^{\cdot 75}} = \frac{1}{1{\cdot}681} = {\cdot}5946$
$2^{-1}=\frac{1}{2} \quad = {\cdot}5$

$$2^{-1.25} = \frac{1}{2^{1.25}} = \frac{1}{2{\cdot}378} = {\cdot}4206$$

$$2^{-1.5} = \frac{1}{2^{1.5}} = \frac{1}{2{\cdot}828} = {\cdot}3536$$

$$2^{-1.75} = \frac{1}{2^{1.75}} = \frac{1}{3{\cdot}362} = {\cdot}2974$$

$$2^{-2} = \frac{1}{2^2} = \tfrac{1}{4} = {\cdot}25$$

Finding these values for powers of 2 affords exercise in index laws and the use of fractional and of negative indices. In the examples given above, the numbers have been taken to three or four places of decimals but for practical purposes two places are enough in most cases.

x	-2	$-1{\cdot}5$	-1	$-0{\cdot}5$	0	0·5	$+1{\cdot}0$	$+1{\cdot}5$
y	·25	·35	·5	·7	1·0	1·4	2·0	2·8

x	$+1{\cdot}75$	$+2{\cdot}0$	$+2{\cdot}25$	$+2{\cdot}5$	$+2{\cdot}75$	$+3{\cdot}0$
y	3·4	4·0	4·75	5·65	6·7	8·0

A graph can now be drawn showing indices of 2 on the x axis and the corresponding numbers on the y axis. For this purpose the pairs as shown are adequate. Those indicated by — can be omitted if the teacher wishes to make the number of points as small as possible:

Index	-1	$-{\cdot}5$	0	·125	·25	·375	·5	·625	·75	·875	1
Number	·1	·31	1	1·33	1·78	2·37	3·16	4·22	5·62	7·5	10

The graph can be used for reading off any number between ·25 and 8, as a power of 2.

Example: 2·4 is $2^{1.25}$ and 1·6 is $2^{.7}$, as read from the graph. This can be applied in multiplication and division.

Thus: $2{\cdot}4\times1{\cdot}6=2^{1.25+.7}=2^{1.95}=3{\cdot}8$ (from graph)

$2{\cdot}4\times1{\cdot}6=3{\cdot}84$ (by multiplication)

Examples such as the above show the method of logarithms and also the need for a high degree of accuracy in the graph, or for a list of figures giving a detailed statement of numbers and the corresponding indices.

The introduction of 10 as a base may be made in a similar way. Suitable figures for making a graph are shown in the third table.

After using this graph for examples such as:

$3{\cdot}4\times2{\cdot}6$ and $8{\cdot}7\div3{\cdot}6$

the children may be introduced to tables of logarithms. These should be used for whole numbers at first. After their use for whole numbers has been well practised, the children should learn how to deal with logarithms of fractions, cf. p. 17.

STAGE 4. VARIATION

Algebra provides a neat method of dealing with questions in proportion. In the section on proportion it was suggested that unitary method should lead up to the fractional (or ratio) method. The use of algebra is a further step in generalisation. Only the best children will wish to use it. The others prefer the arithmetical methods, but for those who can appreciate it the algebraic method is the better.

I. *Direct proportion.*

Example.—The weight of a block of metal is proportional to its volume. 24 cu. in. of the metal weigh 8·8 lb. What would be the weight of 1 cu. ft.?

If w stands for weight in lb. of a volume v cu in., then $\frac{w}{v} = k$

$$\frac{8{\cdot}8}{24} = \frac{x}{144 \times 12}$$

$$\therefore x = \frac{1{\cdot}1}{\cancelto{}{3}} \times \cancelto{48}{144} \times 12$$

$\therefore x = 52{\cdot}8 \times 12 = 633{\cdot}6$ lb.

II. *Inverse proportion.*

Example.—If 15 men work 8 hours a day, they can finish a job in 6 days. How many hours a day would they have to work in order to finish the job in 7 days?

If h stands for the number of hours
and d ,, ,, ,, ,, ,, days
then $h \times d = k$

$8 \times 6 = x \times 7$

$$\therefore x = \frac{48}{7} = 6\tfrac{6}{7}$$

$\therefore$ They would work 7 hours per day approx.

III. *Joint variation.*

Example.—If 15 men work 8 hours a day, they can finish a job in 6 days. How long would it take 24 men, working 6 hours per day?

If n stands for number of men, h for hours and d for days, then

$n \times h \times d = k$

$15 \times 8 \times 6 = 24 \times 6 \times x$

$$\therefore x = \frac{15 \times 8 \times 6}{24 \times 6} = 5 \text{ days}$$

Other examples are obtained from mechanics, physics and engineering.

Example.—The volume of gas in a cylinder is 1000 cu. in. when the pressure is 15 lb. per sq. in. and the absolute temperature is 280°. What will the pressure be if the volume is compressed to 600 cu. in. and the absolute temperature raised to 371°?

$$\frac{pv}{t} = k$$

$$\frac{15 \times 1000}{280} = \frac{x \times 600}{371}$$

$$\therefore x = \frac{\cancelto{5}{1500}}{\cancelto{4}{28}} \times \frac{\cancelto{53}{371}}{\cancelto{2}{600}}$$

$$= \frac{265}{8} = 33\tfrac{1}{8} \text{ lb. per sq. in.}$$

The work in proportion should be linked with graphs.

STAGE 5. DIRECTED NUMBERS

In the earlier stages the children have worked with positive quantities. They have subtracted one positive quantity from another, but faced with $3-5$ they have said, "I cannot." The idea of a negative number cannot be taught by merely saying, "$3-5 = -2$."

I. Meaning must be attached to the -2. Drawing money from a bank and having an overdraft gives one meaning to $-£2$.

Going up 20 stairs from the ground floor of a building and coming down 25 stairs leaves one -5 stairs from the ground floor. The basement may be -18 stairs from ground level. A miner may work -200 ft. from sea level. The mercury may stand at $-5°$ C.

The train in the example given in Fig. 43 (Section XI) begins its journey at midday. Times before midday would be negative. y represents its distance north of London. If it continued its southward journey beyond London, y would become negative.

II. The addition of negative numbers is easily illustrated by questions on going up and down stairs, thermometers, and money.

Example.—From the ground floor I go up 10 stairs, down 3. Where am I? ($10-3 = 7$; i.e., $+7$ from ground floor.)

If I go up 10 and then down 18, where am I? ($10-18 = -8$; i.e., -8 from ground floor; i.e., 8 below ground floor.)

The thermometer stood at 14° C. It went up 2° and down 20°. What did it indicate? ($14+2-20 = -4$; i.e., $-4°$ C.)

III. The multiplication of negative numbers by positive numbers follows easily.

To move -2 stairs, three times over, results in moving -6 stairs.

At this stage the children should be able to generalise and say $-a \times b = -ab$. The multiplication of a minus number by a plus number gives a minus product.

IV. The subtraction of a negative number presents difficulties to most children. It can be illustrated by the cancelling of a debt. Tom has 3*d.* but he owes Bob 2*d.* Therefore he owns 3*d.*$-$2*d.*$=$1*d.* If the debt is taken away (cancelled), Tom owns 1*d.*$-(-$2*d.*$)=$1*d.*$+$2*d.*$=$3*d.*

If motion northwards is regarded as $+$, motion southwards is $-$. When motion southwards is retraced; i.e., taken away, it becomes motion northwards.

In the train example already referred to:
y=distance north of London;
x=time after leaving Newcastle at noon.

$$y=273-60x$$

If x is -2, the hour is 10 a.m. and the distance north of London is given by:

$$\begin{aligned} y&=273-60\times(-2)\\ &=273-(-120)\\ &=273+120=393 \end{aligned}$$

Many illustrations can be obtained from graphs.

The children generalise and say

$$a-(-b)=a+b$$

The subtraction of a negative number gives a positive.

V. The division of a negative number by a positive can be obtained from $(-a)\times b=-ab$

$$\therefore \frac{-ab}{b} = -a$$

The children have learnt this manipulation in Stage 2. It can be illustrated by going down 6 steps in 3 leaps:

$$-6\div 3=-2$$

They say the division of a negative number by a positive gives a negative number.

VI. The division of a negative number by a negative can be understood by using the "measuring" conception of division. How many -3s are there in -6?

Obviously there are 2, and $-6\div -3=2$

$$\text{or } \frac{-6}{-3}=2$$

The division of a negative number gives a positive number and $\dfrac{-a}{-b} = \dfrac{a}{b}$

VII. The division of a positive number by a negative follows from (VI).

Because $-6\div -3=2$

$\therefore\ -6\div 2=-3$

The division of a positive number by a negative number gives a negative number.

These points (I) to (VII) should be introduced gradually in mental work. Simple applications can be made in mental and in written work, but elaborate examples and those involving many brackets should be avoided. Some of the best applications occur in connection with graphs and mechanics.

XVI. TRIGONOMETRY

THE first records of trigonometry show its beginning during the last three centuries B.C., in Alexandria. This was a period of great intellectual activity. Aristarchus, who first measured the distances of sun and moon; Archimedes, one of the greatest mathematicians of the world, whose name is familiar even now; Hero of Alexandria, who described a number of the mechanical appliances we use to-day; these are three among a remarkable group of men. They discovered how to map the heavens and the earth; how to navigate the oceans; how to make machines, including a steam engine—Hero describes one. They were practical men and their discoveries were made as they considered the needs of real life. Mathematics was one of their main interests and trigonometry was one of the methods they developed for dealing with the problems of everyday. Their trigonometry would be called very elementary to-day, hardly worthy of the name trigonometry, but it was the beginning and in elementary trigonometry we find useful work for senior schools.

Trigonometry for the senior schools is that which makes practical measurements easy. "Anything in the nature of formal work in trigonometry should be rigidly excluded," says the Board of Education pamphlet, *Senior School Mathematics*, No. 101. Knowledge and use of the three ratios, sine, cosine and tangent, give power to deal with many problems of measurement. It can be taught to the "A" stream children and the best of the "B" stream without any difficulty.

The method of teaching is to introduce the ratios, one at a time, by their use.

STAGE 1. INTRODUCTION AND USE OF TANGENTS OF ANGLES

I. *Introduction.*—One of the best introductions is by measurements of sun shadows (see Section XII).

The children work in twos or threes, out of doors. Each group chooses some suitable object to be measured. The object must be in such a position that the sun casts a clear shadow of it on a level surface; it may be a post, a building, a child, anything that stands vertically and can be measured easily, Fig. 84.

The height of the object is measured and the length of its shadow, at a particular time. The ends of all the shadows must be marked at the same moment, so that the sun is at the same altitude for all the observations. Their lengths can then be measured without haste. Having got these measurements, the children make scale drawings of their triangles. They compare these and discover that although the triangles are of different sizes, (1) they are all of the same shape; (2) the ratio of AB to BC is the same in all; (3) the angle ACB is the same size in all. They are told that the angle ACB is called the angle of altitude of the sun; and that the ratio $\frac{AB}{BC}$ is called the tangent of the angle ACB.

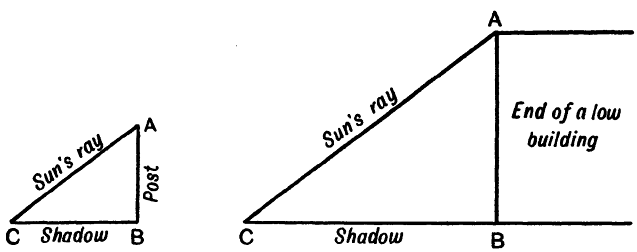


FIG. 84. VARIOUS METHODS OF MARKING SHADOWS

II. *Use of a tangent.*—The children use the sun shadow method for finding the height of a tall building, monument, post or tree, as described in Section XII, but they use the tangent of the angle in calculation instead of making a scale drawing, Fig. 85.

Example:
Height of measured post $=5$ ft.
Length of its shadow at 11 a.m. $=8$ ft.
Tangent of angle $=\frac{5}{8}$

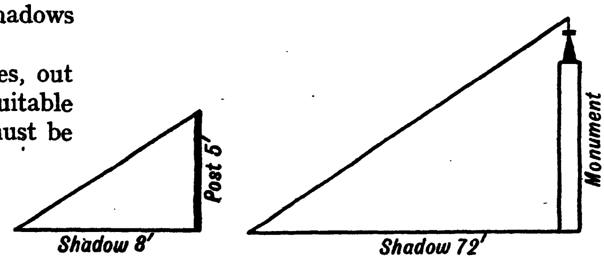


FIG. 85. FINDING HEIGHT BY USING THE TANGENT OF AN ANGLE

Length of shadow of monument=72 ft.

$$\therefore \frac{\text{Height of monument}}{72} = \frac{5}{8}$$

$$\therefore \text{Height of monument} = \frac{5\times72}{8} = 45 \text{ ft.}$$

III. *Finding the tangents of angles.*—Before introducing children to a table of tangents, it is wise to let them become better acquainted with the meaning of the term, by drawing. Each child draws an angle and chooses a point P on one of its arms. From P a perpendicular PN is drawn to the other arm, Fig. 86. The lengths of PN and ON are measured and the tangent of $\hat{PON}$ $\frac{PN}{ON}$ is found. Each child can find tangents of several angles.

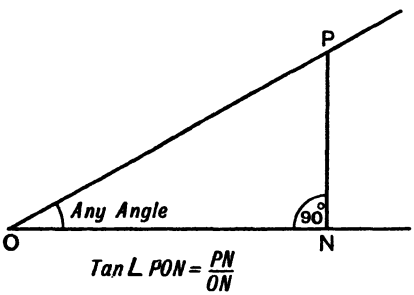


FIG. 86

Results can be collected and discussed. A table of tangents should then be examined. The children should notice that passing from 0° to 90°, as the angle increases the tangent increases from 0 to 1.

IV. *Problems using tangents of angles.*—The work done in finding the height of the school (Section XII) should be used. From the data obtained, the height of the school

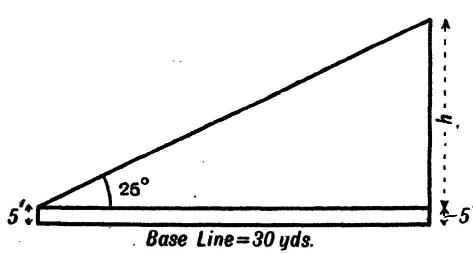


FIG. 87. TAN. 25° $= \frac{h}{30}$

can be obtained by means of the tangent of the angle of elevation of the top of the school, Fig. 87.

tan. 25°=·466 h=41·94 ft.

tan. 25° $= \frac{h}{30}$ ∴ height of school=

h=30×·466×3 42 ft.+5 ft.

=47 ft.

EXAMPLES

Examples similar to the above should be given.

1. The rope holding a captive balloon is 200 yd. long and makes an angle of 61° with the ground. How high is the balloon?

Examples which use a different position of the right-angled triangle are as follows:

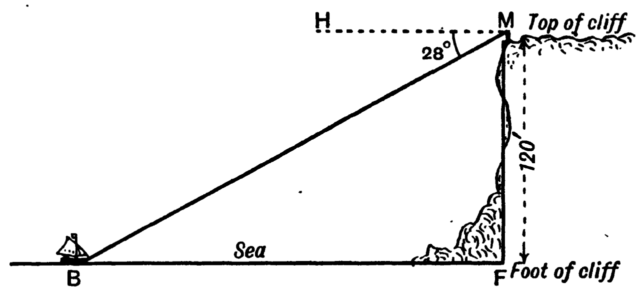


FIG. 88. DIAGRAM SHOWING ANGLE OF DEPRESSION OF A BOAT

2. The positions of three hamlets, P, Q and R, are taken as corners of a triangle. The angle PQR is 60° and the angle RPQ is 30°. If PQ measures 2 miles, find how far R is from Q.

3. A man, standing on the top of a cliff 120 ft. high, measures the angle of depression of a boat at sea and finds it to be 28°. How far is the boat from the foot of the cliff? (The man's eye is 5 ft. above the top of the cliff.) M is the man standing on top of the cliff. His eye is 125 ft. above the sea. MH is a horizontal line passing through the man's eye. B is the boat, Fig. 88.

$\hat{HMB}$ is the angle of depression of the boat. It is equal to $\hat{MBF}$.

$$\frac{MF}{BF} = \text{tan. MBF} = \text{tan. } 28° = \cdot53;$$

$$\therefore BF = \frac{125}{\cdot53} = 235\cdot8 \text{ ft.}$$

V. *Finding heights of inaccessible objects.*—A method is given in Section XII. It lays down a base line, running towards the object, measures it and from each end observes the angle of elevation of the object. A scale drawing is made and the height of the object is read off from it.

By using tangents of angles, the height can be calculated. The neatest method is to use the tangents of angles ATR and BTR, as shown in Fig. 89.

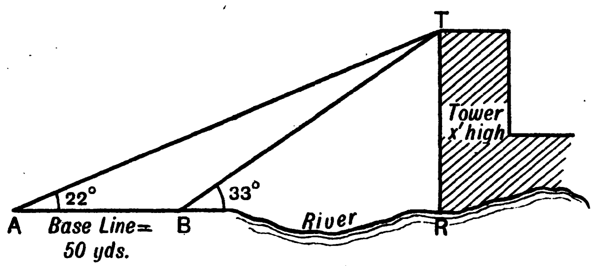


FIG. 89. INACCESSIBLE OBJECT: FINDING HEIGHT BY TANGENTS OF ANGLES

$$A\hat{T}R = 90° - T\hat{A}R = 90° - 22° = 68°$$
$$B\hat{T}R = 90° - T\hat{B}R = 90° - 33° = 57°$$
$$\frac{AR}{x} = \text{tan. ATR} = \text{tan. } 68° = 2{\cdot}47$$
$$\frac{BR}{x} = \text{tan. BTR} = \text{tan. } 57° = 1{\cdot}54$$
$$\text{subtracting, } \frac{AR}{x} - \frac{BR}{x} = {\cdot}93$$
$$\text{i.e., } \frac{AR-BR}{x} = {\cdot}93$$
$$\text{i.e., } \frac{150}{x} = {\cdot}93 \text{ (AB=150 ft.)}$$
$$x = \frac{150}{{\cdot}93} = 161 \text{ ft.}$$

This method can be used by children who can deal with equations.

EXAMPLES

1. Two observers 2 miles apart see a balloon. To one it is due north at an angle of elevation 40°. To the other it is due south at an angle of elevation of 60°. Find the height of the balloon.

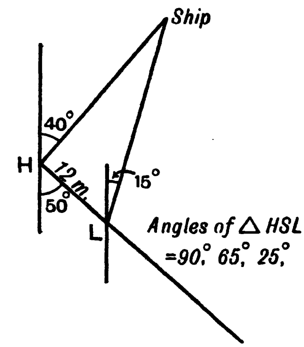


FIG. 90. DIAGRAM FOR EXAMPLE 2

2. A lighthouse, L, is 12 miles, S. 50° E., from the entrance of a harbour. At 9 a.m. a ship left the harbour. At 11 a.m. it is in a position N. 40° E. from the harbour and N. 15° E. from the lighthouse, Fig. 90. Find the speed of the ship in miles per hour.

(Key to method:—Angles of △ H.S.L. =90°, 65°, 25°.)

3. From the diagram, Fig. 91, find the difference in level of high tide and low tide. The observation point P is 135 ft. above

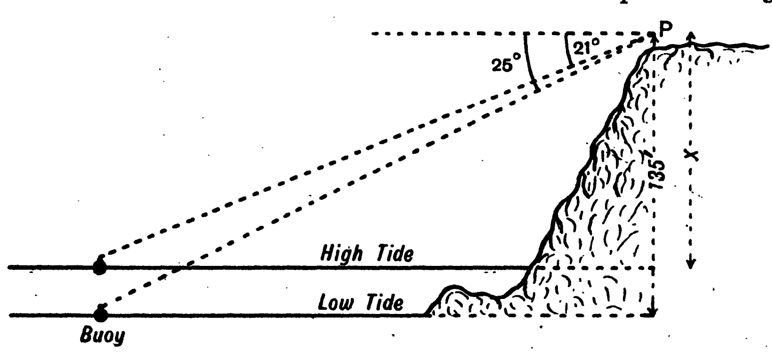


FIG. 91. DIAGRAM FOR EXAMPLE 3

the level of low tide mark. The diagram represents a spring tide in Jersey, Channel Islands. (135 tan. 65°=x tan. 69°.)

STAGE 2. INTRODUCTION AND USE OF SINES OF ANGLES

I. *Introduction*.—The sine may be introduced by further study of the similar triangles obtained from sun shadows; or the children all draw a right-angled triangle with one of the other angles 30°, Fig. 92. The lengths used for the sides will vary but all the triangles drawn will be the same shape (cf. the sun shadow triangles). The name "similar triangles" can be given. The children are reminded about the tangent of the angle.

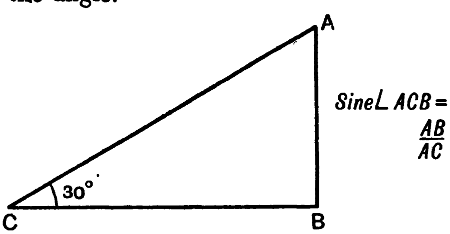


FIG. 92

The ratio of AB to CB is the same, whatever the lengths of the sides.

Tangent of 30°=

$$\frac{AB}{AC} = \frac{\text{side opposite the angle } 30°}{\text{side adjacent to the angle } 30°}$$

They now proceed to investigate the ratio $\frac{AB}{CA}$. This is found to be ½ by all the children and the name sine 30° is given. A similar experiment can be done for one or more other angles and the general statement arrived at:

$$\text{sine ACB} = \frac{AB}{AC}\text{; i.e., } \frac{\text{side opposite angle}}{\text{hypotenuse}}$$

II. *Use of sine of angle*.—Before investigating the sine table, it is advisable that the children should realise its practical use. An example of the following type is suitable:

A ladder 20 ft. long is set against a wall. The ladder makes an angle of 70° with the ground. Find the height of the top of the ladder above the ground, given that sine 70°=·94.

III. *Finding sines of angles*.—A similar method to that used for finding tangents can be adopted but variety is introduced by drawing figure 93 and working from it.

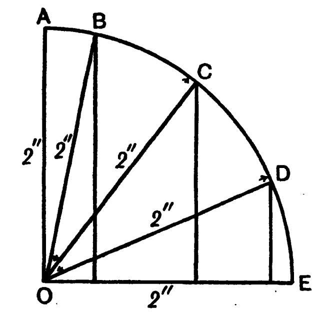


FIG. 93. FINDING SINES OF VARIOUS ANGLES

Angles of different sizes can be drawn and a table drawn up.

Hypotenuse 2 in.

angle	side opposite to angle	side opposite / hypotenuse	sine of angle
23°	·8 in.	$\frac{·8}{2}$	·4
52°	1·6 in.	$\frac{1·6}{2}$	·8
79°	1·96 in.	$\frac{1·96}{2}$	·98

A table of sines of angles from 0° to 90° should then be studied and discussed. The difficulty in getting accurate results from the drawing, for angles larger than 70°, is explained when the slow rate of change of sine for angles between 80° and 90° is observed.

EXAMPLES

The following are problems using sines:

1. A ship sails 30 miles in a N.E. direction, Fig. 94. How much farther north has it gone?

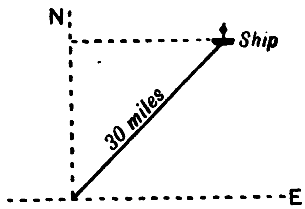


FIG. 94. DIAGRAM FOR EXAMPLE 1

2. A trap door, AB, in the floor is raised so as to make an angle of 50° with the floor, Fig. 95. How high is B above the floor?

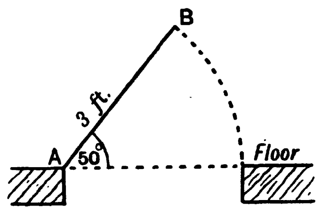


FIG. 95. DIAGRAM FOR EXAMPLE 2

3. A sloping road runs uphill at an angle of 10° to the horizontal. If a man walks 400 yd. along it, how much has he risen?

The following are harder problems:

4. A ship leaves a port, P, and sails N. 10° E. for 15 miles. It turns and sails E. 10° N. for 22 miles. It turns and sails S. 20° E. for 7 miles and arrives at an island, I, Fig.

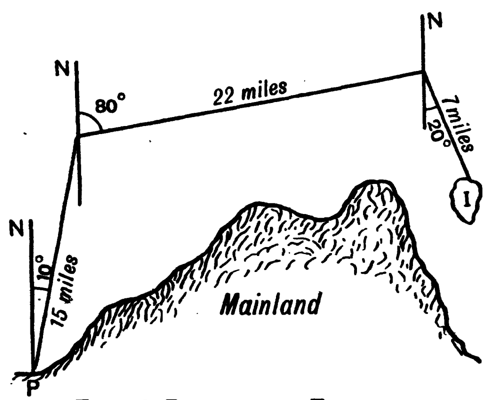


FIG. 96. DIAGRAM FOR EXAMPLE 4

96. How much farther north is I than P? How much farther east is I than P?

5. A road runs uphill at an angle of 20° with the horizontal. Its steepness is to be indicated by a notice at the side of the road saying, "Slope 1 in . . ." Fill in the missing figure.

6. The angle between the slant face of a cone and its circular base is 60°. The slant height is 10 in. Find the vertical height of the cone, Fig. 97.

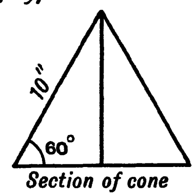


FIG. 97

Note.—Example 5 raises the question as to whether sine or tangent of angle should be used. Gradients of roads are rarely as much at 1 in 4. Sutton Bank in Yorkshire, a "very dangerous" bank used in motor trials, has a gradient of 1 in 4. Sine 14°= ·242 and tangent 14°=·249. Whichever method is used, the gradient of Sutton Bank is 14° to the horizontal.

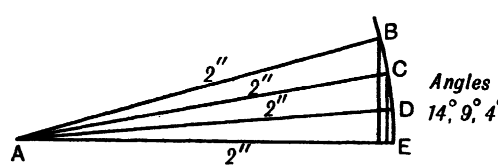


FIG. 98. GRADIENTS OF ROADS

For smaller angles, the sine and the tangent approximate even more closely. Figure 98 shows how the hypotenuse of the triangle and the side adjacent to the angle approach equality as the angle approaches 0°. Therefore, in dealing with gradients of roads either sine or tangent of the angle may be used. The practical issue is that the distance measured along the road (hypotenuse) or distance measured from a map (the adjacent side, or projection of the road on to the horizontal) may be used.

When larger gradients than those of roads are being dealt with, it is important that statements should make their meaning clear; e.g., 1 in 2 (horizontally). This might have been stated as a gradient of 27° to the horizontal. (·5=tan. 27°=sine 30°.)

Compare with work on levels in Section XII.

STAGE 3. INTRODUCTION AND USE OF COSINES OF ANGLES

I. *Introduction.*—Cosine may be introduced by further study of similar, right-angled, triangles, Fig. 99. As a rule, little

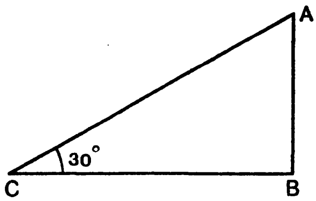


FIG. 99. COSINE 30° $= \frac{CB}{CA}$

time is needed because if $\frac{AB}{CB}$ and $\frac{AB}{CA}$ are fixed ratios for right-angled triangles, ABC, having C=30°, it follows that $\frac{CB}{CA}$ is a fixed ratio. The name cosine is given.

$$\text{Cosine } 30° = \frac{CB}{CA}$$

$$= \frac{\text{side adjacent to angle } 30°}{\text{hypotenuse}}$$

The children should note that:

$A\hat{C}B$ is the complement of $C\hat{A}B$.

$\frac{CB}{CA}$, the sine of CAB, is the cosine of $A\hat{C}B$.

II. *Use of the cosine of an angle.*—The following is an example of the use of the cosine of an angle:

The roof of a lean-to shed is 6 ft. wide and it makes an angle of 15° with the horizontal. Over what width would it give shelter from vertical rain, Fig. 100?

III. *Finding the cosines of angles.*—A method similar to that used for sines can be used and a table of cosines discussed. The fact that the sine of an angle is equal to the cosine of its complement explains the method commonly used in tables, of

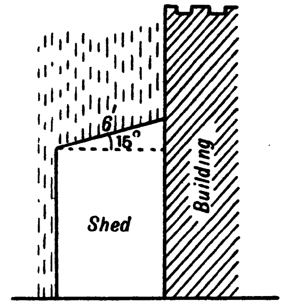


FIG. 100. MAKING USE OF THE COSINE

writing angles 0° to 45° down the left hand side of the page, and angles from 45° to 90° up the right hand side of the page. For the work of the senior school it is not necessary to use smaller divisions than degrees.

EXAMPLES

The following are examples using cosine:

1. A ship sails 12 miles in a direction E. 25° S. How far eastwards has it moved?

2. Construct an angle whose cosine is $\frac{3}{5}$.

3. A searchlight at O catches an enemy aeroplane in its beam when the beam is inclined at 43° to the horizontal. At the same time the 'plane's distance is found, by a rangefinder, to be 3,600 yd. from O. If N is the point immediately under the 'plane when it was sighted, find the distance of N from O, Fig. 101.

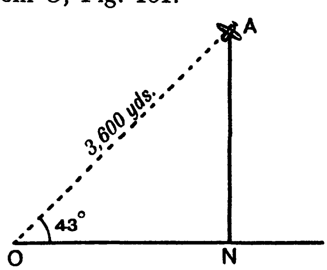


FIG. 101. DIAGRAM FOR EXAMPLE 3

STAGE 4. INTRODUCTION AND USE OF FORMULA $\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$

The children can discover by drawing and measuring that the sides of a triangle are proportional, not to the opposite angles but to the sines of the opposite angles. Triangles of any shape are drawn, sides and angles are measured and the results entered in tabular form:

Triangle 1	side	opposite angle	$\frac{\text{side}}{\text{angle}}$	$\frac{\text{side}}{\text{sine angle}}$	
	3	80	$\frac{3}{80} = \cdot037$	$\frac{3}{\cdot98}$	3·06
	2·0	41	$\frac{2}{41} = \cdot048$	$\frac{2}{\cdot65}$	3·07
	2·65	59	$\frac{2\cdot65}{59} = \cdot044$	$\frac{2\cdot65}{\cdot86}$	3·08
Triangle 2					

Note.—The larger the triangle, the more accurate the results. Triangles with sides less than 2 in. give unconvincing results. The third column may be omitted.

Various members of the class will use differently shaped triangles. Some will do two or three triangles while others do one.

By comparison of results the conclusion is drawn, by inductive reasoning, that in any triangle the sides are proportional to the sines of the opposite angles, Fig. 102.

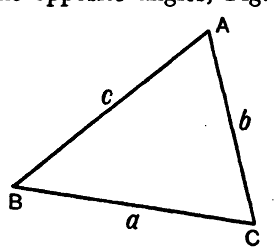


FIG. 102. $\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$

Stated in the usual form, this is:

$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$$

One question that is sure to arise in the course of this lesson is, "How can I find the sine of an obtuse angle?" It is a good thing that this question should arise from the need for the sine of an angle larger than 90°. An obtuse angle cannot be an angle of a right-angled triangle, so its sine cannot be defined in the usual way. The children can be told that it has been found a useful decision to say that the sine of an angle is equal to the sine of its supplement. After illustrating the truth of the formula for acute-angled triangles, the children can show that it also applies to obtuse-angled triangles.

EXAMPLES

The following examples use the formula:

1. Two observers, A and B, a mile apart on a straight road, each measure the angle between the road and a line pointing towards a distant hilltop. A finds that the angle is 70° and B finds it to be 80°. Find the distance of the hilltop from A, Fig. 103.

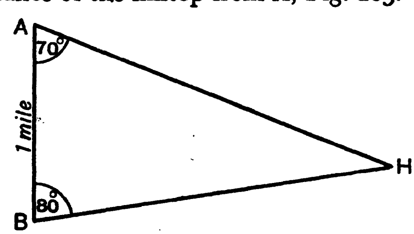


FIG. 103. DIAGRAM FOR EXAMPLE 1

$$\frac{1}{\sin 30} = \frac{AH}{\sin 80}$$

$$\frac{1}{\cdot5} = \frac{AH}{\cdot98}$$

$AH = 2 \times \cdot98$ miles

$= 1\cdot96$ miles.

2. A boy usually walks home from school along a path running due west for a mile. Sometimes it is flooded and he goes along a road which runs from school W. 30° N. He then turns left along a road which runs S. 17° W., and takes him home, Fig. 104. How much farther has he to walk when the usual path is flooded?

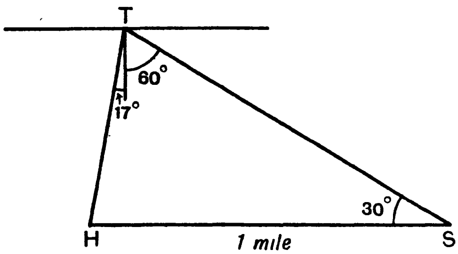


FIG. 104. DIAGRAM FOR EXAMPLE 2

3. A lighthouse stands on a rock 6 miles from a harbour. After sailing 8 miles from the harbour, a ship sees the lighthouse N. 10° W., and the harbour W. 30° N. How far is the ship from the lighthouse?

The following are harder examples:

4. Two ships A and B sail from a port at 9 a.m. A sails at 12 knots. At 10 a.m., the captain of A sees the port, W. 30° N., and sees the other ship, B, in a direction E. 20° N. Fig. 105. What is the distance of B from A if B's speed is 15 knots? (1 knot is a speed of 1 sea mile per hour.)

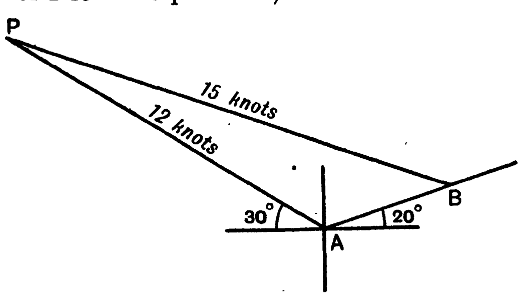


FIG. 105. DIAGRAM FOR EXAMPLE 4

5. A chimney stands on a sloping hill whose gradient is 7° to the horizontal. From a point P 120 yd. up the hill, the angle of elevation of the top of the chimney is 8°, Fig. 106. Find the height of the chimney.

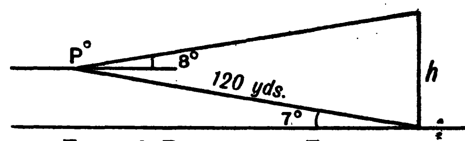


FIG. 106. DIAGRAM FOR EXAMPLE 5

$$\frac{h}{\sin 15^\circ} = \frac{120}{\sin 82^\circ}$$

Note.—By using the formula, a triangle can be completely determined if there are given either two angles and one side, or an angle, the opposite side and one other side.

EXAMPLES

Examples like the following can be done, but are not very interesting:

1. In a triangle ABC, $a=3$ in., $\hat{A}=40°$, $\hat{B}=60°$. Find b and c.

2. Given $a=3$ in., $\hat{A}=40$, $b=4$ in., find $\hat{B}$ and c.

A deductive proof can be given to children who are ready for it.

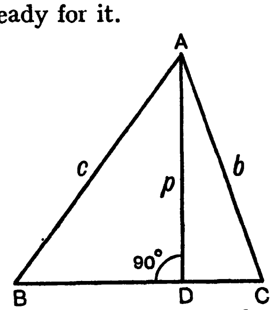


FIG. 107. DIAGRAM TO PROVE $\frac{b}{\sin B} = \frac{c}{\sin C}$

In the triangle ABC, AD is drawn perpendicular to BC, Fig. 107.

In triangle ABD, $p=c \sin B$.

In triangle ACD, $p=b \sin C$.

$\therefore c \sin B = b \sin C$.

i.e. $\frac{b}{\sin B} = \frac{c}{\sin C}$

By dropping a perpendicular from C to AB, it can be proved that:

$b \sin A = a \sin B$.

$$\therefore \frac{b}{\sin B} = \frac{a}{\sin A} \therefore \frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$$

STAGE 5. INTRODUCTION AND USE OF THE FORMULA—AREA OF TRIANGLE$=\frac{1}{2}ab\sin C$

Deductive proof.

In the triangle ABC, if AD is the perpendicular from A to BC, area of triangle $=\frac{1}{2}BC\times AD$.

$AD=b\sin C$ (in $\triangle$ ADC; cf. last par.).

$\therefore$ area of triangle$=\frac{1}{2}BC\times b\sin C$

$=\frac{1}{2}ab\sin C$.

EXAMPLES

1. In a triangular field, two sides measure 300 yd. and 220 yd. respectively. The angle between them is 50°. Find the area of the field. Area$=(\frac{1}{2}\times 300\times 220\times \sin 50)$ sq. yd.

2. A hexagon is inscribed in a circle of diameter 10 in. Find its area.

Hexagon is composed of 6 equilateral trangles, whose sides are equal to the radius of the circle.

$\therefore$ area$=6\times\frac{1}{2}\times 5\times 5\times \sin 60°$.

XVII. NOTES ON THE HISTORY OF MATHEMATICS AND ITS USE IN TEACHING

MATHEMATICS is commonly regarded as a formal academic subject abstracted from the affairs of everyday life. Mathematicians, in the eyes of schoolboys, are dry old fogies, far removed from the joy of life.

In reality, mathematics has been an essential factor in the progress of mankind; no advance has been made without it and mathematicians have been among the most adventurous of men. The story of mathematics tells tales of discovery, full of excitement and romance to those who have ears to hear. For the appreciation of the more recent history, some knowledge of mathematics is required; a knowledge that may be beyond that of the average teacher and far beyond that of senior school pupils. But an appreciation of the earlier history is something that the teacher can endeavour to pass on to the pupils. The difficulties they are facing to-day are those which stood in the way of the greatest minds of the past. To know about the struggles and successes of real men in the past adds interest and vitality to the studies of to-day. Mathematics becomes real and alive when it is seen as a part of the achievements of mankind.

Many modern text books recognise this and insert short, historical notes at appropriate points. Admittedly they are scrappy, but it is not desired to give a course on the history of mathematics. The best results are gained by giving a very short account of the men and their discoveries, or the old traditions connected with each new piece of work introduced to the class. Some books have been written so as to be of interest to children, and these should be available in the classroom rather than in the library. Most of the books are for teachers, but they provide much that is of value for making mathematics alive. Mathematics have played a big part in the development of all the sciences and the history of mathematics is closely interlinked with theirs. Progress in mathematics has often been concerned with measurements of time and the making of calendars. Astronomy and the study of the heavens made this possible and the history of the great astronomers is part of the history of mathematics.

Teachers should read *Mathematics for the Million* and should collect historical references that can be introduced into lessons. A list of names of some books on the history of mathematics is appended.

BOOKS DEALING WITH THE HISTORY OF MATHEMATICS

A History of Mathematics, by F. Cajori (Macmillan; 17s.).

A Primer of the History of Mathematics, by W. W. R. Ball (Macmillan; 2s. 6d.).

A Short History of Mathematics (2 volumes), by D. E. Smith (Ginn & Co.; 21s. each).

Pioneers of Science, by Sir Oliver Lodge (Macmillan; 7s. 6d.).

A History of Mathematics, by V. Sanford (Harrap; 10s. 6d.).

The Study of the History of Mathematics, by George Sarton (Harvard Press).

The Great Mathematicians, by H. W. Turnbull (Methuen; 2s. 6d.).

Number Stories of Long Ago, by D. E. Smith (Ginn & Co.; 2s. 9d.).

The Story of Arithmetic, by S. Cunnington (out of print).

Mathematics for the Million, by J. F. Horrabin (Allen & Unwin).

A Voyage in Space (six lectures delivered at the Royal Institute, Christmas, 1913), by H. H. Turner (S.P.C.K.; 7s. 6d.).

XVIII. TREATMENT OF "C" AND "D" STREAM CHILDREN

Difference from "A" and "B" a matter of degree not of nature.—In our anxiety to find a suitable curriculum for "C" and "D" children, we sometimes make the mistake of thinking of them as essentially different from normal children. Intelligence tests do not draw any lines of clear demarcation; they space out the children; they determine the position of "normal" in intelligence, but from this level children grade away, both upwards and downwards, indefinitely, without any clearly marked breaks. For practical purposes, levels have been determined. Children with I.Q.s between 70 and 90 form the "C" and "D" streams; children below 70, are educated best in special schools, but they are not marked off from the rest of humanity by clearly defined abnormalities. Their minds work more slowly, they cannot keep pace with their fellows, but the differences lie in degree rather than in kind of ability. Teaching methods are the same, in essentials, but the children are some years behind their chronological age.

Dull and backward, and backward children.—The same applies to teaching methods for "C" and "D" stream children, except that we find among them many who are "backward" and not both "dull and backward." The causes of backwardness are many, and are discussed in Section III. In many cases the backwardness dates from infant or junior school days. The passage from "concretes" to sums dealing with abstract numbers is not an easy one, and some children have never made it. It cannot be achieved until the child's mind is sufficiently developed. Some children are much later than others in reaching this stage. If the speed set for the class is too great for the individual, he cannot keep up with the others. Once he falls behind in arithmetic, he is lost. He becomes convinced that he cannot do arithmetic and, unless some special treatment is given, he will not make any progress.

Treatment for backward children.—Backwardness as distinct from dullness can usually be discovered by the use of intelligence tests. In dealing with it, a teacher can get help from infant school methods. One does not send the child back to the infants, but one often uses the same methods. For these backward children, the work must be carefully graded and the pace set by the individual child. Difficulties must appear one at a time. Careful treatment may restore the backward child to a position much nearer his true level.

Treatment for dull and backward children.—The "dull and backward" children do not present so many possibilities as the merely backward. Their minds move much more slowly, they have a smaller mental grasp, they hold things less securely, but they think in the same way as the normal child and have similar interests. The modifications required for them in mathematics are not changes in method and not, to any great extent, changes in curriculum. What they need is more time to do the questions, easier examples, more practice at each stage. The numbers involved in their examples should be small; their problems should have fewer steps; they should do more practical work.

They do not attempt as much as "A" and "B" stream children, but they should do the first steps of the work set out in Sections VI to XIII. This gives elementary ideas about the meaning of the decimal point, percentages, proportion, graphs, practical measurements indoors and out of doors. By doing this, they will apply mathematics to everyday affairs as far as their powers allow.

"C" and "D" children respond well to projects. They find great satisfaction in doing things and their sense of achievement can be a valuable factor in their education. Very simple projects connected with the model of a post office have been found to stimulate weak "D" children. The teacher should find out what does interest these children and then devise simple projects connected with it. Some details of a lesson on a square pyramid to "C" and "D" children are given in Stage 16 in the section on geometry.

TREATMENT OF THE DULL AND BACKWARD CHILD

SYNOPSIS OF CONTENTS

GENERAL CONSIDERATIONS

The dull and backward child.—Is there one of us who has not sighed over a section of the class and thought that life would be less of a problem without it? That section is usually no credit to its teacher as far as results are concerned and yet needs twice the attention; its members are not only slow-learning but often troublesome and difficult.

At the present time, there is a wave of interest in these children who compose the lowest group of our all-standard schools and the "C" division of forms of reorganised junior schools. Authorities are asking for teachers who will experiment and record their results with various methods of instruction, and the Board of Education in the pamphlet on *The Education of the Backward Children* (1937) suggests that successful work with a class of dull children should be reckoned as an added qualification for the post of head teacher. For the teacher who has a whole class of backward children, and also for those who have a group, and even for those in rural schools who have the whole of the juniors to teach and therefore a fair number of slow pupils, it is an opportune time to reconsider these children in the light of the new volume on *The Backward Child*, written by Dr. Cyril Burt and published this year, and the Board of Education's pamphlet already referred to. By so doing we may put aside our traditional ideas about discipline and results in the three R's, and learn new and more effective ways of dealing with this type of child.

First, who is the dull child and who is the backward? Can he be both dull and backward? The backward child is, as far as teachers are concerned, the educationally backward, without being mentally deficient. He is not up to the normal educational standard for his age. Dr. Burt defines him as one, "who in the middle of his school career would be unable to do the work of the class next below which is normal for his age." This definition is accepted in the Board of Education's *Handbook for Teachers* (1927). This means that a child of eleven and a half years working with a first year group in the junior school would be considered backward if he were unable to do the work of the third year juniors who would be approximately nine and a half to ten years of age. If only one year behind, the child is "somewhat retarded but creates no special difficulties" (Board of Education's *Handbook*, 1927) and can be accommodated in a class where the average age is somewhat below his own. Dr. Burt says, "This is everywhere a common practice: it carries with it little or no disadvantage, so long as the ages are not too freely mixed."

Causes of backwardness.—Some of these children are backward for a number of reasons, but not because they are innately dull; i.e., their intelligence is normal. They may have had long absences from school on account of illness and so missed some fundamental instruction, which has impeded their progress through the junior school. Ill health itself may be a possible cause, and most teachers now take the trouble to find out from medical cards and by careful observation if there is any physical explanation; e.g., defective vision, hearing, malnutrition or anaemia. Defective speech and backwardness are often found together.

Ineffective teaching in the lower classes is a common root of the evil. Many conscientious teachers are over anxious in the early years and begin to teach small children to read before they are able to speak, and to do sums before they have any ideas that figures have an everyday significance, with some meaning for the child, who continues in a mental muddle, growing farther from understanding as the years bring more advanced instruction. These teachers would be genuinely shocked to know that they have actually created backwardness.

Backwardness in one subject has often been found to pivot on an apparently small misunderstanding, but one which has been enough to hinder the child's whole progress. He goes from one misunderstanding to another and gradually loses all interest and sinks into a state of inert boredom whenever he is required to attack the subject. He decides that he "can't do so and so" or that he is "no good at" the particular subject, and before there can be any improvement, he has to be re-educated from the beginning. In the middle years, during the struggle for scholarships, ineffective teaching of the average child often goes hand in hand with the success of the bright child, and while the efficiency of head teachers and their assistants depends on the number of scholarships to their credit, backward children will continue to be manufactured in the junior school.

It is not only teaching which lacks persistence which is to blame, but also methods which are dull and uninteresting and unrelated to the life of the child. Endeavour from the child is more likely to survive a difficult piece of work approached from an interesting point of view than something both dull and hard which is too much for the average child. Let us look to our methods of the moment, for it is not one department only which has been guilty.

Emotional difficulties are a general cause of backwardness although the opposite works and backwardness is certainly the cause of many emotional difficulties. The outstanding trouble is discouragement, due to both adverse criticism and to the child's loss of belief in his own powers. There is a place for just and constructive criticism but, when a child is already feeling inferior through failure, blame from the teacher or parent invariably produces unfortunate results. There are many discouraged children in our schools but they are usually called "lazy," "obstinate," or "stupid" according to the outward signs the child has adopted to persuade himself that he is not a "dud." While energy is swamped in emotional distress, the child is, of course, unable to concentrate on work which he barely understands. There is a simple lesson which all teachers know but which is easily overlooked in the stress of working for results and within the narrow life of the classroom. It is a psychological truth which has been proved by laboratory experiments that praise begets effort and blame begets fatigue. These discouraged children must be praised for something and there is no child who is altogether a failure.

Many of these children are being forced to work towards a goal which they have no desire to reach. The parent who wants a son to do as well as his cleverer brother, the teacher who holds up a sister in the same family as a prodigy and a headmaster who forces competition in an attempt to acquire a high general standard are guilty of making school a place of defeat and humiliation for these children. In order to do their best, they should work towards a goal which seems desirable to them and they should be interested in the approach to that goal.

There are also temperamental peculiarities which should, but do not often, receive suitable consideration when it is a question of learning in a large group. The sluggish minded child who needs longer to absorb a new situation but who will persist if given the opportunity; the over sanguine child who one imagines has understood because of a certain glibness but who in reality has imbibed nothing, are brief examples of the children we all deal with and recognise and yet expect to learn at equal rates with normal class mates. Unless individual attention is provided, they join the backward group in due course and become discouraged and still more backward.

Social conditions play a large and important part in the educational progress of children. Teachers in slum areas know full well that the delicate child is nearly always the backward one although the same child with a good home and food and with more comfortable clothes would probably be able to keep a normal pace in the class. Not only poverty with its attendant evils but also the drabness of background is a deterrent to those who have missed lessons owing to ill health. The child who has picture books and parents who read to him will not lose much if he spends half his early school years in and out of hospital, but the child with a similar history from a home in the slums has already begun to tread the backward path and in some cases reaches the school for mental defectives because of his reading disabilities.

The dull child.—In any of these cases the child may be of normal intelligence, but we now come to the child who is backward because he is dull; those who are known as "dull and backward." From an educational point of view, the child cannot be dull without being backward and his trouble is quite distinct from the child whose backwardness is due to any of the reasons already mentioned. The backward are backward only when compared with a standard of attainment, the dull are dull in school and at home; it is a state of mind. But they are not bad enough to be classed as mentally deficient although they are born with a sub-normal capacity to acquire education, to learn easily. There are cases where the dullness is acquired early in life through a disease or injury.

This need not mean that they are abnormal in any other way; they often make good citizens and are quite successful in family life. On the other hand, the dull child has become the young delinquent and, later, the adult law breaker. Unless he is effectively educated, in the fullest sense of the word, the dull boy of to-day constitutes a menace to the community of to-morrow.

Intellectually, they are able to concentrate for very short periods only; they are practically incapable of sustained attention to anything in which they are uninterested and they have particularly poor memories because they fail to associate one idea with another. The power to deduct is weak and they reason more easily when doing things than when dealing with the abstract; they therefore take longer to grasp a rule and to memorise it, but do so more easily if the idea has arisen from a practical situation. They cannot easily apply in one situation, experiences learned in another; they do not anticipate consequences or criticise their own conduct, and are slow to form judgments or to generalise.

Their accomplishments in all physical activities closely approximate to those of the normal child and their power of motor ability is also nearly parallel. They usually reach as near success as they can when manipulating materials and performing the operations in constructive work.

They experience the strong emotional tendencies—social interests in the home, vocations, clubs and friendships as normal children of their age and they have a deep desire to be like others. Generally speaking, the weakness is mainly mental.

Triers and non-triers.—Many teachers will recognise the two types into which these children are classified by the Board of Education in the pamphlet on *The Education of the Backward Child* recently published. They are those who try and those who do not try. Those who try, include many whose difficulties have not yet been realised and therefore no one has shown them how to clear up their misunderstandings. There are others who try and fail "because they are being urged to attack the wrong things" in unsuitable lessons; and there are still others, who have already been mentioned, who try but are powerless against their own emotional or temperamental peculiarities.

Any of these causes underlying the failure of children who *do* try affect some children adversely so that they do *not* try. Some, however, are too tired to try; their vitality has been exhausted by domestic duties at home; poor food, lack of accommodation and unsuitable sleeping conditions. On the other hand, quite good homes from a material point of view are to blame for this inertia. There are a number of over protected children who have had everything done for them from birth and by the time they reach the senior school they are almost incapable of making any effort for themselves. Many more have been over disciplined and their lives are so directed in every detail that they "have lost all initiative and may act as though they suffer permanently from paralysis of the will." These latter will soon recover in a school where the discipline is fairly free, but rigidity at school as well as in the home may result in permanent harm.

There are children who do not belong to any of these groups and their difficulties are hard to diagnose. For instance, the teacher may be identified with the parent who has subjected the child to harsh discipline, unjust treatment and excessive restrictions and who therefore comes to school with a strong antagonism to authority which will be passed on to the teacher and headmaster as other wielders of authority. Such a situation causes a serious obstacle and the child is stubborn and will not try. If he is subjected to more pressure and discipline, he only goes from bad to worse. The solution here comes by way of a release from authority. A teacher who reads this and recognises one of his own problems, will be interested to read the case of Jerry in Chapter 4 of Homer Lane's *Talks to Parents and Teachers.* Jerry had been sent to the little Commonwealth (a Home Office School run by Lane on original lines involving self-government) for chronic truancy. He was excellent at games, enjoyed all kinds of handicraft and was good at them, but he could not learn. He was cheerful, companionable, with a delightful sense of humour and certainly not feeble minded. This was the verdict of his teacher: "His brain is no good; he cannot hold anything he is taught. He is stupid." One evening he came to Lane in great excitement because he had succeeded in solving a puzzle called the "Pig in Clover." "I didn't know that you cared for puzzles," said Lane. "I don't much," he replied, "but when I saw Miss B. (the teacher) trying to do it, I thought I'd have a try. *She* couldn't get 'em in the clover." This incident provided the key to the situation and a plan was made with the hope that its success would end Jerry's tangle with authority. He was given a sum which involved the number of planks needed for the new floor on which he was working. When he failed to solve it, he was sent to Lane who upbraided him with his stupidity and said that he himself could do it in his head and then proceeded to bungle hopelessly while Jerry stood over him and pointed out his errors. The plan had worked and Lane made a lame excuse to leave the sum to be worked out by Jerry. Not long after, he was called to order at the school council when Jerry was charged with doing arithmetic at 11.15 p.m.

Distinguishing the backward from the dull.—In order to give careful consideration to the treatment of both backward, and dull and backward, it is necessary to be able to distinguish between them. Most teachers would say that they can do this from their experience of various types of children but there are numerous examples of discrepancies between the teacher's opinion and the results of scientific testing. Children easily hide their real natures and capacity and assume masks through which it is difficult to penetrate.

Intelligence tests.—Even the more accurate intelligence test given by a trained worker is not infallible. These children of ours are actually lacking in the power of abstract thought; the intelligence which they do possess may be manifested in many activities of life which the tests cannot assess. If accurately named, these intelligence tests should be known as those which test abstract thought. Experiments have been made with thousands of children in order to ascertain what can be expected from children of various ages. The individual tests are verbal and although the child in question may be intelligent enough in handling concrete material and in his social contacts with his companions, his slow or inarticulate speech may result in a low score. The following are a few examples of verbal tests selected at random. The child of eight is asked to count backwards from 20; to name ½*d.*, 6*d.*, 1*d.*, 1*s.*, 2*s* 6*d.*, 2*s.* (placed in this order); and to read a passage and recall two items. In his seventh year, he is asked to repeat a series of numbers backwards. In his ninth year, four numbers have to be repeated backwards and six forwards; the child is also asked to make sentences from words and to count the value of a number of stamps. A twelve year old is given three examples and then asked to state in what way the following are alike:

Rose, potato, tree;

Snake, cow and sparrow;

Knife, blade, penny, piece of wire, etc.;

and to interpret the meaning of a picture.

Although these tests are extremely valuable in giving us an idea of what a normal child should be able to answer at each age, they are not foolproof for the sub-normal. There are others which test by giving the child something to do with his hands; these are more suitable in some cases, especially as their way of going about the puzzle, or of looking at the apparatus, indicates something of his personality to the tester. Picture and group tests with the minimum of writing but a certain amount of reading are again successful with some children and aim at the discovery of certain kinds of intelligence. An accurate estimate of one child's intelligence needs several tests of different types. Although they may not be consistently successful with backward children, they are used with a fair degree of accuracy and their almost universal use has provided us with some valuable information. For instance, those whose intelligence quotient is less than 85 are seriously handicapped in school, and they cannot keep pace with the normal children in the three R's. They correspond to our dull children who cannot improve their intelligence; they will always be dull educationally although they will be able to undertake a certain degree of responsibility and initiative under supervision. It is estimated that out of one hundred children of 11 plus ready for transfer from the junior mixed department, about fifteen belong to this group. If 25 per cent of this hundred are removed to selected schools because they are the most intelligent, 20 per cent of the remaining number are left in the senior school in either the "C" classes or groups in other classes.

Those children whose intelligence quotient is over 85 are not considered dull although they may be among our backward children who should be able to do the school work of other children of their own age.

What is the correct achievement for a child at any age? Here again opinions differ and a child may be backward when compared with the attainments of one group of children and normal when considered with another group. Teachers and headmasters have various standards. In order to avoid this difficulty, it is now possible to use standardised tests of attainments for the usual school subjects. If a child of twelve years is tested in reading and reaches only the level gained by the child of ten years, we say he has a reading quotient of 87·5 and by taking the average of a number of tests we arrive at the educational quotient.

Let us suppose that your backward child has been given an adequate intelligence test by a trained psychologist and he is found to be fairly normal. The teacher can then test his attainments in the fundamental subjects and work out his educational quotient. If this is low, the child is obviously not achieving according to his capacity and is capable of making further progress, providing of course that the cause of his backwardness is removed and special individual teaching is arranged. Generally speaking, backwardness is curable when the child's intelligence is normal, but where there is no discrepancy between the two quotients, then it is highly probable that the child is making as much progress as his intelligence allows.

If every local education authority provided a psychologist who would be responsible for this testing, the two types could be distinguished and the teacher's work would begin by plans based on the special need of the two types. As this is a dream to be realised in the future, the teacher is faced with the responsibility of discrimination. Many of the tests require a particular technique and others need expensive apparatus. These difficulties, together with the limited time at the disposal of teachers, make efficient testing impracticable, at present.

The teacher has to rely on himself and his colleagues; but opinions are not enough. The conclusions must be reached by careful investigation and open-minded observation. By open-minded, one means observation without reservations; we often are so saturated with ideas as to what children are or should be like, that we fail to see or accept the child as he is. One hopes that the time will soon come when records of individual children will be kept from the nursery school to the senior school, passing from one department to another and supplying not only information about attainments but the more important knowledge of physical condition, home circumstances, absences from school, temperamental peculiarities, emotional development, social adjustment and outstanding interests.

Value and nature of records.—Close and prolonged observation is invaluable in the establishment of accurate knowledge about children, and at the present time such methods are in use in clinics and in laboratories where students of children accumulate the knowledge which eventually finds its way into the schools. A valuable little book, *The Educational Guidance of the School Child*, has been written this year by a group of specialists who give illuminating suggestions for child study and guidance and explain clearly the need and method of keeping records.

The senior teacher will need to collect all possible information and history of his backward group. The junior departments may have something to offer. Medical cards, reports from care committee workers, social workers and the visiting nurse about the economic, intellectual and moral character of the home, the history of the family so far as it is possible to find out, the history of the child from the parent and other teachers, are possible fields to be explored and should briefly but systematically and faithfully be recorded and added to when fresh information comes along. Observations should be made in the playground as well as in the classroom and recorded together with the habits of the child and his method of work, his practical and social interest, his degree of stability and vitality, etc.

Records are at present in an experimental stage and many schools are devising their own. The *Handbook of Suggestions for Teachers* (1937) advises that they should not be over elaborate nor entail excessive clerical labour: "They will be more concerned with the points in which a child differs from his fellows than with those in which he belongs to the common average; it will give information, on the one hand, about the more permanent factors in his make-up, his health, his physical defects, if any, and the nature of his home, his temperament, his native ability; and, on the other, it will deal with the changes represented by his successive stages of achievement. They will wherever possible be based upon objective standards of assessment rather than depend upon personal impressions; and they will be wide enough in scope to enable the reader to form some picture of the development of the child as a whole."

If records have not been kept in the earlier years, they might begin when the children reach the senior school, in order that the backward children may not suffer any setback through lack of understanding if passed from one teacher to another.

Organisation.

Normal and backward associated.—It has been assumed that the practice of teaching backward children of twelve with normal children of nine and ten has been discarded; partly owing to reorganisation, and partly because in actual practice this method does not improve the older child but emphasises still more his inferiority and difference from other children. As we have already pointed out, these children are often normal as far as physical and social development are concerned, and need association with their own age and group. To leave them with younger children who are bound to outstrip the older ones is asking for trouble. They will try to gain respect by any means, often illegitimate. In these cases, the dull and backward become the delinquents and sometimes are the undoing of younger children. They must not be denied promotion in the all-age school nor yet forced to compete with their cleverer neighbours in an attempt to secure a general standard. If the normal and backward have to be in the same class, the backward section must be treated as an entirely separate unit as far as intellectual work is concerned. The plan is far from ideal but the intelligent teacher, who can modify methods and give them extra individual attention with a time-table of their own, will be able to do a great deal for them. If this arrangement is made, every precaution must be taken to prevent the group losing self-confidence and self-respect; no publicity must be given, by the teacher in class, to their weaknesses; and it will be necessary to counterbalance their failures by praise and approval of small successes in other fields. They should be monitors and have responsibility in small matters and every appreciation of any triumphs, however slight.

The treble-track system.—Segregation, although an ugly-sounding idea, is a better proposition. In the special class the competition and sense of inferiority is minimised. The ideal plan is the treble-track system in vogue in some of the larger all-standard schools and in the reorganised schools. The "A" classes are advanced, "B" classes are for those with average ability and "C" classes are for the slow. Dr. Burt likens the scheme of promotion in such a school to an arrangement of "railway lines on the busiest routes—a special track for the rarer and faster expresses, and another for the slow and heavy trains, both parallel to the old local line now busy with the mass of ordinary passenger traffic."

From both these types of "C" classes and from the section of slow pupils, there should be constant and easy transference and promotion. When a backward child (not dull) has caught up, he should return immediately to his own age group and if a child in an ordinary class has a temporary set-back, it should be possible for him to be transferred to the special class directly his needs are discovered. It might even be necessary to allow a child to "go slow" in one subject, e.g. arithmetic, by attending the special class for individual attention, intensive coaching and slow practice in just that subject. Authorities on the subject are emphatic that "in dealing with such cases, fluidity is essential."

The special class.—It is very important that the children should not lose prestige by these transfers to the class which has been known in the past as "a refuse heap for the rest of the school" and has been organised to relieve the drag and hindrance caused by the dull children. The class now needs a new name, for its aim is to be positive besides negative; it is to provide the golden opportunities for a number of discouraged children besides relieving the rest of the school. Various names have been used, the "practical class," the "industrial class," the "opportunity class"—anything but the "backward" or "special" class. In this article, it will be known as the "adjustment class." It is, of course, impossible to make a secret of backwardness but the attitude of the staff towards the backward children can change any scorn to matter-of-fact acceptance or even sympathy and helpfulness. Too often have teachers been guilty of ridicule in the classroom. Dullness is no crime; but insensitive treatment of handicapped children certainly deserves the name. Temporary transfer or full time attendance in the "opportunity class" should be accepted by the staff and children as a means to recover lost ground or as an opportunity of learning those things which suit certain personalities. The more practical nature of the curriculum may even cause the class to be specially attractive and its members may be looked upon with something like envy.

The children should be given every opportunity for association with other classes and with children of normal intelligence. If they are capable of competition with another class, it should be well encouraged. Ascendancy in physical things, if displayed, will have a tonic effect and will do much to prevent an exaggeration of the importance of weakness in academic things. They should regard themselves as a valuable part of the school and be allowed to show at exhibitions and to join in school plays and functions. They will make excellent scene shifters and will be efficient at making costumes, painting scenery and selling programmes. In schools where the assembly allows scope for children as well as the head teacher, they can take an equal part with the other classes; sometimes contributing a song, a lecturette or some spoken poem. Such jobs as the distribution of books and the arrangement of the piano and tables might be handed over to them. If the house system is in use, there will be excellent opportunities for social intercourse and adjustment. On occasions, the class might have some special display of its own and invite others to see it. In one school, a hobbies exhibition was organised and a special feature was made of co-operative class efforts in railway models. The backward class surprised everybody by carrying off the prize. They had even set their trains to run to a time-table of their own compilation.

The right teacher.—The question of one class teacher or subject specialists is debatable. These children require individual understanding which occasional teachers cannot possibly give them, and their achievement depends very much on pleasant relations with adults in charge; the advantage seems, therefore, on the side of the one teacher. They will, however, profit by contacts with various personalities and seem more like the rest of the school if they are visited by specialist teachers or if they change rooms on occasions. A happy compromise is to put the class into the hands of the ablest teacher on the staff, allowing experimentation with the curriculum, and then arrange for the art and music specialist and possibly the science teacher to take their own subjects, but in close co-operation with the class teacher. The "ablest" teacher is not usually the motherly person with the placid temperament, nor yet one who can produce the best results. Dr. Burt says, "What is wanted is a bright, adaptable person, physically active and mentally vivacious; firm, patient, sympathetic and inspired by strong common sense." In the pamphlet of the Board of Education already mentioned, the following is recommended: "He should be generous and open minded, quick to show sympathy when it is needed but slow to give up hope when things are not going well; he is lively and cheerful himself, and his example and influence breed liveliness and cheerfulness in his pupils; he may not be distinguished academically, but he will certainly possess a fund of common sense and have an undoubted gift in some direction or other. . . ."

Psychologists advise the separation of backward girls and boys in the senior school, if it is possible, especially in the poorer industrial areas on the grounds that they are often more precocious though mentally immature. Numbers may make this impracticable; the solution then lies in the hands of the teacher who will need to canalise their physical energies into interesting pursuits.

Conditions for teaching and learning.

The classroom.—There are plenty of old-fashioned schools in use and many children who are taught in stuffy, dark classrooms; we must keep in mind that whatever is bad for normal children is still worse for the sub-normal for they have not the same resistance against discomfort and their efforts at concentration are easily diverted on the slightest provocation. Classroom conditions are most important, and if they are not healthful the teacher can hope to do little real improvement to the child's attitude or accomplishment. Air movement, temperature and humidity have a marked effect on comfort and on physical and mental energy. Adequate lighting means eye protection and less effort when book and written work are involved. Blackboard work should be more than usually plain and distinct. Desks are most important. There are still classes of children sitting on backless forms in rows of seven or eight. If there is any choice of desk whatever in the school, the adjustment class should have the most comfortable and if all the seating accommodation is poor, then a series of protests must be made to the local education authority until something better is provided. It is a good idea to alter the traditional arrangement of desks and to place them in informal groups; those sitting together who are at the same stage in the primary subjects. Whatever helps to destroy the associations with past experience and failure is a step towards better achievement. The room should resemble a laboratory for "doing things" rather than an auditorium for the teacher. Shelves to hold exhibits, materials and books achieve additional informality.

Dr. Burt advises that the adjustment classroom should be as near the playground exit as possible so that when the children seem tired or their interest temporarily flags, they can go out for a free run or for a short sharp exercise. "Oral lessons can be often taken in a sheltered corner of the playground with the children sitting on mats. Indoors the benches need not be screwed to the floor nor the children to the benches. . . . Portable tables and chairs might well be substituted for the ordinary school furniture."

There is too little attention given to the appearance of classrooms for older children. One of the first jobs which the members of the new class can do for themselves is to clear away all rubbish including those out-of-date prints and cases of stuffed birds and to rearrange the furniture to give sufficient space for movement and for practical activities. A cheerful environment is most necessary but this does not mean that every surface should be covered with posters and that every window sill should be a receptacle for aspidistras, which, by the way, are symbolic of an educational past which might be more easily forgotten if removed from every classroom. Coloured pictures, a coat of paint on boxes and shelves, and perhaps a large earthenware pot of flowers transform many drab classrooms. The painting and cleaning can be done by the children.

The right atmosphere.—Besides the physical conditions of teaching, there are others which are more difficult to achieve. The military discipline of school life is disappearing but there are still far too many silent classrooms. This does not always indicate good work; children are usually quiet because they are afraid, and no one does his best work in the presence of fear. The adjustment class, in common with all others, should have the atmosphere of an interested community, sharing the responsibility of their education with the teacher, co-operating with each other in practical and intellectual pursuits and enjoying the discussion and argument which come when alert people live together for several hours daily. Verbal freedom is certainly one essential condition of life in the adjustment class. There is no need for the law of silence when children are interested. It is the dull teacher with dull methods who has to enforce such a rule. One of the chief difficulties of these particular children is their inability to express themselves in conversation but, by giving them freedom to talk naturally to each other and to the teacher, a valuable step is taken towards their speech education. All children are interested listeners when there is something worth listening to; and schools which encourage what is loosely called "free discipline" have no difficulty in getting quiet attentive audiences for themselves or for a child who is to address the class. "Free discipline" is an unhappy phrase; one really means "inner discipline" as opposed to "external discipline." The spirit of enquiry and the stimulus to effort which the teacher wishes to arouse in these particular children cannot possibly flourish where there is rigid discipline and, unless this is recognised, very little else can be done.

Besides verbal freedom, they must have liberty to move about the room to get materials, to consult books or to ask the teacher a question. The general health is improved by movement and is also a normal stimulant of the sensory centres and therefore of intelligence in general. No child should sit motionless for long periods, and to say to the dull child, "Sit still," is equal to saying, "Don't learn." The rule of physical liberty is absolutely indispensable if good results are required from backward children.

Banish the "hands up" rule and let them behave naturally. If they feel happier when standing up to do something, do not insist on the usual posture. A few trestle tables are excellent equipment as many practical tasks need large, level surfaces which sloping desks do not supply.

If these conditions of work are new to the group, they should be discussed with them in order that they may understand just what this freedom means. Restrictions should also be clearly stated. There should be as few as possible depending on the organisation of the school; e.g., unfortunate teachers who share a room will have to insist on silence at certain times. The happy, unrestrained atmosphere which is absolutely necessary for adjustment and growth is much easier to achieve when the whole school is run on the same lines. "Not only are backward children improved, but backwardness is actually prevented in schools where there is reasonable freedom of movement, opportunities for conversation and a not too rigid control" (Board of Education).

The time-table.

The importance of elasticity.—The same considerations apply to the time-table, which is drawn up as a form of educational machinery to be a guide to the teacher in the balance of the subjects of the curriculum and to ensure that the use of public places and mechanical aids shall not overlap; e.g., hall, subject rooms, piano, etc. It is the modern practice to space out long periods, e.g., English, and to leave the sub-division to the teacher to use as the interests and the needs of the class dictate. If a few minutes' spelling drill is needed, it may be taken before the class begin to make plans for their play or before the reading of a new poem, but the whole is called "English" instead of the old sub-divisions, "spelling" and "dramatisation" or "poetry." The special class teacher should have still more freedom to use the school day profitably, so long as he provides adequate periods for practical work, games and physical training, art and music. On no account must the three R's encroach on the time allotted to other subjects.

One of the characteristics of these children is the limited capacity for long concentration. The teacher should be free to change the work when he becomes aware of their fatigue. On the other hand, if they are unusually absorbed, the lesson might continue beyond the usual time. For practical work, they should have long enough to enable them to finish a job with satisfaction or to stop at a convenient process. No child likes to be suddenly separated from a creative effort any more than an adult does. Expeditions should be fairly frequent and these will, of course, interfere with the carrying out of the time-table. Permission has to be obtained but this is an official procedure which involves no difficulty. A list of excursions, with their specific purposes and provisional dates, has to be sent to the local education authority. Some head teachers arrange for a month's or term's excursions in advance; for the adjustment class it is probably wiser to arrange a month ahead.

Free activity periods.—There is great value in having times for "free activity" during the week. Some experimental classes have allowed as much as an hour a day when the backward children can choose their own occupations. One school had an afternoon session each week when the choice of activity rested with the boys. They could go from room to room where the various activities were in progress or they could join the dramatic readings and music in the hall. No boy dared to move during the first half hour of the first "free afternoon"; each felt that there was some "catch" in the idea; then a few literally slunk from one room to another. When they were more used to the innovation, the scheme was most successful. Another school arranged that each Thursday morning was devoted to excursions and free activities.

In the adjustment class the teacher would display games, books, painting and drawing materials, odds and ends of junk and tools, and leave children entire freedom to choose and to go from one to another if they so desired. They might want to finish a piece of work begun in another period, or to pursue a suggestion which had been given by the teacher during a talk; they might take the opportunity to look up something in a magazine or to exchange a few stamps with someone else. Co-operation, discussion and complete informality would be the order of the free period. Among the games, one would find puzzles, jig-saws, mechanical parts of ships and aeroplanes, codes and their appropriate keys, printing sets, games of ludo and snakes and ladders, guessing and memory games, etc. Discarded material like corks, match boxes, wheels, parts of clocks, pulleys and string will provide a stimulus for experiment and fiddling which is highly valuable. The teacher must decide how often this period should occur, but it should not be less than several hours weekly.

A piece of valuable work might be undertaken by the teacher during such periods. Educationalists are insistent that the curricula of "C" classes should be based on the interests of the children, but there is a wide field of research still untouched as to the nature of their preferences. The teacher can observe and record such details as: which material aroused the most ingenuity on the part of the children; which were the longest periods of concentration on any one occupation and which occupation in various instances; which games were most popular; which materials or games aroused the most co-operation. It has been found possible to keep a record of the activities of each child during free periods; this also is of the greatest value in illuminating the habits of work and play of retarded children.

Aims.—Certain points should be kept in the mind of the teacher who plans the programme for these children.

1. They can give attention only for short periods; i.e., five to ten minutes' mechanical drill.

2. On the other hand, short periods are especially inadvisable for any activity which involves getting materials or apparatus as they take longer to settle into a working mood and to adjust themselves to the situation.

3. They need a certain amount of regularity, more than normal children.

Another excellent plan is to set aside times when teacher and children can talk over the work together. Success depends on the pupil understanding what he must do to improve and then putting his will into the task. Education cannot be one-sided, pupil and teacher have to co-operate. Some teachers begin the day by explaining what has to be done and then letting the children discuss how and when they shall do it; and then, at the end of the day, they discuss together again what progress has been made. The idea will perhaps be clearer as the methods are more fully explained.

The class as a whole will work together in some activities but the variety of mental levels and levels of achievement in the tool subjects (three R's) makes it advisable to divide the children into groups for that part of the work. Some teachers work on an individual basis but, where attainments are level, the child gains confidence by working with others. In social studies and science it is better for them to pursue one common interest, each participating and benefiting according to his individual ability.

There should be a wholesale scrap, and without scruple, of a good deal of traditional time-table reverence. There should be the minimum of formality, drudgery and explanation. All which appeals neither to the natural interests of the child nor bears closely upon his work and his leisure in after life can be dispensed with. In the words of Dr. Burt, "Thought and attention must be concentrated more on organising activities to suit the class than on organising lessons to suit the syllabus; more on the allocation of work to individual pupils than on its allocation to successive periods of the day."

THE CURRICULUM

The needs of the child.—We have considered the conditions under which these children should be taught, the length of time which should be devoted to the various aspects of his education, and now the question arises, "What should they learn?"

The curriculum will, of course, differ from that of the other classes in two important respects; it will cover less ground and the quality will be less profound. It will also be characterised by far less book work and more practical activity. Although simpler, this does not mean the material which would appeal to younger children, for the interests of the dull and backward are those of his own age group and anything which he considers babyish will arouse his scorn and disgust and will be worse than useless, for it will emphasise his difference from others. Nor will a truncated course used for the "A" or "B" classes be of any use. Many teachers have realised that they must go slower with the "C" class and have therefore attempted to give them a shorter course; e.g., history up to 1485 instead of 1918, geography of Europe instead of Europe and Asia. What is wanted is a curriculum entirely based on the needs and interests of these particular children and no other will be successful. In some ways, they are normal and enjoy the usual activities of their age; where the ordinary curriculum provides for these they should be allowed to join in and no difference made. Games should be played with the rest of the school; they should take their part in choirs and in all out-of-school projects.

To come to a satisfactory conclusion on what is really ideal, we are forced to consider the aims of our teaching; what do we want to do for these children? I think we should agree that we wish to equip them to meet those difficulties in life which will be inevitable because of their limited capacity. The backward child will need to know how to keep himself fit, how to keep a job, how to make a home and how to enjoy his leisure; all of which can be called "education for satisfactory citizenship." We might further consider what knowledge and skill the lack of which will place him at a disadvantage later on. He will need to know enough mathematics to enable him to deal with his earnings and to make a good home; he will want to be able to write and to read a post card, public notices and bills, street signs and communications from government or local departments of administration; e.g., census forms or voting papers.

The next consideration concerns his ability. On the one hand we have his requirements and on the other his deficiencies. He cannot possibly "catch up" to the clever children, nor can the best teacher make a dull child into a bright one. No one can teach or add to intelligence; it is only possible to stimulate it to the utmost and make the best of what there is already.

Bearing in mind these facts, the teacher's best plan is to scrap all traditional curricula and build up one which provides for the child's needs and takes into account his limited capacity; at the same time keeping in mind that the plans must be made in the light of the children's interests and of the differences in various neighbourhoods. It is easy to overlook the fact that the knowledge we retain in after life and which is consequently really useful to us is largely confined to knowledge of those subjects in which we have an interest. This is more than ever true of the dull and backward. There is still an idea that the teacher exercises the mental faculties of the pupils by trying to force attention to uncongenial work. This has been proved entirely fallacious and most teachers of dull children will welcome the news which releases them from the bondage of "doing things for their good." Another exploded idea is that backward children need longer at the practice of the three R's because they are slow. Dr. Burt in his last book writes emphatically that this is not only a mistaken theory but "it is positively harmful", (*The Backward Child*, page 610).

Points to emphasise.—The important thing is, that the time is spent to advantage; i.e., with methods suited to the particular child and his understanding. It is important to remember also that what is taught should have a purpose for the children; one which they can understand. They appreciate reading to enjoy a story or to find out something which they particularly need to know in order to fulfil an objective or to discover what they have to say in a play.

A fair amount of elasticity should be allowed; there can be omissions; e.g., geography and history need not be taken as two subjects, in fact they are better taught through units of work or social studies. Some curricula are organised round a project which will introduce life situations where the interests of the children centre for a time round desirable pieces of knowledge. In such cases, the tool subjects (three R's) are practised in a time set aside for them. This method is discussed later.

Although the limited powers of the child are to be taken into consideration, full use should be made of any particular powers which are noticed and the activities should be such as directly encourage personality and character. Everything which they are capable of learning and which will function in after life should have its place. There should be games which will develop attention, concentration and judgment, excursions and visual aids which will make for clearness of perception and, above all, plenty of opportunities to express themselves in speech.

A warning must be added with regard to the backward child as opposed to the dull one. Discrimination is necessary when reorganisation of curricula is proceeding. The backward child needs to be helped over some obstacle and be given timely hints and encouragement after his difficulty has been diagnosed; then he will forge ahead, to be drafted when ready to his normal age group. The two types of problem have to be kept in mind and provided for.

I. *Suggestions for planning.*—Some practical suggestions may be useful in the planning of a new curriculum. Health is most important; it has already been mentioned in the aims of teaching. A health conscience is never stimulated entirely through talk; with the "C" child talks matter very little, whatever the subject. He probably comes from a home where there has been the minimum of habit training and if he has reached the senior school without having formed good physical habits, he will be fortunate in having another chance to acquire them. Lessons on ear and teeth structure are not the slightest use in persuading him to clean them regularly; talks about the need of well-aired bedrooms when they are actually sitting in a room with the windows shut are equally ineffective. The best way is to provide the means of living a healthy life while at school and by indirect methods to show him the value of personal habits of cleanliness and hygiene. The children can be responsible for ventilation of their classroom, for the record of temperature, for the cleanliness of washing bowls. An adequate supply of soap and towels and reminders to use them after a grubby game; the provision of a mirror where it can be used; informal discussions on the relative values of different makes of hair oil, tooth brushes and powder, are incentives towards decent living. When their interest has been aroused, the more formal talks can follow but even then they must concern everyday matters which affect the children; e.g., food which is good and yet keeps one slim (for the girls), length of rest needed, the best forms of exercise, the danger of dirt and so on. In their final year, they might be taken to see such local arrangements as those for the disposal of rubbish, for cleansing verminous houses, and the girls might in addition visit the welfare centres. Discussions with them on the various health services; what to do about the notification of infectious diseases, what useful stores to keep in a medicine box, first aid at home, should be interesting and useful, especially if they can compile some simple reference note book to take away with them and if the whole course is dealt with informally and embodies the special requirements of the particular children. The teacher will find the *Handbook of Suggestions on Health and Education* (Board of Education) useful and stimulating.

As far as tool subjects are concerned, they must be planned in such a way that the children will apply them to the specific situations in life in which they function. To know how to read, write and spell will not be enough unless the child can use what he has learned in situations in which he is most likely to need to use them. He will have to be given help in the interpretation of his reading, told how to use numbers when shopping, how to find his gain in weight over the previous month, how to organise team games and compute scores, to estimate the time spent on a job, etc. This will be more fully dealt with in a later paragraph.

As a satisfactory citizen, the backward child will need to be helped to become a worthy member of his family. Often, he has been made to feel his inferiority, but the school can give him responsibility in which he feels some pride and which may suggest to him various efforts which he can make in the home and so regain his self-respect and change the attitude of the rest of the family. Sharing classroom responsibilities teaches sharing in other spheres. Such simple jobs as taking care of their own clothes, sweeping the back yard, carpentry repairs and electric wiring, and the hints which the girls have been given in connection with budgets for housekeeping, fashions, making something out of nothing, about which they are able to chat to their mothers, may mean a great deal towards gaining a prestige and an appreciative audience. If there is a possibility of some co-operation with the parents and teacher, the child gains still more. Most parents are ready and anxious to meet the teacher and discuss with him the methods he is using. This results in treatment being carried over from school to home and is very important both to teacher and child. At the same time, the parents can give illuminating details of behaviour and situations in the home, and this helps the teacher to understand the child and to make any necessary adaptations of his school learning to his home situation.

The freedom which has already been discussed brings the members of the class in closer contact than in the formal group, and this is the most effective method of introducing social life. They have constantly to adjust each other, to give way, to wait turns for the use of apparatus, to consult each other, to work under a leader and to behave amicably together; all of which forms a valuable lesson for future experience, when it will be most necessary for them to maintain satisfactory relations with employers and fellow workers.

The use of leisure cannot be separated from a consideration of cultural subjects and their place in the curriculum, for the individual who is properly and happily engaged after working hours is safe from delinquency and is an asset to the group among whom he lives. Talks alone will not suffice; the function of the school is to guide them to experience repeatedly satisfaction in legitimate, recreational activities so that they will choose these outlets as a matter of course when they leave school. This part of the work cannot be casual or left to chance; there must be conscious means taken to build up the appreciations of which they are capable. Although mentally backward, they are by no means backward in artistic appreciation; their response to music is eager, especially when they take some part themselves. Community singing should have its place some time every day, if only for fifteen minutes between more strenuous efforts. They will enjoy hearing some remarks about the songs; e.g., the origins of traditional songs. A gramophone is useful to illustrate talks about composers. They can appreciate stories from Wagner and then follow selections from the opera. They should be chosen to attend the children's concerts which are given in some towns and can follow the music in the school radio programme. Dancing and eurythmics appeal especially to girls and both sexes will enjoy country dances and will listen to talks about their origins.

Drawing, painting and particularly design will interest them, especially if they are provided with coloured materials and allowed opportunities for spontaneous work. Coarse embroidery of the peasant type can be taught to the girls and the boys can use stencils and print with various media. Collections of pottery can be made to illustrate good design and for the girls an exhibition of coloured and patterned materials. They will be more successful with strong bold work than the more delicate variety. They will, of course, learn with satisfaction how to make simple furniture.

Such active pursuits are more suitable for the backward children than reading and literature. But although they cannot read the great masterpieces of the language or act in Shakespearean plays, there is no reason why they cannot appreciate them if the teacher reads aloud with sympathy and insight. Their enjoyment and the lasting value of the experience depends entirely upon the teacher, for a love of poetry and good prose will result only if the teacher infects them with the enthusiasm. If the teacher is uninterested, he will do better to keep to his own line. In a little book, *The Child and his Pencil*, one reads the story of the children in a remote Irish village school who, in spite of such poverty which is unfamiliar in this country and their mental deficiencies, so caught the enthusiasm of their headmaster (who writes the story) that they burst into delightful verse themselves. The book illustrates the feeling for beauty in the sound of words which many of the backward children possess. It is a happy plan to connect the joyous events of school life with a line or two of beautiful verse. As the first daffodil bursts in the school garden, the following lines may be introduced to the class:

"Daffodils that come before the swallow
dare
And take the winds of March with
beauty."

When the almond blossom has unfolded, and the fact is mentioned in the class discussion, is the time to recite to them the verse from Katherine Tynan:

"A little cloud of roses,
All in a world of grey.
The almond flower uncloses
Upon the wild March day."

Every teacher will have favourites, but there is no need to teach whole poems or even to teach at all; connect them with pleasurable situations and repeat them several times and allow the memorisation to be voluntary; use the appropriate few lines and suggest that anyone who wants to keep an anthology can have the poem to copy. Once a week there might be a poetry reading period in which the children can choose their favourites and discuss them as one would in an informal way with friends. For such periods, a group gathered round the teacher is preferable to a class sitting in ordered formation in desks.

Gardening is splendid for both boys and girls, and with the subject some first hand nature study will be valuable. This should take the form of actual observation, pictorial or simple written record and discussion, and the work need not be confined to plant life. Backward children are often most interested in animals and natural phenomena; aquaria and a vivarium might be kept and cared for by members of the class. The changing cycle of natural life can be suitably demonstrated by collections of flowers and leaves, fruit and seeds, by the class. They can name them and be entirely responsible for the exhibition. The insects and creatures found while gardening can be identified, and something told about their habits. Birds can be watched for in the district and compared with illustrated charts which will give the names and habits. Records will include data of their arrivals and departures. In country districts, the local wild flowers can be collected and classified; even in barren districts there are always the despised weeds to deal with. Town classes may get into touch with other classes in the country who will send flowers in exchange for news about the city. It might be possible to keep pets and to master thoroughly the details of their training and breeding or to undertake a poultry club.

Weather observation and record and knowledge of the "things which work" have also a place but in each case the work should be done in relation to the habits and use of the neighbourhood. In a remote country district the boys will not be so interested in knowing how to handle electrical lighting and heating as they will be in knowing the eugenics of the farmyard.

Finally, the curriculum should provide those experiences which teach the children to be companionable in a helpful, friendly way. They are more suggestible than normal adolescents, and they will either find companionship through common interests or perhaps form associations for illegitimate purposes. The usual practice is to wait until they are leaving school and then to suggest those clubs which will meet their requirements. Actually the work should begin earlier than this. Day school associations should be pleasant and profitable; there should be freedom in the classroom and school which suggests to the child the attractive community life which he may, later on, meet in settlements and evening schools if he cares to join them. In his last term he will hear of the facilities offered by the district and should be introduced to the leader of the club which interests him most.

No curriculum need be unchangeable and every activity need not be planned beforehand in the syllabus. Although the general lines of the curriculum will be planned in advance and recorded in the class syllabus, there is no reason why it cannot be interrupted when anything of educational interest is taking place out of school. The narrow school life should extend to embrace such happenings as local celebrations, speed and aviation contests, and national events. The teacher will use them to illustrate and supplement the ordinary work of the moment. The activities which cannot be planned in advance include discussions and spontaneous conversations, nature study, which depends on what is brought into school from streams and hedges, and letter writing which may follow the arrival of gifts to the class. These are recorded at the end of the week as a report.

II. *The project system.*—Various authorities have suggested that the curriculum should be planned in terms of projects rather than subjects. Dr. Burt suggests that "these will be concrete tasks or topics, arising out of the child's natural interests and daily life, 'our food,' 'our health,' 'our neighbourhood,' 'Christmas,' 'transport,' and the like —each embodying a more or less definite aim, and each ingeniously devised so that the next steps in knowledge and skill will be taken in their turn, until the whole of the ground, mapped out as appropriate for the age and intelligence of the class and its various members, has ultimately been covered. There should be projects for the individual, projects for little groups of two and three, and projects for the whole class; and the class master or class mistress will act, not merely as a teacher, but also as a tutor." The terms "units of work" or "centres of interest" have been used to explain this method, but for the purpose of this paper the word "project" has been selected.

Projects have their origin in the philosophy and educational theories of John Dewey and are the outcome of an extensive investigation into the activities which children engage in out of school. The first outstanding experiment of consistent teaching on project lines was the work of Dr. Collings in America during four years when he was superintendent of schools in a rural county in Missouri. An account is published in *An Experiment with a Project Curriculum* and another in *Project Teaching in the Elementary School*. Other useful books are *Curriculum Making in the Elementary School* by the staff of the Lincoln School and the *Project Method* by W. H. Kilpatrick. In the *Child-Centred School*, by Rugg and Shumaker, there is a stimulating and critical account of the method.

Generally stated, a project is a whole-hearted purpose of a group of children, co-operating together and carried out by them with the guidance of a wise teacher. The purposes arise from the life of the children; they are worth while as understood by them and they have a good deal of freedom in carrying them through. They meet with many problems which need solutions before their plan can be completed. The method makes the fullest possible use of initiative, experiment and interest. Sometimes it is necessary to suggest a project to the class, but it is dropped at once if it does not meet with the thorough co-operation of the children. The following are a few examples:

1. A School Theatre, arranged in a disused classroom.
2. Our Town.
3. Aviation.
4. Transport.
5. A Class Newspaper.
6. The Post Office.
7. Furnishing an empty classroom as an "Activity Room."

Plans are made between class and teacher during the daily discussion periods. There is no set syllabus from which to work. When the project begins, the teacher makes a plan of the possibilities and a list of the facts which they might possibly learn and of the studies they might make, but these plans have often to be rearranged as the work proceeds. The class may prefer to pursue a different line of investigation from that visualised by the teacher.

The advance plan does, however, set the teacher at ease and indicates the sort of preparation which will be necessary. In actual practice, it is the children who, coming to grips with problems, unconsciously decide what knowledge they shall be given. For instance, there was a class who studied the London Docks and who began to make a large model but were faced by a series of problems dealing with unloading, storage, distribution, etc., which necessitated expeditions and enquiries. In the study of their town, another class brought up the following problems, among many others:—"What happens when people cannot pay their rent?" "Who pays for the upkeep of the roads?" "Does my mother trade when she pays her rent?" "How does electricity work?" "What happens to a cheque after it is paid into the bank?"

During a study of primitive life, a boy wanted to know, "Why does a Red Indian have so many squaws, when my father has only one wife?"

The teacher has to be alert to make every use of situations, to provide books, materials and pictures, and to arrange expeditions. It is necessary to bring together the stray ends of partly assimilated knowledge to give information just at the psychological moment when interest is at its height and to see that the balance of the curriculum is fairly well kept. Apart from the separate practice of the three R's—and this is necessary—the time-table shows no compartments for such subjects as history, English and geography, but periods for discussion, expedition and activity.

With younger children, projects usually involve a good deal of imaginative and constructive activity. The class theatre had its programme sellers, property manager and booking clerk as well as children who painted backsheets and made properties. It has been mentioned that projects are conceived and carried out by a group. This group may be the school, the class, a group in the class or a couple of children working together. A Christmas festival and a school magazine are examples of the first. A class project lends itself to several group projects, each with its own leader. Transport can be divided into studies of aircraft, ships, railways, motor transport and pack animals. The children volunteer for that which interests them most. The class who undertook the dock project worked in companies round ships, warehouses and distribution, but one boy insisted upon the construction and study of the Tower of London and two others joined him and carried through the idea with marked success. Another class worked out a pageant, but one child scorned to make dresses and scenes but undertook to do the research into books on costume and to edit the attempts of dialogue after he had consulted reference books dealing with the usage in the special period. The history of their own district was explored and recorded by another class, and according to their special interest and ability they chose to undertake research, illustrations, maps, or to hectograph and make books. As far as possible, each child undertakes some responsibility, but the natural leaders in every class lead the rest.

This method applied to backward children needs modification, but it is more suitable than the subject approach and involves far more movement and experiment than ordinary methods. There is an urgent need for teachers who will try the method and faithfully record their difficulties, successes and failures together with results.

In the first place, the project in the adjustment class will have to be chosen by the teacher and closely guided by him. The choice must be made from the lives and experience of the majority and cannot be decided upon until their special lines and preferences have been discovered. Neighbourhood will play an important part. Where there is a central railway station, an aerodrome, a busy river, a seaport and ships, a wireless station or a motor car factory close to the school, the project has an obvious beginning. All children are interested in houses and food, two subjects which are rather popular. If it is possible to select several, the matter can be voted upon by the pupils. If the class are not enthusiastic, the idea had better drop and another be chosen.

The guidance of the teacher in directing experience will be of the greatest importance, but the suggestions should be broad enough to allow for individual choice. For instance, a record of the progress of the study is usually kept by each individual; e.g., *My Book of Babies* when the project group of girls was "The Care of Children." The book was a suggestion from the teacher, but each girl chose to keep it in her own way. There were volumes of cuttings, written accounts, original illustrations, notes, addresses of local welfare centres, etc. The normal adolescent is more of an individual than the junior school child who usually undertakes these units of work, and although co-operation and helpfulness are to be fully encouraged, there is a particular need for individual choice and expression. In a study of ships, the teacher will suggest that models should be made, but the kind, materials and details should be left for each child to decide. Of course, good illustrations, simple instructions and supplementary talks by the teacher will enlighten and influence the choice. By giving this opportunity to select a purpose within the wider interest, the teacher can tell in which direction lies the greatest interest and can pursue that line. When a number of boys have chosen to model the older types of ships, they might study their history through pictures, conversation and expeditions. If they select specific types such as the Norwegian whaler, the Chinese junk, or the Canadian canoe, the human geography of these countries can be followed up. Modern steamships will suggest speed records, routes and a study of the larger ports of embarkation.

During the course of a project, the ordinary child plans, questions, suggests, looks up information and solves problems: all outward signs of intelligence. The backward children will only show simple indications of these abilities, but the method will stimulate them to question and to make suggestions in the carrying out of the plan, especially if the teacher guides with a light touch, watching for signs of liveliness and initiative and receiving each attempt with due consideration and approval.

The tool subjects need periods of practice apart from the project but it will provide most of the motivation for the duller drill. For instance, in studying motor transport, lists will be made of costs of cars (from catalogues), and through investigation and questioning the repairs bill can be estimated, the selling price at the end of a year, cost of petrol for each 100 or 1,000 miles, and taxes can be worked out.

The outstanding value of this method is that it brings real purpose into school life and contacts with reality. A good deal which has hitherto passed unobserved becomes vivid and interesting. There is no better way to awake powers of observation or to give meaning to school subjects. History and geography especially are more living when taught from present experiences. "Shelter" or "Homes" have often been used as topics which extend to a study of homes throughout the world and conditions of life which determine structure, materials and form. "Clothing" is another well-used subject and includes an historical survey and deals with suitable clothing under various climatic conditions, as well as the interesting study of adornment.

When well carried out, the method results in both group and individual development. Each member of the class should profit by the pursuance of a personal interest and by the practice of the qualities of co-operation and consideration which are necessary to a successful piece of class activity. There is a widening of interest outwards from the immediate, the things far off in space or time, and a deepening influence through actual experience and contacts. Every project should come to a successful conclusion so that pupils feel the pleasure of achievement and completion. Their length varies; some last a week, others a month or a term, but for backward children they should not become too involved and the problems and issues should be settled soon after their production, for the children cannot sustain an enquiry or pursue a goal too far off or too complicated.

The following have been successfully carried out with groups of retarded children in senior schools:

Milk.
Markets.
Building a House.
The Cement Industry.
The Brick Industry.
Lighting.
Heating.
Planning a New Home.
The Farm.
The Police Service.
Parks.
Main Highways of the World.
The Telephone.
History of Communication.
Aviation.
Docks.
Printing.
The Multiple Stores.

METHODS OF TEACHING

The new class.—The senior school has the unfortunate, but very important, task of counteracting the impression of inferiority which the children have already acquired. From the beginning the teacher has to avoid all suggestion, even in his manner, and thought, of inferiority and discouragement. The child's problem is the result of a number of factors over which he has had no control and for which he cannot be blamed. It is the main work of the teacher to do all possible to make him hopeful, to strengthen his self-respect, and to arouse in him a strong desire and determination to succeed. The will of the teacher alone is not sufficient; the child must voluntarily co-operate. In the first place, he must achieve significance and preserve his own self-esteem; he must win praise and so be raised in his own eyes and in those of his fellows. It is well to begin with the easiest material so that he achieves a high percentage of success. Success begets more success; failure is followed by still more failure. As many children as possible should be given some service to perform in the room and such responsibility as they can successfully support. It is a good idea to have a class meeting to discuss the jobs which have to be done and to let them feel that, in this new school, the running of the class is in their hands and that the teachers have confidence in them. From the beginning, they should be encouraged to express their opinions which should be listened to with respect. If any have some pretensions to knowledge of a certain subject, they can be treated like experts and their opinions especially sought. In isolated districts, the writer has found chicken and horse experts; a small backward boy who knew about every species of cattle; many young fishermen; a boy whose hobby was bees, and so on. They all became vivid and talkative as soon as they were on their own subject.

It is wise to do away with all competition in the classroom. The children have been the tail of every examination list for years, getting more and more hopeless. Under the new circumstances, there should be no comparison and no valuation of work or conduct by marks. Let each child work to improve his own standard, keep a record chart or progress ladder and advance on himself. Co-operation rather than competition should be the order in the adjustment class. Encourage the children to help each other and to share knowledge rather than store it as a weapon of superiority. By ruthlessly putting this suggestion into practice, you are giving these depressed children a fresh start in life and relieving them of a distracting burden.

Thirdly, introduce happiness into the classroom with a sense of humour. Happiness and contentment increase effective output and these children need a great deal to counteract their previous experiences. This again largely depends on the teacher but there is also a glow of satisfaction which comes from work well completed; give them tasks which they can well complete and help them in the performance.

Child or subject.—The next thing is not to hurry up and try to teach them, but to try to understand them. Subjects are of secondary importance; the child comes first. Dr. Burt suggests that each child should be made the subject of a small, intensive research. In the case of the backward child, it will not be enough to discover just where his backwardness lies but also what are the causes for such backwardness. This brings us to the need for records and observation, already mentioned. As new factors come to light, they should be added to the previous notes. It is especially important with both dull and backward to investigate their health record and to become aware of any aggravation or weakness which troubles them at the moment. Eyes, ears and the speech organs must be specially watched. Besides physical characteristics and a study of their backwardness, it is necessary to know their preferences, their weak and strong interests, their stage of emotional development and temperamental make-up. It is useful to watch them at play when they are unobserved; the friends they make, their attitude towards them; the games which stimulate them most can be noticed and will add to the teacher's knowledge. In an experimental class, the first few days were spent as the children wished, with picture books, games and handwork. This gave the teacher an opportunity to observe and encouraged more natural behaviour and set them at their ease in a new situation. Above all, one has to find out their interests for these should motivate the curriculum. When interest is used in teaching, method, power and energy are released. The pamphlet on *The Education of the Backward Child* goes so far as to suggest that "the best way is through the children's own choice of what they wish to do."

The child's interests.—What are the interests of this age? Play interests at the age of eleven are usually in the form of games; e.g., tag, hide-and-seek, ball games, playing catch, lotto, playing house and schools, picture puzzles, jumping the rope, spinning tops, flying kites, marbles, table games such as spinning for a turn and matching cards. The children are also interested in construction, collections and dramatisation. Motors, boats, aeroplanes, are endless sources of interest as well as animals. Guessing and memory games are popular as they get towards twelve. The girls like to look after younger children and still play with dolls. Stories of animals and child life are enjoyed, and the boys begin to ask for adventure stories.

During their last two years in the senior school, jobs and housekeeping become more significant, girls being interested in the preparation of food and making the home attractive, boys wanting to make worth while things, to work co-operatively and to feel through the use of tools and machinery that their jobs are real. Remunerative jobs especially attract them, the girls going errands and helping in home duties and the boys doing odd jobs—running newspaper rounds, delivering for a grocer or helping on a farm. Their play interests are active; swimming, hiking, football, basketball and card games like poker and rummy predominate among the boys, and to a less extent among the girls. Folk dances and rhythmic exercises appeal to both. Gangs or chumming up in a group develop among the boys. They do not join clubs and leagues in the same way that normal children do because of this inferior feeling about themselves. The boys like stories of fact, invention, adventure, magazine articles describing how to make things and material in science magazines. For the girls, the greatest appeal comes through stories of familiar experiences of girls of their own age, stories of home life and fairy stories with an element of romance. They have already begun to be interested in the cheap variety of two-penny fiction magazines, especially any to do with the cinema.

This is a brief and general outline; the teacher will find many variations and individual preferences. Locality plays its part, the immediate neighbourhood of the school as well as the town. Home circumstances also make differences. Each group will have different interests which only those in contact with the children can discover. The work does not stop here; new interests should be formed while in school which will carry over to after school life. In many homes there is a dearth of stimulus and opportunities for experiences which help towards the adjustments to life. Books, toys, games are needed by all children but particularly the backward ones.

Teaching requirements.—Practical work will be necessary in all subjects and the children must have plenty of opportunities to move about, to get up and see what someone else has done, to ask an opinion or to lend a hand. They must do things with their hands before their brains can be active. Listening, reading and thinking are all too passive; they want something to handle and to watch at close quarters; to use tools and a variety of materials; to conduct their mental processes with the help of apparatus; to go on excursions. This is apart from the usual manual training and domestic science. There should be the doing side in every subject. It is of the utmost importance that the teacher realises the full significance of the inability of these children to deal with abstract ideas and relations. When, however, he is dealing with concrete problems, he can use his mind and actually reasons and solves problems.

There will also be a greater need for pictures, models and actual objects with which they can grow familiar. A passing display will not be sufficient nor will too profuse a display be much good, for the child cannot discriminate and is apt to ignore a mass of material which is constantly displayed. The teacher has to exercise imagination in the choice of stimulating material, remembering that these children are not likely to observe anything fresh in their environment unless their attention is called to it. Where it is possible to give them first-hand experience, it should be used. "No opportunity should be lost to use illustration from the commonest matters of everyday life" (Board of Education).

The ideal teacher will be the one who can stimulate and arouse a lively response from the class. A pleasant voice well used is an asset, but rapid speech should be avoided, and there will need to be constant repetition. A backward child of the writer's acquaintance is very much interested in gardening and natural life. He helps in the school garden and does his best to follow any instruction, but while working on his plot at home he discusses his school experiences in the following way:—"Mr. X said something about selling these red flowers; I couldn't get the name; I think he said you could have them for *6d.* or *3d.* No, I didn't quite hear what he said. When? Oh, I think he said after school. You know I don't understand what he meant about soil from leaves," etc. All the time his face puckers in an effort to reconstruct the experience and to understand.

When all is summed up, the method most suitable is that of natural learning, the way small children learn before they come to school. They see and ask names, they play and meet problems which they solve by trial and error, they are taken for excursions when they talk and ask questions, and the adult is pleased to instruct them; they investigate for themselves, experiment and meet any number of real situations which involve learning and understanding.

THE SUBJECTS OF THE CURRICULUM

Spoken English.

The importance of verbal expression.—Speech is more important for the backward than for the normal child. In some cases, inability to speak clearly and with confidence has been a considerable factor in causing backwardness. Many dull children learn to talk later than others and come to school with very limited powers of expression. When language is limited, the mind also suffers, for knowledge of words makes for clearer thought; the attention can be applied when the object is not actually present. Without words, the memory cannot store up knowledge which will be useful when fresh experiences come along. The dull child suffers also because, owing to his lack of awareness, he does not attend to the happenings around him; they pass him by and leave him unaffected; the mind, therefore, remains comparatively barren and manifests its deficiencies in a stilted vocabulary. A word must be said here to warn teachers of the case of the dull child who is garrulous and extremely glib but who has few ideas and uses his rush of words to hide an abyss of emptiness.

After school life these children will need to be able to express themselves readily and naturally about the things which concern them; they will want to understand directions and instructions and to be able to convey their meaning to a third person; they will also want sufficient vocabulary to follow their radio programmes. They will not need to talk learnedly or with any particular accuracy. These needs indicate the aims of the work in the adjustment class; to increase vocabulary and to encourage fluent, natural expression. Hitherto, teachers have often failed to secure the results due to conscientious teaching because time and energy have been concentrated on correct description, phraseology and pronunciation which, instead of creating confidence, have resulted in actual fear of verbal expression in the classroom and destroyed spontaneous conversation between children and teacher. The practice of allowing inarticulate children to tell stories which bore and irritate the rest of the class and all the striving for pedantic English have been of small value.

Speech encouragement.—The most effective means for securing natural speech is through the atmosphere of the classroom. A happy unrestrained environment soon loosens the inhibitions; understanding treatment and the confidence that every sentence will not be the signal for speech correction will result in spontaneous conversation with the teacher and other children. These children who come fresh to the senior school as "C's" will have been the silent members of many classes, those who have dreaded being called upon to talk, who felt that they were failures because they could not speak in a way to gain the approval of the teacher; nor could they give the information about set subjects under discussion. They have not been the children who shone when visitors have wanted to hear poems or plays; their role as passive, dumb pupils has almost become a habit. A complete change of discipline and approach is the only way to reverse their conceptions of themselves and their capacity to talk. Many of them have not heard their own voices in the classroom and will be afraid of using them audibly. The rule of silence must be banished; the teacher must muster the difficult technique of discussion rather than the lecture method of teaching, and of asking questions in such a way that one-word replies will not suffice. If talks are given while the children gather informally round the teacher, they volunteer information and ask questions more easily than if they have to direct them through the whole length and breadth of the room. No definite work can be done until they have confidence in their own voices. In the days of complete silence, of, "Speak only when you are told to do so," the children could often talk only in whispers when they were asked, because fear and apprehension affects the muscles of the larynx and it was therefore a physical impossibility to speak clearly and audibly. The best way to learn to talk well is to talk, and this provision for this practice must be made.

The teacher does a great deal in another indirect way; that is, by the use of his own voice and vocabulary. Adults can have considerable influence with adolescents, and the manner of speech, the turn of phrases, the tone of the voice, the courtesy implied, all have their effect. A great deal is "caught" in this class rather than "taught."

No corrections should be made when the children are speaking; they can be dealt with in a separate period. Interruption and correction destroys confidence and fluency. The child who volunteers an observation during a discussion should be given plenty of time to explain, questions should be encouraged and the subject changed if the interest of the class is diverted as a result of a chance observation from one of the children. Units of work allow a good deal of discussion and stimulate conversation.

As the children become used to the freedom in speech, short periods can be devoted to speeches by individuals. They will not be so ambitious as the "lecturettes" in the other classes but they will be equally valuable. It is necessary to talk with them about the technique of making a speech, selecting beforehand, speaking in sentences and audibly. They should volunteer to speak on any subject which interests them; e.g., the film they have just seen, a football match, a dinner they cooked, etc. Sometimes, they might be warned that certain children will be required to tell the others a funny story, an exciting one, a joke, or to ask riddles, and after a day or two volunteers can be selected. These exercises must be taken cheerfully; there should be an air of enjoyment about it; fun and laughter must be allowed.

Practice in listening to and in giving directions to others are necessary, and these should be practical. They might include directions for finding things in cupboards, for playing a game, for performing a process in handiwork, for discovering the solution of a puzzle. Of course, the children give the directions as well as follow them and the reward of a clear direction will be the ease with which the others can follow. Listening to and carrying out instructions will be practical in the same way. Question and answer games are useful but the questions need to be simple; e.g., "What is the difference between a cat's mouth and a dog's mouth?" Similarities and differences are especially difficult and the questions might take the form suggested in order to give the necessary practice. The telephone should be explained and a system arranged by the class after some investigation. The games will include conversations concerned with ordering goods, finding inquiries, invitations and complaints. It is advisable to suggest types to them and for the teacher to take a turn. If the school is fortunate and has the telephone, the backward children should be responsible for dealing with it, consulting the directory to supply numbers and keeping a check on the calls, so that they can compare their estimate with the bills. In any case, they can make up a directory of their own for the use of their home made instrument.

Later in the course, they can be trained to give brief descriptions, trying to be as accurate as possible in the use of the right word for the meaning. This, however, should not be formal or overdone. They might be given the opportunity to hear the salesman at an auction and then practise a mock sale. Once a term, they might like to make a collection of discarded treasures which they wanted to exchange with each other. The proceedings should begin with a display and allow time for consideration, and then various volunteers would undertake to conduct the proceedings. Incidentally, this will give the teacher valuable insight into the interests of individuals. Descriptions of their pets may result in a show followed by discussions on food and training; a friend of the school who is an expert might offer to discuss the subject with them. Journeys taken on their cycles, hikes, fishing expeditions can be described, the audience asking questions when explicit directions for repeating a route are not given clearly. There is no need to wait for a certain period to come round; let the boy explain the day after he has been and treat the information with all seriousness and ask to be told when others have taken the same route. The work might be linked with geography and a folio of good walks recorded by simple plans. If any are capable of writing the directions, they should be attached.

Vocabulary.—Enough has been said to indicate how the interests and hobbies of the children can be canalled in the cause of spoken English. The second aim of the teacher is to encourage a richer vocabulary. Lists of words are useless, they must be those actually lived by the children. Words do not become part of a person unless they have formed part of meaningful experience, mental or practical. The adult who does not possess a motor car listens politely to his friend as he talks in car language about his Morris, but the various terms mean nothing to him until he gets one of his own and then a whole new vocabulary comes to life in a few days. Every new experience brings a fresh set of words. Because of the disabilities of the children, they need practical experiences before new words are their own. Language, therefore, must be associated with pictures, objects, models, films, excursions or to those things which they use or make. In this sense, the vocabulary of the teacher is an experience and it is useful to consult a vocabulary list and then introduce useful phrases into the conversation, at the same time encouraging the children to do the same. Units of work are invaluable in this direction. The projects include visits out of school, examination of actualities, pictures and material for construction and illustration: the child finds himself in situations where he needs to use the new terms and to make himself understood; he has to explain how and why he has made something; all associating new ideas with the corresponding vocabulary. It is not enough, however, to use them; they should be listed and placed so that they serve as references for use when the children are recording their experiences, writing letters with accounts of their doings, etc. If they keep dictionaries of their own making the words should be entered into them in the correct alphabetical order and referred to when necessary. They should also form the basis for spelling practice.

Kennedy Frazer in his book *Education of the Backward Child* suggests games in this connection; e.g., sets of small pictures which can be shown, each child who can give the correct name scoring a mark. A progression is through the use of an adjective to describe the object in the picture. Such games are useful additions and appeal to the slow child.

Faults.—Finally, there is the question of correction of faults and good usage. There should be no teaching of grammar in this class. A consciousness of error and a desire to improve are the first requisites to good speech; this must be followed by practice. It is more valuable to call attention to the *correct* use in a child's speech than to point out errors; others will then want the same approval. Again, the indirect influence of the teacher's speech is most important. When they are aware of a recurring error, the children should be encouraged to watch and to correct themselves. It is useful to notice and list the outstanding errors amongst the class and to deal with each as opportunity arises but after confidence has been gained.

Correct speaking.—Speech training for better enunciation should be incidental and informal. There is usually a bad habit of failure to move the lips and jaw, and this results in slovenly and inaccurate articulation. The idea is to wait until speeches are to be made or plays acted and then give a few timely hints on better production. The children will then attend and value the help for their particular purpose and be willing to undertake some practice to ensure more mobility. At this stage they can be introduced to tongue twisters, and this may result in an enthusiasm for making a collection and having competitions of skill which will result in very valuable speech training. At the same time, they will be interested to see from a mirror how the voice is produced, which movements of the tongue produce a certain kind of sound, and so on.

Singing, dramatisation and verse speaking are excellent aids to spoken English. To be successful, the plays must be well within the capacity of the children, and although the teacher will have to direct more than usual they should make their own suggestions for scenery and properties. Every child can take part; the dullest can be a scene shifter and can paint backcloths and make dresses, crowns, swords and other necessities. Favourite stories are easily adapted and are better than the printed volumes of plays which are difficult to read or, if easy, are too babyish. *The Pied Piper* is a type of play which is most successful; it can be read to the children in the original and re-read. They enjoy the rhythm and without much trouble will remember a number of the original lines. With some help they will select their own scenes, characters, stage manager, and will have plenty of ideas about properties. Let them use their own paraphrase if it occurs, and select a number of children to be mice, children or townsfolk. *The King of the Golden River* has also been used with success. The work should be continuous and should be practised until a play is good enough for an audience, when it should be performed for the whole school or for another class which can be invited by letter and given programmes made by its hosts. Both speech and vocabulary are improved and the children gain confidence through the success of their efforts.

The dramatisation of poems is particularly helpful as the rhythm emphasises the sounds of words and clearer enunciation is the result. Short, interesting poems with a marked rhythm and attractive narrative are the best. A. A. Milne has done a great service in providing teachers with a number of most suitable story poems. *The Little Black Hen, Emmeline, The King's Breakfast,* are too well-known to need more than a reference. Again the selection of parts can be left in the hands of the children and, in most cases, those who are not speaking can be used to form hedges, woods and houses. Rhymes of London Town are suitable for city children, e.g., *Friday Street.* Short ballads also lend themselves to this treatment and good use can be made of the chorus. The secret of success is the enthusiasm of the teacher which easily infects the class and gets over their self-consciousness. The more retiring and silent members forget themselves when they are speaking with a chorus and learn to know the individual parts. One day the silent child will undertake to deputise for his absent friend, and his success gains the wholehearted approval of his companions and teacher, and he is well on the way to confidence in speech.

Even this brief survey is incomplete without reference to speech defects. If a child has reached the senior school and still has a speech defect which can be treated, it is the responsibility of the teacher to do all in his power towards the cure. Stammerers must have special psychological treatment if possible, other disorders can be treated at a Speech Theraphy Clinic; addresses will be supplied by the Speech Institute, Gordon Square, London, W.C.1. Lisping, adenoid speech, defects in particular sounds can be treated by the teacher and helpful methods are suggested in the little book of Dr. Ida Ward on the *Speech Defects.*

Reading and writing.

The necessity of reading.—It is impossible to separate these two subjects in the adjustment class. While the children are writing, they must also be reading. Normally, the child of twelve has the educational tools of reading, writing and number already under his control; he can use them in the service of less elementary subjects. The backward child has been striving for the mastery of the tool subjects ever since he came to school and, even if he has been fortunate to meet teachers who have understood his problems and helped him to achieve as far as his capacity allowed, he will still not be able to extract information and to use his skill with the ease of the normal child. The exception will be the one who is backward in perhaps one other subject, i.e., arithmetic, and who is not dull. This child will probably be transferred back to his own class when his mathematics have improved, but while he is in the adjustment class he should read and write as a normal child of his age. For the rest, a new technique is needed. Achievement is much more dependent on learning situations provided by the teacher than in the ordinary class. Both subjects have to become alive by their contacts with life and through the interests of the children. For some of them, it is necessary that they sound the word before they can realise its significance; sometimes their attention has to be called to particular characteristics and in many cases they cannot remember until they associate words with experiences. Their limited mental background often provides no response to the incidents in their books and so they find little meaning in the printed word. Reading, and by this one means reading for content, to understand and interpret, co-ordinates highly with mental ability and, because of this, people have asked whether it is worth while to teach backward children to read at all. In the opinion of many specialists, it is not only worth while but absolutely necessary for their own self-respect and for their success as members of a community. At a meeting of the British Psychological Society in 1936, Dr. Fildes of the London Child Guidance Clinic stated that out of 4,000 delinquents, 40 per cent had been retarded readers while at school. It is vitally important that backwardness in reading should not be allowed to go on. The school is the largest society into which the child enters and the success he achieves there indicates to the child his relation to the larger society of the world. Because of his failure to read, he counts himself a failure in the eyes of his teacher and in the eyes of his companions and his parents and, unless he is definitely mentally deficient, he is painfully conscious and aware of the shortcomings which lack of reading skill involves. This feeling of incompetence is very serious, for it results in a stream of failure and the child is incapable of further effort. Next, inhibitions over which he has no control appear; perhaps he plays truant or begins to stammer. He begins to blame other things and people for his misfortune and comes to think of himself as without responsibility: "I'm a dud and cannot do things, therefore it's no use trying." The future delinquent finds it impossible to continue without achievement and turns his attention to illegitimate performances because he must prove to others that he is strong and worthy and able to keep his end up somehow.

Besides the need to read as a satisfactory member of a community, the child wants a certain knowledge as an individual even though it is only to read simple directions, letters and the captions during a film.

Having decided that they should read, and to help them to a well adjusted maturity, in spite of difficulties, it is wise to review the children as they come from the junior school.

There may be those who have received sensible attention and who although slow readers will make some progress. There are those who know themselves as "duds," who are discouraged and bored and there are even those who are frightened of the subject and whose emotional reactions to the lessons are too strong to enable them to profit at all. The teacher will be surprised to find any who enjoy reading. The first step is to dethrone the subject from its exalted position in the curriculum; let them feel that ability to do other things is the most important factor; that there is a certain advantage in being able to read, but it does not overshadow everything else. Then those obstacles must be removed and discouragement and boredom changed to positive pleasure and confidence. This, however, will come only through success. Interest alone will not effect the change, although this must first be aroused; interest, that is, in attacking causes of failure and in improvement. Their difficulties must be solved in order to allow some measure of success, and as soon as a child begins to feel he can do something, he will continue to be successful.

The common use of reading and writing.—It is easy to see how spoken English permeates the whole of the curriculum; it is not a matter of a few speech training lessons each week, but a continuous process through practice and listening. It is more difficult to perceive a class curriculum where reading and writing are not reserved for special periods, although there are particular practice times. Every opportunity for the common use of the two subjects should be utilised, and the following suggestions are made with this procedure in mind.

I. The first consideration is the removal of problems and the provision of methods by which the child can overcome difficulties for himself. There are two main goals; the first is that the child must develop power to acquire word images and to retain them, and the second is that he should be taught how to derive meaning from the printed page. When both are achieved, the child can read. It will be necessary to discover everything possible about the child's difficulties; there is a reason for his disability besides his actual dullness and for the backward child there is no reason beyond that which must be brought to light. Unfortunately, many children are adept in concealing their deficiencies from us. Speech defects are obvious causes and these should have attention. Lack of vocabulary and poor pronunciation are also to blame, especially when combined with dullness. As they talk and experience more and become lively with interest, reading will improve. The less obvious reasons will reveal themselves after the child has been carefully watched and after he has read individually to the teacher several times. The writer finds that at first one has to note down an individual's peculiarities as he is struggling, and later ponder on them before a solution can be evolved. Confusion of word patterns is a common cause. Recently a child confused twelve words in a short paragraph and, on examination, each error contained some letter formation which was very similar to the correct word; e.g., *very* instead of *give*, *are* for *ask*, *on* for *pony*, *want* for *water*, and so on. Of course, the normal child understands what he is reading, and if he does confuse patterns when he is in the infant's school, practice and intelligence prevent his backwardness. It is more difficult for the backward children, for their lack of understanding prevents them guessing correctly when they fail to recognise patterns of words; where the normal child may have a slight difficulty in visual discrimination, the dull child seems to be an acute case.

Although complete word blindness is as rare as one case in one thousand normal children in London, partial cases known as dislexia and border-line cases are far more numerous. The defect is described as "a condition in which, with normal vision and therefore seeing the letters and words distinctly, an individual is no longer able to interpret written or printed language." Most teachers are familiar with some degree of word blindness among their pupils. The children so afflicted struggle through a page with promptings, and are able to remember the outstanding facts if questioned at once, but during the second reading of the same page they are a complete failure. They do not associate the object with the word or idea for which it stands. Letters and figures present no difficulty. Remedies such as spelling words rapidly by letter, writing the words, teaching phonetics and vocalisation when reading, are suggested by various authorities. Then there are motor-minded children who need every sort of practical help; e.g., writing words in sand, touching objects with one hand and the printed words with another. When this defect is associated with dullness, the task of teaching is slow, but with the child's co-operation and plenty of drill through the association of words and touch or motion, he will learn in the end. Eyes are a constant source of trouble to the slow readers. There is a mechanism involved in reading which has to be acquired and which is complicated for the normal child, but infinitely more so for the slow, halting reader whose erratic movements prevent the early formation of the necessary habits. It is still more difficult if there is any eye weakness. The teacher should insist that each of the children should be re-tested for vision and hearing on entering the senior school. If the child has to wear spectacles, the teacher must assume responsibility for their cleanliness and good condition and for their regular use. Anything which can be done to remedy a physical defect is hastening the achievement of the child.

The work will be easier and more fruitful if children with similar problems can work in groups, but this is impossible until their weaknesses are discovered. While the teacher is giving attention to one group, the rest will occupy themselves with work which does not need help. There should be a practice period each day for every child until he can be left to read silently, for meaning. The practice of putting children in charge of groups is ineffective in this class; they must have the help of a specialist and the encouragement of the teacher. Reading round the whole class is equally ineffective. In the normal class in the senior school, the percentage of oral reading should be very small in comparison with silent reading but, because of the problems, most children in the adjustment class will need to hear themselves read; the group work therefore has to be oral reading. It is advocated that audience situations should be used for the practice of oral reading; this is an intelligent method with normal children and can be used at intervals with the backward children. A group undertakes to read aloud the incidents in a story, each child having a section which he reads and understands beforehand. The audience has no books and the success of the reading is judged by the comprehension of the class.

As there is such a need to develop power to acquire word images, an exercise can be taken for a few minutes daily in visual concentration. The procedure adopted in the Decroly Schools (see *The Decroly School*, by Mdlle. Hamaide) is as follows:

1. Keep a blackboard with a small curtain attached which can be drawn easily.
2. Refer to the words which have some content for the children at the time, or to those which will occur in their books or ask for a suitable phrase.
3. Write while the children watch, calling attention to characteristics of words. Length or shortness is remembered easily; the teacher should point out minor details but not too many.
4. The children read a sentence or phrase; with the poorest group, a word is enough at the beginning.
5. The children consciously concentrate on the written material for a few seconds. It is necessary that they make a real effort and also that they are not left longer than a few seconds or they will lose the image.
6. The teacher will draw the curtain and the children will write as much as they can remember without any delay whatever. If they cannot proceed with one word, encourage them to leave it and to write whatever they can remember of the phrase. Success does not depend on complete whole words only; praise should be given for parts of words, strokes and similar patterns.
7. Draw the curtain for another concentrated glance and yet another if necessary.
8. It may be that only one section needs this specialised treatment, and these children can be helped in this way while the rest are at other practice. It is impossible to treat these children, with their wide range of ability and special deficiencies, as a unit. The exercise described is valuable if taken regularly and scientifically, if the children know why they are to do it and if they are interested to watch their own development.

Flash card drill is indispensable, but the words must be arranged so that they are different and not similar. First sets should be easier; this means that they should be nouns and verbs which have some pleasurable significance for the children; e.g., new words met during a project or on an expedition, those associated with games, swimming, handicraft or whatever is the enthusiasm of the moment. Outside interests must certainly be used, words occurring in connection with football matches, motor racing, films, etc. A set of about ten is produced and they must be made by the teacher with reference to the particular class. The most satisfactory are printed with Indian ink and a parcel pen on stiff, white card. The letters should be 1½ in. high. The words in a set must show distinct differences; e.g., *aeroplane* should be shown before *news*, and *advertisement* before *city*. Not only length but shape and pattern have to be considered. After each card has been named, they are exposed one after another in quick succession; two seconds is long enough for the child to react. The response can be given in a chorus sometimes, but usually individuals answer as soon as they can recognise the word. The teacher has to watch for the slowest and give them extra practice with perhaps something which interests them still more. There are flash cards which cause amusement but result in a quick response. They are "Look and Do" type; e.g., a set which requires the group to do something with the hands, such as twist, shake, point, clap, etc. Another suggests more vigorous movement, such as jump, stand, sit, laugh, etc. The teacher can invent a number of these. The difficult groups are those common words which are a source of failure to so many with weak visual memories—up, though, from, was, saw, etc. A set can be made so that the children respond with the hands and associate the word with the movement, such as up, down, under, across, behind, and so on.

Each new activity brings new words and phrases which should be clearly listed for reference and also entered in the home made dictionaries under the initial letter. Whenever the language used is taught as reading material, meaning is attached which makes recognition quicker and builds up a working vocabulary and helps the children to read for the meaning which the word conveys.

The method of "spelling out" is of little value except to occasional children who have already been mentioned as suffering from a degree of word blindness. There is, however, a place for every method in the adjustment class, and a mixture of them all and spelling aloud will probably be valuable on some occasions and with some children, but it is far less important than other methods. The place of phonetic teaching is also debatable. Those children who are partially word blind can associate sounds and letters and, if their speech is normal, phonetic teaching should be efficacious. It is not advisable to approach this form of teaching without an explanation to the children or they are confused between names and sounds of letters and sometimes fail to associate phonetics with the normal reading. It is a good plan to let them collect words which have a common sound and to write the word down to their dictation. When a fair number have accumulated, encourage them to discover why they have had to do the exercise. It is usually an easy matter for them to realise that they were required to discover that every time they meet "a—r—" in a word, it will sound *ar*. The words then have to be listed and constant reference made during the reading practice period. Phonetics for most backward children are harmful as the practice of building and hesitating produces poor eye movements and the sounds themselves have no interest for the reader.

II. The second aim is to train the children to derive meaning from the written word, to read for content; actually the only reading which is really reading. The writer has taught backward children to read perfectly with a method known as "phonoscript" and their performance deluded many people but not their teacher. They read like automatic machines, and when the writer met them after they had been at work for two years they told her that they still could not read properly. After a few weeks of evening practice on more intelligent lines, they read easily and for meaning. Senior boys and girls are often particularly difficult to teach to read for content because they have no intelligent interest in the subject matter. The complaint is made that easy readers contain babyish material which they despise. The remedy lies in the hands of the teacher. Let them read anything which concerns their hobbies and interests. Cookery books, catalogues, illustrated magazines, advertisements, football scores, directions for making things, newspapers and books dealing with their special hobbies; e.g., stamp collecting, homing pigeons, fretwork, etc. If, at the same time, they are learning a working vocabulary of common words and can refer to the teacher when necessary, the interest carries them through the difficulties. They quickly remember words which have a pleasurable meaning for them. The best book for practice is the one which provides plenty of repetition of word forms, for the backward child requires more repetition than does the normal child. The book which introduces the fewest new words on each page, but contains interesting material, is also valuable. However, they are not absolutely necessary if other practice and supplementary reading material is provided. It is necessary to banish many difficult reading books of the type which is used successfully with normal children.

A class bulletin forms additional reading material and creates the concept of reading to get information. This can take several forms and is usually written by the teacher, being taken over by the children as they progress. News of sports, matches, club meetings, outings, directions for individual work, references to interesting topical news and suggestions of good films at the local cinema are the kinds of things usually mentioned. If written daily, the teacher will find the pupils grouped round it as soon as they enter the room and those who are puzzled are taught by the others. Written directions for practice work or other activities suit the same purpose. In one class, there were a number of cards, clearly printed, called "job cards." After an exercise had been completed the children were free to select a card, read the directions and then carry them out. They concerned the care of the school pets, handwork, drawing and practical exercises in weight and measurement. Arthur Gates in his book, *The Improvement of Reading*, explains devices for the direction of accurate interpretation. For instance, the pupil reads a series of directions which tell how to colour an outline drawing; e.g.:

Colour the cat blue.
Colour the cat black.
Colour the cat brown.

After reading a short story he is asked to solve such problems as, "Who got the most milk?"

The cat.
The rat.
The bat.

"How did the little girl feel?"

She felt sad.
She was mad.
She was glad.

Individual children can undertake to keep cuttings on various subjects from newspapers and to arrange them for the classroom library; e.g., weather forecasts might be searched out and displayed on the daily bulletin. All should know how to use a newspaper and how to get information from it. Whenever information is needed by the teacher, the task should be undertaken by a pupil. They can search for addresses in the telephone directory, look up an index in a text book or consult a table of contents. They can be given such exercises as, "From your newspaper find the answer to the following questions":

1. What does the paper cost?
2. Find a grocery advertisement. Copy the names of six articles sold in a grocery shop.
3. Find an advertisement under "Help wanted—male."
4. What is the weather report?

There are other interesting activities which not only call attention to reading content, but test the degree of comprehension. The following are examples from *Education of the Slow Learning Child*, by C. P. Ingram:

1. Put a cross (x) on the sign that tells you to be careful:

Give more	Dangerous	Fresh Eggs

2. Put a cross (x) on the sign for a public park:

Fire Escape	Keep off the Grass	Keep Out

3. Put a cross (x) on the sign for an empty house:

To Let	Level Crossing	Wet Paint

There should be a daily period for such training although the reading of bulletins, searching newspapers, etc., can be accomplished incidentally when individuals have completed other tasks. The many opportunities which arise for experiences which involve reading cannot be limited to a certain time during the day; they must be seized at the psychological moment and turned to good account. It is questionable whether written problems in arithmetic should be used at all, but when they are the teacher should consider that this factitive reading is part of their reading experience and should give help in providing a method of interpretation. Note-making from text books is unnecessary; it is better to keep notes of actualities supplemented by facts discovered during expeditions and cuttings and pictures from catalogues and magazines. No classroom is complete without illustrated catalogues, and the teacher can devise many uses for them besides their endless value as material to browse over and for giving information.

The class library.—Reading for enjoyment should have its place, and although these children will never be book worms or frequent visitors to the free libraries, they should know how to use books and in some cases an interest may be aroused which will be fruitful in the future. Some teachers have organised a corner of the room as a class library and book corner which is cared for and administered by the more academic members of the class. It is especially attractive with coloured shelves, a table and chairs. The books are varied and among them are the less orthodox magazines beloved by most children. The teacher will sometimes read aloud from them, choosing an attractive incident and then telling them where they can read from if they want to know more. This often results in a waiting list for a particular book. There will be books on construction to which they can make reference and scrap books of items collected and made by members of the class. If there is an interest in this class library, it will be worth while to organise visits to the free library with explanations of the procedure. If the current literature for boys and girls is consulted, the teacher cannot help becoming enthusiastic for them to be able to enjoy these good things and will do everything possible to give them some interest in books.

Reading and writing, companion subjects.—We began by commenting that writing and reading cannot be separated in the adjustment class. The children cannot write English without having some knowledge of reading and without some facility in speech. Again, the subject need not be kept in a compartment by itself. Writing and reading are often better for being practised together. There are such exercises as, "Look up the 'Help Wanted' column and find an advertisement you would like to answer," or the "lost" advertisements are consulted and the pupil selects one which he could answer. One class was warned a week ahead that it would be asked to write on "How would you spend 5s. on a day out?" Plenty of literature was supplied so that the children could consult lists of excursions to the sea, programmes of places of amusement, bus drives to interesting places in the neighbourhood, etc. They made their plans, learned to spell unusual words, some made a map of the journey and they all worked out actual costs before writing their account. These activities are examples of the two subjects aiding each other and the overlap which is bound to be a characteristic of intelligent teaching methods.

Formal writing.—The teacher has to decide how much practice in written English is desirable for backward children. The *Handbook of Suggestions for Teachers* recommends that "for most backward children anything like formal composition would be quite out of place. The aim of the teacher would be rather to get them to want to write, and to provide them with exercises in which they can see some purpose. Any interesting thing that they are doing or making may serve as a basis for simple written work." This advice is once more emphasising the need for the teacher to provide learning situations which appeal and motivate the need to write. Thinking of their after-school experience, it is obvious that they will require to be able to write a short letter and fill up official forms.

There will be plenty of opportunities for writing to firms for catalogues, to travel bureaux for posters and booklets, to public bodies for information. Enthusiasm is aroused when there is a definite situation of this sort and there is also some purpose in attending to lessons on the form of a letter and the choice of the accurate word for the meaning. All the class should do the exercise unless they are quite incapable and the vote should be taken on a selection made by the teacher, the successful letter being sent in the writer's own name so that the answer will be addressed to him. There will be occasions when letters of invitation will need to be sent to members of another class to invite them to hear a play or to see an exhibition. Each pupil might choose a friend and make a programme for him and send his letter of invitation. If they are answered, there will be a splendid opportunity for reading to extract meaning. Sometimes letters of explanation might be attempted or contacts can be made with the members of another class in a different district. Many classes have their own letter box and send notes to each other in a legitimate way. The addressing of envelopes should be taught in this connection. There is no need to force situations or to provide regular exercises in letter writing; it is best to allow the activity when there is the definite need. As the children are nearing leaving age, it will be opportune to suggest that they should look up the advertisements in the newspaper and draft answers to those of the type they would actually like to answer. This might lead to answering other advertisements for articles to be sold, "lost" and "found," etc. It will interest them to make up their own advertisements.

A good supply of unused official forms will be necessary for their practice in filling them up correctly. Here again is an instance of reading correlated with writing.

Telegrams are interesting and valuable for an investigation in the use of the accurate word and concise directions. The puzzle will be to convey their message in a limited number of words. Actual forms should be used and a mock counter set up with assistants who undertake to count up the charge. The senders will, of course, check their own to see that they are not overcharged.

The *Suggestions for Teachers* also considers that a class newspaper is a useful method of stimulating the interest in written English. There comes to mind a particular class which chose its own editor, business manager, advertising agent and cartoonist and then wrote advertisements, news items, original poems, jokes, crosswords, stories and open letters and handed them in at appointed times, to be paid 1*d*. per word if the contribution was accepted. The contributors were most alert to see that the payment (cardboard coins) was accurate and did not mind in the least if they were asked to rewrite their effort and present it in a tidier form. The teacher's part was to give instruction, suited to their level, on punctuation, the use of the paragraph, how to consult a simple dictionary for difficult spellings and so on. Another class undertook to produce a Christmas Annual on the same lines. The efforts were crude when compared with those of normal children but the achievement was very much appreciated and of great value to the children.

Record keeping although concerned with other subjects stimulates effort of this sort. Nature study observations should be recorded daily, briefly and accurately. Volunteers usually take turns each week and the records are placed conspicuously where they can be read by others. Their attention often has to be drawn to them, for backward children do not spontaneously notice. It may be useful to suggest here that observation and discrimination may be encouraged by picture collections which are classified and mounted. Each child might select his own preference and the teacher in a poor district should collect magazines and papers from which cuttings can be made. The search for illustrations calls their attention to detail and causes them to be aware while they are out of school. They begin to look for pictures at home and this simple device has the effect of giving them eyes to see at least in one direction. Their pictures should be classified; e.g., a collection of aeroplane illustrations should be classified into various models and something might be added in writing to explain the differences. If these are kept in books or loose-leaf folders, they might sometimes be available in the library and the children should be encouraged to exchange or to explain their collections to each other. Weather records might be kept by other individuals and compared with the forecasts in the newspaper. These records should be investigated at the end of each month and a comparison made with the previous month and with the month of the preceding year. Gardening records may prove interesting; e.g., the dates of the appearance of first shoots, the flowers, the fruit, etc. Country children will be able to keep short records of birds and wild flowers, the progress of crops and the harvest. Farm children will choose to write of the birth of young ones, the damage done by rooks, the date when the cows have to return to the barns for the winter, etc.

Diaries are kept by some classes. Each pupil has his own book into which he puts any details which he wishes to record about experiences at home or at school. They are often illustrated with sketches or newspaper cuttings and can be taken from class to class. They are not used in any formal way; the children fill them up during free periods or during the course of their formal practice work. Some make story books of their own experiences from which they get a great deal of satisfaction both because they have achieved and because it forms a means of expression.

In many such ways written English can be encouraged. As far as technique is concerned, the children should write first and then their common mistakes should be dealt with by the teacher without any attempt to teach grammar.

Spelling.

The position of spelling.—There is no need to regard spelling as a separate subject; it can be thought of as the handmaid of written English and should be practised in close contact with that subject. The practice of giving lists of words to be learnt and tested without reference to the activities and special needs of the children will have little effect in the adjustment class. Printed spelling books are equally useless. There is actually no transference between words learnt by heart from arbitrary lists and the same words when needed in an actual situation. Real needs will arise during the writing of letters and diaries, in record keeping and writing news for the bulletin. Of course, there is no need to teach the unusual word which is required for one special occasion but those which are wanted fairly often should be made the basis of the spelling drill. Individual differences will be very marked; spelling often depends upon reading ability and it is unnecessary to give all the class drill in the same words. A plan was tried where each member of the group kept two books; in one was recorded the words which he knew, and in the other were the words to be learned. The latter were transferred in due course. It is better to emphasise the spellings which are known than to call attention continually to the failures. If a person gets the idea that he is a bad speller, it is the hardest thing to convince him that he need not be and to get his co-operation towards improvement.

Suggestions for teaching.—On Monday, each child begins with the list of words in which he failed during the previous week; i.e., those words he could not spell when he needed them in written English. The teacher will organise spelling drill periods and those who need the words he has chosen (from a record kept during the previous week) will come to the drill. This will be followed by individual study when they can learn them in any way which suits them. Swift tests are given again on Wednesday and Friday and individual study should continue until the necessary words are learned. The lists should not be kept long; a few properly learnt each week will add up to a considerable number in the course of several years. The will of the children must be in the task and they should be encouraged to collect the spellings as they learn them and to find a plan of marking up successes.

People vary considerably in the way they learn to spell. Some can remember the look of the word; they often try it out on scrap paper before writing to see if it looks right. Others have aural memories for words and spell it to themselves; they have to hear it. For some the motor response is easier; they learn by continually writing the same word. For this reason, each member of the class should be encouraged to use any way he prefers and the teacher should devise a method of spelling drill which will help all types. The following has been well tried and with success:

1. The teacher writes the word, the class attends as he says it distinctly by syllables.
2. The children spell it by syllables, to themselves or aloud.
3. Close eyes and try to see each syllable as it is said.

4. Look again if the image is not produced and try again.
5. If still not clear, spell aloud letter by letter and try again.
6. When clear, write the word after the teacher has covered the copy. (Use the curtain suggested in connection with reading.)
7. Compare with the correct version.
8. Look again and rewrite if wrong.
9. When correct, write three times without copying from oneself or from copy on the blackboard.

Besides individual study after such drill, there should be opportunities for using the word in writing. When a project is in progress, there are common words which are constantly in use and plenty of opportunities will come along. Words which are learned and not used tend to remain in the immediate memory and are soon lost. At intervals, there might be spelling bees and word-taking-and-making games, the selection of words being made from those in the pupils' own word books. Dictation as is often used is of absolutely no use in this class, but to warn the children that they are to have a passage to write which will contain some of the words they have learned is a test which might be used occasionally.

Crafts.

The handwork appeal.—The member of the adjustment class approaches nearer the normal child in motor ability than he does in any more definitely intellectual work. He enjoys the use of materials and the operations in the construction of an article. At the same time he has not the ability of the intelligent child who is also interested in practical work and he is not capable of following a systematised course which involves reference to directions and charts. He will also take longer than the normal child to acquire simple skills, and the work must be graded in easier stages than for the ordinary child.

It is essential that handwork should have a conspicuous place in the curriculum, for the manipulation of materials and tools during the creation of any object provokes that thought which the dull child cannot use on an abstract plane. The child thinks about the job, plans, considers what to do when things are not quite straightforward, what materials he shall choose next, etc. If these processes are analysed, it will be obvious that imagination, judgment and reasoning take place in a mind which is slow to use these mechanisms unless they directly concern a personal problem, and handwork is in the nature of something deeply personal. Like the normal child, he loves to do and to make; when he can produce a finished article he not only has the satisfaction of creation but he is assured that he is not so different from others. The handling and manipulation of materials is in itself a widening influence; once a child has worked in clay or wood he does not forget their properties and continues an interest in anything which concerns their production and in articles which are made with them. It gives him a subject on which he can talk with some show of authority. Later on in life, he will be likely to make use of his knowledge and will select a hobby which involves the skills learned at school. Several new blocks of workmen's flats are now equipped with workshops in the basements where the men can carry on their hobby and make useful objects for the home.

Success and failure.—There has already been some mention of the need for movement; handwork supplies opportunities for activity of the body and is therefore valuable in that way. The training to use the muscles, to manipulate skilfully and to subdue the material to serve the purpose, are important lessons which occur during manual training. If used in its fullest sense, handwork is the means of linking together the more formal subjects of the curriculum and giving them meaning. All handwork should bear closely on the other work, but particularly on mathematics.

A warning must, however, be given. Handwork has little of these advantages if taught mechanically. In the past, teachers have been glad to set the dull child to work on a piece of mechanical handwork and to feel that at least he is getting on with something and looks concentrated and will not get into mischief. Raffia and other simple weaving, plaiting, knitting, are among the mechanical types of work and of these Dr. Burt writes that "they tend to be merely mechanical, and where no controlling purpose is involved, so far from keeping the mind busy [this work] merely leaves it free to day-dream; it acts not as a stimulant but as a soporific. . . . Its direct educational value is negligible." The Board of Education in the pamphlet on the *Education of the Backward Children* writes, "In the past it has been the custom among some teachers to rely upon routine occupations of a monotonous character to fill the space allocated in the time-table to practical work. Such work showing as it does little or no progression in difficulty and little or no power to exercise the wits of the children cannot be educationally justified."

On the other hand, the usual course in a senior school craft is too difficult for them; what is needed is a special course designed in close contact with the rest of the curriculum which will allow for varied and gradual progression and for a fairly high standard of execution and finish. It is not a case of slowing down and easing the ordinary course, but actually a course taught by methods specially adapted to backward children.

Suggestions for a course.—The pamphlet referred to in a preceding paragraph also emphasises that all backward children should have their full share of instruction in the domestic subjects and the handicraft rooms and "perhaps even more so in gardening." But the courses in both domestic science and woodwork or metalwork must be graded to suit the backward child and yet he must still be occupied with tasks which are interesting and worth while to him. These courses are liable to become stereotyped, and insufficient adjustments are made to suit the requirements of individuals and groups. They should be governed by psychological principles and the educational ideals which the class teacher who undertakes the adjustment class is trying to practise. It is an easy matter to take manual subjects as a course of collective lessons, but this must be avoided. Each child should choose his own task, thereby setting his own problem; each should work with the minimum of help and judge his own achievement by the final results.

This last point applies to handwork which is taken in the classroom by the teacher. Work which is dictated at every step leaves no chance for the practice of thinking, reasoning and judgment. Various techniques have to be taught and then the pupil should be free to use some initiative, to make what he wants with a choice of materials and design. It is not necessary for every child to do the same sort of thing. The classroom of the backward children should be equipped with tools and materials rather than with the traditional stationery and text books, and each child should be allowed to choose what things he shall make and with what materials. They may be simple but they are worthy if they involve the solution of some concrete problem; the solution, of course, being the child's. The teacher is needed to act in an advisory capacity when referred to or when the pupil can go no further alone. Even then the teacher tries to stimulate him to think so that the next suggestion or the final solution comes from him. The selection of materials is in the hands of the teacher and, if suitably chosen, can stimulate thought and suggest possibilities. Things which are seen often suggest ideas. Properties and scenery for dramatic performances, seats and fences for the garden, wheelbarrows and rabbit hutches, rugs, games and toys for an infants' school, towels and bags for use in their own classroom are the kind of thing the children will enjoy. Toy theatres and puppets are excellent from a creative and emotional point of view and both can be easily worked in close connection with the primary subjects. No classroom should be without a good supply of clay, kept in good condition. There will also be the numerous repairs which can be undertaken by the class, the linen from the staff room, the loose handles, broken apparatus, the toys from the nearest nursery school, etc. When individual records are kept, they can be made by each child. One can easily imagine that the type of handwork growing from some such practical need receives the greatest attention and calls for a considerable degree of careful execution.

Units of work or projects may be developed to provide opportunities for handwork which not only is valuable in the ways already mentioned but which also serves to interest the child in ideas about art and work in the world around and in the use of raw material as well as the interdependence and co-operation of workers. One group was taken to watch builders at work and studied the development from day to day and also began its own house in the playground. There were lively discussions on the value of materials, the manufacture of composition substances, and the relative values of different forms of lighting which resulted in talks on the history of lighting and an exhibition visit. The principle of central heating was investigated with the help of the school caretaker, who organised conducted tours over the school and explained how the classrooms were heated, the cost of fuel and of cleaning. Some of the class reports of this project were made for the school newspaper.

The habits which teachers inculcate in their pupils through handwork are still applicable in the adjustment class. They should learn to work neatly, care for tools and use them skilfully and independently and treat materials economically.

Mathematics.

Grouping the children.—Weakness in this subject is more pronounced among senior girls than senior boys and there are many cases of children who are backward in no other subject but arithmetic. If intensive work in the adjustment class fails, the trouble is possibly emotional, and psychological help is needed.

At the beginning, it is necessary to distinguish between the child who is backward for physical, psychological or other reasons except dullness. These again should be separated into groups of backward pupils who try and those who do not. For the former, "a revision course is necessary which aims at reasonable facility in simple calculations with small numbers and a fair knowledge of weights and measures but not to deal with large numbers or difficult problems" (Board of Education Pamphlet). The backward ones who have lost interest or who are bored are more difficult to approach. They want an entirely new point of view. It is possible that they might find this in the approach which is made to the work for dull pupils and later they may advance and join the other section.

For the dull children, there will have to be a separate scheme and special methods of teaching. A real appreciation of numbers is very hard for these children. Many elementary facts which the normal child comes across and assimilates in his every-day life pass by the dull one and he has to be awakened to the knowledge of their significance. The teacher should realise their many limitations. They can understand by observation and using the rules in concrete situations but they cannot realise these situations when they are described in words. Their power of visualisation, already mentioned with regard to reading, may be slight and their imagery is poor. They cannot concentrate for the same length of time so that a lesson should never be longer than thirty minutes, unless there is practical work to be done. They take longer to grasp a rule and need several explanations; they then take longer to memorise it and must have revision practice at short intervals in order to retain the new skill and fresh knowledge.

Mechanical number.—We shall first consider mechanical number; i.e., the four fundamental rules and money. It is best to begin from the individual child's level, however low it may be. Each child coming from the junior school should be tested to find what he can do and the teacher must not be afraid of going back far into the elementary rules. Blockage sometimes begins at some trifling misunderstanding which no one has cleared up. There will probably be almost as many stages of achievement as there are children in the class and for this reason it is advisable to use a simple assignment plan for the mechanical work. Do not be in a hurry to teach them; they will probably be bored with arithmetic and feel they are hopeless. The results they have achieved in the past have so often been incorrect that they have lost confidence in their ability to do arithmetic correctly and have floundered through their course with a steady increase of mental instability. It remains for the senior school teacher once more to create in them a feeling of power that they can do something right. They have probably not understood accuracy; i.e., that a number of answers are absolutely correct and that they are capable of producing them correctly. It is more often a case of getting something down which they hope will satisfy the teacher enough to get a right mark. Let them practise the stage which they can do and make their books (to measurement) for the record of scores. This mechanical number is boring unless they have a purpose and can see in some tangible form how they progress.

Apparatus and assignments.—When they have more confidence, the children can be introduced to the next stage which, if possible, should be taught to groups on the same level of attainment. Every classroom should be provided with materials for practical work and apparatus for the demonstration of process besides a supply for individual use. Whatever can be used to appeal to the visual or manual faculties should be introduced when teaching. Large tens of beads on wires, a chain of beads in two colours for division, cardboard coins and counters, small abaci, a pair of household scales and weights, steel tape measures, pint measures, large clock faces are among likely equipment. When a group has appeared to understand the new process, the children will be given apparatus if they cannot get the answer immediately, but will discard it as soon as they can work the example easily. A score should be kept by each child, who must compete with himself; the next assignment will depend upon his success with the previous one. Of course, they consist of quite simple lists of easy examples without words, which can be worked swiftly. Absolute accuracy in the writing down will facilitate correct working. Large numbers should be avoided at all costs. Teaching should be measured by what the child can learn to use and the number concepts of these children will be very limited. The teacher will find it best to make his own assignments and practice cards for there are no ordinary text books suitable for each particular group. In fact, one cannot be written for backward children for no single one would meet the needs for each environment and all the degrees of difficulty. Added to which, there is the question of reading and the extraction of meaning which is the greatest problem for these children. While they are deciphering the words and puzzling over the method, fatigue overtakes them and they give up or hazard something instead of performing the process.

Application to ordinary life.—The question of measurement; i.e., quantity, amount, size, distance, space and time, must be considered as problematic arithmetic for it will profit them nothing if they can talk glibly about tons and bushels and not know what is represented by the facts they deal with. Problems are vital; most of us use arithmetic in life only when we need to solve a problem of our own. It is the application of mathematics to problems which the dull child finds so difficult and yet he will have to use numbers in situations out of school. Many children fail to connect school arithmetic, and the problems which they solve themselves, in their play, shopping and travelling experiences. The teacher's function is to teach the children to apply their mechanical arithmetic to meet the needs of an ordinary life carried on in a simple environment; to give meaning to mathematics. Abstract number problems must be eliminated and others introduced which are in close contact with the actual experiences of life. Fundamentally, arithmetic is partly a social science and for the type of child in mind this is the only aspect which matters.

The following is a list of practical situations which might form a basis for problem work.

1. Estimation of cost of Christmas party for one class, for a school, for a family.
2. Estimation of value of time spent on a job.
3. Keeping scores of games.
4. Reading temperature graph.
5. Records of difference in temperature, a.m. and p.m.
6. Cost of school milk over various periods for one child, for a family, for a class.
7. Finding gain in weight over previous month.
8. Finding differences in age, calculation from one birthday to another.
9. Finding difference in heights.
10. Bills for purchase of clothes, food, furniture and tools.
11. Payment for travelling; e.g., bus or car to and from school per week, month, term.
12. Cost of amusements for family, or for one during a year, a month, a week.
13. Cost of insurance stamps. The principle of insurance, cost per month, etc.
14. Cost at so much per day of losing time through sickness.
15. Cost of postage, parcel post, telegrams, postal orders, licences, registered post.
16. Money saved over varying periods of time, the accumulation of interest in Post Office Savings Bank.
17. Cost of school equipment.
18. Simple household budgets (boys and girls).
19. Extra cost of payment by instalments.
20. Reading time-tables, finding gain in time by express, and record breaking engines.
21. Innumerable bills and comparisons from catalogues.
22. Time books.
23. Laundry lists.
24. Cost of repairs of shoes per family, extra cost over home repairs.
25. Cost of large quantities and their saving over small amounts; e.g., sack of flour or potatoes.

One could continue to enumerate the possibilities but conditions in each district vary and the teacher will make his own lists. The neighbourhood prices and the habits of buying amongst the parents must be explored. It is a good plan to keep problem books where the various types are entered; e.g., a specimen household budget is worked out and then the pupil compiles a number of original ones for various sized families. When catalogue prices are used, they might be cut out and pasted at the head of the page and then bills worked from them. Tool prices will interest boys and clothes will perhaps be more popular with the girls.

Connection with activities.—Examples which occur in manual training, gardening and domestic science should also have a place in the problem book. This will involve measurement and cost and, if worked closely with the rest of the curriculum, many excellent opportunities will be used in the service of arithmetic. Seed catalogues can be written for by members of the class, quality and prices compared, orders compiled and posted, later on to be checked and the result of sales recorded to ascertain any profit. Patterns and prices of dress materials can be written for and a choice made by the girls, the cost of each article being worked out from catalogued prices. Every opportunity afforded by the social life of the school should be used, and the accounts for out-of-school activities should be the responsibility of the members of the adjustment class. They might also be responsible for the milk scheme in operation in their department, for its distribution and the collection of "empties" as well as the balance of cash. If a class effort of any description happens to be in progress, they should undertake any book-keeping which has to be done. One class bought a small printing press. The money was advanced to the children and by a series of efforts; e.g., a jam jar collection and sale, and a lantern performance for other classes, the debt was repaid. In this case all the accounts were kept by members of the class. In some districts tuck shops are allowed and these afford practice of easy book-keeping.

The Industry Book.—There is also an idea known as "Industry Book" keeping. In a country district, this would take the form of a farm book in which various members of the group enter such costs as gathering and marketing, the price of pigs and the consequent profit of the sale of litters. Dull children who live on farms are surprisingly well informed about these details and the interest should be canalled into the service of arithmetic. Profits of poultry keeping are also suitable subjects. In cities, the "Industry Book" records the profit on jobs such as carrying papers, minding babies, going errands, helping at market stalls, etc.

These problems will be discussed verbally and then used as data for original work, but if it is necessary to give a written problem it should be stated directly with the minimum words and within the reading vocabulary of the class and be true to the current number of facts in like situations.

Problems in measurement can be dealt with similarly. The child must experience the measures in concrete situations so that by comparison and association he will know what is meant by the facts he deals with. For instance, he should know how much bulk a ton represents by observation of the load of so many trucks delivered at the school, and he should know the height of the school or flag mast and must be able to compare other heights against it. By directed observation of this sort, concepts of measurement are built up to which he will be able to refer.

Short cuts.—For those who find mechanical work an obstacle when working out their own problems, a ready reckoner will be useful. "A ready reckoner may be used by the children who are unable to make the necessary calculations with reasonable ease and accuracy, since an acquaintance with short cuts to knowledge is better than complete ignorance" (on *The Teaching of the Backward Child*).

Most projects are rich in number content and are splendid in motivation of problems. One class ran a poultry club which involved accounts, the calculation of the price of timber, food, bills for eggs and the measurement of materials for making houses. The reader who is interested will find the account of a country school experiment carried out on these lines in a small book, *Education for Life*, by A. A. Matthews, which is both stimulating and suggestive.

Lastly, how much time should be given to this subject? The answer is indicated in *Senior School Mathematics* and referred to again in the *Handbook of Suggestions*. The maximum is four hours per week in boys' schools, and three in girls' schools, but there are schools who have reduced the time to two hours weekly without impairing the efficiency of the work. These schools have used the opportunities for mathematics provided through practical work. This seems a workable plan for the adjustment class; a great deal of incidental work will be outside the scheduled period which will be devoted to practice of mechanical work, short easy tests, lesson and discussions of new rules and the working of the sort of problem suggested.

Conclusion.—This brief outline of possible methods with the backward child follows those which are advocated by educationalists and psychologists. It falls, however, to the class teacher to put them to the test in actual practice, to add and to modify. The old idea that the more backward the child the more "grind" there must be, is exploded and the new methods are full of interest for teachers and pupils. The work will not be dull and, although it will not bring quick results, there will be satisfaction and reward in watching the steady growth of confidence and independence which will come through profitable activity. To save boys and girls from despondency, even delinquency, is no mean achievement.

LEAVERS' CLASSES AND VOCATIONAL GUIDANCE

From the painting by F. Madox Brown in the Manchester City Art Gallery]

WORK

This picture, painted in 1852, represents the main street of Hampstead, not far from the Heath. Various types of useful work are illustrated by the labourers in the middle of the picture and the brain workers who are standing to the right. As a contrast, the rich, who do not need to work, and the pariah, who has never been taught to work, are shown over to the left and in the background.

THE LEAVERS' CLASSES

A BOYS' SCHOOL IN AN INDUSTRIAL AREA

Introduction.—The groups of lessons under this heading are designed to give assistance in solving some of the problems which are peculiar to the highest age group of the school.

It is assumed that the children are passed into a special class at the beginning of their last year, or, if the size of the school will not allow a whole year, at the beginning of their last term as schoolchildren.

The special aims and the suggested scheme of work have been built up on the knowledge that the child, on the day after he leaves the class, will be pitchforked into industry. "Pitchforked" is used intentionally, for convention, ignorance and economic demands of home unite to thrust most children through the nearest unlocked workmen's entrance.

This sudden transition from school to industry holds great dangers because of the gulf which separates the two.

Life in school is communal; isolation is avoided in all activities. Moral and spiritual values are placed before materialism. The background is of the past, ideals and philosophy of bygone generations being given through literature, art and music. Mathematical and scientific facts are not given unless they have been subjected to the test of years of application. The boy is encouraged to develop; every avenue of his capabilities is explored to bring out the best, irrespective of its material value. He is made to feel that the successful completion of a task is worthy of congratulation. Authority is elastic, personal and sympathetic, and assistance is always at hand to ease the burden of responsibilities should they prove too heavy. Physical welfare is constantly watched, unhealthy habits checked and personal rivalry is never allowed to reach a point where it might hinder another. Leisure hours are linked with school life, and home shelters him. It is a life of absorption, of room and freedom for development, of companionship and goodwill, and above all, of safety.

The life in industry is starkly individual, with everyone intent on earning his own living. In return for a weekly pay envelope, industry demands certain labours of mind and body. The demand is well defined and urgent; nothing less will suffice, nothing more is expected. Industry never refers to moral and spiritual values because they are looked upon as a person's private business. The philosophy of the life is of the matter-of-fact present and any thoughts which can be spared from this must be directed to the future. Skill at the job is the only talent to be fostered; others must be suppressed until the whistle has blown. Successful completion of a job is no longer a matter for congratulation; it must be an unnoticed habit. Authority is hard and impersonal, making no exceptions and giving no quarter. Heavy responsibilities must be borne unaided; a cruel rivalry is always present, cruel because one may climb only over one's fellows. Habits are ignored and physical welfare watched no farther than the carrying out of the job. The day has no longer any unity, work and leisure being prisoned in separate compartments which must never be opened together.

Even home life has undergone a change. Economics of food and shelter are discussed; those wishing to keep their feet under the table are expected to put their share on it.

Parents and friends are powerless to assist in the new difficulties.

It is a life of rendering full return for receipts, of narrow efficiency in one direction, of throttled development elsewhere, of isolation, of individual effort in the teeth of jealous fellows, above all, a life bereft of any sense of security, with every hour charged with the fear of the consequences of inefficiency.

The general aim of the leavers' class may be stated as an attempt to throw a bridge across the gap between the two lives, a bridge which is a separate entity but having its approaches springing gradually from both sides, a bridge so designed that at any given moment those crossing are able to see whence they came and whither they are bound. In practical terms, this means a rounding off of school life and an introduction to post-school life.

As post-school life is a matter of some sixty years, it is necessary to narrow down the front to something within the scope of a year's or term's work. It should consist of daily work, daily social intercourse, and daily spiritual needs. Introduction to these three will mean that the boy will leave school knowing what daily work is and what implications go with it, knowing how much his future happiness depends on his relations with his fellows and knowing that no character has stability unless certain principles of conduct are firmly rooted.

The class has a tradition of its own. The very fact that it is composed entirely of leavers, sets it apart from the rest of the school. Although at the "awkward" stage, the idealism of the adolescent is making a tentative appearance and, with a little guiding, fastens on to the idea, "This is where we begin to be men". From such an idea to a code of things a fellow does and things a fellow never does is not an impossible step.

The process of putting away childish things is encouraged at every possible opportunity. Self-reliance, self-control and adaptability in attacking difficulties are expected from everyone, and failure to show these qualities or thoughtless breaking of the code brings relegation to one of the other forms. The worst crime on the sheet is the wasting of time, either one's own or another's. Personal responsibility is unescapable. For this reason monitors, class prefects and the like are banished to oblivion. Pens, books, papers are looked upon as tools with which work has to be done, and everyone must see that his tools are to his hand to enable him to do his five and a half hours a day.

Tasks are varied but worth while; no boy is ever put on a footling job merely to keep him occupied. Although there is variation, each boy has his share of those which he considers unpalatable or irksome, and no excuse is allowed in explanation of work unfinished within a reasonable time. This means that Tom Jones, so clever at drawing, is not allowed to escape his daily ration of stocks and shares.

Relations between boy and teacher are not quite the same as in other classes. The teacher is found to be less of a willing help in time of trouble and more of a critic of results, very intolerant of anything less than an hour's work in sixty minutes and very apt to answer, "Find out," to the appeal, "Please, sir, how do I do this?" The old friendship is there, but it is more personal, due to so many private and confidential chats when doing part of a practical job together, and to the teacher's readiness to give point to manly qualities by treating the boy as something of a companion whenever he displays a more mature outlook.

One of the first things a boy must decide, after talking things over with his parents and teacher, is the kind of work he thinks would appeal to him. A careful note is made of this choice and of any subsequent change of mind. Once he has definitely decided, his work is so arranged that he finds himself constantly reminded of his decision. No attempt is made to teach him how to do the job, but he is given opportunity to learn what the job is and the atmosphere surrounding it.

The familiar background of the past is not so apparent in the teaching, boys being led to think and work in terms of the future.

The teacher's preparation for the work of the class must of necessity traverse unfamiliar ground, but it need never be laborious. He has to introduce the boys to life's daily work. In order to do this he must be familiar with all the industries of the district, a task very much lighter than it appears at first glance. Every district has one or possibly two central industries, whilst the others cluster round with their roots in the centre and have much in common. If a thorough study is made of the central industry, the others, being more or less complementary, are easily grasped with little additional study. In addition to actual processes, the teacher should gather all the trade terms he possibly can and form an accurate estimate of the conditions under which the processes are carried out. His estimate should be in terms of the boys who are to step among them. The commercial library of the town, together with the non-fictional boxes of the county library will provide all the books necessary to cover the industries.

Reading should be supplemented by actual contact in the workshops. This may present some difficulty as industry does not welcome inquisitive strangers, but no firm will close its doors on an honest attempt to assist their future employees. An interview of ten minutes, or a carefully worded letter explaining the purpose, invariably secures the desired permission to visit. Once inside, it pays to waste nobody's time and to work quickly, for this will probably earn an invitation to repeat the visit.

In addition to watching processes, the visit can be utilised to study the atmosphere of the workshop and the toll, physical and mental, that the various operations exact of the men, and whether the organisation offers opportunities to beginners. It is not always easy to judge the strain on a workman. The furnaces of an ironworks on a hot afternoon appear to offer the worst possible conditions, yet work at these is far less exacting than some jobs in a mass-production factory. It is helpful to linger at the gates of different works at the end of a shift, studying the men's bearing and energy as they leave.

The greatest help in preparation comes from the workmen themselves. They are quick to seize an opportunity to teach something to a teacher, and a suggestion of a desire to sit at their feet will be enough to persuade them to talk about their jobs.

To this knowledge of the local industries the teacher adds a sound grasp of the social life open to the elementary school boy who is making his way to the twenties. Young peoples' clubs, guilds and associations prove mines of information about their games, hobbies, flirtations, home conditions, ambitions, codes and etiquette. These are the hammers which will forge the social character of the boy who is to leave school.

As his insight into the boy's future environment accumulates, the teacher becomes more and more conscious of the necessity to give him some lasting moral stiffening, and thereupon decides on a few salient points to drive home in such a manner that they will hold fast even in a world where the dishonest steward and the girl who says, "I'm no angel," are waiting to introduce themselves.

One rather painful part of the teacher's work is the tearing aside of some of the delightful illusions of boyhood, but he forces himself to do it, knowing that his hand is more gentle than that of the workman who is to show the boy his job.

From Monday morning to Friday afternoon the teacher fills his room with the atmosphere most suited to develop the characteristics every boy needs in the grim struggle ahead—self-reliance, self-discipline and an uncompromising fighting spirit.

Further details of the aims of the class are to be found under the various subjects given, and these general notes may be left summarised:—

1. The function of the leavers' class is to bridge the gap between schoolroom and workshop.

2. The aim of the class is to introduce each boy to industrial and social life.

3. The test of the class is the number who leave it and pass into a sphere in which they give of their best—happily.

The curriculum.—As the class is to be a bridge which is a separate entity, it follows that the time-table will have features peculiar to itself. These features will vary considerably to meet the claims of district, school traditions and local standards of life, so that the accompanying table must be regarded merely as an example:—

<table>
<tr><th></th><th>9.30</th><th>10</th><th>11</th><th>12</th><th>3.30</th><th>4.30</th></tr>
<tr><td>MON.</td><td>Bible Reading</td><td rowspan="5">Physical Training</td><td rowspan="5">Arithmetic</td><td rowspan="5">Literature</td><td>Industrial Processes</td><td>Dramatics</td></tr>
<tr><td>TUES.</td><td>Christianity at Home</td><td colspan="2">Practical Work</td></tr>
<tr><td>WED.</td><td>Christianity at Work</td><td colspan="2">Industrial Processes</td></tr>
<tr><td>THURS.</td><td>Christianity at Play</td><td colspan="2">Practical Work</td></tr>
<tr><td>FRI.</td><td>Bible Repetition</td><td>Industrial Processes</td><td>Music</td></tr>
</table>

it is to their advantage to begin to apply themselves to one task over longer periods.

The reliefs which appear, music and drama, are given by design, meagre space at the end of tiring days, for it bears close relation to the time and place for such activities in post-school life. History, geography, art, science, botany, have all disappeared as separate subjects, just as they will vanish in the future, cropping up only as part of a job, in reading or in general conversation.

In addition to monotony and narrowness, a definite lopsidedness is apparent. This also approximates the future which holds an overweight of toil and an underweight of relaxation for the boy.

The time-honoured break for recreation is missing. A minute may be used to obey the calls of nature, but class work goes on. To carry on whilst listening to the shouts of freedom in the playground is good preparation for the transition of long hours and working on Saturdays.

Although plain, the table is elastic. Practical work, for example, may on occasion be stretched across a whole day. Daily work, daily social life, spiritual needs,—each has its place.

When the elasticity is exercised it may serve to heighten the monotonous effect of the whole table, but this is a gain rather than a detriment. It must contain long periods if it is to approximate industrial time-tables. In a short time the children will be forced to spend eight hours a day at a machine or addressing envelopes, and

The absence of organised games, swimming, gardening and optional periods does not mean that such activities are no longer encouraged. They are encouraged more energetically than ever but the time given to them must be taken from the boy's leisure hours, and he must organise them and carry through without the teacher's leadership, just as he will be forced to do in the future.

The aim of the religious knowledge periods is to concentrate on the teaching of Christ in the atmosphere of workshop, home, and social life. To see Him not as a village carpenter's assistant, but toiling in a modern factory, to use His life as a guide for conduct towards relatives and friends and to drive home a few pegs to which the boy can cling for steadiness under the impact of the new life with its labour, its vicious and subtle sexual experiences, its dishonesty and demands for sacrifice. The fifteenth psalm, the Commandments and the parable of the Good Samaritan are typical pegs well worth the trouble of driving.

The extra ten minutes added to the physical training period is to allow for short talks and discussions on physical matters and personal hygiene. It also provides opportunity to stress the commercial value of an attractive personal appearance and to point out how this depends almost entirely on right habits, scrupulous care of the body and the applications of corrective exercises and games when daily work is against balanced development. As the boys are completely unaware of the importance of such points the time allowed will not be found excessive.

PRACTICAL WORK

INTRODUCTION to industries by means of practical work in school hours is perhaps the most interesting method both for teacher and scholar. Whatever practical work is selected, it should, in the first place, further the aim of the class, which is to introduce the children to life ahead, or, more particularly in this case, to industries.

Handwork and crafts as we know them in school are not sufficient, for a craft is an end in itself, almost insulated from the rest of one's activities. It is a relief from the necessary daily occupations, ministering to the desires of those portions of the mind which are starved by the ordinary day's work. The aim of a craft is perfect creation, and efforts which fall short of this are deemed a failure, while the whole atmosphere surrounding it is suggestive of the privacy of one's home or garden shed, far removed from the hurly-burly of industry's workshops; all of which renders a craft inappropriate for the purpose of the leavers' class.

At the same time, completed work should have a definite practical value. It should be worthy of serious treatment and should not be merely a footling pastime; it should call for serious consideration from the most scatter-brained individual in the class, demand thought and preparation outside school hours, be big enough to form a topic of conversation between a boy and his father, and progressive enough to ensure lasting enthusiasm. In addition, the work should embrace, in one scheme, some small part of as many local trades as possible, introducing methods and materials obtaining in these trades. Some part of the scheme should be within the scope of every child in the class, calling for the use of brain as well as hand, and not rigid enough to prevent it bearing the marks of the individuality of those who work upon it.

Finally, whatever is chosen should lend itself to small groups working under leaders and should also give practice in costing, purchase of raw materials, book-keeping, mechanical drawing and the dozen other tasks which are attendant upon the production of any article in industry.

The best way to give all these considerations full scope is to embark upon a class project. The nature of the project is essentially a matter for each individual teacher, but there are some points common to all which may be mentioned.

Projects cost money and as his class is one of hundreds with equal claim upon the local education authority, the teacher will usually find his share falls short of his needs. If, however, he takes the class into his confidence and sets before them the financial position, ways and means of filling the gap between income and expenditure will be suggested by the children. Such ways include a weekly school magazine, sale of photographs by the camera club, a class tuck shop, repairs to bicycles and a percentage of the sales from the garden. Moreover, tradesmen are usually willing to stretch a point when purchases are being made. When the class tackles its own financial problems the effect is apparent and is far beyond the paying of bills. No one has greater pride in his proprietory rights than the boy of fourteen, and the fact that some of the materials have been bought with money he raised is sufficient to keep his interest and enthusiasm sizzling through the term. Nor could the work have better protection than, "Be careful, that costs money!" from the lips of an irate leaver.

Co-operation with the woodwork and metalwork rooms is almost an essential. The teacher finds his work halved if he has access to their tools and assistance. He cannot, however, expect co-operation unless he exercises the greatest care with everything borrowed and takes the instructors into his confidence regarding his plans. As a general rule, no tool should be borrowed unless the teacher is familiar with it.

The policy of solving problems as the work proceeds is not recommended; in every case the teacher should have a technical knowledge sufficient to deal with the main lines. Such knowledge is always to be found by those who seek from books, friends and workmen. Difficulties arise in spite of preparation, and by tackling them together the teacher and scholar find very close touch.

Work on a project should be limited to the periods on the time-table. For this reason it is advisable to set aside afternoon sessions for the purpose, so that if time arrives at a point where it is impossible to leave off, the extra comes from the leisure time of the volunteers who are prepared to stay. Timing of the work is important; it is undesirable to subject the class to a race against the clock or to have children without occupation for the last half hour. The work set should just fill the session. It is wise to guard against the well-meaning advice of colleagues and parents. The more interesting the project the greater the amount of advice offered. They are interested in the end, but the most valuable part of a project is the means, not the end. The boys' bungling efforts must come before any skilled assistance.

At every opportunity the practical work should be associated with technical books, the work being suspended until the boys have mastered the next step in theory. The trial and error method must be excluded for it has no place in industry.

The preliminaries to all projects are the same. A careful estimate of cost is made after the class has produced scale drawings under the teacher's supervision; 20 per cent is added to this estimate, and ways and means of meeting the cost are discussed. Returning to the drawings, the children then work out quantities of raw materials after due allowance for waste, and later produce large scale drawings of the different parts.

The class is split into groups with responsible leaders. One is given charge of the account book, in which are entered details of all transactions,—quantities bought, costs, tradesmen, and waste. This section is also responsible for all correspondence. A single boy is made responsible for the safe return of all borrowed tools. Another is appointed clerk to the works, with instructions to record daily progress of each group. As far as the nature of the work will allow, separate groups should be responsible for sections of the work from start to finish, and the section subdivided so that each member of the group knows exactly what he has to do.

Once the organisation is clear to every child, the work begins and should be carried through without alteration. Strict adherence means that where a boy shows incompetence, the work of everyone will be slowed up, but this is in itself a valuable lesson, for it will demonstrate why industry will not tolerate a time waster. With every session's work the teacher finds endless opportunities to teach lessons in industry—the right use of tools, accurate working to instructions, intelligent adaptability,—to name but a few.

When the work is complete, totals of cost, materials and hours of labour are worked out. If current rates of pay in the different trades are ascertained, a selling price for the finished job can be arrived at and used as a practical illustration in lessons on costs of production and margins of profit.

When the work is put to practical use it will probably prove less effective than was anticipated, and the final stage begins. Plans are brought out once more and the whole scheme examined from the user's point of view. All suggestions for improvement are considered and those which prove practical are carried out. When these are done, the project, once more being put to practical use, may be regarded as complete.

It will be noticed that throughout the above method an attempt is made to approximate actual working conditions. The children are led to feel that this is work rather than to imagine that they are workmen. Anything which will assist an industrial atmosphere is adopted. The teacher appears as a practical man intent on producing an article,—overalls are worn, toolbags carried, and everywhere there is a bustle of activity. It is difficult to lift it beyond a game of make-believe in the presence of solid facts like school furniture and school buildings, but the enthusiastic drive of teacher and class must cause these facts to fade, or the major value of the project to the leaver will be lost.

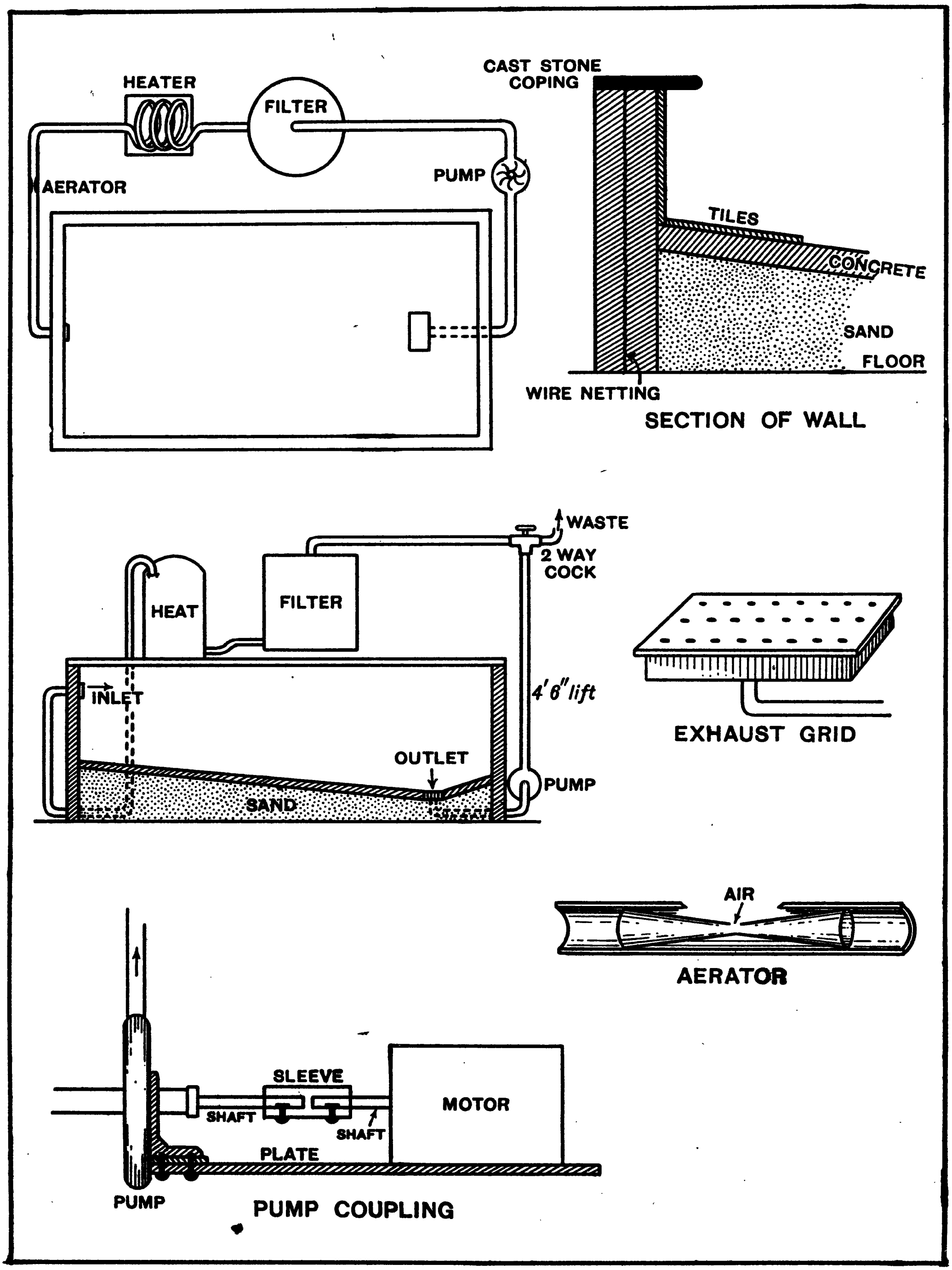
MODEL SWIMMING BATH AND FILTRATION PLANT

AFTER a decision had been made, the boys were taken to study the most modern swimming bath in the district. Their enthusiasm caught the interest of the engineer, who made many valuable suggestions.

This plant was then simplified to bring it within the scope of classwork. Plans and estimates were made and checked, groups organised, and work began. The bath, 6 ft. by 3 ft. by 14 in. varying to 21 in. was constructed of reinforced concrete 2 in. thick. Two wooden walls were set up, one inside the other with 2 in. between and wire netting fixed in the middle of the space. The concrete mixture was 5 gravel, 4 sand, 3 cement, turned over twice dry and twice after water had been added. This was dropped between the wooden walls and thoroughly worked by prodding with thin sticks. When set, the wood was removed and the floor begun. Wooden pegs had been left in the wet concrete at the points where inlet and outlet pipes would be fixed. These were now removed and the grating and pipe at the outlet fixed in position. Slabs of concrete which had been cast and left to set for a week were laid to form the floor of the bath. The space left by the rise towards the shallow end was filled with sand. When the slabs were in position the whole of the interior was faced with a skim of sand and cement. A small quantity of *Pudlo* was put in all concrete mixings to render it waterproof.

The tiles were then cemented to the inside with a mixture of 1 sand, 1 cement. Before they had set hard, the joints were scraped out with a point and filled with a mixing of white cement. The coping round the edge was of slabs of *Vinculum* cast stone.

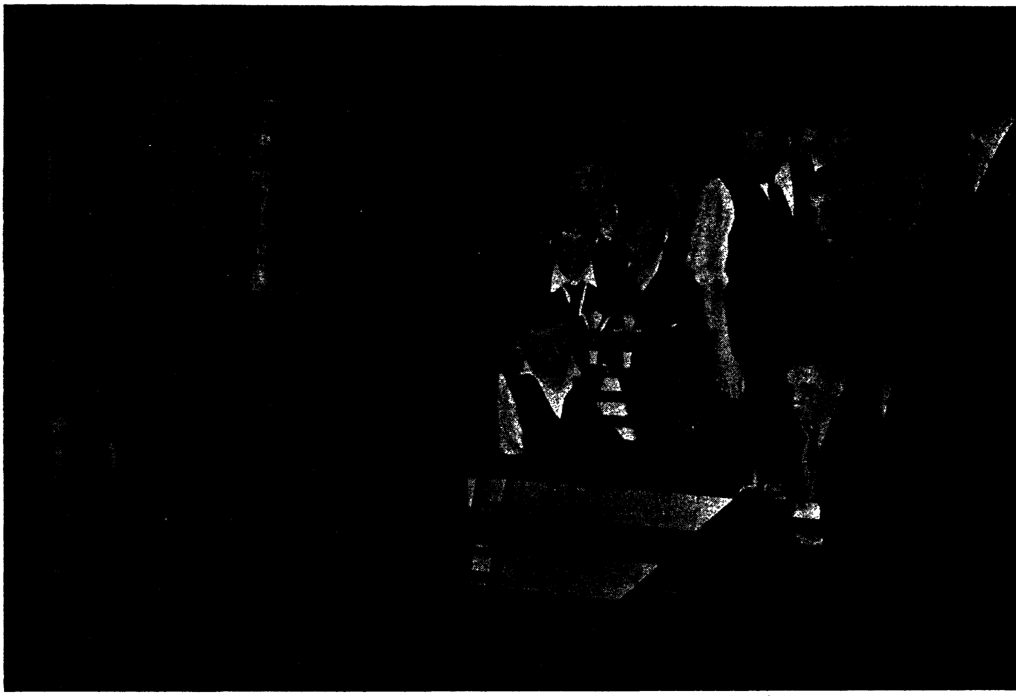
The water pipes were of $\frac{1}{2}$ in. pipe screwed at the joints to drawings sent with the order. The joints were made watertight by smearing the screw with red lead.



Model Swimming Bath and Filtration Plant

The filter was constructed from an oil drum. This was cleaned and filled with layers of pebbles and sea sand; the outlet was soldered in with a fine gauze covering it, and a new top, holding the inlet pipe was soldered down. The heater was composed of the coil and jacket of an old gas califont, mounted over a gas ring.

The water was aerated by soldering a constriction in the pipe and piercing the constriction at its narrowest point with a fine hole. The water sucked in air as it rushed past the constriction.



MODEL SWIMMING BATH, PUMP, FILTERS AND HEATING PLANT NOW USED AS SLIPPER BATH BY SCHOOL FOOTBALL TEAMS

Circulation of the water was obtained by inserting a small centrifugal pump. The rough castings for this were purchased and afterwards machined and fitted in the metal-work room. A small electric motor was connected up to drive it.

The steps and diving stand were made in the woodwork room. Vent pipes to carry away the gas fumes from the heater were made of thin sheet iron from the metalwork room. The whole was allowed to stand for a week before testing and filling with water.

The water was then pumped out and the whole of the metal exposed to the air given a coat of bright green paint. At the outset it had been planned with a view to using it as a slipper bath for the football teams, but when tried, the filter proved useless in the presence of soapy water. A two-way cock was therefore fixed beyond the pump and another pipe connected up and carried outside to a convenient drain. The water could then be directed through the filter and back into the bath, or, if soapy, pumped away into the drain.

During construction the boys were brought into contact with the following trades:—reinforced concrete; cement plastering; tile making and fixing; pipe screwing; jointing and bending; sheet metalwork; gas fitting; motor and pump fitting; pump construction; filtration and joinery.

They worked with these materials:—wood; sand, cement and gravel; tiles; copper; gunmetal; iron; steel; brass; sheet metal.

They learned the correct use of such tools as shovel; riddle; bricklayer's and plasterer's trowels; straight edge; plumb line; square; joiner's tools; blow pipe; soldering iron; lathe; drill; scriber; micrometer; taps and dies; hearth and anvil.

From technical books they were able to discover methods of waterproofing materials; concrete mixtures; reinforcing methods; filtration of water; use and construction of electric motors; methods of coupling to power; aeration; welding; the making of lathe tools.

In addition they encountered official regulations governing the use of gas; electricity, and the safeguards of vent pipes, insulation and earthing.

Cost was low. The califont was purchased at scrap price and the resale of taps, valves and pipes which were not required from it resulted in a net gain sufficient to purchase the sand and gravel. Tiles of third quality were ordered and the firm became so interested that they gave the whole order and in addition sent a man to the school to supervise the boys and teach them the proper methods of fixing. Castings for the pump and the two-way cock together with the piping cost under £1. The heaviest item was £2 for the electric motor. Total cost was in the neighbourhood of £4.

Gas fitting was done free and in no case did a firm of tradesmen charge current prices.

MOTOR CAR

A VERY instructive and interesting project is the close study of a motor car. This was tackled in one leaver's class and completed well within a term.

The boys were taken to a large 'bus garage and to several private garages with the object of gaining a superficial knowledge of the construction of motor vehicles. This was supplemented by many lessons and much study of books from the technical shelf and handbooks which manufacturers supply with their cars.

A little begging was then indulged in and a local owner offered a derelict which he was glad to see off his hands. It was towed into the playground and proved to be a saloon, the organs of which were perfectly sound and in working order. The boys brought their own spanners and chisels and the work of dismantling was begun. Drills, hacksaws, hammers and screwdrivers were borrowed from the metal room.

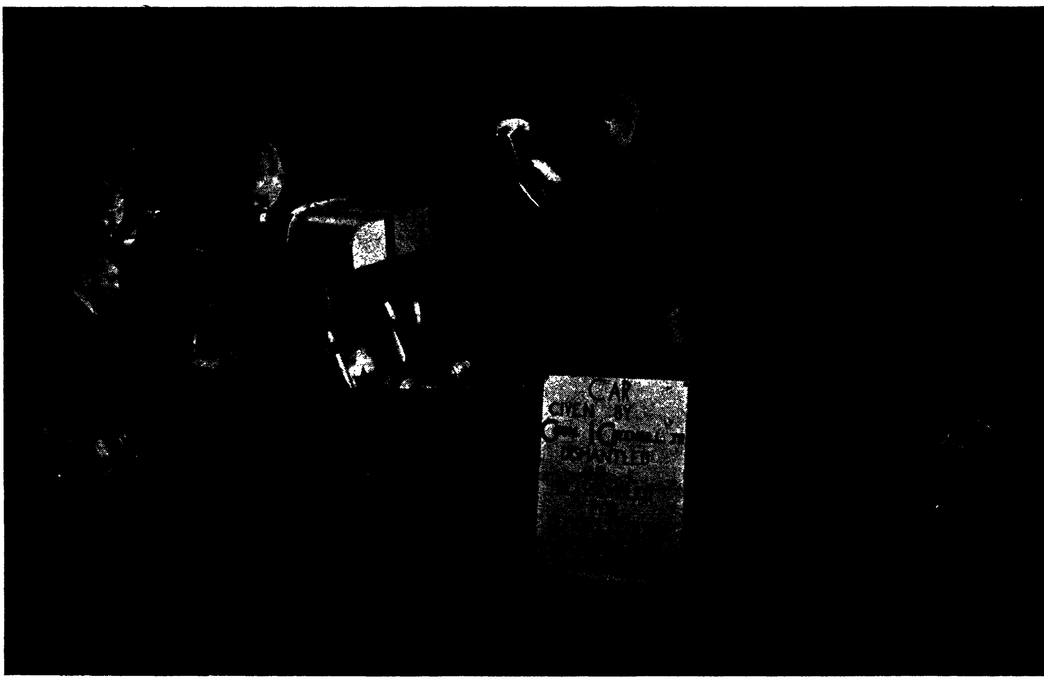
The order of dismantling was the subject of much thought. In the first place everything which was likely to prove a source of danger to the boys at work was removed. This included glass, doors, and broken edges of sheet metal. Bucket seats and floor boards followed. The seats were afterwards mounted on wood bases and proved welcome additions to the staff room. The bolts holding the body were now exposed and, after freeing it from the bonnet, the body was unbolted and lifted off. The bonnet was similarly treated and then the chassis was levered up on to stout wooden trestles high enough to enable boys to work underneath. All further work was suspended until the whole had been given a thorough clean and the engine sump and gear box had been drained.

A number of wooden boxes had been prepared with several divisions partitioned off in each, and these were brought out and labelled. As the various parts were dis-disconnected they were immediately placed in the box made to receive them.

All connections to the dash board were released and this came away. Petrol tank, magneto, radiator, steering column followed, and the engine was then open to attack. This was the biggest problem, owing to its weight. The transmission was disconnected beyond the gear box and the engine bolts removed from the chassis. The front axle bar was taken out and the engine jockeyed forward with crowbars until it was clear of all obstructions. Stout bars of wood were lashed under it and the male staff pressed into service during playtime. They lifted it clear and carried it into the classroom, where it was placed on a large groundsheet put down to receive it.

many of the nuts proved stubborn, but they usually moved after being treated with paraffin or heated with a blow lamp borrowed from the metalwork room.

The next stage was carried out in sections. The class was divided into small groups and each was made responsible for taking down a part to the last nut and bolt, cleaning and scraping it to brightness and reassembling it. The magneto and self-starter



THE CAR DISMANTLED

The boys could have tackled the engine, but it was thought advisable to have them well clear until such a heavy weight was safely on the ground. Shackle bolts were then removed to free the axles. The car was by this time in pieces which could be handled and stored in the classroom; the chassis, transmission, controls, steering column, axles and wheels were therefore taken inside. All that would not be required again was loaded on to a refuse lorry and the playground cleared. During dismantling

were not treated in this way. The teacher devoted most of his time to supervising the work on the engine, gear box and differential.

The chassis frame was mounted on a stand and the different parts gradually replaced. Bearings in the engine and transmission were left rather slack or eased out with a fine file and emery until the boys, without much effort, could swing the engine over either in neutral or gear, by turning the starting handle. This could be done as the wheels were clear of the floor.

A dummy dashboard was fixed but was used only to carry the tank. Instruments and indicators were not replaced.

When re-assembled, plated parts and engine case were polished with metal polish and the rest covered with lacquer paint. Chassis frame and water circuit were black, braking system light blue, petrol supply and carburettor dark blue, exhaust system red, transmission green.

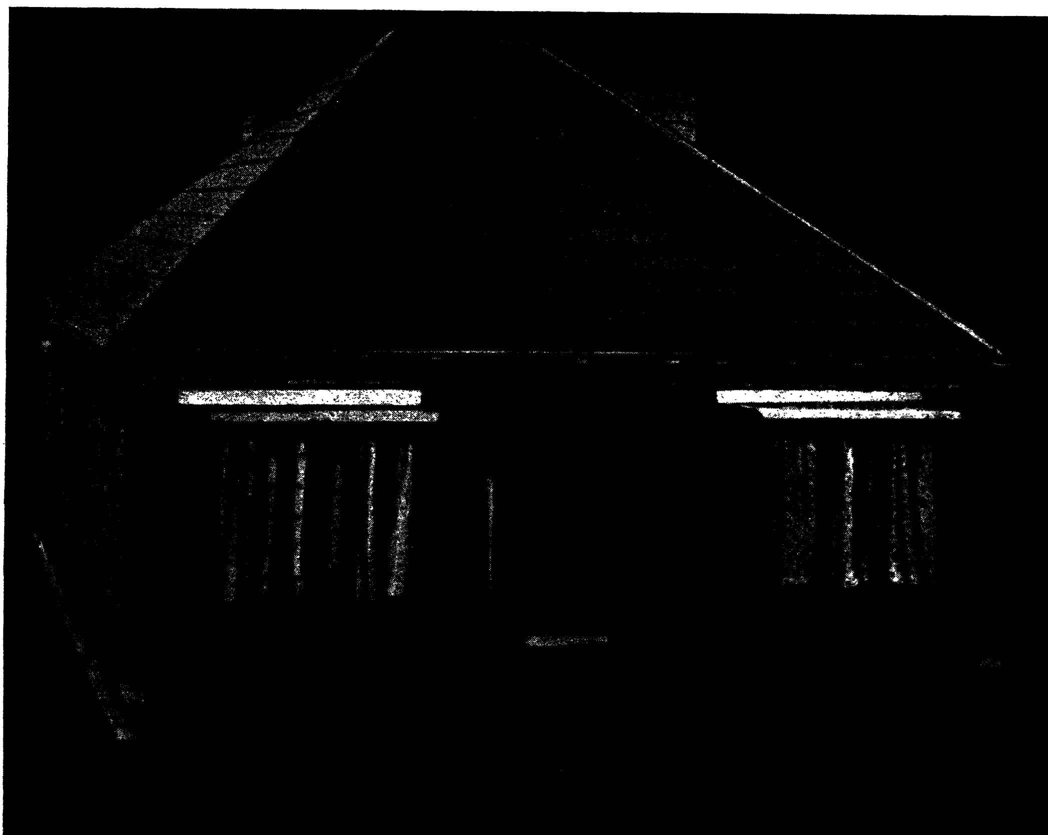
Nuts holding inspection plates and other covers were screwed thumb-tight so that they could be quickly removed for demonstration purposes.

The boys were allowed to inspect each other's work and became familiar with all parts of the car.

The total cost of the project was under 10*s*.; paint and a few nuts and bolts to replace those which had to be sawn off were the only purchases. The car is put to practical use with each successive class, the boys being able to learn how things work by taking them to pieces and rebuilding.

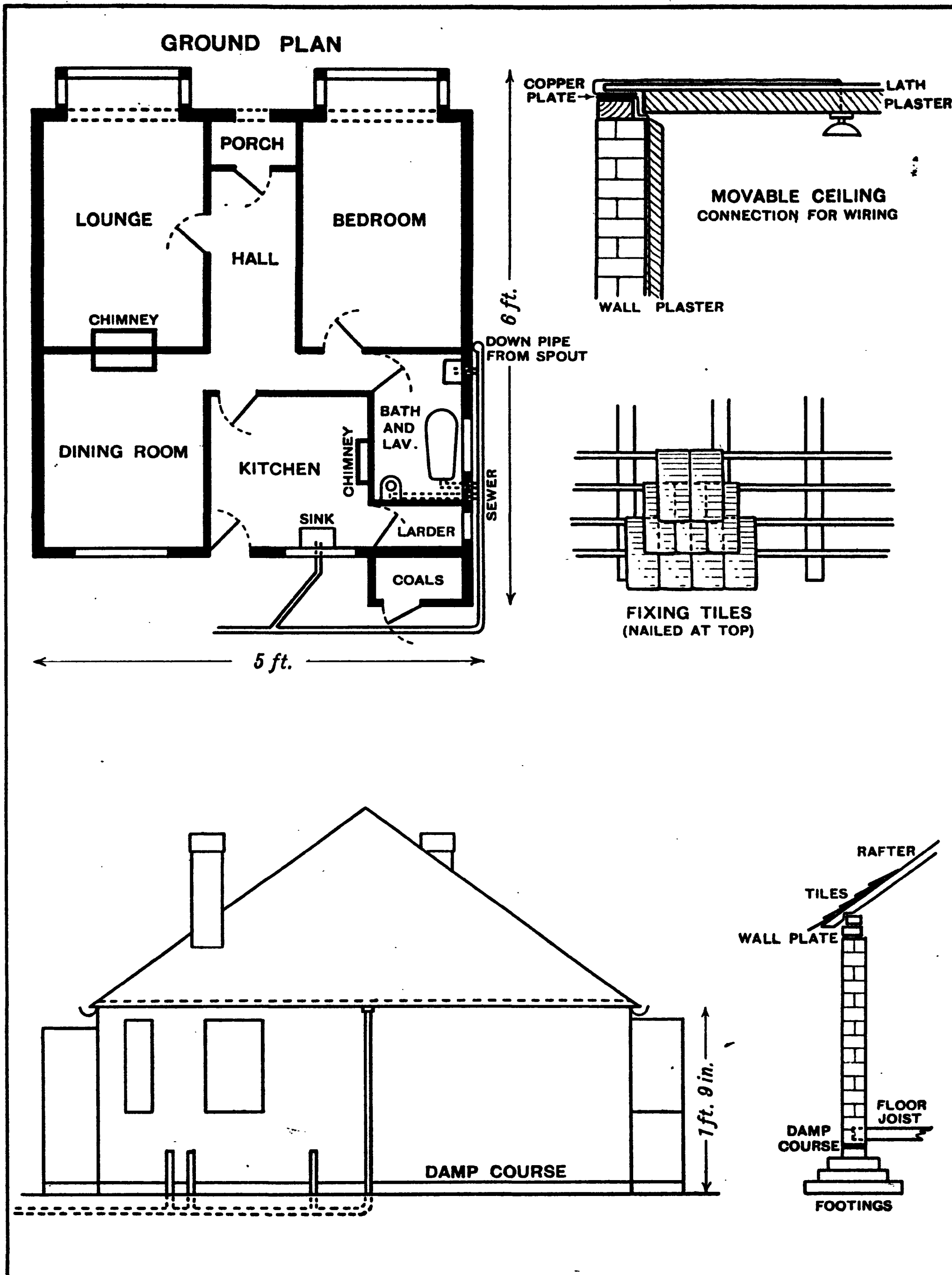
MODEL BUNGALOW

THE size of the bungalow is shown on the sketches reproduced here. The boys were taken to study various buildings in the district and one bungalow in particular. This bungalow was decided upon and the model was built to a scale of



MODEL BUNGALOW

Roof and ceilings built to remove; to allow plastering, wiring, etc., to be done. Afterwards used by girls' housewifery class.



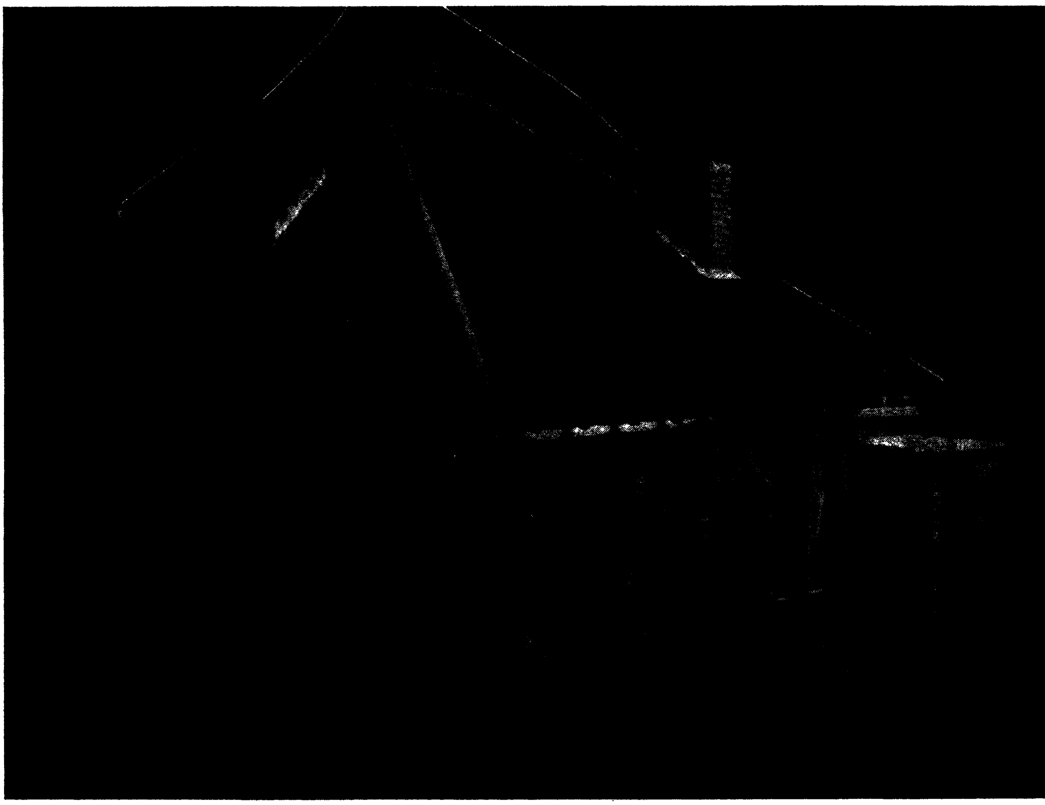
Model Bungalow

one-sixth, the only exception being the roof tiles which were too small to handle at that size.

A stout base was made of 3 in. by 2 in. wood and covered with 6 mm. plywood. Strip wood $\frac{3}{4}$ in. by $\frac{1}{2}$ in. was ordered and sawn into $1\frac{1}{2}$ in. lengths. This gave the bricks one-sixth of actual dimensions. 13,000 of these were cut. Single layers of plywood formed the damp course. Glue was used as mortar. Floor joists were made from plasterer's laths and plywood floors nailed on to them. Roof principals were slater's lath, and the tiles were cut from the thinnest plywood obtainable. After many experiments it was found that a mixture of sand and adamant in equal proportions keyed on to the wooden walls most effectively. This was therefore used as plaster. Ceilings and roof had to be removable to enable boys to work inside.

Before plastering, the rooms were wired for lights, but the switches were fixed on a switch board at the back. Lights were supplied from 6 volt accumulators.

Fireplaces were made of sheet metal and the wooden surrounds filled with small tiles.



Back View of Model Bungalow

Bathroom and lavatory fittings were obtained from firms who made these things in miniature for advertisement purposes. Floors were stained and varnished and walls were coloured with distemper.

Door frames, window frames and doors were made to scale in the woodwork room. Spouting and roof leading was made from thin sheet metal in the metalwork room and window panes were cut from odd glass from broken pictures in the lumber room. Sewage and drain pipes could not be obtained in earthenware and ½ in. compo piping was used in its place.

Work was not begun until the theory of bricklaying and roof construction had been well studied. Each boy had to build a model 9 in. wall and corner in Old English and Flemish bonds entirely from memory before touching the project. As most of them found it easier, the Flemish bond was adopted.

Once the footings and damp course had been laid and the door frames placed in position, the walls rose quickly. Every third course was strengthened by driving fine panel pins down through several courses. This was found to be necessary as the glue between the bricks reacted to the changes in the atmosphere and weakened the walls. All inside walls were left as rough as possible to help the plaster to key on firmly. Brickwork over the windows was supported on stout beams.

Before plastering, the walls were saturated with water and the plaster was sprayed for a week after it had been put on. This was to ensure that it dried out slowly and by this means needless cracking was avoided.

Two wall plates were necessary, one to top the brickwork and the other to carry the roof beams. The roof tiles were fixed on by nailing with panel pins. Four stout loops were screwed into the roof to enable wires to be fixed and passed through a pulley for lifting it on and off. The wiring to the lights was cheap flex, varnished over to resist the damp in the plaster.

When complete, the model was found very useful as a background for many lessons connected with home.

The total cost was about £4 10*s*. The largest item being the strip wood, of which 1,700 ft. were ordered and very little was left. Two squares of plywood, a hundredweight of adamant, 50 ft. of ¼ in. moulding (for picture rail), 2 lb. of assorted nails, four tins of distemper and 3 lb. of glue were other items. Switches, flex, battery and lamps cost 6*s*. 6*d*.

During construction the boys studied and practised all the trades connected with house building, and became familiar with the tools used by these trades.

The work offered excellent facilities for grouping under a foreman and at every point it was possible to couple actual work with study from technical books on the subject.

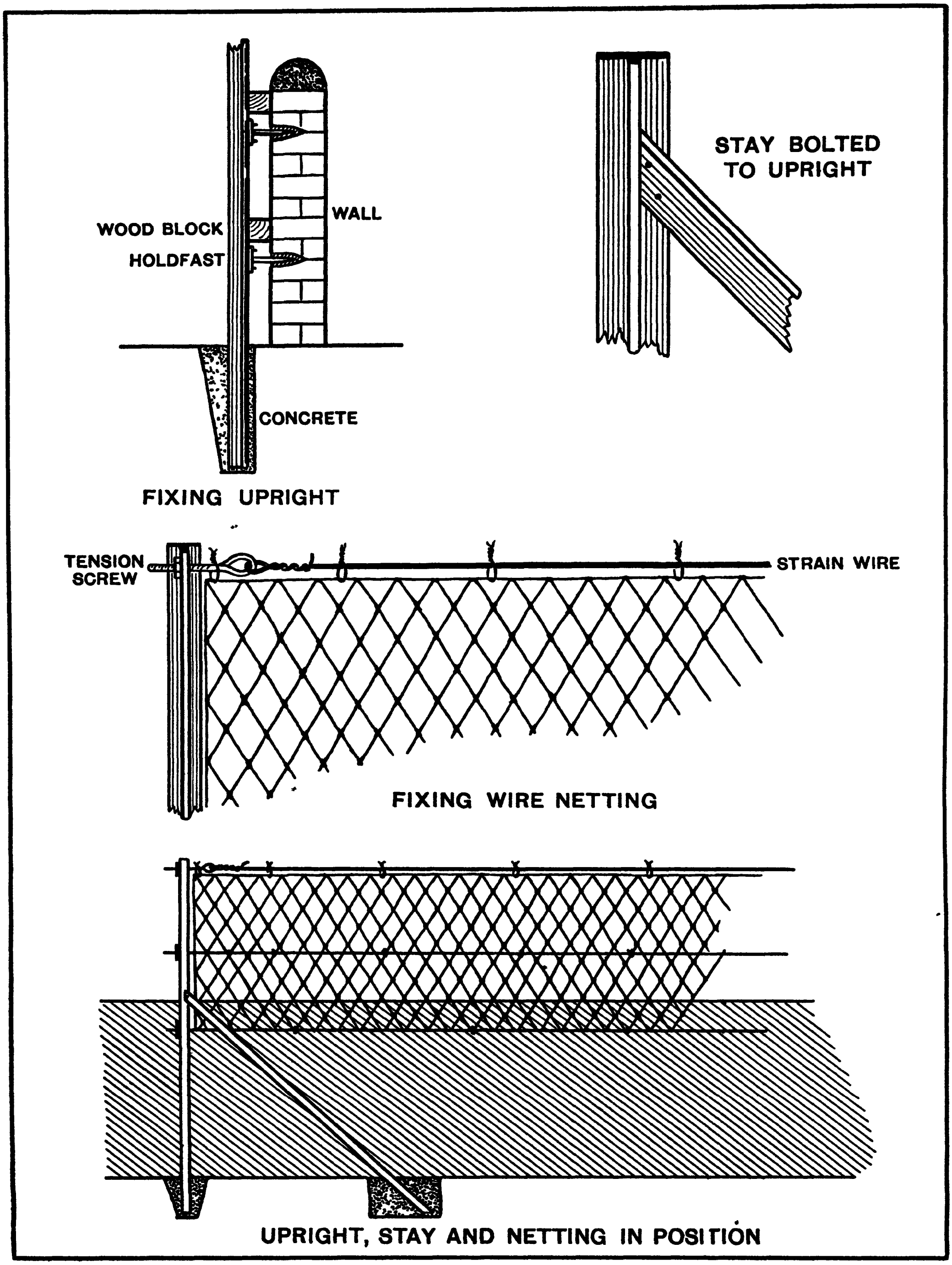
WIRE NETTING SURROUND FOR PLAYGROUND

THIS is an extremely useful project for the summer term when outdoor work is possible. It has the additional merit of simplicity. The cost is rather heavy, and at a school where it was carried out was beyond the limits of the school fund. The local education authority, however, impressed by its value, consented to pay for materials.

The work began with a careful survey of the playground and boundary walls. Scale drawings were completed and from these a list of materials required was drawn up. The virtues of round and angular uprights were compared and in the end it was decided that 'T' iron should be used whilst diagonal supports should be of lighter 'L' iron. The ground on the outside of one boundary wall fell sharply for a distance of 10 ft. and it was felt that it would be unwise to subject the wall to any strain at the top. The cross section of the uprights was therefore greater than would be in normal cases where they could be braced to the wall for support.

The fence was to be 10 ft. high, so that uprights were ordered 12 ft., allowing 2 ft. in the ground. Sufficient were obtained to place them at 18 ft. apart.

Six gauge wire carried the netting, which was heavily galvanized and 1½ in. mesh, ½ in. bolts were used to bolt the struts to the uprights.



WIRE NETTING SURROUND FOR PLAYGROUND

Work was divided and each group had a definite task. (1) Marked each upright and strut with a scriber at ground level and at points where holes had to be drilled. The ends of the struts were marked at an angle which would allow them to fit flush with the flange on the upright. (2) Drilled all holes. (3) Cut off all angles with hack saws. (4) Marked out the position of uprights and struts in the playground and excavated the holes. (5) Painted the work as it was finished.

When ready for erection, everything was bolted together whilst lying on the ground to ensure that no mistake had been made. It was then taken to pieces and carried to position.

Fresh groups were formed for erection. (1) Mixed concrete; cement, sand and gravel in proportions of 1: 2: 3, turning it over twice dry and twice after adding water. (2) Reared the uprights and wedged them after testing with a plumb line. (3) Followed (2) filling up the holes with concrete, working it well down and finally smoothing off with a trowel. (4) Placed struts in position and bolted them to the uprights.

The work was then left for a week to allow the concrete to set. Tension screws (with eye bolts) were fixed in each corner post and the wire threaded through the holes in the posts. After it had been fixed to the eye bolts, the tension nuts were tightened until each wire was taut. The netting was then unrolled and fixed to the wires by means of short lengths of copper wire at frequent intervals, each length being looped round and twisted tight with a pair of pliers.

Finally, every nut was pulled up as tightly as possible and the work touched up with paint wherever it had been scratched in the course of erection.

Ball games could now be played in the playground without the frequent stoppages for retrieving balls which had gone out of bounds.

In a project of this kind, the co-operation of the metalwork room is essential. It is the only place where one may borrow the squares and scribers for marking out, the hack saws for cutting, and the drilling machines for drilling the holes. During erection the teacher should be with the group responsible for rearing the uprights and wedging them in position, and he should not allow them to leave an upright until he is satisfied that there is no possibility of it falling. The boys who are given the task of fixing the netting in position should be carefully selected and supervised as they have to work on steps some 6 or 8 ft. from the ground.

In cases where the boundary wall is strong enough to act as a support for the fence, holdfasts should be driven into the wall before erection and the uprights bolted to them. Vibration is reduced if blocks of wood are driven as wedges between the wall and the uprights; these should be painted before being driven home.

DECORATING THE ROOM

AN interesting project for the winter months, when outside work is impossible, is the interior decoration of a room in the school. The most suitable room is usually found to be the staff room, as this is a room where work can be carried on without interfering with any class and also where the ceiling is low enough for boys to work at without risk.

Scale plans and elevations are drawn, and these are used when making sketches of the interior as seen from the doorway and also as seen from the opposite side. Each boy then works out a scheme of decoration and colours to his own taste. The work is examined critically and selections are made. Better results are sometimes obtained by combining features from several designs. The final selections should be submitted for approval by the people who use the room.

The scheme having been settled, work may begin. All old colour and paint should be removed. This should be so well done that the bare plaster and woodwork are revealed. The room is carefully examined and all flaws in plaster are marked. There are several good preparations on the market for filling cracks and flaws in plaster, but a thin mixture of adamant will serve, provided the place is well damped before applying the filling. Preparations are also sold for removing old distemper but the cheapest method is to scrape with a metal scraper.

The ceiling is scraped and cracks filled with a thin plaster of Paris mixture, which should be applied quickly as it soon dries. Paint may be removed by using one of the preparations sold for the purpose, but if expense is to be considered, the ordinary painter's blow-lamp should be used to burn it off, the burning being done under the direct supervision of the teacher. All cracks in the wood are then filled with a paste made by mixing ground whiting with boiled linseed oil. Walls and woodwork are finally rubbed down with a dry piece of pumice and wiped off with a clean duster.

Interest is added if the boys are allowed to mix their colour washes, but caution is necessary as it is most difficult to produce a desired tone. Preparation is based on a whiting paste. The whiting is broken and covered with water for several hours; the water is then run off and the residue stirred into a smooth paste which is strained through a piece of muslin. A weak solution of size is added and the whole well mixed and again strained. The colouring pigment is then added very sparingly and the paste stirred until all streaks have disappeared. Water is added to dilute the mixture for use. Better results are obtained if soft water is used.

A less risky way is to purchase tins of good quality distemper which requires nothing more than diluting. Many firms supply a wash for the under coat which has been tested to ensure that it will impart the exact colour tone to the final coat. They also supply ceiling washes tinted to complete the colour scheme below. If ready-mixed distemper is purchased, it is advisable to enquire whether or not the walls should be sized before applying the first coat.

The ceiling is completed before the walls are touched. Distemper is thin and should be applied evenly with a fairly broad brush. Brush strokes must all be in one direction, in a straight line from the window. This is necessary because the brush sometimes throws up the distemper into tiny furrows which will be revealed by shadow if the light strikes them from the side. A second coat is not usually necessary on the ceiling.

The walls are cleared of any spots dropped during the work on the ceiling, and the under coat is put on. Again each wall should be brushed in a similar direction. If the scheme includes panels of different colour on the walls they are marked out with pencil before the under coat is applied. The lines are visible through the coat.

When this is dry the second coat is applied evenly. It is a good plan to establish a rule that two strokes must be made with the brush before dipping into the distemper for further supply, so that the eager boy will not apply too thickly.

Woodwork is next cleaned of spots and covered with a priming coat of paint. This should be made very thin by adding turpentine and boiled linseed oil. When dry, the second coat is added and, later, the finishing coat. Paint is never laid on thickly, but spread over the maximum area by firm strokes of the brush. Ventilators are left open during the periods of drying as paint needs fresh air to oxidize and dry properly.

If the woodwork is stained instead of painted, two methods are possible. The simpler is to mix a water stain of vandyke brown crystals, a little size and water. It is applied with a broad brush and left to soak into the wood and dry. Two coats of good copal varnish then bring it up to a live colour and impart a polished surface. The second method is to use a spirit stain and afterwards cover with a coat of shellac. This is left for several months before applying another thin coat of shellac. Woodwork which has previously been painted is not a good subject for staining.

The last part to receive attention is the floor. All cracks are stopped with putty which has been tinted with spirit stain, and the whole floor rubbed and cleaned with glasspaper or pumice. The stain used is thinned to give the desired depth and then applied quickly but evenly. When dry, it is polished with beeswax or a standard wax polish.

ICE BOX

PRELIMINARY work on the construction of an ice box includes several lessons on latent heat, freezing mixtures, the ways in which food may become unwholesome, and the methods of preserving food. These are followed by a history of refrigeration and details of modern refrigerators.

Self-cooling refrigerators require mechanical assistance and are therefore beyond the powers of a leaver's class, but a simple ice chest may be undertaken with confidence.

The size of the box is influenced by the space available and the extent to which it will be used when finished. It is usually large enough to accommodate the food brought by those who stay for dinner and the bottles of milk delivered at the school. Scale and section drawings are made after the size has been agreed upon and then each boy is asked to sketch the design of the outside which he considers would fit most unobtrusively into the place prepared to receive it. Ornate or complicated designs are ruled out and the best attempt of those remaining is adopted.

The work is then divided between the groups.

The first is responsible for the inner chest. This may be made of thin sheet iron, soldered along all joints to make them airtight, or of plywood lined with zinc sheeting. In the latter the zinc lining is inserted and tacked in position with plenty of overlap at the joints. When finished it is given two good coats of white lacquer paint inside and outside. Before painting, all rust and grease are removed from the sheet iron chest by vigorous rubbing with emery cloth and scrubbing with soda water.

The second group constructs the ice chamber out of sheet iron. It is a simple tray $2\frac{1}{2}$ in. deep with an over-all dimension the same as the top of the inner cupboard. A small hole is bored at the back as close as possible to the bottom, and a length of $\frac{1}{2}$ in. copper tube is soldered into it. The tube should be long enough to carry water to a trough on the ground.

The third group prepares the insulating packing. Any bad conductor of heat will do provided it is damp resisting and sanitary. Alternating layers of thick brown paper and charcoal, sandwiched between two sheets of plywood, form a good cheap packing. Packs are made to fit snugly against the bottom, sides and back of the inner chest.

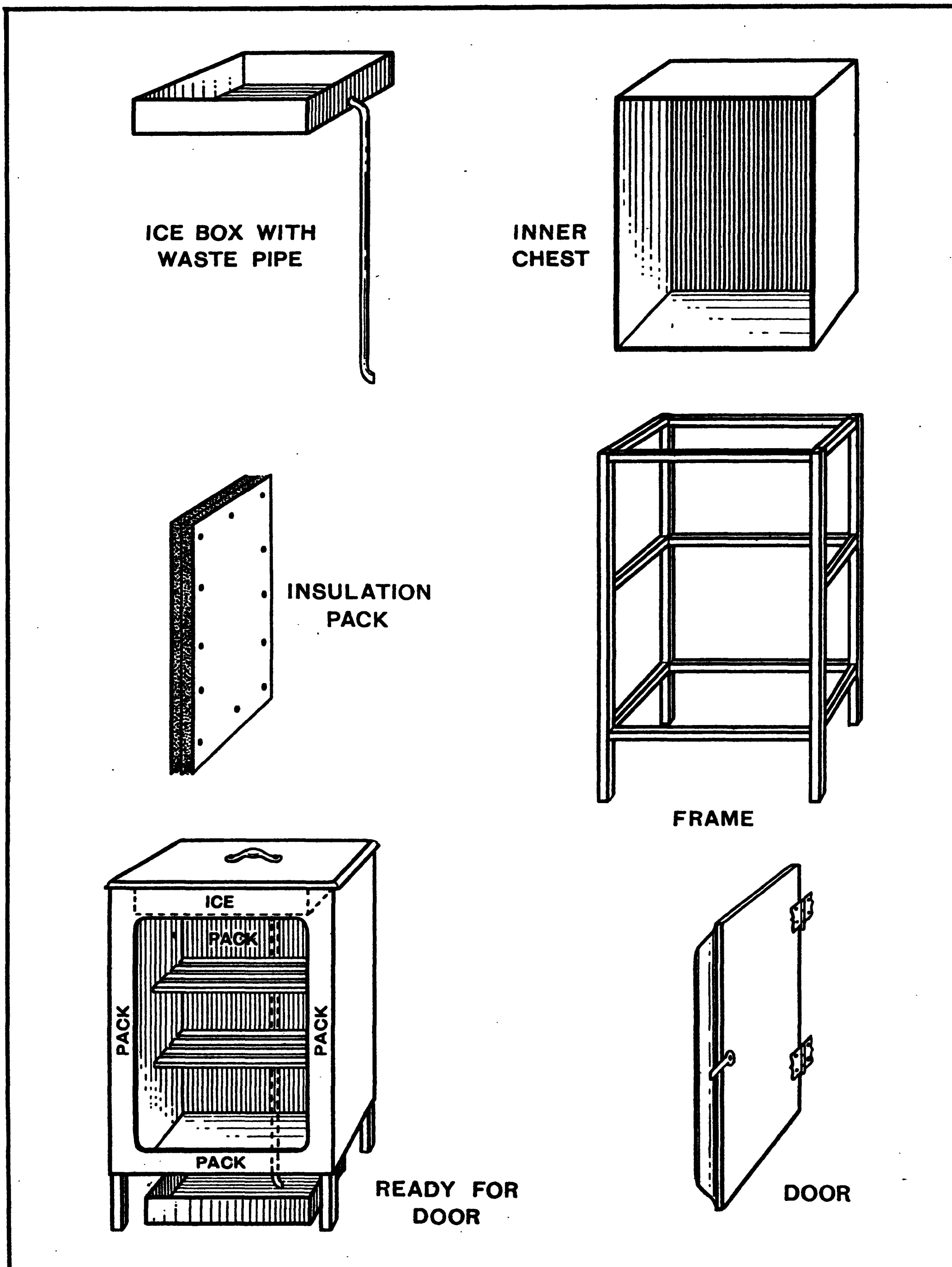
The fourth group has the task of making neat racks to slip inside the chest for the purpose of carrying the food. The material used is strip wood and the racks are well painted before being used.

The fifth group works on the outer case, which is a wooden frame covered with thick plywood. Each panel of plywood is cut and planed to size and fixed in position with neat brass screws driven into the framework. The legs are left 6 in. long.

The top is made free of the rest so that it can be lifted off at will, and the bottom has a hole bored at the back large enough to take the copper tube.

The whole of the outside is then stained with a spirit stain and given two coats of shellac.

The sixth group makes the door of stout plywood. An insulating pack is fixed on the inside and completely encased with thin plywood. The sides of the pack are made to slope so that the door will open and close easily, but at the same time, when closed, it should fill the opening as closely as a safe


ICE BOX WITH WASTE PIPE
INNER CHEST
INSULATION PACK
FRAME
ICE
PACK
PACK
PACK
PACK
READY FOR DOOR
DOOR

Ice Box

door. The inside is finished white and the outside stained and polished to match the outer case.

The last group bends and solders sheet iron to form a water-tight tray which fits between the legs of the chest. It is afterwards cleaned and given heavy coats of paint, white inside and black outside.

Assembly is simple. The insulating packs are fixed inside the case with glue, a channel is cut down the back pack just deep enough to receive the pipe. The inner chest, with the ice chamber in position on top, is then pushed into place. Some force is necessary as the packs are designed to fill the space between inner and outer cases. When all is properly housed, a frame of heavy plywood is screwed on to the front to cover the packing and to carry the door. Brass hinges and latch are screwed on the door, which is finally hung to swing evenly. When the tray has been placed underneath the chest is ready for use.

The top is lifted off and the ice chamber filled with a mixture of ice and common salt, or of ice alone. In a short time the temperature of the cupboard will be lowered to a safe level for food on the hottest day. As the ice melts the water runs down the pipe into the tray.

VISITS TO WORKS

Aim of lessons.—The subject matter of the lessons given under this heading has been selected either because the particular industry is basic, that is, an industry upon which many other industries have their foundations, or because it absorbs great numbers of schoolchildren. The exceptions, such as swimming baths and gas works, owe their inclusion to their public utility. They form ideal places for a first visit by a new class because, having a single direction of activity, they present the teacher with an opportunity to give his children some valuable training in observation before plunging them into factories with a bewildering multitude of operations, activities and productions.

The common aim of the lessons may be summed up in the word PREPARATION. A child cannot be considered as prepared to make the best use of a visit unless he has (1) an outline of each process of manufacture, simple enough to be carried through the visit and verified by his own personal observation, yet broad enough to cover the essential features of the process; (2) pointers and defined interest which will prompt him to question the guide during the visit; (3) one operation fixed in his mind to act as a sort of key stone, so that he will readily see other operations leading up to or moving from that which specially interests him; (4) an awareness of anything strange or startling he may see or hear, and of any discomfort he may have to endure; (5) clear and definite instructions on how he must behave in the presence of everything which may be deemed a potential danger.

Method of presenting lessons.—The method of presenting the lessons varies but little, being almost wholly narratory, with frequent reference to illustrations. These illustrations should, whenever possible, include specimens of raw material and finished products. Machinery is best illustrated by simple diagrammatic sketches rather than photographs. For our purpose, what a machine does is more important than its appearance. Nor should much time be given to describing how a machine works, for we want the boy to stand in front of the machine and concentrate on observation of the operation.

Classroom experiments to illustrate a process may appear attractive, but should be used very sparingly, chiefly because it is impossible to reproduce anything remotely resembling the industrial process,—a serious handicap when the children are to accumulate their knowledge during the visit chiefly by way of the eye. Much blackboard space is desirable, one board being reserved for the summary, and another for incidental sketching. These incidental sketches are perhaps the most important illustrations and should be resorted to whenever there is the slightest indication that a point has not been fully grasped. A few lines, coupled with explanation, will be found to be sufficient. Speed is essential, no matter how crude the resulting sketch. One is tempted to write "the cruder the better". Throughout the lesson the teacher should have three or four colours of chalk in his hand.

He will find it useful to have his blackboard summary written on a slip of paper near at hand, so that he runs no risk of confusing the children by taking them back over several operations in order to repair an omission. The summary should be built up on the blackboard as the lesson proceeds.

Machinery, materials and processes should be given their trade names,—again to avoid confusion. As an instance, a boy is confused if his teacher tells him that sheet metal is cleaned by laying it in a bath of dilute hydrochloric acid, and next day the guide at the works says, "This is the muriatic pickle."

Bearing in mind that the children are being prepared for observation, it is advisable to keep all the processes connected in the lesson and to put all necessary side issues together at the beginning. A case in point is the hollow-ware factory visit. It is necessary to give some explanation of annealing. The best place for any metallurgical points about annealing is at the beginning rather than at some point in the chain of operations.

Any question from the class should, if at all possible, be utilised to give some child a definite question to ask the guide. If the teacher feels an answer should be given at once, he may add, "But the man at the works probably knows more about it than I. Ask him to-morrow and tell the rest when we get back."

Time must be allowed for a thorough warning of danger. The teacher is justified in using his powers of exaggeration when describing the price paid for carelessness, and he should stress the fact that, as far as danger is concerned, appearances often belie potentialities. Preparation should end with definite questioning by the teacher to ascertain how far the lesson has gone home.

As these notes on method and aim apply to the whole series of lessons, the aim and method are omitted in the layout. Lists of apparatus are also omitted, as a glance through the matter of the lesson, together with the blackboard summary and diagrams, is sufficient to make clear what apparatus is needed.

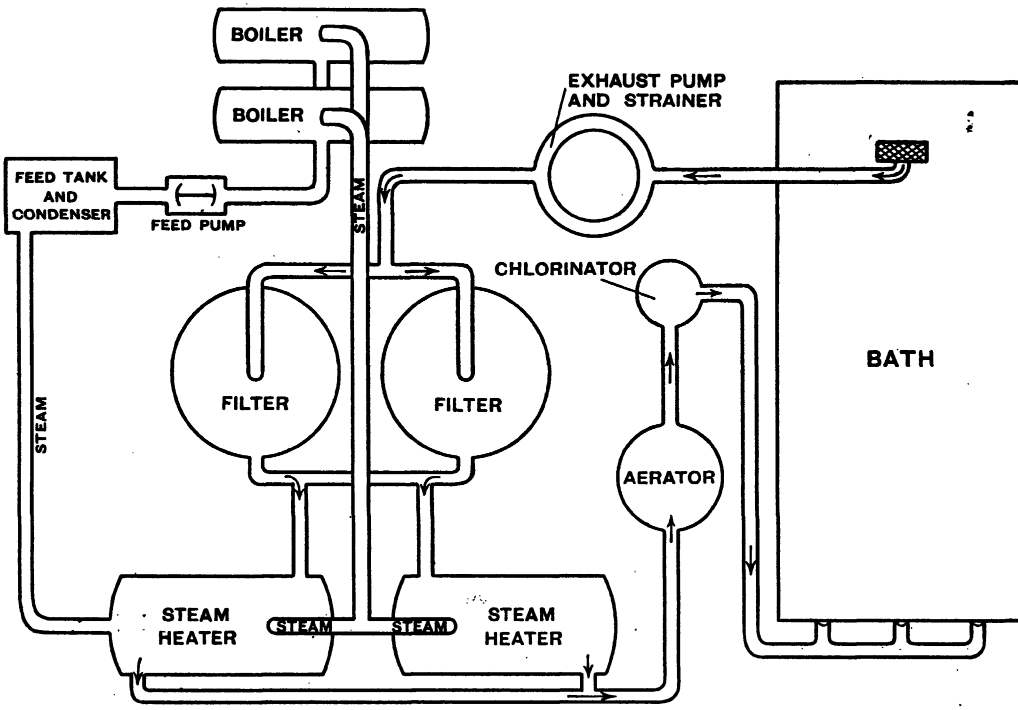
Special features and essential groundwork are to be found under the heading *preliminary knowledge.*

VISIT TO A SWIMMING BATH PLANT

Preliminary knowledge.—The filtration plant of a modern swimming bath provides much interesting material which may be studied at closer range than is possible in an ordinary factory.

The class should know the layout of an ordinary household hot water system and should have studied the school radiator system to understand the use of boiler and pump in the circulating of the water. Filtration of water by allowing it to sink through a bed of gravel and sand should be revised. The qualities of chlorine as a germicide, particularly in water, will have appeared in the hygiene lessons.

A glass beaker of water is allowed to stand for a day or so and then compared with another beakerful freshly drawn from the tap. The dull appearance of the former is due to a loss of oxygen, as may be proved if air or oxygen is bubbled through it for



BATH FILTRATION

some time, when it will regain its former sparkling appearance.

Pressure of water in relation to its depth should be illustrated by a simple classroom experiment.

Matter of the lesson.—

1. *The bath.*—When taken "behind the scenes" the boys will see that the bath is a tank made of reinforced concrete which has probably been treated with some water-proofing preparation. The inside has been covered with a layer of glazed tiles or bricks. The floor of the tank slopes from both ends to the lowest point, which is placed within a few feet of one end wall. At this point is a copper grid which gives access to a large diameter exhaust pipe. At the shallow end, near the surface of the water are several smaller grids which are the ends of the inlet pipes. It is possible to walk round the outside of the walls of the bath and to crawl underneath into the passage made to take the outlet pipe.

2. *The plant.*—The work of the plant is to make the water fit to swim in by heating, cleaning and recuperating. Heating is done by steam. A large boiler generates steam sufficient for all heating. The steam passes into a large tank containing row upon row of water pipes. As the water from the bath travels through these pipes its temperature is raised by the steam jacket. A thermometer on the top of the heater registers the temperature of the water as it leaves the heater, and automatically controls the steam supply, to prevent over-heating.

3. *Filter.*—The water is cleansed in a large filter. This is a tank which contains successive layers of pebbles. The largest at the bottom being 1 in. in diameter, the smallest $\frac{1}{4}$ in. On top of these is a thick layer of fine quartz sand. The water is introduced at the top and makes its way

down until it is drawn off at the bottom perfectly clean once more. As the filter collects all the dirt, it has to be cleaned every month or so. This is accomplished by backwashing. The usual flow of water is reversed and a flow forced at pressure up the filter and allowed to run to waste from the top. This stream carries away all the dirt in the filter.

4. *Chlorination.*—Before the water is reintroduced to the bath it is treated with chlorine. The apparatus for this work is small and may be described as a meter which regulates a minute flow of strongly impregnated water into the bath water. The chlorine is usually stored in an iron cylinder which is fitted to the chlorinator.

5. *Aerator.*—The sparkling appearance of the water as it re-enters the bath is due to its passage through an aerator. Nothing can be seen of the apparatus except a tank with pipes running to and from it. Detailed description would occupy a lesson in itself, and it is sufficient to explain simply that the water mixes with air in its passage through the tank and absorbs the oxygen it needs from this air.

6. As the plant must run without interruption for long periods, all the apparatus is duplicated and so arranged that the water may be diverted to a spare part at a moment's notice.

7. *The water's journey.*—Although full use is made of different levels to assist the flow of water, it is not relied upon, for a steady flow with no stalling at any point is essential. Pumps are therefore introduced into the system in order to assist and regulate the flow. The water is drawn from the bath at the lowest point. It passes through a gauze strainer which collects all solid rubbish; thence to the filters, and from these to the steam heaters. After being heated it passes through the aerator and lastly through the chlorinator. Free from dirt and germ, it passes into the bath once more at the shallow end. At the end of each inlet pipe is a valve which allows water to pass in but not out.

8. Radiators about the building and the pipes in the drying rooms are heated by the waste steam from the steam heaters, and further excess is condensed in the feed tank of the boilers.

Blackboard summary.—

1. WATER must be kept free from:—
   Dirt by filtration;
   Germs by chlorination;
   Foul Gas by aeration.

2. Swimming temperature 65°—70° F.

3. Water exhausted from DEEP end by pressure and pump.

↓

Gauze strainer to remove solid matter.

↓

Filtered through beds of pebbles and gravel.

↓

Heated by steam from boilers.

↓

Chlorinated.

↓

Re-vitalised in an aerator.

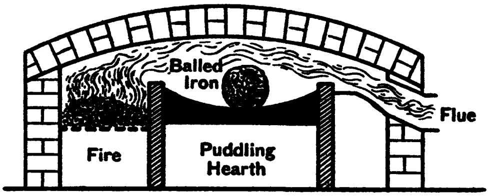
↓

Returned to bath at SHALLOW end.

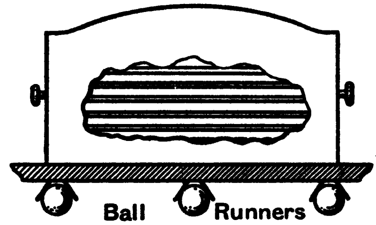
VISIT TO AN IRON WORKS

Preliminary knowledge.—Before entering the iron works, the iron has undergone the first stage of purification in a blast furnace. There it was smelted, together with coke and limestone. Many of the impurities were collected on the surface of the liquid metal by the limestone, enabling the metal to be tapped out of the furnace, leaving the impurities behind to be tapped out later in the form of slag. The iron is run into sand moulds and solidifies into rough short bars called pig iron. The slag is tipped away on a slag heap and cools into a hard metallic stone which is now used in the manufacture of road surfaces.

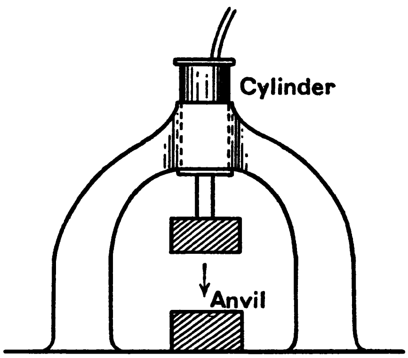
Pig iron contains far too many impurities to be of any practical use without further



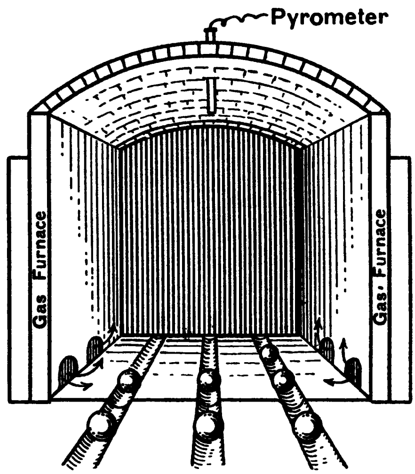
PUDDLING FURNACE



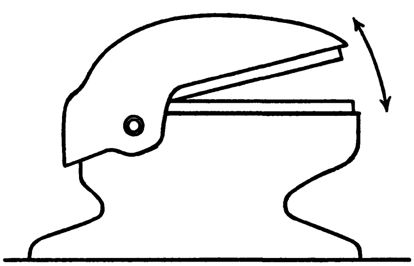
SHEETS IN ANNEALING POT ON TROLLEY READY TO ENTER FURNACE.



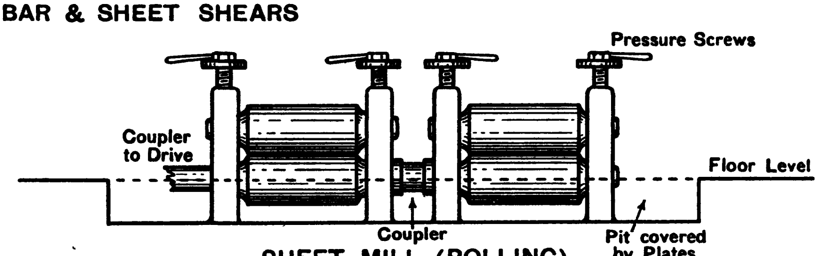
FORGE HAMMER



INSIDE AN ANNEALING FURNACE

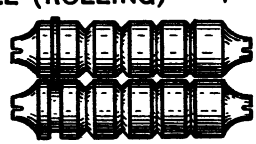


BAR & SHEET SHEARS



SHEET MILL (ROLLING)

SHEET ROLL



BAR ROLLS

IRON WORKS

treatment. In a foundry it is smelted in another furnace and becomes cast iron, which is hard, brittle and fusible, containing from 2 per cent. to 6 per cent of carbon, visible as tiny black specks. Steel is hard, fusible and malleable, containing from 1 per cent to 2 per cent of carbon. Both have very small percentages of phosphorous, manganese and sulphur.

The process described in this lesson is the conversion of pig iron to wrought iron, which is the metal used for work which may be subjected to heavy blows or sudden strains. Wrought iron is soft, malleable and tenacious, having only 2 per cent of carbon.

Cast iron is admirable for a desk support, but would be unsuitable for the school gates, which must be made of something less brittle. Wrought iron is therefore used.

Matter of the lesson.—

1. *Puddling furnace.*—The pig iron is put into a saucer-shaped furnace called a puddling furnace, together with sheet iron scrap from the shears, and heated until the whole is in a state of semi-fusion. The puddler (furnaceman) inserts his puddling rod through a hole in the furnace door and works the metal about, assisted by the saucer shape of the furnace floor, until the whole is a spongy ball of white hot metal.

2. *Shingling.*—The ball is rolled out on to a trolley and hauled across to a forge hammer worked either by steam or hydraulic power. The hammer first squeezes it, and then as it becomes firmer, hammers it into a solid square block. The shingler, that is the man handling the iron, turns it over and over under the hammer until the pores of the metal are closed up and the impurities have been hammered out.

3. *Forge rolling.*—The block is repeatedly passed through a pair of powerful grooved rolls until it is flattened out into a bar about 1 in. thick.

4. *Packing.*—The bar is taken to heavy shears which cut it into short lengths. These are wired together into flat bundles or packs, and the packs are transported to the rolling mill where they are placed in the mill furnace.

5. *Sheet mill.*—The packs are fed into the furnace by a steam ram which steadily pushes them through. Here they are heated to about 900° (welding heat). At welding heat each pack is taken out and passed through a pair of heavy smooth rolls which press and weld it into a flat sheet. After re-heating it is passed through the next pair of rolls which press it out into a long and very thin sheet. It is then bent double, re-heated and passed through the third mill. This gives it the required thickness and it is taken to the shears to have the edges trimmed to size.

6. *Cold rolling.*—In order to produce a polished surface, the sheet is passed through a pair of heavy rolls without being previously heated. Again the shearers trim if necessary.

7. *Annealing.*—Rolling makes the metal hard and brittle. The sheets are therefore placed in an annealing furnace to restore toughness and malleable qualities. They are placed on a trolley in a thick steel tank called an annealing pot, and this is sealed up with clay and sand to exclude the air and prevent oxidation. Once in the furnace the door is sealed with clay and the heat is slowly raised to 1,400° and then slowly lowered. Annealing furnaces are usually gas or oil fired to allow easy manipulation of the heat. They are fitted with pyrometers which record the heat automatically every hour.

8. *Stretching.*—The continued rolling may result in an uneven tensile strength in the sheet. Even strength may be restored by placing the sheet in a machine which grips each end and pulls with a steady horizontal pull of about twenty tons.

9. *Testing.*—Specimens of sheets made from every "heat," that is every group of balls from the puddling furnace, are taken to the laboratory and tested for grading purposes.

10. *Bar mill.*—Bars or girders may be required in place of sheets. In this case the

packs are taken from the forge to the bar mill. This is similar to the sheet mill but the rolls are grooved instead of flat. The process of re-heating before passing through the rolls is repeated. The last groove on the last pair of rolls is calculated to give the bar or girder the correct cross section after due allowance for cooling and contraction. The shears employed in this mill are shorter but more powerful.

11. *Power.*—Steam engines are still used in rolling mills, though electric motors are displacing them. The huge flywheels of the engines are a feature, and very necessary because the insertion of bars or sheets above normal thickness between the rolls throws such an extra heavy load on the engines that the ordinary type would fail to carry it. The sudden release of load after the bar had passed through would also be too much for an engine with a lighter flywheel.

12. *Corrugating and pressing.*—The familiar corrugated sheet and any special shapes not producible by rolling are pressed to shape under powerful hydraulic presses.

Conditions.—An iron works is hot and noisy. The showers of sparks from the forge hammer are strong enough to burn small holes in clothing if boys are too near. The flywheels of the engines exert a strong draught and it is unwise to approach near the guard rails. Boys should not look into the heart of the furnaces unless supplied with cobalt glass. Thin bars come through the rolls at a great pace, twisting and turning like white hot snakes. Boys should not be near these mills. Visitors should avoid standing on rail or trolley tracks, as these carry trolleys of hot metal.

Blackboard summary.—

Blast furnace—Ore, coke, limestone,—PIG IRON and slag

Iron Works

Puddling Furnace

Forge Hammer

Bar Rolls

Bars of WROUGHT IRON

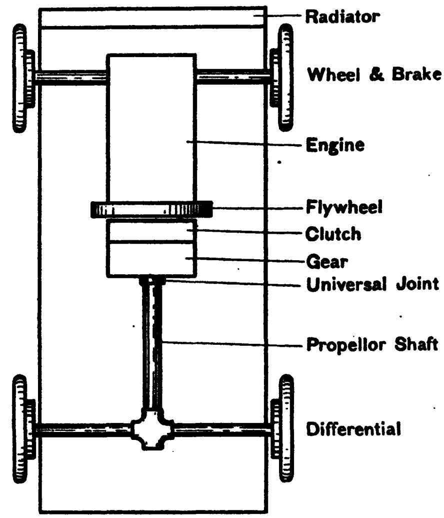
SHEET MILLS	BAR MILLS
Furnace	Furnace
Flat rolls	Grooved rolls
Shears	
IRON SHEETS	RAILS, GIRDERS, BARS

VISIT TO A MOTOR BUS GARAGE

Preliminary knowledge.—Some of the difficulties attending a regular bus service should be pointed out with a view to impressing upon the children the first class organisation which is necessary to keep a service free from mechanical trouble and other delays for three hundred and sixty-five days in the year.

Some knowledge of certain parts of a motor vehicle should be given in a short and general manner:—

Name	*Work done*
Cylinder	Holds the explosive mixture.
Piston	Compresses the mixture and makes the stroke.
Piston ring	Keeps the cylinder gas-tight.
Piston rod	Connects piston with crankshaft.
Carburettor	Mixes air with the petrol vapour.
Magneto	Gives spark at the right time to explode the compressed mixture.
Crankshaft	Changes up and down motion into a circular drive.
Camshaft	Works the inlet and outlet valves to the cylinder.
Radiator and water system	Keep the cylinders cool.
Exhaust	Carries away waste gases.
Flywheel	Keeps engine steady.
Clutch	Allows for gear changes without stopping engine.
Gear	Regulates the speed of the drive.
Propellor shaft	Carries motion of engine to back wheel.
Universal joint	Allows play for propellor shaft in any direction without disturbing the drive.
Differential	Changes the side to side motion into a forward motion, and allows one wheel to turn faster than its partner.
Chassis	The framework which carries engine and body.



LAYOUT OF 'BUS COMPONENTS

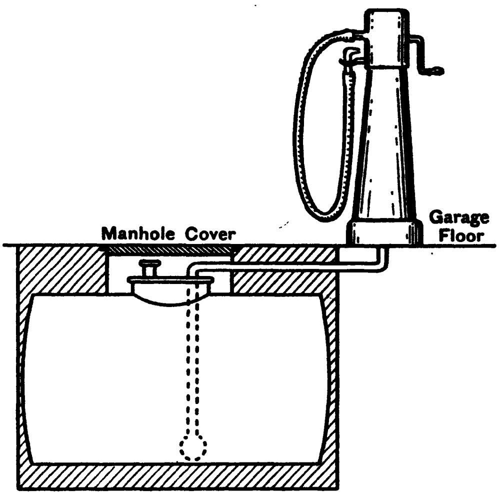
Matter of the lesson.—

1. *Route organisation.*—Outside the office several lists are posted daily. Drivers and conductors consult these when coming on duty. The first gives the names of the men with the route they are to operate alongside. The next gives the numbers of the buses posted to each route. The third gives the time each bus is to leave the garage.

Conductors apply for sheets, tickets, punches, and indicator boards and numbers. Drivers go to their own lockers and take out their tool kits, driving coats and anything else they may require on the route. Both mount their bus and drive out to scheduled time.

2. *Running supplies.*—Before the arrival of the drivers the buses have been supplied. Petrol tanks have been filled from pumps drawing on huge tanks below ground. These tanks have a capacity of from 3,000 to 5,000 gallons. The amount of petrol in each tank may be ascertained by inserting a graduated brass rod which is supplied by the makers of the tanks. Near the pumps are accurate graphs of the daily petrol consumption.

Tyres are blown up to regulation pressure by connecting them to steel cylinders containing compressed air. A small room nearby



PETROL STORAGE TANK AND DELIVERY PUMP

has an air compressor plant, driven by an electric motor, and from this a man loads a sufficient number of cylinders to last the day. Another pump has supplied the bus with an ample supply of oil, and a man has inspected the bearings to make sure that all are well greased.

Cleaners have then gone over the inside with brush, mop or vacuum cleaner, and the outside has been washed down. Another room off the main garage is devoted to batteries. At the one end is a large switchboard from which the operator controls the recharging of the batteries. These are always kept well charged and are tested daily. For light repairs, the garage has a staff of skilled mechanics who work at night. At the end of every shift, when the driver brings his bus in, he fills in his report sheet and hands it in at the office. On this sheet he reports any incident or accident during the day and also any defect, however slight, in the running of his bus. The mechanics collect these report sheets when reporting for duty and spend their shift in correcting all reported defects.

3. *Overhauling.* — Another staff of mechanics do their work during the day. One by one the buses are taken down for a thorough overhaul. This is carried out even if the bus has a perfectly trouble-free report sheet. All parts showing wear are replaced by new spare parts. Repair work in the garage does not extend beyond bench work. Repairs which necessitate the use of machinery are carried out at the works where the buses are made.

4. *The bus.*—Whenever the visit is made, several vehicles will be found to be in various stages of erection. One or more will be stationed over the inspection pits, providing an excellent opportunity to examine the layout of the underside of the buses. It will be possible, therefore, to go through the construction of a motor vehicle during the visit. Every company has its own particular design, but the main principles of engine, transmission and control are common to all. If the preparation for the visit has included the chief parts and the special function of each, the demonstrations by the mechanics will be of great value.

Blackboard summary.—

1. List of parts given in *preliminary knowledge.*

2. DAYTIME.

Service must operate.

Drivers and conductors find their bus and route from lists posted at office.

Driver—Tool kit from locker, running supplies for vehicle.

Conductor—Tickets, punch, route charts from office.

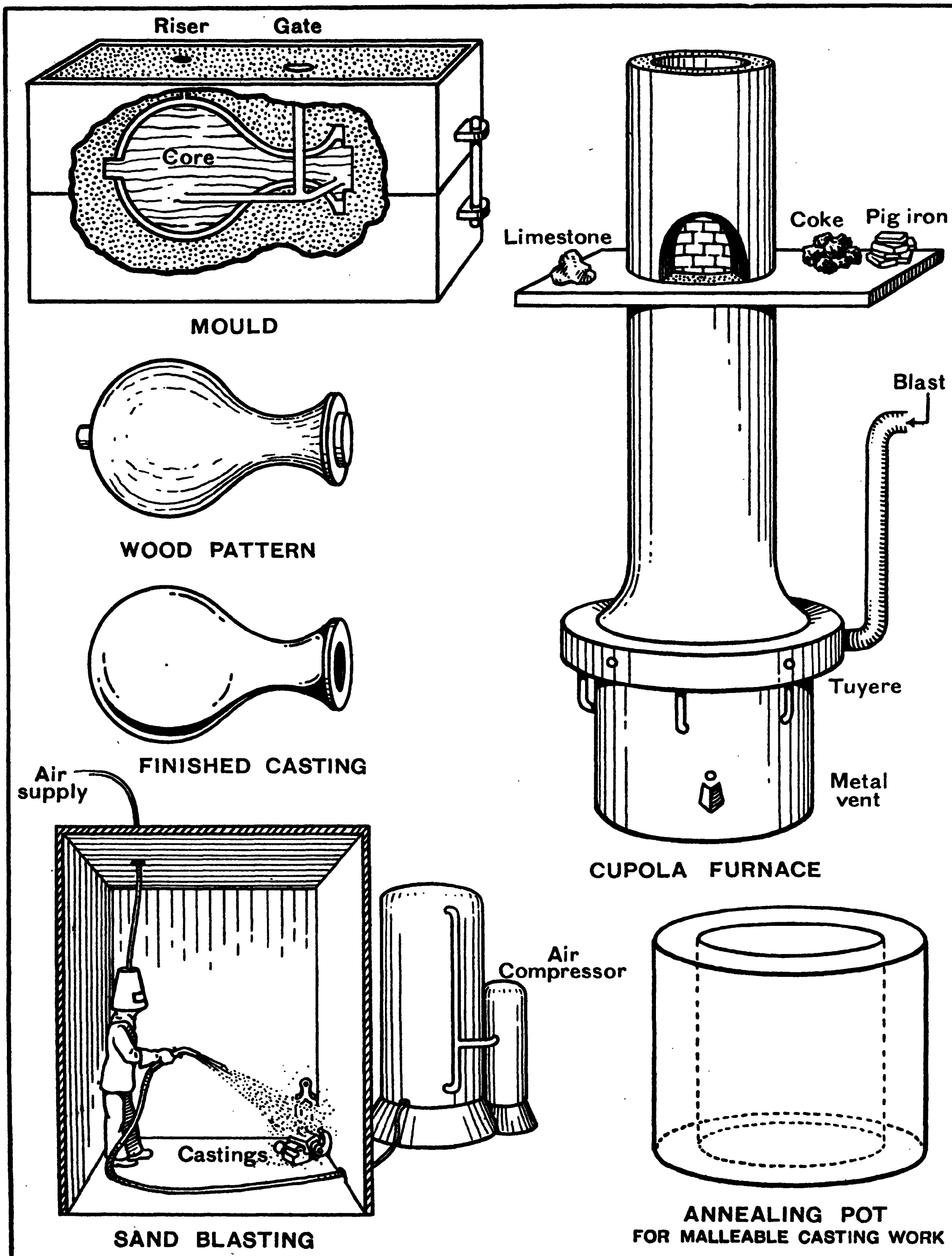
Time-table to be kept.

3. AT NIGHT.

Drivers and conductors report.
Bus inspected.
Tyres inflated.
Batteries charged.
Interior cleaned and disinfected.

4. Day mechanics take down buses in rotation for detailed inspection.

Complete overhauls are done at works.



IRON FOUNDRY

VISIT TO AN IRON FOUNDRY

Preliminary knowledge.—The first stage in the conversion of iron ore to cast iron is dealt with in the visit to an iron works. The foundry starts with the pig iron from the blast furnace and converts it into articles made of cast iron. The essential differences between pig, wrought and cast iron should be revised.

The furnace used in a foundry is a cupola furnace. The difference between this and a blast furnace is at the top. The cupola has an open top which allows gases and impurities to escape during the smelting. The hearth and tuyères at the bottom, together with the slag and metal vents, are similar to those in the blast furnace but on a much smaller scale.

Foundries may be engaged in either heavy or light work. For heavy castings the moulds are constructed in pits in the foundry floor, but light castings are dealt with in iron boxes.

The process of annealing castings to render them malleable is different from annealing processes described in other lessons, but the effect on the metal is the same.

The use of cores is sometimes confusing to boys and it is advisable to explain simply that a core is necessary whenever a hollow is wanted in the casting. The core fills in the hollow space with sand, which can be removed afterwards, in order to prevent the molten metal from running into that space.

Matter of the lesson.—

1. *Orders.*—An order for a casting is accompanied by a drawing or blue print which gives every measurement in minute detail. Specifications of the finish and quality of iron required are also clearly stated. This is important because different specifications alter the work of furnaceman and moulder.

2. *Patterns.*—Drawings are passed on to the patternmaker who makes a pattern of the finished job in wood, or metal. Metal patterns are used only for large repetition orders where the constant use of the wood pattern would damage it. This pattern is used to shape the sand in the mould to receive the metal. The maker must therefore keep two things in mind. (*a*) He must allow for shrinkage of the cooling metal by making the pattern slightly larger than the stated measurements. (*b*) He must ensure that his pattern can be withdrawn from the mould without disturbing the sand. This often causes him to make it in sections so that one section can be removed first to make way for another section to be moved laterally before lifting clear of the sand. The pattern shop is a combination of the shops used by joiners and cabinetmakers.

3. *Furnace.*—The furnaceman has been informed of the quality of iron needed and arranges his charges and blast to produce that quality. He charges the furnace from a platform at the top with pig iron, scrap metal, coke and limestone. Relative quantities of each vary with quality. The inferior iron will contain little virgin iron but much scrap. He raises the temperature with the blast and the charges gradually sink to the hearth where the smelting takes place. Slag and metal vents are plugged with fireclay plugs during smelting. When the upper plug is poked out with a long rod molten slag pours out and is removed in trolleys. When the iron is ready, the lower plug is removed and the metal runs out into clay-lined ladles, which are instantly conveyed to the moulds in the foundry.

4. *Core shop.*—Cores are made from sea sand mixed with a binding agent known as core oil. Iron moulds have been made with interiors the exact size and shape of the core. The sand is rammed in the mould and when the latter is taken apart the core is revealed perfectly shaped. The cores are strengthened in thin places by lengths of wire. Larger cores have to be ventilated to allow a free passage of gas through them. This is done by laying straws or wax strings in the sand. These burn when touched by the metal and leave a hole through which

gas can escape. When moulded the cores are stoved in a large oven until they have hardened enough to be handled by the moulders without damage.

5. *Foundry*.—Having received the patterns, the moulders construct the mould. The mould box is in two halves and each half is moulded separately. Bed sand, finely ground in a pan mill, is used. It is mixed with fine coal dust, hence its name "black sand". The pattern is placed in the box and the sand rammed round until the box is full. It should be noted that the boxes have sides only. The pattern is removed, leaving an impression of one half. The other half of the box is treated in the same way so that when the two halves are placed together they enclose a complete impression of the whole pattern. The face of each half is dusted with fine "parting dust" to prevent the two faces adhering. In the top half the moulder cuts holes, down which the metal will be poured. These are called *gates*. Opposite to the gates he cuts other holes called *risers*. The risers are really vents through which air or gas may escape as the metal runs into the mould. The box is then put together and firmly clamped down. Gates and risers are sealed with paper to prevent the mould absorbing moisture from the atmosphere.

6. *Casting*.—The ladle of metal is brought along and the metal poured down the gates until it bubbles up into the risers. This ensures that the mould has been completely filled. Gas fires at the risers and round the joints of the box. This gas is caused by the hot metal burning the coal dust on the face of the sand. Before it can escape it forms a momentary buffer between the metal and the sand, remaining long enough to prevent the sand fusing into the metal and pitting the surface of the casting. By the time it escapes, the metal has begun to harden on the surface. When it has cooled sufficiently to handle, the box is parted and the casting shaken free from the sand.

7. *Trimming*.—The metal in the gates and risers has solidified with the rest and adheres to the casting. This is sawn or knocked off and all raw edges are ground off on carborundum grinders. The casting is then placed in a sand blast chamber where a jet of steel shot cleans it and removes all sand.

8. *Annealing*.—When malleable castings are required, they are placed in circular annealing pots and packed round with ferric oxide, the pot being then sealed with clay. They are placed in a gas-fired furnace and the door is sealed up. The heat is then gradually raised and lowered as with other methods of annealing. When the castings are withdrawn they are found to be bendable, yet as strong as before.

9. Accuracy and care are essential throughout a foundry. Much of the work appears to be rough and ready, but the care is there. The casings for motor engines, for instance, must leave the mould with less than 1/100 in. error.

Conditions.—Visitors should be warned of the danger in the hot metal. If split, it splashes like water so that it is wise to keep well back during the casting.

Children visiting engineering works should be warned on three points:

1. Electric welding and acetylene welding must NOT be watched without cobalt-glass protection for the eyes.

2. The machine shop is full of revolving belts and pulleys. It is unsafe to stand within three yards of the smallest.

3. The welding and numerous electric motors necessitate many live cables. These must on no account be touched even if they appear to be well insulated.

Particular stress is desirable on the preparation for the machine shop, as there is a possibility that the children will be overwhelmed by what appears to be a mass of whirling machinery. They should be on the look out for certain machines.

Blackboard Summary:—

1. Iron ore + coke + limestone (blast furnace) = PIG IRON + slag

Pig iron + coke + limestone (cupola furnace) = CAST IRON + slag.

2. ORDERS—Drawings Measurements Quality Finish

Patterns Cores Furnace charges

Moulder Molten iron

Mould in sand

Casting

Sandblast and Grinders ←

FINISHED CASTING

VISIT TO A COAL GAS WORKS

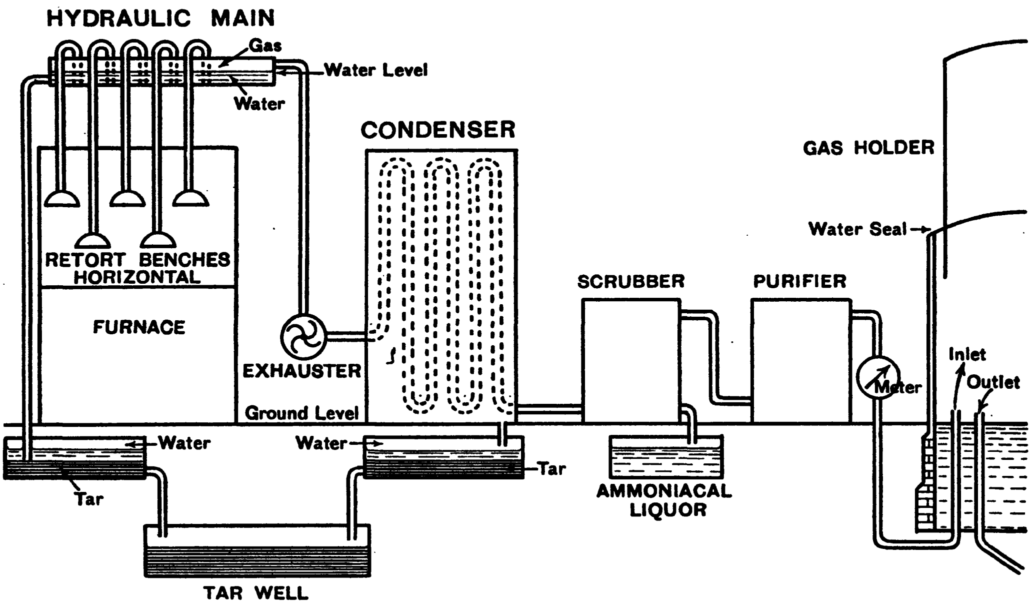
Preliminary knowledge.—Coal gas was first discovered at the works of "Iron mad Wilkinson", who passed it on to Murdoch, then working with Watt at the famous Soho foundry. Murdoch developed the discovery and the ruins of the world's first gas holder may still be seen in the Soho works, now Messrs. W. and T. Avery, Ltd.

The well-known experiment illustrating the distillation of coal to obtain gas is worth extending slightly. An ordinary "churchwarden" clay pipe is set up with the bowl filled with small coal, and the top of the bowl sealed with fire clay. When the bowl has been heated with a bunsen, heavy fumes will pour from the mouthpiece. These will burn if a light is applied. When the clay seal is removed, the bowl will be found to contain coke and a layer of tar and carbon. The experiment should then be repeated, but this time the mouthpiece of the pipe is placed in a beaker containing water. As the coal distils, the fumes will be observed bubbling through the water, leaving behind a cloudy trail which settles at the bottom in the form of tar. As the gas passes from the water it is much clearer but smells strongly of ammonia and sulphuretted hydrogen.

The cleansing of the gas from these impurities and the storing ready for use complete the operations of the gas works.

Matter of the lesson.—

1. *Retort.*—Both horizontal and vertical types are still in use and the teacher should ascertain which are used at the works to be visited, so that he may concentrate on that type. Horizontal retorts are benches of six or nine silica clay tubes, 8 to 12 ft. long and fitted at each end with air-tight iron doors. A furnace beneath raises the temperature to between 1,200° and 1,400° C. The furnace is usually a producer-gas furnace. A mechanical charger thrusts pulverised coal into each tube from the back. As the coal distils under the heat the gases pass up an ascension pipe at the front and bubble into the hydraulic main above. The coke is automatically discharged from the front as



COAL GAS WORKS

the charger thrusts fresh coal in at the other end.

Vertical retorts are larger tubes of similar clay and are fed automatically from coal bunkers above. The coke is extracted from the bottom by a slowly turning screw. This type is also heated by a producer-gas furnace.

2. *Hydraulic main.*—This is a large trough partly filled with water, which condenses much of the tar as the gases bubble through it. Exhausters help the gas through this and all succeeding apparatus.

3. *Condensers.*—The gas is then passed through condensers, which are towers or banks of large diameter pipes, cooled by air or running water. The hot gas cools on its journey through these and deposits the remainder of its tar and some ammoniacal liquor. It is next forced through washers and scrubbers.

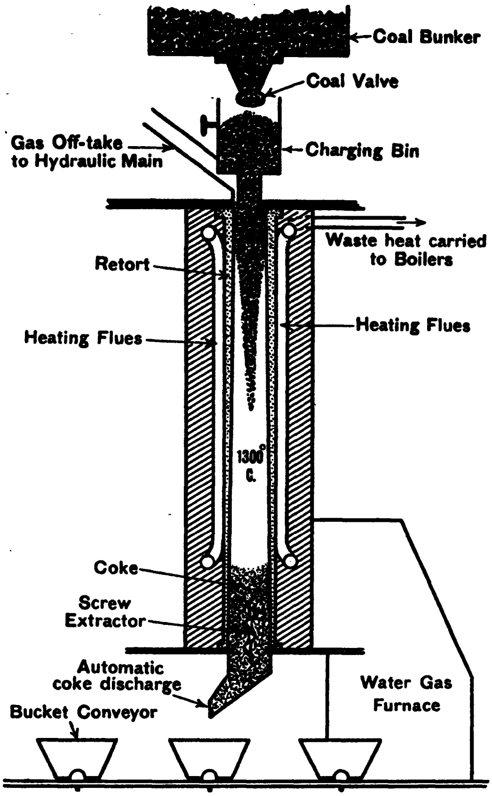
4. *Washers and Scrubbers.*—These dissolve the ammonia and other gaseous impurities. The washers are usually tanks containing plates full of tiny holes which split up the gas into minute streams. Fine jets of water play across the plates and wash the streams of gas. The scrubbers are drums of revolving brushes, partly filled with water. As the brushes revolve, they pick up the water and cause it to trickle through the gas. After washing the gas passes into purifiers.

5. *Purifiers.*—These are tanks containing trays of ferric oxide. As the gas passes over the trays, the oxide absorbs the sulphuretted hydrogen. After leaving the purifiers, the gas is fit for domestic consumption, but many works now pass it through a benzol extractor plant.

6. *Benzol extractor plant.*—This extracts and liquidifies the small percentage of benzol and renders it fit for use in motor cars. The percentage is about .02.

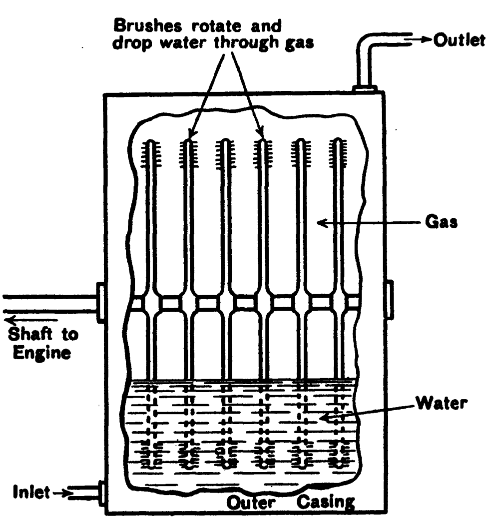
7. *Meter.*—This records the amount of gas passing into the gas holder.

8. *Gas holder.*—This is a huge tank in which the gas is stored. The most common type is telescopic, a circular steel chamber in several sections, with each section or "lift" moving in the lift below and guided by rollers running on rails fastened to the lift above. The lowest lift is stationary in



Time from entry as Coal to discharge as Coke 12 hours (in 25 ft. Retort)

Vertical Retort



Rotary Scrubber

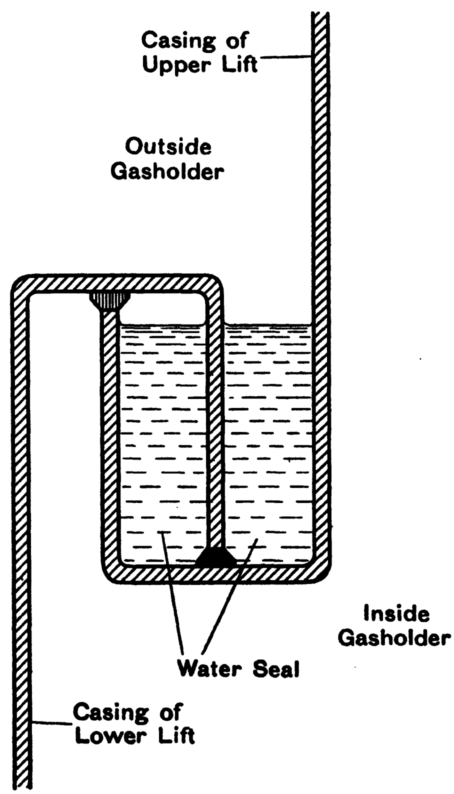
water below ground level. All joints are sealed with water and the sections lift in response to the pressure of gas within.

An automatic governor valve regulates admission to the gas holder and thus prevents fluctuating pressure on the street mains.

9. *By-products.*—The coke is graded according to size, different grades being sold for use in furnaces, heating apparatus, domestic stoves, etc.

Tar, ammoniacal liquor, spent oxide (sulphur), are sold to chemical works and used in the manufacture of carbon, bakelite, dyes, creosote, sulphuric acid, graphite pencils, disinfectants, pitch, drugs, and explosives.

Conditions.—Much dust, heat and a gas-laden atmosphere will be found in the retort house.



Water Seal Between "Lifts" of Telescopic Gas Holder

The journey to the top of the retort bank has to be made up vertical steel ladders. Those with nailed boots should be particularly careful to put the instep well on to each rung. In the case of the vertical type, the climb is at least 80 ft.

The transport of coal and coke is effected by endless chains of bucket conveyors. Clothing should be kept well clear of them or serious accident might be encountered.

Blackboard Summary :—

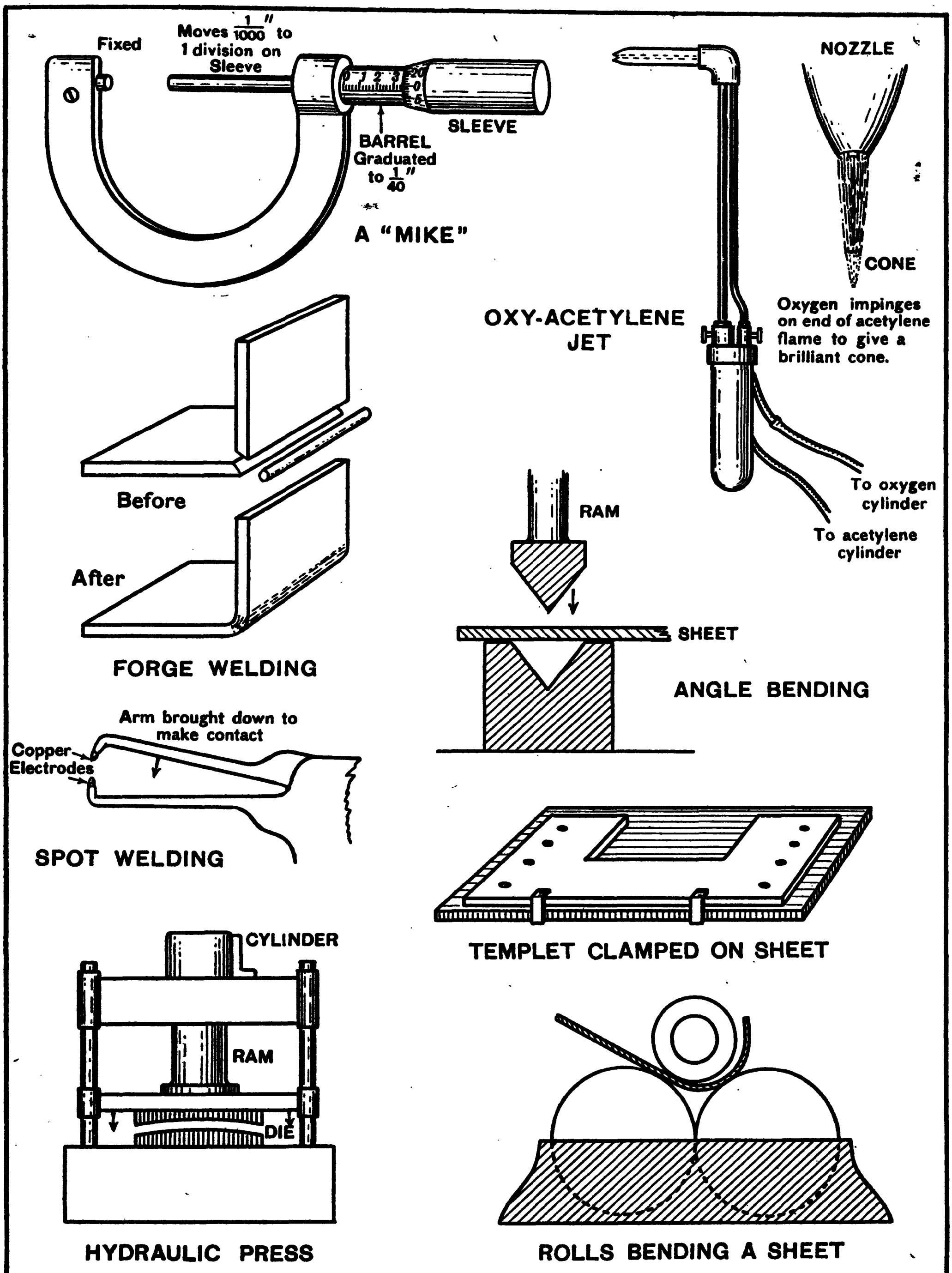
Pulverised Coal
|
RETORT
|
Hot Gaseous Mixture — Coke

HYDRAULIC MAIN
|
Hot Gaseous Mixture — Tar
|
CONDENSERS
|
Gaseous Mixture — Tar, Ammoniacal Liquor
|
WASHERS AND SCRUBBERS
|
Gases — Ammonia
|
PURIFIERS
|
Gas — Suplhuretted Hydrogen, Carbon dioxide, Carbon bisulphide
|
BENZOL EXTRACTOR
|
Gas — Benzol
|
GAS HOLDER
|
HOME AND WORKS

VISIT TO GENERAL ENGINEERING WORKS

Preliminary knowledge.—The productions of this type of works are so numerous and so varied that the teacher is strongly advised to make a preliminary visit to the works, in order to ascertain the major productions and frame his preparation for these alone. For the same reason, the lesson set out below is limited to machines for shaping metal and methods of "sticking the pieces together."

Joining pieces of metal by means of rivets



GENERAL ENGINEERING WORKS

or nuts and bolts may be passed over, but time should be given to welding. The union of the metals may be illustrated by using plasticine. Two separate pieces are placed side by side with a thin strip lying along the joint. The joint is then worked and pressed until the three become one united piece. If this is then pulled it will most likely break apart at some point other than the original joint. This is what happens when two pieces of metal are welded.

The class should also know how an electric arc may be produced and how resistance to a current will generate heat. A vernier scale and a micrometer screw gauge should be introduced. By way of explanation, it is sufficient to demonstrate how the vernier is used, and to show that the screw of the micrometer has forty threads to the inch, so that one turns advances it $\frac{1}{40}$ in. The sleeve fixed to the screw is divided into twenty-five divisions, and the class will readily see that by turning the sleeve through one division the end of the screw is advanced one-twentyfifth of one-forthieth, or $\frac{1}{1000}$ in.

If the science room possesses a model of a hydraulic ram it should be demonstrated to the class, otherwise it will suffice to explain that power for presses is often secured by using pressure of water.

Matter of the lesson.—

1. *Shaping the metal.*—Material arrives at the works in the form of large metal sheets and bars of varying thicknesses. They are cut to size under shears and then marked out for shaping. The marking is done with chalk or white paint, and for repetition work a flat pattern of wood or sheet metal is used. These patterns are called templets. Straight cutting on sheets up to $1\frac{1}{2}$ in. thick is done on the shears, but thicker work and intricate edges are dealt with under an oxy-hydrogen or oxy-acetylene flame cutting machine.

Circular and elliptical bending is done by passing the sheet between bending rolls. Machines similar to presses, with a knife edge pressing into a 'V' slot, execute the angular bends. Hollows are obtained by pressing the metal out under draw-presses. Great power is often required and therefore hydraulic power is most common on these machines.

2. *Assembling.*—Having shaped the separate pieces, the next step is to fix them together. This may be done by means of nuts and bolts or rivets, but much is now done by welding.

(*a*) Thick metal is usually forge-welded. The edges to be welded are brought together, making a sharp angle. The joint is heated to welding heat by a gas furnace which can be moved to apply its heat to a given spot. Simultaneously a bar of softer metal is heated at a furnace near by. When at welding heat, the bar is laid in the joint and hammered or pressed until it unites with the other and forms a solid joint.

(*b*) Lighter and more delicate work is usually electric-welded. It can be used on aluminium and copper alloys, and recent developments indicate that its use will be extended to many more metals.

A thin rod usually of similar metal to that which is being welded, but carrying a fluxing agent, is fixed in the welder's handle. This forms one electrode and the work forms the other. The current is switched on and an arc springs across from the rod to the work. The heat is sufficient to bring the joint to welding heat immediately round the arc, and to fuse the rod into it. The welder moves the rod to and fro in a semicircular movement. This has the effect of throwing up the surface of the weld in tiny waves, and the top of the wave hardens at once, preventing oxydization below, inside the joint.

If a continuous joint is not desired, the work may be spot-welded. The joint is forced together by the horns of a machine something like a pair of large coal tongs. As they press, the current passes from one to the other through the work. The resistance generates a welding heat and the work is firmly welded over the area touched by the copper jaws.

(*c*) Oxy-acetylene welding is similar to arc welding. The flame is played on to the joint and the welder holds the fluxing rod in his free hand. The fluxing and movement are the same as in the arc method.

3. *Machine shop.*—Complementary fittings for the above work are dealt with in the machine shop. Here the standard of accuracy must be the highest obtainable. An error of $\frac{1}{1000}$ in. will mean scrapped work, so gauges of every description are in constant use. The tools in all the machines are of very hard steel, sharpened at the cutting edge and set at an angle which will allow them to peel off shavings of metal from the work. In some machines the work is held in a chuck and revolves or slides against a fixed tool; in others the tool revolves or slides against fixed work. The most common machines are lathes for circular work, planers for flat cutting and millers for cutting grooves.

Semi-automatic machines, such as capstan lathes, have a number of different tools so arranged that they swing round to bear on the work in rotation, carrying out their operation without any pause for change.

Other machines are almost wholly automatic, feeding themselves, carrying out the operation and discharging the work and scrap without human assistance.

4. *Testing and painting.*—The final stage of the engineer's production is the most important. All work is carefully tested on machines which record its degree of accuracy, its ability to stand internal or external strain, and its ability to do the work for which it has been designed. The importance of this stage can be appreciated by remembering that these works produce the component parts for cars, aircraft, locomotives and ships.

Blackboard Summary.—

SHEETS, BARS AND GIRDERS OF IRON AND STEEL

Marked off from drawings and templets

Pieces shaped by

Hydraulic presses | Flame cutters | Shears | Rolls | Drills | Lathes | Planers

Pieces assembled by

Bolting | Rivetting | Forge welding | Arc welding | Spot welding

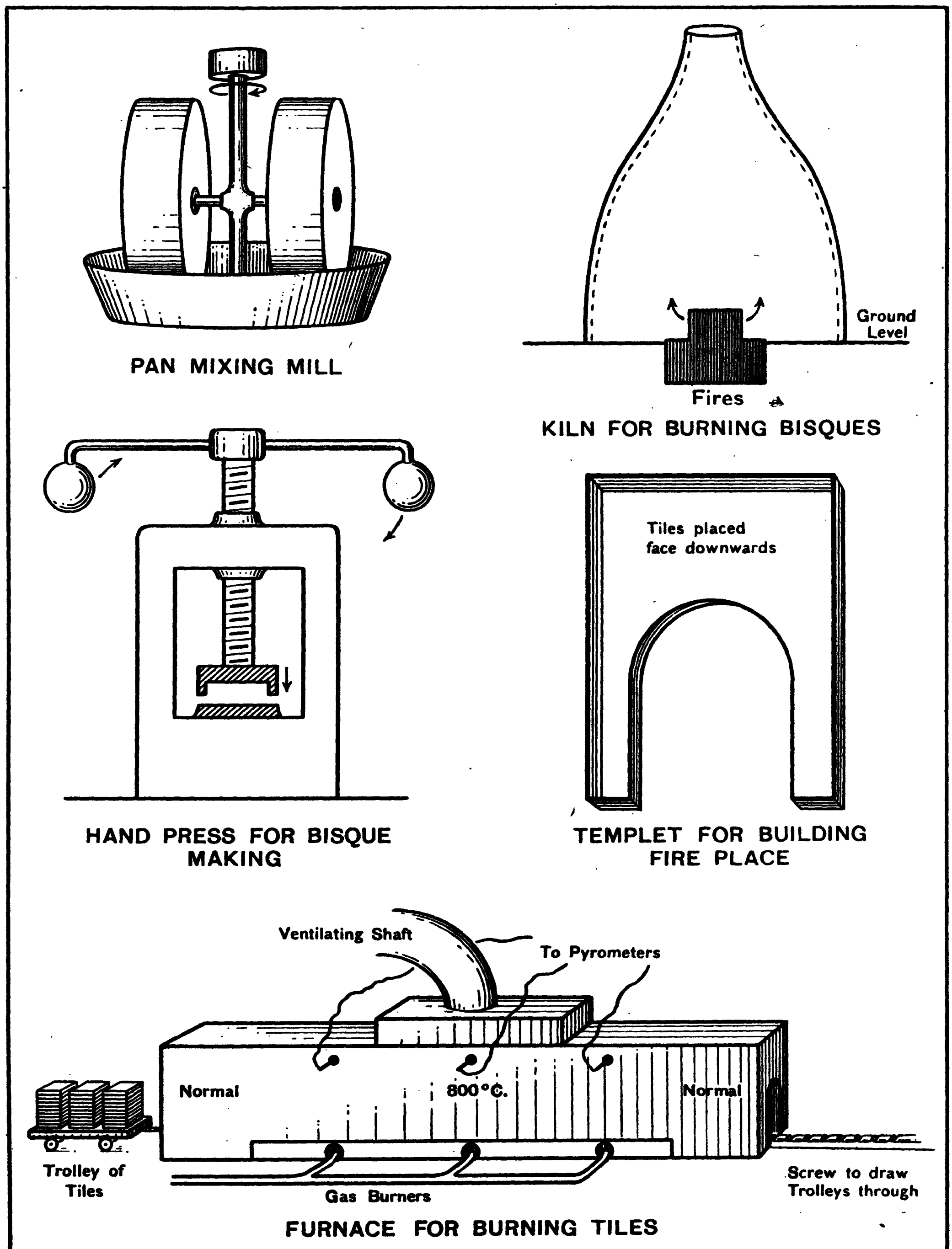
Fitters add component parts from Machine Shops

Tests for accuracy

Painting

Brush | Spray | Cellulose

Packing



GLAZED TILE AND FIREPLACE FACTORY

VISIT TO A GLAZED TILE AND FIREPLACE FACTORY

Preliminary knowledge.—This type of factory has three distinct sections: (1) an iron foundry, where the metal parts of a fire grate such as baskets, dustplates, ovens and dampers are cast, cleaned, polished or enamelled; this information is set out in the visit to an iron foundry; (2) cabinet-maker's shop, where the wood surrounds and mantelshelves are made; the work of the class in the woodwork room renders preparation for this section unnecessary; (3) the tile and slabbing shops, which form the matter of this lesson; information should be given on the mixing and fusion of enamels. This is to be found in the lesson on a hollow-ware factory.

Matter of the lesson.—

1. *Mixing and purifying.*—The clay for the tiles is mixed and crushed in pan mills. China clay, white clay, a little flint and a small percentage of porous stone is the most common mixture. Fine jets of water spray into the mill during the mixing. When thoroughly mixed and of a perfectly even plastic nature, the clay is removed to a drying floor, heated by steam pipes, or flues, where it is dried. The temperature is not allowed to rise much above 100° C. Many of the impurities are extracted during the washing, and the remainder pass off in the drying process. When dry, a laboratory test is made of the purity of the clay. After this 10 per cent of water is added, and the whole mixed once more until plastic.

2. *Pressing.*—The press shop is an array of small hand presses, each having dies of different size or shape. Behind each is a bin of prepared clay, and behind the operator a chain conveyor moves steadily. A handful of clay is placed in the press and the die brought down to press it into a firm block of required shape. This is larger than the ultimate tile by a little more than 4 per cent in each dimension, the allowance being made for shrinkage during firing. The pressings are placed on the conveyor and carried to the end of the shop, where they are stacked in hard fire-clay boxes called *saggars*.

3. *Burning.*—The furnace or kiln is funnel-shaped, heated by coal fires set at intervals in the outer wall, or by an underground furnace in the middle. The saggars are placed in the kiln, one on the other, with spaces between to allow a free passage of heat. One furnace will hold as many as 4,000 saggars, representing 100,000 tiles. When loaded, the entrance to the furnace is built in and sealed with fire clay, the fires are lit and the temperature gradually raised to between 700° and 800° C. It is kept at this temperature for a week and then allowed to cool off. Self-recording pyrometers register the temperature every hour.

4. *Grading.*—When the saggars are cool enough to handle, they are taken out and emptied. The tile, or *bisque* as it is termed, is now shrunk to proper size, and is hard, white and highly porous. It is then passed through a small machine which automatically rejects it unless it is of exact size and thickness. Operatives stand by to separate the rejects into two divisions. The bisques are thus divided into three grades.

5. *Colouring.*—The familiar highly polished and coloured surface of the tile is a coating of enamel. Opaque glass, minerals and water are mixed in a tube mill, metallic components being added to give the required colouring. The liquid has the appearance of grey distemper.

6. *Dipping.*—The bisques are then dipped in the first colour, called the ground colour. A second or third colour is superimposed but is applied with a rubber sponge. Mottle effects are obtained by mixing the second colour with sawdust, which burns out during the firing and leaves the ground colour exposed in spots.

7. *Stoving.*—The bisques are allowed to dry in racks, which are later put on trolleys and pushed very slowly through a long furnace, usually about 200 ft. in extent. This furnace is heated by producer gas and

is carefully regulated to rise from normal to 800° C. and back to normal along its length. Pyrometers check the temperature. The trolleys are insulated from the heat by clay and asbestos. The furnace is traversed in a little over thirty hours and trolleys emerge at regular intervals.

8. *Re-grading.*—The tiles have now a glazed finish, but some are chipped and others twisted by the heat. All are therefore scrutinised and those with the slightest defect are thrown out.

9. *Slabbing.*—In this shop the tiles are made up into hearths, curbs and backs. A wooden templet of the job is placed on the floor and the tiles laid in it face down; white cement is run over all, and this, while still damp, is covered with a thick layer of concrete reinforced by iron rods. The whole sets into one solid block, and when the templet is removed, the fireplace is revealed. The tiles should fit perfectly flat but firmly in the bottom of the templet. Slight adjustments are made to the fit by grinding the edge of the tile on a carborundum wheel.

Nothing further is required except washing and packing. The fire grate, tiles and wood surrounds are not assembled until workmen are fitting them in the house.

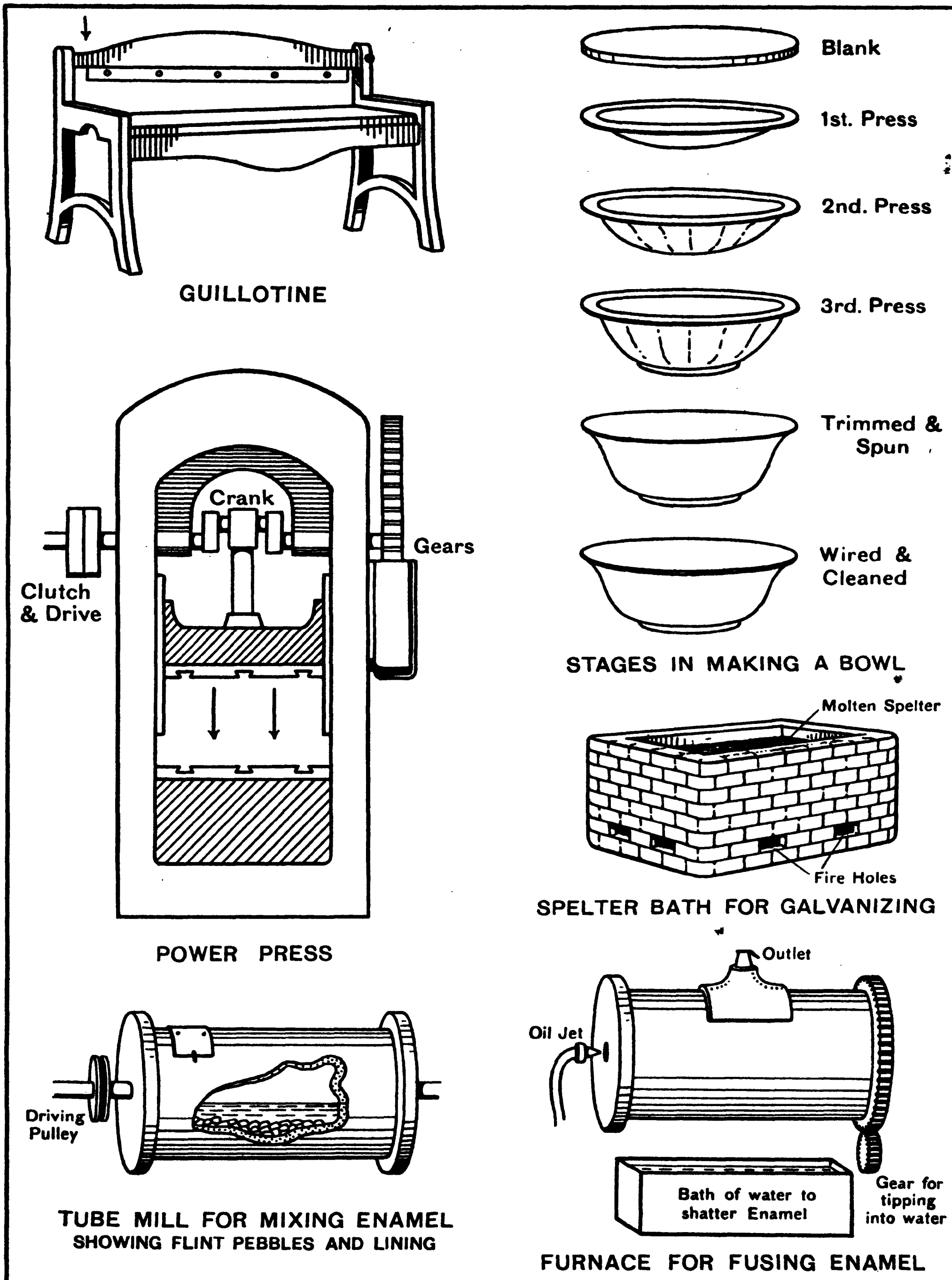
Consignments for bathrooms, lavatories, kitchens, etc., are, of course, packed immediately after re-grading.

Blackboard Summary.—

Clay and porous stone mixed with water in pan mill
↓
Mixture dried
↓
10% water added
↓
Shaped under hand presses
↓
Saggars filled and placed in kiln
↓
Kiln sealed and fired
↓
Bisques removed from kiln and graded to size
↓
Dipped or sprayed with enamel
↓
Stoved in furnace
↓
Graded 1st, 2nd, 3rd
↓
Passed to slabbing shops to make fireplaces or packed for despatch

VISIT TO A HOLLOW-WARE FACTORY

Preliminary knowledge.—The class should understand that so-called "tin-boxes", "enamel bowls", and "galvanized buckets" are articles made of sheet iron and covered with a film of tin, enamel or spelter either for decorative purposes or for protection. Covering work with enamel is really a trade in itself, but an increasing number of hollow-ware factories are installing their own enamel shops. The process is therefore dealt with in this lesson. The difference between japanned ware and enamel ware should be explained, but in a simple manner. It is sufficient if the class knows that japanned



HOLLOW-WARE FACTORY

work has a film of paint which has been hardened in a stove and is merely "stuck on" the surface of the metal. The enamel, however, is fused on to the metal, works down into the "pores" in the surface and keys itself into it. For this reason enamel must be chipped off with sharp blows, but the other may be flaked off with a pen knife.

The class should also be reminded of the annealing process in a sheet iron works.

Matter of the lesson.—

1. *Material.*—The material used is sheet iron of varying thickness, which is received in large sheets from the sheet rolling mills of an iron works.

2. *Blanks.*—Hollow-ware is invariably ordered in quantities and the machines are designed to turn out large numbers of each design without much attention. The sheets are guillotined into flat shapes which will just allow the specified article to be made out of them with the minimum of waste. A quicker method is to stamp out the blank. The stamp is a heavy machine similar to a press. Its tool, however, has a cutting edge and comes down with a heavy blow instead of a steady squeeze. The tool is the size and shape of the desired blank. The sheet is placed beneath and the blank is struck out at a single blow.

3. *Presses.*—Much hollow-ware is shaped under presses. These powerful machines are constructed so that the dies can be easily changed for a fresh shape. The pressing action is slow as there is great danger of the metal tearing, and the drawing out is done in stages. A deep bowl, for example, starts as a flat blank and will go under half a dozen presses, each one drawing it out a little deeper, before it is the required depth. After every two pressings the blank must be placed in the annealing furnace because the strain of pressing makes the metal brittle. Another difficulty in press work is the tendency of the blank to curl up on the outside as the die touches it in the middle. This is overcome by using a double action press. The ram holding the die is encased in a cylinder which comes down first and holds down the metal all round the edge until the ram has done its work.

4. *Annealing.*—All work from the presses passes into the annealing furnace. This is a gas or oil-fired furnace containing racks to hold the work. It is kept at annealing temperature and when the pressings are withdrawn they are found to be quite malleable once more.

5. *Spinning.*—Bowls and pots often leave the press with wrinkled sides. These are smoothed out by placing the work in a spinning lathe. A block of hard wood is fixed on the faceplate of the lathe and shaped to fit the inside of the bowl. A plunger holds the bowl firmly on the block and the whole rotates at a great speed. A round nosed tool is then brought to bear on the side of the bowl and presses out all wrinkles.

6. *Trimming.*—The edges are trimmed in another lathe which has a revolving steel cutting tool, the effect being similar to a cook trimming the edge of a pie, with a knife; the cutter is followed by another tool which bends over the edge. A turn of steel wire is placed in this turnover and another application of the tool flattens it down to hold the wire and form the lip of the bowl.

7. *Bench work.*—Shapes which will not permit press work owing to their depth or complicated design have to be built up by the tinsmiths. Blanks for all parts are cut out with hand shears and bent and shaped either by hammering or by passing through bending rolls. When all parts are ready they are fixed together in one of three ways; (*a*) by rivets, as can be seen in buckets. The rivet is placed head down on the anvil and the work is held on top. A sharp blow causes it to pierce the metal; another spreads out the end of the rivet to grip the pieces together. (*b*) By soldering. This method is used more particularly for canisters and other articles destined to hold food. (*c*) By welding. This method is always adopted

for heavy work and for work which must stand great strains.

8. *Smithy.*—Bucket handles, rings and shackles are fashioned out of thin strips of rolled iron by blacksmiths who have little apparatus beyond a coke hearth, hammer and anvil.

9. *Galvanizing.*—When the jobs leave the tinsmiths or press room they are dirty or greasy. They must now be cleaned and covered with a protective film.

The products for rougher wear are galvanized. First they are placed in a bath of muriatic acid called a *pickle.* The acid removes all dirt and grease. After being washed in water they are placed in a strong solution of soda and then dipped in a bath of molten spelter which is covered with a fairly thick layer of sal ammoniac. As the work emerges it is found to be galvanized. The spelter has actually formed an alloy with the surface of the iron and will not chip off.

10. *Tinning.*—Containers for food must not be galvanized and are therefore tinned. After leaving the acid pickle they are washed in water and cleaned in dry sawdust. Then they are dipped in boiling mutton tallow and next in a bath of molten tin. Soon afterwards they are dipped in the tin a second time. This is called "running off", for much of the first layer of tin comes away, leaving only a thin film adhering to the work. A brisk rubbing with dry bran brings the tinned surface to silvery brightness.

11. *Japanning.*—Work which requires a decorative finish is japanned. This process consists of covering the work with a coat of varnish, then stoving it in drying stoves at about 250° F. The black japan is a mixture containing such ingredients as asphalt, linseed oil and turpentine. After being stoved for six to twelve hours the coating hardens. Further gloss may be added by another coat of varnish. Decorative designs are usually applied from transfers after stoving, the whole being varnished over to fix it.

12. *Enamel shop.*—The enamel is prepared by fusing the ingredients (which are kept a close secret) together in an oil furnace. The molten mass is then run out into a bath of cold water. It cools instantly and fractures into a white spongy mass. If it were allowed to solidify before this it would be too hard to crush. The fractured mass is then placed in a revolving barrel containing flint balls. Water is added and the flints crush and mix the enamel with the water. It is passed on to another mixing barrel where it is mixed with metallic oxides to give it a certain colour. The mixture is now a buff colour or dull grey, and ready for use. If the article to be enamelled is of sheet metal, it is cleaned in a pickle, but if it is of cast iron it is cleaned by sand blasting. Once it has been cleaned, it must not be handled with bare hands or soiled in any way. The article is dipped in a bowl of enamel for its first coat. It is then conveyed to a drying room where it remains until quite dry. Then it is placed in a gas fire furnace at 800° to 900° C. The enamel fuses on to the metal under the heat and when it is withdrawn and cooled it is found to be firmly keyed on to the metal. The process of drying and stoving must be repeated for every individual colour, each one fusing to unite with the layer below.

Patterns and designs are obtained by painting the colours on through stencils.

Scrupulous cleanliness is essential in enamel work.

Conditions.—The acid pickles are strong enough to burn flesh or clothing, and should therefore not be too closely approached. The fumes from the galvanizing shop and the japanning stoves are very pungent, whilst the visitor finds the smell from the tallow in the tinning shop very sickly. It is advisable not to allow boys to linger in these places.

Great care should be exercised in the enamel shop, for if an article is but brushed with the clothes before it is stoved, it has to be scrapped.

Blackboard summary.—

SHEET IRON

Blanks fashioned under

Stamps — Guillotines — Hand shears

Stamps: Pressed → Spun → Trimmed

Guillotines, Hand shears: Riveted (Heavy work) — Soldered (Food containers)

Protected from corrosion by

Japanning — Enamelling — Galvanizing — Tinning — Cellulose painting

Galvanizing: Cleaned and polished

Packed

VISIT TO A STONEMASON'S WORKS

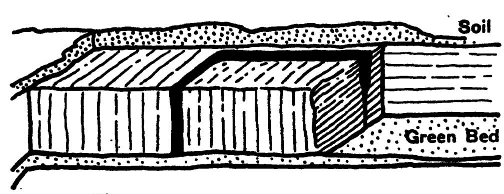
Preliminary knowledge. — Information about the more familiar stones may be given in summary form:—

Stone	*Quarrying*	*Durability (outside)*	*Building*	*Decoration*
Portland	Good	High	Suitable	Fair
Sandstone	Good	Medium	Suitable	Fair
Marble	Good	High	Suitable	Good
Alabaster	Good	Low	Unsuitable	Good

The effect on stone of various climates and local conditions, such as smoke or acid laden atmospheres, should be touched upon.

Unless the works to be visited has its own quarry near, some details of quarrying should be presented.

(1) The top soil is removed and the rock laid bare. (2) Having decided which way the "grain" lies, the quarryman makes his cuts. The first is a channel or chad, 10 ft. long, parallel to and 5 ft. away from the front edge of the stone. The chad is $4\frac{1}{2}$ in. wide at the top, narrowing to 3 in. at the bottom. The depth is dictated by the distance below of the layer of "green" or softer rock. It is usually from 4 to 6 ft. The cutting is done with a pointed pick.



BLOCK READY FOR SPLITTING FROM QUARRY

Gutters are then cut from each end of the chad to the front edge. Iron wedges are hammered evenly along the chad and the rock splits off from the green bed in a rectangular block. It is then lifted on to the quarry railway by a strong jib crane. (3) Before leaving the quarry each block is tested for "shakes" or flaws. The mason taps it at various points with his mallet and judges it on the resulting sound.

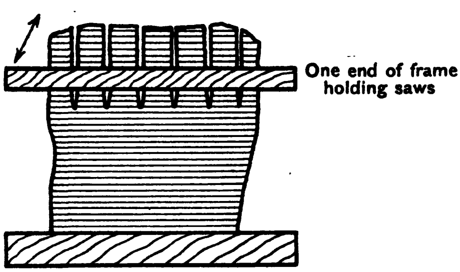
Matter of the lesson.—

1. *Sawing.*—When a block is brought into the works it is cut up into slabs, the thickness depending on the work to be done. The saws are steel blades, 20 ft. long, 6 in. deep and ¼ in. thick. They have no teeth but possess a wave which gives them a slightly jagged edge. The blades are fixed horizontally in a frame which moves backwards and forwards across the block. Copious supplies of water trickle into the cuts made and the blades slowly work their way down until the block is divided into slabs. The slabs are then cut into sections under a carborundum saw. This is a thin wheel of carborundum which grinds its way through the slab as the carriage to which it is fixed moves forward.

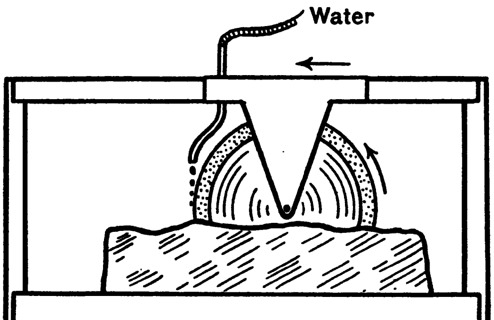
2. *Working.*—The stone is now reduced to portions capable of being handled by the masons. Designs and shapes are marked out in charcoal through a templet placed on the stone, and the mason begins to cut. He uses a round headed mallet and steel chisels ranging from a fine point to serrated cutters with an edge 4 in. across.

3. *Scouring.*—The final smooth surface is obtained on a scouring machine. This is a moving arm, on the end of which is a flat carborundum scourer. The stone is placed beneath and the arm moves with a scouring motion about the surface. Water trickles over it during the process. The polish on very hard stones is obtained by treating with sand blast, a jet of steel shot ejected from a nozzle at terrific force by compressed air. As the blast moves over the stone it removes the slightest roughness.

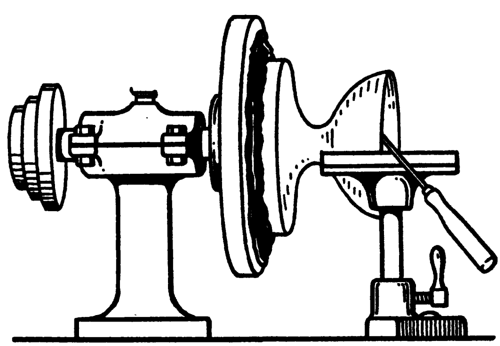
4. *Softer stones.*—Stones used mainly for decorative purposes, such as alabaster, are sawn from the block in a similar manner but can be shaped in machines almost identical with those used by a cabinetmaker. Circular work is turned on lathes, straight work cut by circular saws, fretted designs by band saws, and polishing is done on grindstones and calico bob wheels.



END VIEW OF BLOCK BEING SAWN INTO SLABS



CARBORUNDUM SAW CUTTING THROUGH A BLOCK


TURNING AN ALABASTER BOWL

Here again, intricate designs and carvings are done by hand, the mason using similar tools to those mentioned above.

5. *Cements.*—A stonemason often builds up his jobs in sections. These are later assembled. Lead dowels are placed between the sections which are then cemented together. The choice of cement is important, as it must be suitable for the stone and also possess high durability. Masons have their own ideas upon this point.

6. *Tinting.*—For decorative work stones are often tinted to harmonise with a general scheme. The stone is sprayed with a solution to give the required colour. The constituents of these solutions are not for public knowledge.

Blackboard summary.—

1. List of stones given in *preliminary knowledge.*

2. QUARRY.

Top soil removed

Chads and gutters cut into rock

Wedges driven home

Block split off

3. WORKS.

Block sawn into slabs

Steel blades — Carborundum saw

Slabs marked out and shaped

Chisel and mallet — Lathes (Soft stones) — Carborundum grinders

Stone polished by

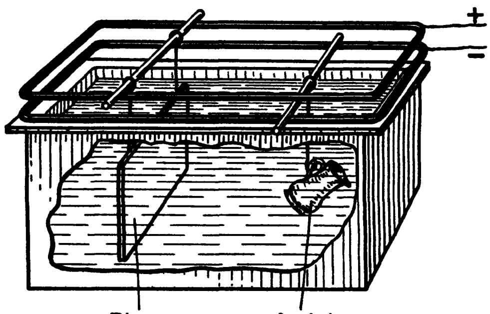
Sandblast (Hard stone) — Carborundum scourer (General) — Felt and calico bobs (Very soft stone)

Sections cemented or dowelled

VISIT TO AN ELECTRO PLATING WORKS

Preliminary knowledge.—Electro plating of metal products has rapidly extended during the last few years and it is now unusual to find a works solely devoted to plating. Most firms now plate their own products.

It is therefore advisable for the teacher to acquaint himself with the products of the works to be visited and give a preliminary lesson on the process of manufacture. The products may be classed as hollow-ware, pressed work, light castings, lock fittings, or sheet metal work, all of which are to be found in detail in this series.



ELECTRO PLATING BATH

This lesson is one in which a classroom experiment may be usefully employed to assist the children to grasp the process of plating. They should also be given in a simple manner the scientific principle on which the process is based, that is, the partial decomposition of metallic solutions by electric currents.

Matter of the lesson.—

1. *Cleaning.*—The article to be plated must be free from all surface dirt. The rigour of the cleansing varies with the nature of the plating, but the usual practice is to boil in an alkaline solution to remove grease, then wash in running water, to dip in a weak acid pickle, and complete with another washing in water. A piece of copper wire is attached to each article. Some plates, such as silver, respond more readily when assisted by some other metal. For these, the article is dipped in an acid solution of the second metal immediately after washing. No article is touched by hand after the boiling in soda water. Rubber gloves are worn by the operatives.

2. *The plating bath.*—This is a large lead-lined bath filled with an acid solution of the plate metal. Two brass tubes run round the top, the upper connected to the anode and the lower to the cathode of a battery or dynamo. Brass crossbars lie across these tubes. The articles to be plated are suspended by their copper wire, the crossbar resting on the cathode tube in such a manner as to be completely immersed. A plate of the metal to be deposited is suspended from the anode crossbar and is also immersed. A current of 4 volts is switched on and the articles remain immersed for some hours, the longer the period, the thicker the plating.

3. *Finishing.*—When withdrawn from the plating bath, the article is dull and often encrusted with tiny white particles. This crust is removed by placing in a scrubber, which is usually a barrel containing wire brushes. The brushes revolve and dip into a weak alcoholic solution as they brush the article. Stale beer is one of the best solutions for the purpose.

After scrubbing, the article is washed in running water and then placed in a revolving barrel which contains water and tiny pellets. As it is tumbled about the action of the pellets is to clean and polish. Finally it is given a high polish on bob wheels made of calico impregnated with jewellers' rouge.

4. *Tinting.*—Should a shaded or tinted finish be desired, it is given before the polishing. The article is brushed or sprayed or partly immersed, whilst still wet from the washing, in solutions of chemicals which will give the desired shade. This entails further washing. The drying after washing is in all cases effected in a bran tub. This is another revolving barrel which contains bran or dry sawdust. In addition to drying it further polishes the article.

Blackboard summary.—

Articles received in dirty condition from the machines
↓
Boiled in strong soda water
↓
Washed in running water
↓
Pickled in dilute acid
↓
Copper hooks fixed
↓
Immersed in plating bath
↓
Current switched on
↓
Removed from bath and scrubbed in an alcoholic solution
↓
Washed in water
↓
Dried in bran tub
↓
Polished on calico bobs
↓
Packed

VISIT TO A LOCK FACTORY

Preliminary knowledge.—A factory of this kind may be divided into distinct sections: (1) a foundry; (2) a machine department; (3) a finishing section.

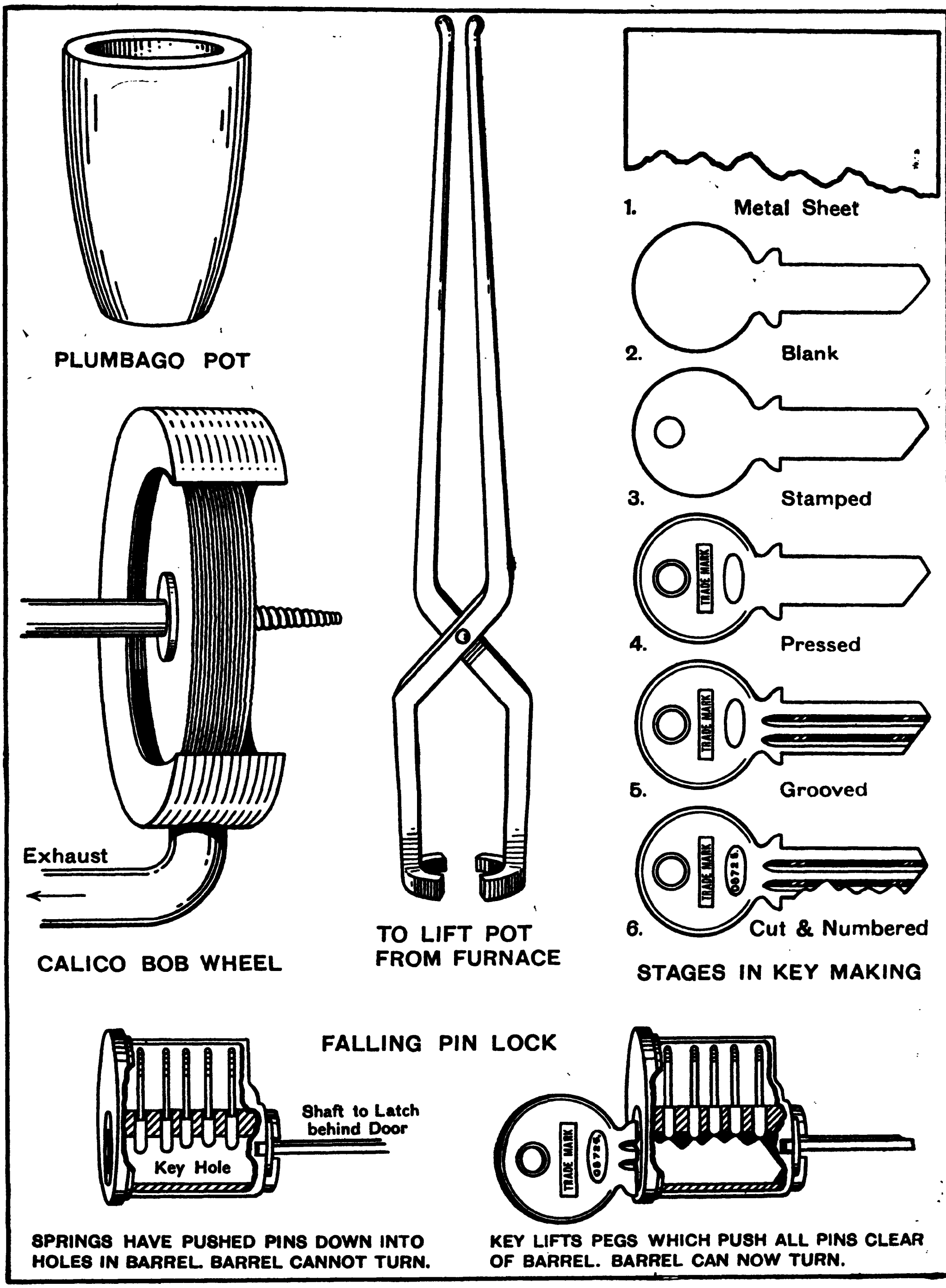
Much of the work in the foundry is in non-ferrous metals, and this differs in some ways from the work in cast iron. The moulding and coring is the same but the metal is smelted in plumbago pots, each holding about 28 lb. of metal. The furnace is underground and the pots are drawn up through gratings. During the casting dense fumes are given off and have to be evacuated through a canopy under which the casting is done.

The machine section has blanking machines, stamps, presses, lathes and drills. These are given in the engineering lesson.

The finishing includes electro plating, which should be revised.

Matter of the lesson.—Locks were at one time the work of skilled craftsmen, but modern machinery has made possible the mass production of reliable locks of all descriptions. In a lock factory one is certain to find the manufacture of allied articles such as door fittings, hinges, window catches, etc.

1. *The foundry.*—This has two sides, the iron foundry and the non-ferrous side. The casting of iron is given fully in another lesson and the differences in non-ferrous casting are referred to above. The patterns will be found to be of metal as there is much repetition. Some of the work is very small and a number of these will be included in the same mould. This is achieved by using a plate pattern. The small patterns are cut into two halves and soldered to a sheet of metal, all the tops on one side and the other halves on the underside, exactly opposite their respective tops. Gates are



Lock Factory

so arranged that the metal is free to run to every part. The plate is now really a single complicated pattern and can be moulded as such. Plate patterns thus ensure the speedy production of small castings.

2. *Blanking shop.*—Many parts of locks may be quickly shaped under presses, and one shop is devoted to preparing sheet metal for the presses. Machines similar to presses are fitted with tools to cut out blanks for the presses at a single blow. Most of them are automatic and require only to be fed with strips of metal, from which the blanks are stamped.

3. *Press shop.*—The blanks are passed on to the presses to be correctly shaped. The operator slips a blank underneath, the plunger comes down and presses the metal out with a steady squeeze.

4. *Machine shop.*—Here one finds a bewildering array of machines, all engaged in shaping some part of a lock to accurate size and shape. This shop deals with the work which cannot be done under a press. Almost every machine is different so that detailed description is not possible. Wherever the work will permit, it is placed on an automatic machine to speed up production. One interesting machine produces keys of the Yale type. By moving a dial indicator the operator fixes the combination of lever slots. A pressed blank is inserted and the machine instantly cuts it to the combination indicated. Keys are thus produced almost automatically yet every one is different.

Here one finds the parts of locks which have to bear most of the wear and tear being machined to a high degree of accuracy in order to eliminate friction as far as possible.

5. *Electro plating.*—Another department is engaged in plating parts which will be exposed to view. The process is described in a special lesson.

6. *Bobbing.*—Another shop is fitted with rows of bob wheels for polishing. When brass parts come from the foundry they are dull and rough. The bob wheels revolve at 4,000 to 6,000 revolutions each minute. Emery wheels grind off all roughness. The next bob is made of calico which is impregnated with powdered emery. This imparts a dull polish which is heightened by the next bob, usually a wheel made of felt. The familiar high polish is obtained on the last bob, which is a very soft calico wheel dusted with rouge powder.

7. *Assembly shop.*—The different parts are finally brought to a department where deft fingered men and women put them together to make a complete lock with keys. Each person has a chart giving combinations of levers and pins for the various types of locks, and they work down this chart with each successive lock. In this way it is ensured that no two locks are produced to take the same key. In the case of cheap lever locks this precaution is not taken. Having assembled the lock, the workman tests the three keys in it and corrects any friction with a file or emery cloth. Testers and inspectors pick locks at random and subject them to most searching tests.

8. *Packing.*—When tested, the locks are given a final polish and packed with the keys in cardboard boxes. The number on a key is the combination of levers as set out on the cutting charts.

Blackboard summary.—

Sheet metal parts → Sheet guillotined to size → Blanks stamped out → Blanks pressed → Pressings machined

Cast metal parts → Foundry → Sand blast and trimming → Castings machined

Exposed parts plated or japanned

Machined components assembled by fitters

Levers, springs and pins inserted

Keys fitted and numbered

The whole cleaned and polished

Packed

POWER

One point of interest in every visit to works is the source of power to drive the machinery. A general lesson on this subject will save much explanation during individual visits. This lesson may also be utilised to point out advantages and disadvantages of the different sources, their relation to running costs, convenience and adaptability. A bicycle, a model steam engine, and plans of internal combustion engines and a small electric motor are useful for demonstration.

The bicycle is arranged so that the back wheels and pedals revolve freely. A boy is set on the saddle and instructed to pedal. If a twist of paper is dropped on the wheel it is flung across the room, proving that power lies in the wheel. This was not present before the pedalling began, and questioning will draw the point that the boy's energy has been transformed to motive power sufficient to carry himself and the bicycle along at speed. The boy is then taken back to the source of his energy, muscle—blood—food. This is the fuel. Further demonstration will show that the energy the boy imparts to the machine is ineffective until it has been carried to the rear hub and transformed into a rotating motion, and the second point will emerge, namely, that power must be concentrated into a rotating motion before it will drive machinery.

Matter of the lesson.—

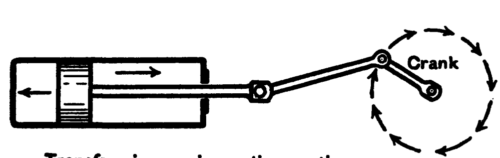
1. *Methods of obtaining power.*—Power in a works is usually obtained by using (*a*) a steam engine; (*b*) an internal combustion engine; (*c*) an electric motor. Water power and wind power have almost disappeared from industry. The central feature of (*a*) and (*b*) is the cylinder in which a piston is caused to move backwards and forwards like the plunger of a bicycle pump.

2. *The steam engine.*—In this engine the piston is moved by the pressure of steam let into the cylinder from a boiler. At the end of a stroke the steam is exhausted or condensed; this removes pressure from the

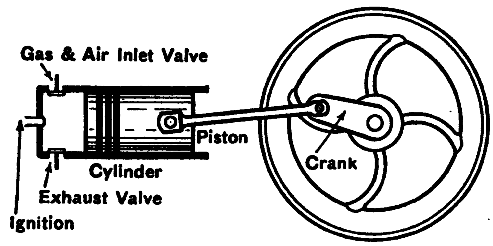
piston head and allows a free return. The piston is joined to a crank by a rod, and as one end of the crank is fixed to a spindle, the thrust of the rod causes the free end of the crank to rotate, with the spindle as the centre of its circle. The power of the thrust now lies in the rotary movement of the spindle, and this will drive a machine to which it is connected by chain or pulley and belt. The motions of the piston, however, are not regular, the out thrust being sharper than the return, and in order to give steadiness to the movement, a heavy flywheel is fixed to the spindle. Steam engines, with ordinary care, are entirely dependable, and are therefore used in circumstances where engine failure would result in disaster, such as winding of pit cages. They are also "good tempered", having very little about them to give trouble by going wrong. Many steam engines have watched generations of workmen pass and still do their own work well.

Unfortunately the engine requires plenty of room. The engine itself is large and unhandy, and it must have boilers to give it steam and coal bunkers to hold the fuel. Further, it resents sudden extra loads and cannot call up reserves to keep going when work beyond its normal capacity is suddenly demanded. It is noisy and its fuel causes smoke and dirt. Above all, and this is the main reason for its gradual elimination from industry, it is expensive to run. In addition to fuel, the weekly wages of men at the boilers besides those in the engine room make it an expensive source of power.

3. *Internal combustion engines*—(*a*) *Gas*.—The gas engine has a motion identical with the steam engine, the difference lies in the force used to push the piston back. Whilst the piston is moving up the cylinder, coal gas and air are entering at the head, and at the end of the stroke, whilst the piston is compressing the gas, an electric spark explodes the mixture. The sudden expansion thrusts the piston back, and then the momentum imparted to the flywheel is enough to ensure the return of the piston for another stroke.



Transforming reciprocating motion into circular motion.



Gas Engine

Gas engines are much smaller and make less noise than steam engines. No one is needed to attend to fuel, and there are no cumbersome dirty boilers. There is nothing outside the engine room except the water tanks for cooling and the pipe to the gas main. When subjected to sudden extra loads it will cope with them fairly successfully. Industry, however, is not too fond of the gas engine, chiefly because it depends on the gas, a commodity controlled by an authority not connected with the firm.

(*b*) *Crude oil engines*.—These are similar to gas engines, but the explosive mixture is vaporised oil and air. After a few strokes the engine generates sufficient heat to vaporise the oil, but it requires assistance from special starting gear at the beginning. It possesses all the advantages of gas engines and is capable of as much work. In addition it is cheaper to run, for much of the fuel is waste oil from machinery or crude stuff costing a few pence a gallon.

(*c*) *The petrol engine*.—This is too delicate to use for general power purposes in a factory.

4. *The electric motor*.—Here we have no cylinders and cranks, but a direct rotary motion which can be coupled up at once. The inner core or armature is free to rotate on a shaft. Surrounding it are a number of electro magnets and when these are

electrified they compel the armature to revolve. Couplings are fixed to the shaft of the armature and a direct drive is obtainable.

The electric motor has overwhelming advantages over its rivals. It concentrates great power in a very small space, it needs no attendant, it is clean, almost noiseless and responds instantly to control by a switch. It will do its work unnoticed save for an instant's switching on or off. Rarely is it known to fail even when given sudden loads almost double its normal capacity. Having no flywheel or cranks, it can be completely encased and so offers no danger to the unwary. It is cheap and tends to become even cheaper to run. The controls may be placed well away from it, in a spot where no unauthorised person can intrude.

5. *Selection of power.*—In every industry the careful selection of power is essential. Running costs are important but must be considered in relation to the work to be done, and with a view to future extension of the work.

Blackboard summary.—

1. Energy from fuel becomes MOTIVE force.
ROTATING motion obtained by using CRANK SHAFT.
FLYWHEEL imparts regularity to motion.

2. STEAM ENGINE.

Heat—Water—Steam
|
Enters cylinder
|
Imparts thrust to piston
|
Operates crank shaft
|
Motion

Cumbersome, costly, percentage of power to fuel rather low, stalls under overload.

3. GAS ENGINE.

Coal gas and air
|
Explodes under compression in cylinder
|
Imparts thrust to piston
|
Operates crank shaft

Less cumbersome, less likely to stall, less waste of power.

4. CRUDE OIL ENGINE.

Oil vaporised by heat and pressure
|
Mixed with air
|
Exploded in cylinder
(Similar to gas engine)

5. ELECTRIC MOTOR.

Current renders magnets active
|
Armature influenced
|
Immediate rotary motion
|
Direct drive possible

Small, clean, noiseless, economical, simple control, responds to overload.

LITERATURE

Aims of lessons.—Literature in the leavers' class includes everything which assists the children to absorb the ideas of others and to give expression to their own.

When mapping out his programme, the teacher remembers that his aim is to approximate the atmosphere of post-school life, and brings his knowledge of the district to act as his guide. The foundation of his scheme is his estimate of the place and form literature will assume in the life of the average youth in the district; on this he builds his plans to introduce the children to what lies ahead.

Lessons are divided under two general headings, one group designed to give each child the ability to express his thoughts clearly in speech and in writing, the other aiming to give him an introduction to the sources from which he will absorb his thoughts and ideas in the future.

Expression of ideas.—In group one, the first care is to encourage the boy to speak. Debates, discussions, question, answer and dramatisation in other classes have already removed diffidence, so that the teacher is left free to concentrate on clarity.

One useful series of lessons is on local idiom and trade terms. Boys are encouraged to listen for them at home and in conversation outside, to bring them to school in their context and to take part in a general discussion on each phrase. Having decided on the precise meaning, the boys may use them in conversation provided they do so correctly.

Another aid to clear expression is constant practice in the delivery of messages. The teacher often checks a delivered message and seeks the messenger's explanation if there has been the slightest variation. School telephones, as supplied by the General Post Office, are most useful in this work. Messengers are expected to use their own intelligence and to carry out their duties with speed and courtesy.

Interesting results may be obtained by occasionally giving the class ten minutes for free conversation, the teacher afterwards calling on boys to give a short outline of the conversation in their little groups. If an outline is laboured the group is called on to assist in the reconstruction of the conversation, remark by remark, and the revised outline given by the first boy.

Daily exercise is given in short verbal descriptions of common objects, care being taken to ensure that essentials are not omitted in the desire for brevity. As a variation, the class may be called upon to give directions from a given spot to the next town as they would to a stranger. The spot chosen should be familiar to everyone in the class.

The minimum desired in written expression is ability to write a letter and ability to put on paper the verbal descriptions mentioned above. The minimum is attained before any other written work is introduced. Letter writing is practised until the framework of a letter becomes mechanical. This applies specially to the letter of application for a post. Interest is added if, on occasion, the whole class answers an advertisement for a boy from the local newspaper and the headmaster or an outsider can be persuaded to "interview" the applicants on the strength of their letters.

Whenever an article appears in the local press on some event familiar to the class, the teacher gives an exercise on the same subject, and afterwards compares the description with that of the journalist.

Each boy has a private notebook in which he writes notes and memoranda of points in his technical reading and scraps of information gathered from newspapers and conversation.

Sources of ideas.—The lessons under the second heading present greater difficulties, for an introduction to future sources of ideas must also include a selection of matter from those sources, and this will vary with the character and interests of each individual.

It is fairly safe to assume that future sources of ideas are conversation, newspapers, cinema, fiction, wireless, non-fictional books, arranged in that order to indicate the percentage of ideas absorbed from each. The matter absorbed, however, is more difficult to tabulate, although it will most probably include matter relating to sport, amusement, recreation, the opposite sex, home, adventure, crime, employment.

Assuming that conversation will give the boy the greatest percentage of his ideas, lessons must be devoted to it, but as each one's conversation will vary with character, work and companions, the lessons have to be limited to simple general rules. The boys are made to understand that no conversation is worth while unless one learns something from it, that it is easy to lose the respect of others by chattering about subjects of which one is ignorant, and above all, that others assess a man's character and intellect upon what they hear him say. The mechanical side of conversation is improved by the teacher being constantly on the alert, insisting on clear cut observations and deprecating any hesitancy due to a sentence not being clearly thought out before speech. The class is reminded upon every conceivable occasion that clarity of thought and speech are vital to progress in industry and are of great social value.

Plenty of space in the scheme is allowed for newspapers, cinema, fiction and broadcasting. Newspapers supply the bulk of the reading material of the majority of workmen, and the teacher therefore deals with the newspaper as if it were a textbook. The chief features of the leading national dailies are the subjects of a series of lessons, the aim being to arouse interest in each. Even the Stock Market will become something more than a meaningless maze of figures if it can be shown how a parliamentary estimate, a new invention or a change in fashion may cause money and business to move from old established businesses to new firms.

When the introduction to newspapers is complete the children are encouraged to use them. They are asked to bring along the previous day's papers from home, and the class is thus provided at no cost, with copies representing many shades of opinion. In class the papers are freely circulated, and atlases are kept handy whenever they are being used. Time is allowed for a short discussion on the news of the day.

Introduction to the cinema resolves itself into an attempt to initiate an attitude of mind which will eventually grow strong enough to act as a check on the ideas which will be absorbed when watching the films. Programmes at the local cinema are freely discussed, and the children encouraged to describe impossible situations, faulty dialogue, anachronisms and camera fakes which they have noticed in the films. Comments on plots and acting are also used to assist in replacing a passive acceptance by a critical attitude.

Fiction is no longer selected for the class. Ample material is placed on the shelves and each boy is responsible for his own selection and reading. He is required to know something of author and plot before replacing the book, and his knowledge is checked by the teacher. The twopenny shocker is a great stumbling block, but its influence often weakens before the healthy excitement found in the pages of such authors as Buchan, Farnol, Macdonald. Boys are helped to discuss authors, and once a boy has expressed a liking for a particular writer he is led to read more of the same man. The introduction to other reading, such as biography, travel, exploration, proceeds with caution. A start is made with stories of men famous in modern sport or adventure, Hobbs, Campbell, Scott, Lawrence, springing readily to mind. As individual boys display interest in particular spheres,—aircraft, wireless, electricity, motors,—for example, the life stories of men prominent in these spheres are put before them.

Interest in technical books is not aroused until boys have decided on the careers they wish to follow. Deep reading is not attempted, but boys are made to understand that such books have to be studied rather than read, and instruction is given on how the books must be used if they are to extend and clarify the information picked up in a person's daily work. Reference books are brought out on every occasion that definite information is required.

The school wireless receiver is used not as a source of information but as an aid in teaching selection and intelligent listening. The class has a copy of the *Radio Times* and certain broadcasts are selected. The selection is as varied as possible and boys are deputed to listen and report to the class. The report is freely discussed and criticised. At intervals the whole class listens to a broadcast during school hours and writes out reports.

The dominating aim in drama lessons is to bring the work into line with what is possible to the boy in the future, particularly opening his eyes to the interest lying in and around amateur dramatic circles.

At the beginning the teacher reads a number of one-act plays, selecting those which hold an appeal to the mind of a boy of fourteen. *The Dear Departed*, *The Monkey's Paw*, are good examples. After a few readings the boys begin to take the plays from the shelves for private reading and the teacher then introduces reading by the boys themselves. A clear space is available so that natural movements may be made whilst reading, and the play moves without break to the end. The teacher is on the alert to cover reading errors and fluffed lines as quickly as possible. Discussion follows the reading but centres round the plot, characterisation being introduced later. When special interest is displayed in a play a number of boys are given the opportunity to prepare the parts. Script is learned at home and the group allowed a corner of the hall for rehearsal. When sure of getting through it they are allowed to present it to the class. Corrections and improvements are not suggested until after the first performance.

One method of arousing interest in characterisation is to select boys to speak and behave through a lesson as if they were certain characters from the plays.

School library.—In addition to the usual list of fiction, readings in literature, anthologies of verse, and plays, it would be useful for the school library to contain copies of the following reference books:—*Everyman's Encyclopaedia; Concise Oxford Dictionary; Whitaker's Almanack; Daily Mail Year Book; Pitman's Year Book; Smallholder, Gardener and Poultrykeeper's Year Book; First Aid to the Injured; Highway Code;* Sherley's *Hints to Dog Owners;* Spon's *Workshop Receipts.* B.B.C. year books, and year books of football, cricket, boxing, tennis. Harriers and track athletics are also recommended, besides a motor repair manual, a ready reckoner, a comprehensive atlas and a book on mechanics, and introductory textbooks to as wide a range of industries as can be gathered.

Daily newspapers.—The preliminary lessons on the newspaper have but one aim, to arouse an intelligent interest which will become wider and stronger with the passage of years. Later lessons are designed to give this interest direction and definition. It is essential that each member of the class should be well supplied with newspapers, obtained without expense in the manner already described, a good general atlas and a dictionary. General reference books should also be available on the shelves. No other apparatus will be needed for the lessons summarised below.

Correlation with other subjects is not overlooked, for this helps the immediate lesson and, what is more important, illustrates the intimate connection between the newspaper and the general affairs of life.

Summary of matter for lessons.—1. The newspaper is a brief and interesting daily booklet on the world. It publishes facts, previously unknown, about people and places, together with opinions and conclusions based on those facts. A list of news items, compiled by the class from the papers of the day, provides all the necessary data for this lesson.

2. *How news is gathered.*—Correspondents and reporters send accounts of all interesting matter brought to their notice to their paper's headquarters. Many papers have their head offices in the Fleet Street area of London. The richest of papers cannot afford to have representatives in all parts of the world, and much news is therefore bought from news agencies, such as Reuter, Press Association and British United Press. Items bought in this manner may be recognised by the wording which is the same in different papers. Agencies were established in the first place because the Post Office refused facilities for transmitting news. *The Times* was the pioneer and was so successful that it obtained the news of Waterloo before the Government. Reuter was a naturalised Englishman who set up his agency for the purpose of gathering commercial news, but it soon became a general agency. The class will recall, "News, copyright by Reuter, etc." broadcast by the B.B.C.

3. *How news reaches the public.*—Much news transmitted to headquarters is never used. Sub-editors select reports which they consider most interesting to readers. A general editor directs the work of sub-editors. A rough proof of the edition is submitted to the chief editor and when he has passed it the printers set to work. Compositors set up the type in the machines and hundreds of thousands of copies are printed. These are handed to the despatch departments where they are packed and sent away by road and rail, ship and aircraft to newsagents in all districts of the United Kingdom and even abroad. The agents hand them to their distributors, usually boys, who deliver them to our homes at breakfast time. Interest is added to this lesson if pictures can be obtained illustrating large printing presses, automatic compositors and drums of papers ready for printing.

4. *Sections of a newspaper.*—These include the leading article, indicating the paper's attitude towards the chief topic of the day; political news, that which concerns nations and governments; general news about individuals, groups and natural phenomena; news of sport and recreation; financial news which is of great interest to those responsible for industrial concerns; details of the movements of ships and aircraft; articles on various subjects by men who are not on the paper's staff; reviews and criticism of books, plays and films; programmes; public notices; stories; photographs and cartoons; correspondence; advertisements, which are the paper's chief source of revenue. This lesson offers great scope for correlation with other subjects.

5. *Newspapers as a medium of communication.*—They provide a medium of communication between individuals, in the Personal and "Agony" columns; between

one individual and the public, in articles and letters to the editor; between firms and the public, in the advertisements; between organisations, governing bodies and the public, in the Public Notices; between Government and nation, in the political columns.

6. *Social value of newspapers.*—They are a vehicle for interchange of points of view on debatable matters; a powerful influence for the welfare of the individual citizen by agitation for redress of injustice; they exercise the right to comment freely upon the public actions of those who wield power over their fellows; they promote better understanding by describing the lives and activities of classes and nationalities other than their own.

7. *Some elements which are not wholly desirable.*—It must be remembered that a newspaper is a commercial undertaking which must be profitable. Profit depends on circulation, which in turn depends on interest. If interest wanes, attempts are sometimes made to recapture it by clamouring for attention.

Methods adopted include exaggeration and misrepresentation, presenting only one side of controversial matters; bribery through gift schemes and over-rewarded competitions; appealing to lower tastes by stressing the sordid and brutal elements of the day's news.

ARITHMETIC

The period is devoted, as stated, to arithmetic. Opportunities for excursion into wider mathematical fields, if considered desirable, may be made in certain afternoon periods, but for one hour each day the class concentrates on arithmetic. The boys are at an age and some at a stage where mathematics may be wider and more interesting, yet the teacher rejects temptation to explore. He reminds himself that arithmetic is a vital necessity to every boy, no matter what branch of industry he enters. It is no exaggeration to say that a boy who leaves school with a weakness at arithmetic is industrially crippled before he starts.

The minimum aimed at is that every boy should possess ability to use the four rules in any of the usual media, to understand fractions and percentages and to differentiate between linear, square and cubic quantities.

When the teacher sorts out his new class he finds the class *A* boy who can romp through a civil service paper, and the class *C* boy who cannot subtract, with the rest of the class strung out at intervals between the two.

For the first week or two all are assumed to be on a level with *C*, and the teacher hammers at first principles, ignoring the bored attitude of *A*.

A paper is then set on the minimum desired, and the class is graded into three fluid groups on the results. The highest is composed of boys who can work individually, as is the second to a lesser degree. The lowest is for those who have not yet satisfied the minimum test.

The work of each group is carefully selected and each boy must show a satisfactory amount of work at the end of each period. The teacher spends the first half hour with the lowest group and tries to tackle a single difficulty with each one individually. This is followed by a quick visit to the higher groups, correcting and noting progress in each case. Occasionally he finds it necessary to spend the whole hour with the *C*'s, and he does so without hesitation for they are his first care until they have acquired the minimum. He never admits that a boy, however backward, has no hope of reaching the minimum. Such cases are not hopeless but desperate—in a short time they will be in industry—and desperate cases need desperate remedies. When orthodox remedies have failed he resorts to unorthodox experiments. The cases are isolated and generalisation is not possible, but it is noticeable that some apparently hopeless cases are due not to sheer inability to grasp simple facts but to an ingrained fear of the subject, fear with its train of dislike or hatred. These will remain as sheep before the arithmetical dog until they discover that the dreaded animal is nothing more than a useful and docile servant. Methods of overcoming this fear depend on the teacher and case. Here is one of many. Nails are needed for the class project. In order to find the quantity which must be purchased the "duffer" is told off to count the number of nails in a pound. This occupies an hour. Later, the teacher counts an ounce and does the rest on paper, chatting with the boy until he begins to see multiplication as a labour-saving servant instead of a vicious taskmaster.

Tests are held fortnightly and never deviate from the minimum though figures become more difficult and exercises take a more problematical aspect as progress is made. Mental calculation is insisted upon at all times, and the boys made to understand that a single unnecessary figure is almost as great a failure as an incorrect answer. Such figures waste time—the greatest offence in industry. The teacher no longer insists upon the logical sequence of reasoning being apparent on the paper because he is not teaching arithmetic as an instrument to develop reasoning powers. In this class it is simply a means of obtaining a result, just as it is in industry. The correct answer in the minimum of time is the aim throughout. Accuracy is set up as a golden image. A boy must know that a calculation is correct before he leaves it, a rule which entails much instruction in checking and cross-checking. The necessity for such a rule may be brought home to the class by pointing out that inaccuracy at work means a lost job, and that his future calculations will be made in places where there is no teacher to correct his errors. He must correct them himself or—visit the labour exchange.

In the shops of a firm famous for its record-breaking cars the writer has seen prominent notices, "The lives of brave men depend upon your accuracy." The teacher never forgets that some of his boys will find their way into motor, aircraft and cycle factories. Whilst stressing the great importance of accuracy, one is arrested by the query, "How many of the great disasters attributed to mechanical breakdown might have their roots in arithmetical failures in our classrooms?"

Having satisfied the demands of the minimum, the boy passes on to individual work. The teacher knows what branch of industry he desires and is likely to enter, and selects work to approximate the calls which will be made on his arithmetic. This is unblushingly vocational, but it helps to catch some of the atmosphere of his future environment, the dominating aim of the class. Summaries of a few individual schemes are given later.

Certain exercises are given to the whole class. Everyone works out all calculations connected with the class project. Exercises on time sheets, rates of pay for piece work, hour and day, overtime, percentage bonus, fines, state insurance, levies, profit sharing schemes, superannuation, travelling expenses, road money, are of general interest. Whilst the teacher keeps close to current figures for these exercises, he often finds it advisable to simplify, especially in the earlier stages.

The number of possible variations of the same exercise is endless. Here are three:—

1. Make out the wages for the following time sheet:—

Mon.	8.30 a.m.—5.30 p.m.
Tues.	8.30 ,, —6.0 ,,
Wed.	8.30 ,, —6.30 ,,
Thurs.	8.30 ,, —7.0 ,,
Fri.	8.30 ,, —5.30 ,,
Sat.	8.30 ,, —4.0 ,,

Rate: 1*s.* 1*d.* per hour, with 2½% bonus. Overtime (after 5.30 p.m. and 12 noon on Sat.), time and a quarter. One hour per day deducted for dinner.

2. How much should be in a pay envelope for the following week?:—

Mon.	5½ doz.	3 scrap.
Tues.	7¼ ,,	9 ,,

Wed.	8 doz.	6 scrap
Thurs.	3 „	2*s*. 6*d*. fine for breaking tool.
Fri.	5½ „	
Sat.	3 „	3 scrap

Piecework rate is 1*s*. 6*d*. per dozen, no pay for scrap. Deductions, 1*s*. 7*d*. health and unemployment insurance, 2*d*. hospital, 1*d*. canteen, 3*d*. sports club.

3. Compare the pocket money of these three young men:—

A. Works near home. Wages 35*s*. per week; gives £1 to mother for board.

B. Works five miles away. Wages 39*s*. 6*d*. per week; gives £1 to mother; travel expenses 5*d*. per day; dinner at canteen 5*d*. (Goes home for dinner on Sat.)

C. Away from home. Wages 45*s*. per week; board and lodgings 25*s*.; washing and mending 2*s*. 6*d*.; cost of week-end at home once a month, 12*s*. 6*d*.

Example of a "minimum" paper set at the beginning of the term.

1. (Write answer only.) Add:—

£13	9	4½
6	18	8½
27	5	11¼
19	3	9
3	14	7

2. (Write answer only.) Subtract:—

£81	0	1¼
74	13	5½

3. What change out of a 10*s*. note is due to a customer who has purchased 4 tins of fruit @ 10½*d*. each; ½ lb. tea @ 2*s*. 8*d*. per lb.; 2½ lb. bacon @1*s*. 5*d*. per lb.?

4. Find the total weight of 23 loads of coal, each load being 22½ cwts.

5. A milkman delivers 128¼ gals. of milk to 54 customers in a week. What is the average consumption per customer?

6. Take ⅘ of 5½ from ⅞ of 12⅝.

7. Square 8.35 and divide the answer by 1.9.

8. Find the cost of planing a floor 20 ft. 3 in. by 13 ft. 4 in. at 2*s*. per sq. yd.

9. A man divides his income as follows:—

Household expenses 65%; clothing 7%; insurance 10½%; savings 5%; amusements and pocket money 12½%.

What amounts will he give to each in a year in which he earns £210?

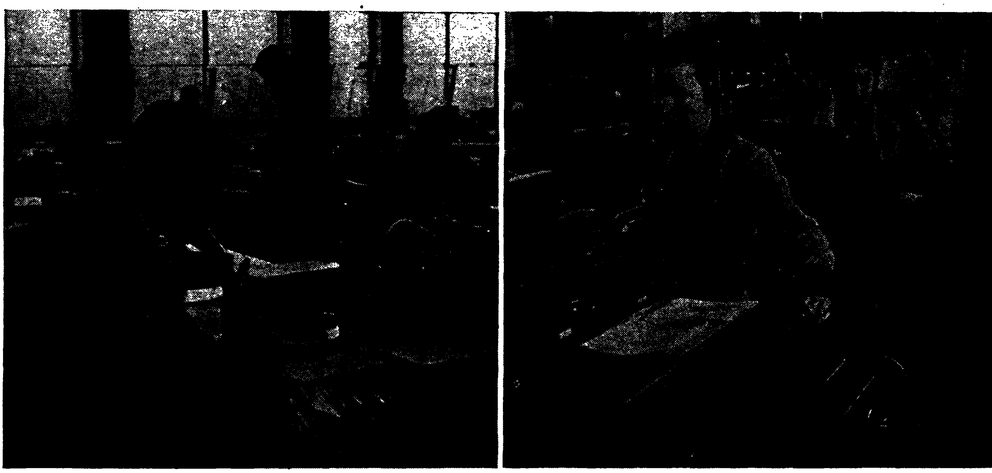
Having passed this test the boy is given a series of exercises and works as an individual. Part of this series is the same for everyone and includes exercises on: Wages and rates of pay; household budgets; relation of costs to consumption of coal, gas and electricity; house rent and purchase (including law charges and building society rates of interest); rates; repairs and depreciation; taxation; postal charges; insurance policies; hire purchase; loans; public services (costs and returns). The rest of the series depends on the industry which attracts the boy.

Those keen to follow one of the many branches of engineering are given problems based on: Fractional parts (especially those found in micrometer and vernier readings); percentages; square and square root; logarithms; mensuration of surfaces and solids; volume; cross section and length; volume and weight; ratio and proportion; gear ratios; relative speeds; decimal equivalents; metric equivalents; water and air pressure; hydraulic equivalents; formulae connected with above.

Those interested in building trades have problems on: Fractional parts; percentages; square and square roots; mensuration of surfaces and solids; safe loads on masonry, roof, floors, beams, chains, ropes; durability tables; costing—raw materials and labour; formulae.

The boy destined for an office works at: Fractional parts; metric and decimal equivalents; percentages; logarithms; proportion; profit and loss; partnerships; business accounts; investments; exchange and discounts; sales and commission; costing—raw materials, overhead charges, freights, labour; customs and excise duties; insurance rates.

GETTING A FIRST JOB



[*Reproduced by courtesy of Cadbury Bros., Ltd.*

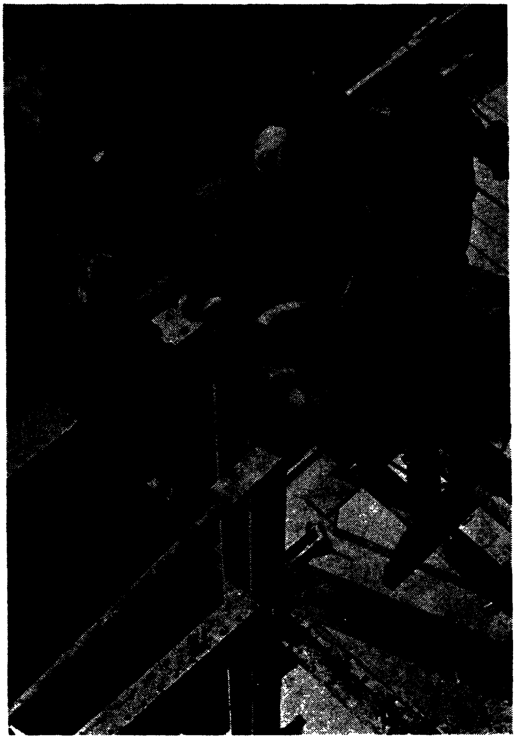
Speaking into a Dictaphone, and a typist listening in to it

Thinking about a job.—During the last year or so at school, boys and girls begin to think of what they will do when they leave school. This is natural; they have passed from childhood and, as a rule, are anxious to go to work. For this there are various reasons; some may wish to help their parents and to become independent, others perhaps may wish to escape from the restrictions and discipline of the school. They little think that the restrictions and discipline of work are more severe than those of school.

Whatever the reason may be, the end of schooldays comes to all and the problem of getting a job must be faced. Everyone agrees that the kind of job boys and girls get when they leave school is important. If it is suitable they learn their duties easily, they fit into new conditions and are happy and contented. They win the approval of their superiors and develop self-confidence. If the work is not suitable, the youngsters find it very difficult, they make many mistakes, become discontented and lose heart. If they leave, as they often do, they are less well qualified for the next job and probably drift from job to job and reach manhood without learning any trade or work properly.

It is very easy to get into the wrong job. Boys and girls know so little of the world of work; their parents, too, are in little better position. The modern world is very complex; so many changes are taking place in industry and commerce that few people have extensive knowledge of the conditions of work outside their own occupation. Very often we find that parents are aware of the disadvantages of their own job and warn their children off it, but allow them to enter others more undesirable.

A favourite question for parents, relatives and friends to ask of boys and girls when they are nearing the age to leave school is, "What do you want to do when you leave school?" It is very rare that the answers given are of any value. A few people have



[Fox Photos

MEN AT WORK ON THE EXTENSION OF MANCHESTER TOWN HALL

How to prepare for getting a job.—The boy or girl leaving school may be compared to a traveller going on a strange journey. If he is wise he will endeavour to get information from previous travellers as to the nature of the route, the difficulties and obstacles he may expect and, not least important, how he should be equipped for the journey. He should have a chart by which to steer his ship on the sea of life. Who will provide this chart? In order to choose the right job, the young person needs to know a good deal about different jobs so that he may be able to compare one with another. He also needs to know a good deal about himself.

In regard to the job, he should know what it requires in the way of ability, knowledge, character and energy; what prospects it offers for getting on, what is the pay, and whether there is a good demand for juniors. He also should know his own powers and temperament. Is he very intelligent, or

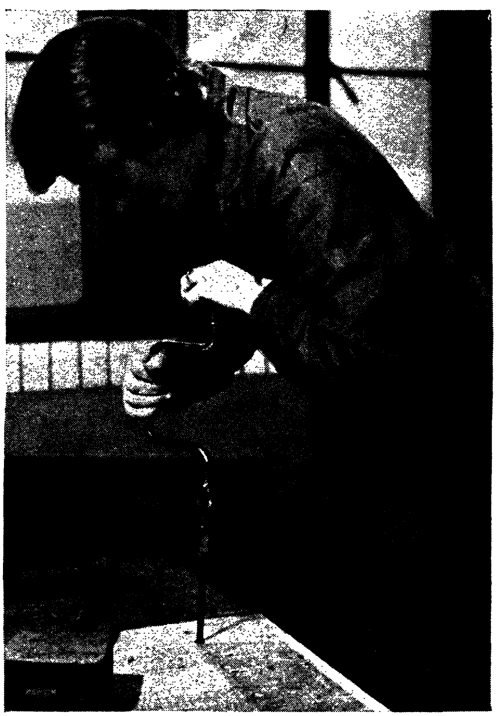
[Fox Photos.

PAINTING A GARGOYLE IN DREAMLAND PARK, MARGATE

definite opinions as to the work they wish to take up. These children present little difficulty; all that is needed is to find a suitable vacancy in the work they desire. The views of the majority of children, however, change almost from week to week. We have all heard of the boy who wanted to be a soldier to get a good view of the Coronation procession, or of girls who wished to take up flying after reading of the exploits of famous airwomen.

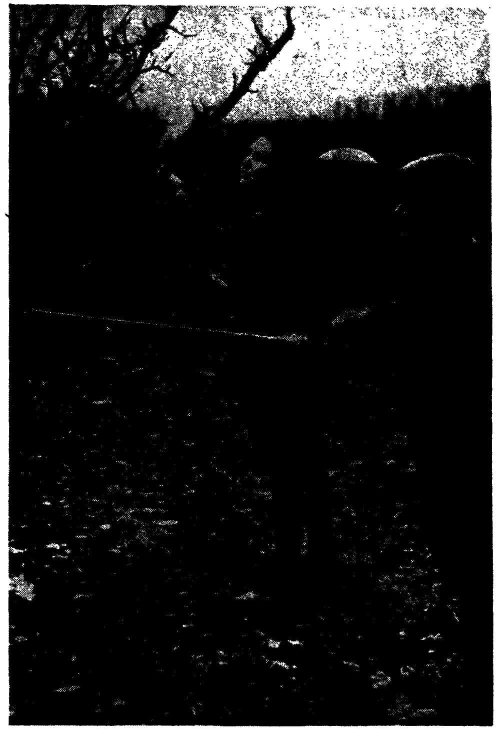
It is clear that the haphazard method of choosing a career is not unlikely to lead to discontent and trouble for the individual and inefficiency and waste to the community. Many of the misfits in industry and commerce are due to lack of guidance when the young person starts work. This in turn is generally the result of ignorance as to the conditions of work and the qualities required for success.

merely average, or dull? Is he energetic or placid, strong or delicate, adventurous or docile, sociable or shy and nervous? Is he dependable, cheerful, good-tempered, or the converse? It is clearly too much to expect the average schoolboy to know anything very definite about jobs and most unreasonable to assume that he can assess his own qualities. Outside help is needed for both tasks and this is a field where the school can render most valuable service. Most schools do help their pupils. Many have established friendly relations with local employers, or work in close co-operation with the employment officers of the district. Usually, however, the part played by the school is to recommend a boy or a girl for the vacant post rather than to guide them to choose the kind of work.



[Fox Photos.

A GIRL FURNITURE MAKER AT WORK AT THE CENTRAL SCHOOL OF ARTS AND CRAFTS, LONDON



[Fox Photos.

SPRAYING FRUIT TREES AT THE MONMOUTHSHIRE AGRICULTURAL INSTITUTE

The school as vocational guide.—No agency is better suited than the school to act as adviser to the young people leaving school. The teachers know the children well, probably better than anyone, not even excluding their parents. They know the kind of home the child has, the family circumstances, his ability and the main traits of his character. Owing to the system of periodical medical examination, the child's medical history is before them and this is in itself a valuable aid in choosing a career; for some pupils, for example, jobs are unsuitable which require good hearing, good eyesight, which involve much standing or exposure to weather or close detailed work. In these cases the medical record is essential if serious damage to the young person's health is to be avoided. All will agree that the

[Fox Photos.

A Woman Dentist Examining a Young Patient in a Surgery on Wheels

school is well qualified to deal with this one side of the problem, the pupil's physical and mental capacity, but to provide information on jobs is not usually considered to be within the province of the school. It should, however, be remembered, that for a number of years the school has devoted its energies towards developing the pupil mentally and physically, in order to fit him or her for a useful place in the adult world. What is more fitting than that the school should complete its work by helping the young people towards getting a suitable job.

During the last months of school, the pupils are interested in the subject of going to work. Any information on this topic will be readily received, for the youngster looks on it as useful and practical and who is so sternly practical as the average school-leaver? There is time, too, at school to consider in detail various kinds of jobs, whereas when the pupil leaves it is often imperative for him to get a job as soon as possible. It should, however, be remembered that some experienced people recommend a youngster to try out a number of jobs and spend a year or two in settling down before making the final choice of a career. This method has its advantages, but it presupposes that there are plenty of jobs available, that the youngster can change his job easily, and that there is a definite purpose behind each change. None of these conditions can be generally accepted. It is not usual for a youth to have a settled plan in life and, in any case, advice and guidance on the change are valuable. It must not be overlooked, however, that no worthwhile work is done without effort, and guiding young people rightly about careers requires much effort. If the teacher adopts the rôle of the experienced navigator and aims to point out to his pupils the far-distant shore and the most suitable course by which they can steer, he himself must chart the crowded seas, study the wrecks and derelicts which dot every route, and realise how little is

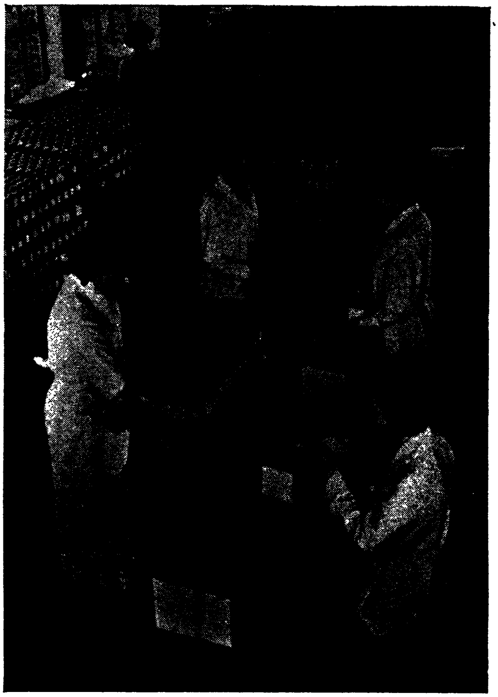
[Fox Photos.

Making Stockings by Machinery

achieved by those who set out ill equipped for the journey.

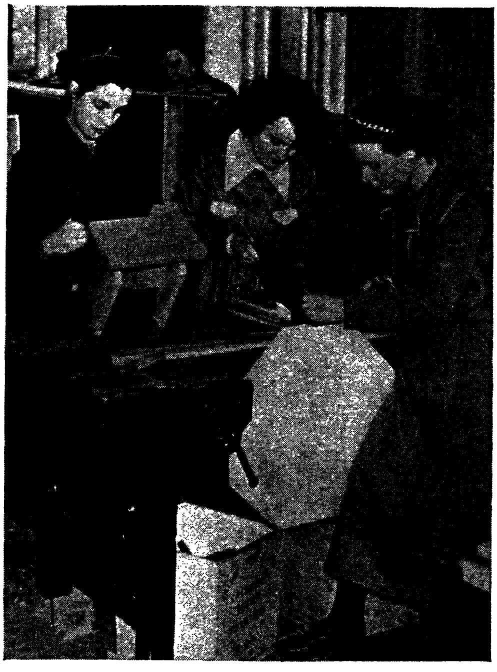
The task of the school.—How best can the school set about this work? The first thing is to attempt to assess the pupil in terms of physique and health, ability, temperament and character. All teachers do this in the course of their daily intercourse with their pupils, but if the information is to be used in guiding the child to a suitable post, the assessment should be more systematic. The following may be helpful in assessing the pupil.

How should the boy or girl be assessed for appearance, taking note of cleanliness, neatness and, not least important, expression? What should be the mark for industry? Is the child energetic, persistent in his work and reliable in the performance of duties set him? Can he do a job without close supervision? General mental attitude is another classification. Is the boy alert and careful, does he work well with others? We may also ask, is the pupil ambitious? Has he or she initiative? Is he self-confident and capable of asserting himself? Then again, such qualities as fearlessness, timidity, submissiveness, shyness, sociability, are of use in suggesting a suitable occupation. We should also consider whether the pupil is noticeable for his desire for change and variety. Is he excitable or stolid in his reactions? His physical condition should also be considered. Is he strong or delicate, has he any defects which may interfere with the successful pursuit of a particular occupation? We may then classify our pupils according to their interests. What a person likes to do is an important consideration in vocational guidance because there is no doubt of the close relationship between interest and output of energy.



[Reproduced by courtesy of Cadbury Bros., Ltd.

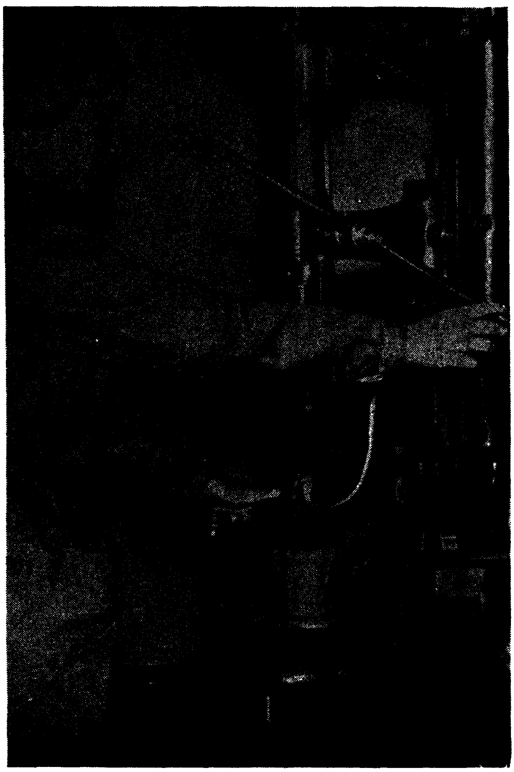
PACKING TINS OF COCOA AT A CHOCOLATE FACTORY



[Fox Photos.

STUDENTS IN A SOUTH WALES COLLEGE LEARNING TO BE CARPENTERS

There are three broad classifications of interest which are useful for our purpose. Is the pupil mainly concerned with people, or with things, or with books, papers or figures? We can obtain information of interest from the nature of the pupil's hobbies, the manner in which he spends his leisure time, and also from any preferences he may have towards the school subjects. The pupil's aptitude for particular kinds of school work will also help us suggesting an occupation. For example, if a pupil excels in English subjects, he or she is probably suitable for clerical work and, with other necessary qualities, for salesmanship. If the pupil has a bent for science and is good at mechanical drawing and calculations, he is probably suitable for some form of technical work, draughtsmanship, mechanical engineering, or chemical work. If a pupil shows skill in manual work, he is suitable for some branches of the building trades or metal or woodwork or the tailoring trades. If he is particularly good at art the artistic crafts may be suggested such as art metalwork, decorating, sign writing, lithography, bookbinding, photo-process work, wood carving. A word of warning should be given here; many pupils who are good at drawing think that there is a future before them in advertising or poster work. It should be remembered that success in these occupations requires high ability and years of hard work. For the really dull and backward boys, it is probable that unskilled labouring, messenger's work, or that of van-boys, are the only occupations open to them. If however, they obtain a post as a messenger or van-boy in a large organisation, it is probable that they will be retained when they reach manhood as drivers, porters, packers, or in some form of semi-skilled labour.



[*Fox Photos*

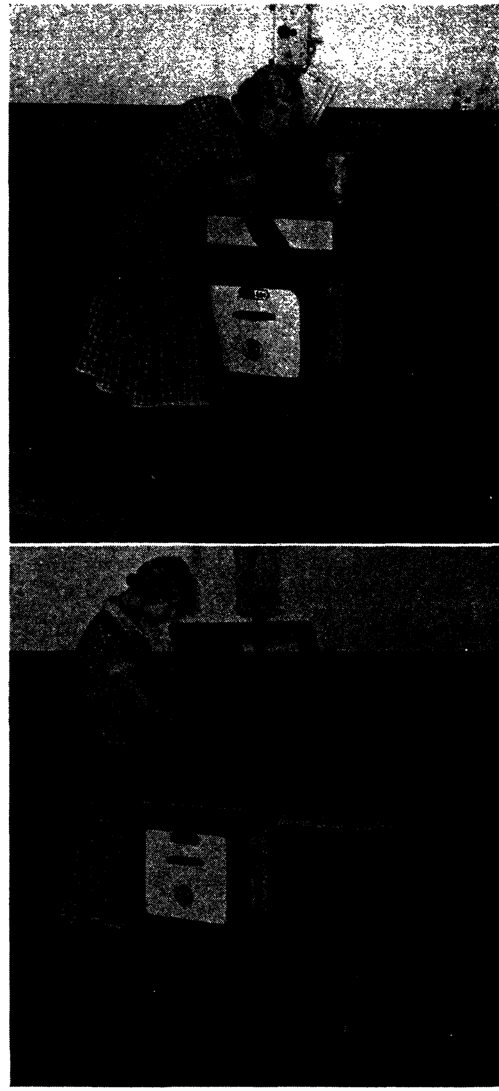
A Young Woman Engineer Drilling Screws from Steel

As an additional means of discovering in what form of work young people are interested picture postcards have been used. The pictures were selected to show some form of activity which might give expression to some general interest; e.g., pictures of machines, of operations in industry or commerce, examples of books, of instruments, of animals, of industries, of the country, scenes requiring great bravery or endurance, or showing a sense of power or excitement, or some new experience; and the child was asked whether he would like or dislike to be the man in the picture. One boy may say that he would not be a fireman because of the dangers; another would prefer to be the fireman because of the bravery depicted. Another might like to work a machine because of what it makes; another would be unwilling to work the machine because he was afraid of making a mistake. From these cards we may get an idea of the boy's temperament and his emotional attitude. Is he keen on financial security? Is he the kind of boy who would avoid responsibility through fear of making mistakes? Is he concerned about a secure job and afraid of losing his employment? Does he like monotony or variety?

In considering jobs, the following points of view may also be brought forward: Is immediate payment more important than future prospects? Should the boy consider a safe job or an unsafe job? This is largely a matter of temperament, for a good case can be made for both sides. Should the junior seek open-air work or indoor work? Should he try the office or the workshop? Should it be a dirty job or a clean job? A job which entails wearing overalls and handling machinery and tools? Should the boy be advised to seek a skilled or an unskilled job?

The study of occupations.—Side by side with the study of the pupil goes the study of the occupations. It is a good plan to make a survey of the occupations of the district which are open to boys and girls leaving school. There are various means of securing this information. The pupils themselves are one source and a valuable one; they are eager to supply items of information. The juvenile employment exchanges are also most valuable. Books and pamphlets on careers, too, provide useful material. The information must be edited and arranged in a form suitable for our purpose and it should be borne in mind that it often requires recasting to suit local conditions. In order to render the material really useful for examination and comparison it is advisable to arrange it systematically. The following methods of arrangement have proved successful and might with advantage be adopted.

What is the nature of the work? What materials are handled? What are the subdivisions of the work into departments, and where necessary into processes? What are the general conditions of entry into the occupation? Is employment regular or seasonal? We might also ask the nature of the previous training required. Is it of a general character or a special character? What particular aptitudes or attainments are required? What are the general conditions of the work from the point of view of health, the general demand of the work on strength,



[Reproduced by courtesy of English Electric Co., Ltd.

DEMONSTRATING AN ELECTRIC COOKER

endurance, etc? and what are the prospects in this occupation? These are questions which should be asked.

Occupations, too, can be grouped according as they require, in the main, similar qualifications. By this method occupations are divided into mental work, social work and manual work skilled and unskilled. Mental work for boys includes office boys, junior clerks, post office messengers; for girls, it includes general office work, shorthand and typewriting, post office clerks, cash desk work. Under social work for boys we find the page boy, kitchen boy, the shop assistant, the messenger in shop or factory, the attendant and the porter. In social work for girls we find showroom work, nursemaids, superior domestic servants, lift girls, waitresses. In the first class of manual work for boys we find printing and bookbinding, cabinet-making and upholstery, engineering, instrument making, jewellery, watch and clock making, gold and silversmithing, etc. For girls, under skilled manual work we find dressmaking, millinery, tailoring, leatherwork and bookbinding. There is another class of manual work of a skilled character involving heavy constructional work. In this class we find building, joinery, plumbing, painting and decorating and masonry. This heavy constructional work is obviously only open to boys. Under manual work, we also find semi-skilled jobs, such as optical work, boot and shoemaking, assembling of machine parts for boys; and artificial flower making, box making, brush making, optical work and fancy packing for girls. Under unskilled manual work we include for boys all kinds of routine factory work, and work of a similar character for girls, such as bottling, labelling, filling, parcelling, etc.

It should be noted that the labour in many factory occupations is generally unskilled or skilled within a very narrow range. The increased use of automatic machinery means that the average factory worker is either a machine-minder or feeder, or engaged in parcelling, filling, wrapping or some form of packing. The work is not necessarily dirty or unpleasant, but much of it is monotonous and requires care and dexterity rather than the skill which comes of long training. Factory work is often carried out under excellent conditions for the workers. In some factories there are good conditions and regular employment; in others, the work is irregular according to the orders—hence a knowledge of the individual factory is necessary.

There are other useful observations to be made on trades. For example, in regard to jewellery and precious metals, watch and clock-making, it should be noticed that these are not large but are highly skilled luxury trades and exposed to periods of abnormal depression and to competition with other luxuries. A note on laundry work may be helpful as showing the kind of information that is available. It is stated that laundry work is steady and fairly well paid and is suitable for strong and healthy types of boys and girls, who would normally go to factory work. The greater part of the work is semi-skilled and calls for commonsense and dexterity rather than superior mental ability. In regard to the building trade we should note that all skilled operatives are assisted by labourers; some do general work, others special work. For example, the bricklayer's labourer's work is semi-skilled and requires some training, but the bricklayer, mason, carpenter, joiner, plumber or painter is a skilled man and the boy trained in one of these skilled occupations may become a foreman, a clerk of the works, or even an estimating clerk, or a works manager.

A note on domestic service may be useful. Much of the work of the domestic servant to-day is skilled. This is due to the extended use of electricity which eliminates much of the rough work previously required and needs considerable intelligence in its use. Resident domestic service is regular and constant and provides work over a long period of years. Domestic service includes work in private houses, hotels, clubs and institutions. The latter are generally more popular than private houses. Work in the latter is more rapid and the life is busier but there is more companionship and freedom and the hours of work are more regular.

With regard to office work, it should be noticed that much of a girl's work in offices consists in operating machines and that as a rule men control the constructive and intellectual work of the office, but there are many and an increasing number of well-paid posts for well educated intelligent girls in these offices.

Getting the job.—The youngster has considered various occupations and has decided on the kind of work he would like. The next step, and a most important one, is to get a job. He or she may learn of a vacancy through an advertisement in the newspaper, or a notice in the shop window or at the gate of the factory or workshop. He may learn of it through the labour exchange, through his school or from a friend, or he may apply direct to a firm for a position. If the youngster wants a particular post, he should not wait for a vacancy but apply directly to the firm. The vacancy may be available just at that time. If application is made direct to the firm it is most important to apply in the right way. Success will depend almost entirely on the impression created by the letter of application. It is probable that many, even hundreds, of applications by letter may be received and probably only half a dozen are chosen and the writers asked to call for an interview.

The opinion is generally held by employers that letters of application leave much to be desired. One employer says, "Letters of application are often unsatisfactory; they are slipshod, badly phrased, lacking in some essential; for example, the age of the writer is often omitted; and they are even known to have been received unsigned." It is not a bad plan for the applicant to read the letter himself and read it unsympathetically, imagine that he is the employer who will receive the letter and ask himself if there is anything in the letter that will cause it to stand out amongst dozens of others and lead the employers to invite the writer to come for an interview. Another employer says, "In regard to layout, on the whole applicants appear to take very little trouble over the general arrangements of their letters. No effort seems to be made to make a favourable first impression."

Very often essential information is omitted; such details as age, which is very important, education and experience and the position for which the applicant wishes to be considered should always be stated. For some positions height is important, so it is helpful if this is stated. Particular attention should be paid to spelling, and this is not always the case. Typical examples of inaccuracies are *vacency* for *vacancy*, *birth* instead of *berth*, *knowlage* for *knowledge*, and *temperery* for *temporary*. *Respectively* is often given for *respectfully*. The tone of the letter is important. It influences one's opinion to a considerable extent and an ingratiating letter should be avoided at all costs. Very frequently letters are too apologetic. It is unnecessary to say that you are sorry to take up the manager's valuable time. Sometimes applicants write, "I shall be pleased to interview you." Actually, of course, it is the manager who grants the interview. An interview should therefore be requested and a time stated when, if convenient to the manager, it would be possible for the applicant to be interviewed. The letter of application should be written on clean notepaper, the writing should be neat and legible, and the spelling correct. The letter should contain all the information which the employer requires to know about the applicant. Here are the questions to which employers require answers:—

What is your name, age, and where do you live?

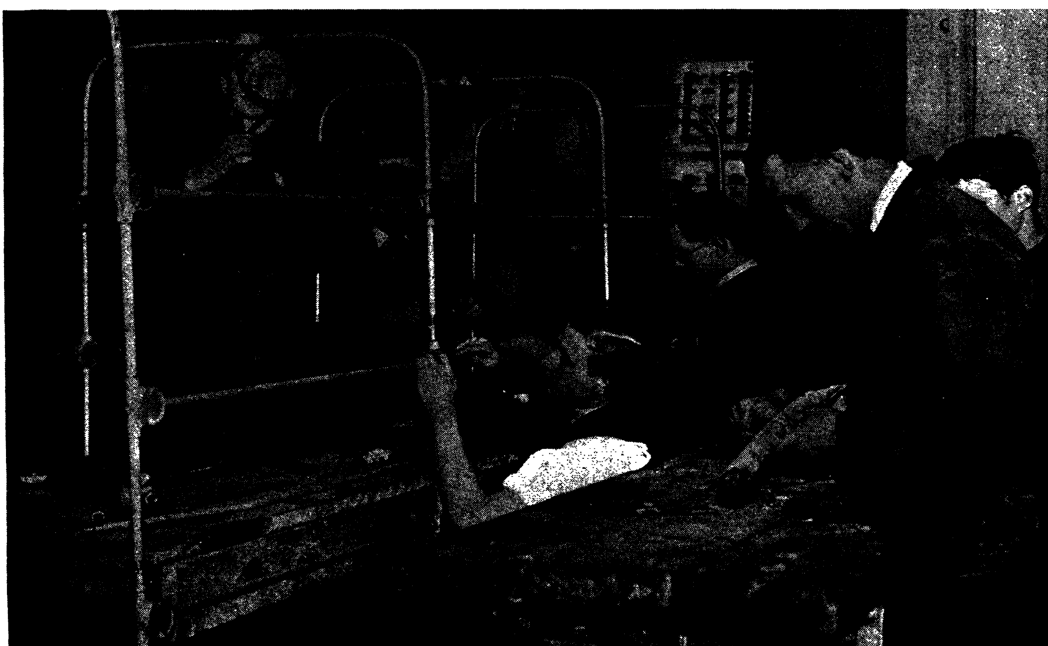
What school did you attend and what standard did you reach?

Whom can you give as references as to your character and ability?

What kind of work do you wish to do in this firm?

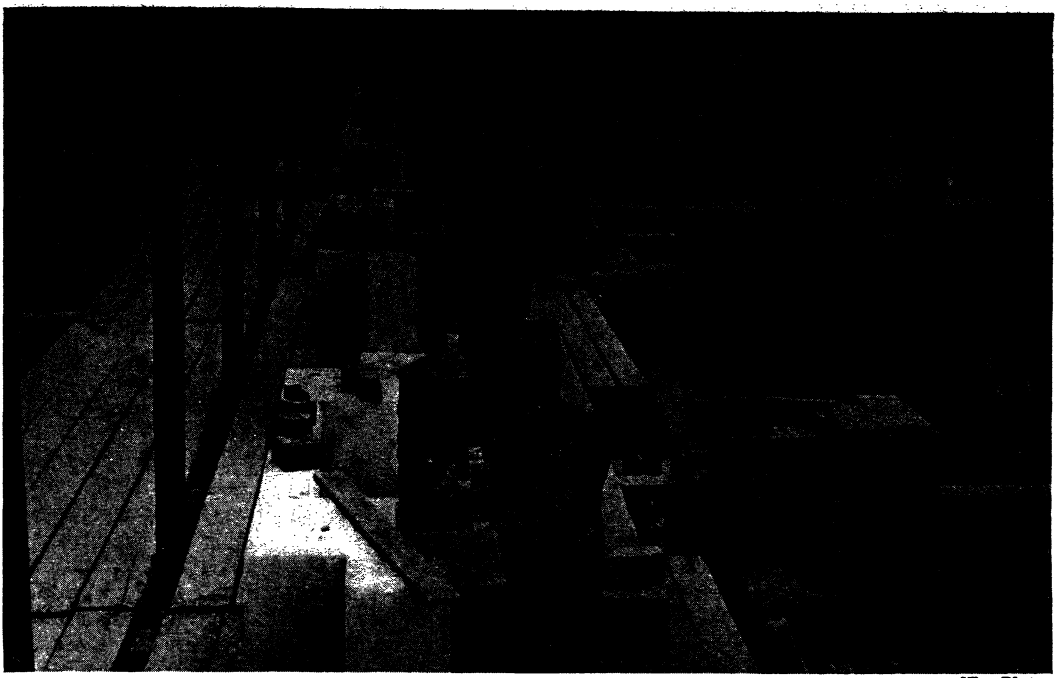
[*Central Press Photos*

ARTIFICER NAVAL APPRENTICES IN WORKSHOP AT THE MECHANICAL TRAINING ESTABLISHMENT, IN THE ROYAL NAVAL BARRACKS AT CHATHAM



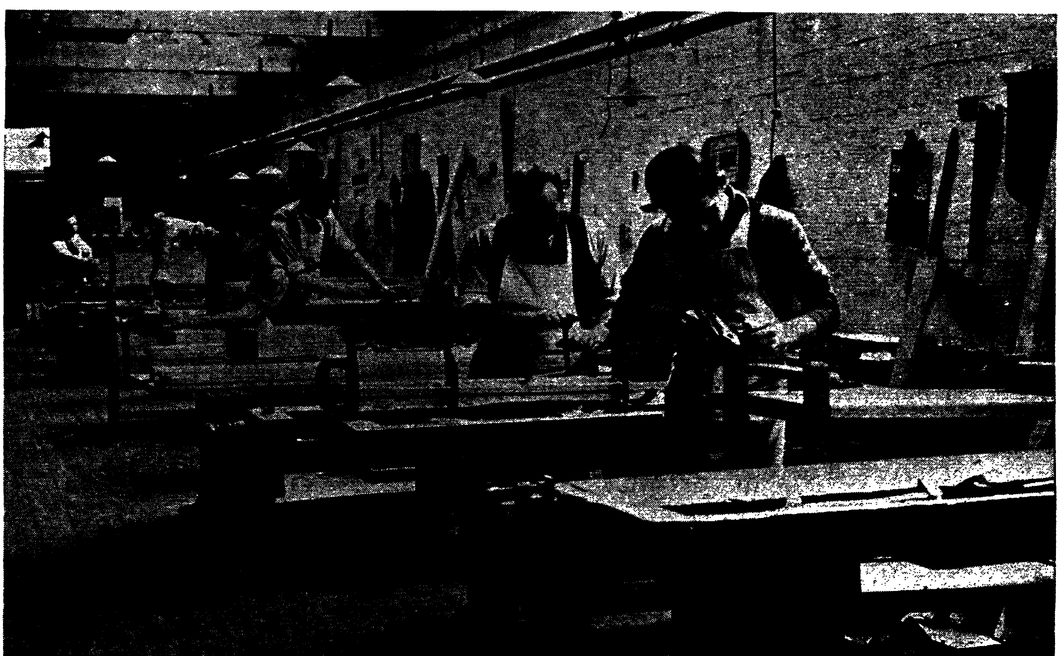
[*Fox Photos.*

CONDUIT WIRING ON A MODEL FRAMEWORK, TRADES TRAINING SCHOOLS, GREAT TITCHFIELD STREET, LONDON



[Fox Photos.

BRICKLAYERS AT WORK ON THE NEW WELSH NATIONAL HEALTH INSURANCE BUILDING AT CARDIFF



[Fox Photos.

FURNITURE MAKING AT A FACTORY IN BRYNMAWR, S. WALES

Practice in setting out the information required in a letter of application may well be given in school. It should be noticed that no set form of words or letters is needed in applying for a position, and such expressions as, "Having seen your advertisement for a junior clerk, I beg to apply for same," should be avoided at all costs.

The reply from the firm will depend largely on the letter of application. Some firms have three kinds of answers. Where the letter indicates that the applicant is not suitable, a polite letter of regret is sent, thanking the applicant for applying, but regretting that there is no vacancy. If the candidate appears to be worth considering, he is told that while there is no suitable vacancy available at the moment, the firm would be glad if he would call to see them at an early date. If the candidate appears specially suitable, a definite appointment is arranged.

The interview.—In practically every case an interview is necessary, and as many juniors fail to do themselves justice at the interview, the following advice may be useful. In the first place, it may be said that nearly as much depends on the manner in which the applicant appears before the employers as on the qualifications which he may present. It is only natural that the boy or girl should be nervous at an interview, but there is no need for them to be disturbed about this, for the employer usually understands and is sympathetic. He wants the applicant to do himself justice, and is usually friendly and pleasant in his manner. It is clear that the self-possessed youth has advantages over the nervous youth who may be better qualified. But if the applicant is convinced that he is able to do the duties for which he may be called on, he has no reason to be unduly nervous.

It is a good plan before the interview for the boy or girl to get to know as much as possible about the duties of the job for which he or she is applying, and to think over beforehand the kind of questions which are likely to be asked. It is, of course, important to be punctual at the interview. A boy who has to apologise for being late has at once put himself in a position of disadvantage. The applicant, of course, will make the most of his appearance in regard to clean face and hands, and well polished shoes, clothes and hair well brushed, all giving a general air of tidiness. He will, of course, knock at the door of the manager's office and wait for the invitation to come in. On entering, he will remove his hat and say, "Good morning, sir," or, "Good afternoon, sir." He should not slouch nor have his hands in his pockets, nor lean on the manager's desk as some boys do. When asked questions, he should not be afraid to speak up and answer the questions, looking the manager straight in the face and adding "Sir" to his answers. A cheerful smile is not a disqualification. When the interview is concluded, he should say, "Good day, sir," or, "Thank you, sir," and close the door when he leaves the room. Throughout the interview he should show his prospective employer that he is keen to get to work, anxious to start and willing to work hard.

The question is often asked, "Should the boy or girl go alone for interview, or be accompanied by a parent?" It is often a good plan for the junior to go by himself for the first interview; he will probably show to better advantage when he is on his own. If the employer is favourably impressed by the applicant, he will almost certainly want to see the parent, who then has the opportunity of discussing matters in which he or she is naturally and properly interested. If, however, the parent does go to the first interview, he or she should bear in mind several things. In the first place, they should not answer for the child. It is the child who is being interviewed, not the parent. They should speak highly of the child, and not stress any weak points he may have, especially any illnesses he may have had in his early days which may have made him backward at school. The boy's willingness and cheerfulness should be stressed rather than his deficiencies. The parent should

[Fox Photos.

KENNELMAIDS IN SUSSEX

Young women are finding the care and management of dogs of all breeds a most attractive occupation.

[Fox Photos.

WOMEN BLACKSMITHS

above all things not plead poverty and try to induce the employer to take the boy because of the hard conditions at home. The employer may, and probably is, sorry for the boy, but his only concern is to get a good junior and the fitness of the boy for the work is really the only thing he can consider.

Very often the applicant is required to fill in a form of application. This should be done with as much care and accuracy as is needed for a letter of application, and the boy or girl before going to the interview should find out all the facts relating to himself or herself which are likely to be required; e.g., name and address; age; date of birth; name of school; class and position at school. Very often young candidates create an unfavourable impression through their ignorance of these salient facts about their own lives. As a rule, an employer requires a testimonial or letter of reference from someone who knows the applicant. It is important that the testimonial should be kept clean; a dirty testimonial is evidence that many people have seen it, and have not been impressed by the applicant. This impression is damaging; it is a good plan to make a copy to show a prospective employer; the original can be produced if necessary.

Application and "interview" for a post.—It is a good idea to give the children some conception of the competitive conditions attendant upon securing a post after leaving school. An advertisement for a boy, for example, is taken from the local newspaper and written on the blackboard. Each member of the class composes, writes, seals and addresses his application without assistance from others. The letters are carefully read and the six most promising are replied to in the name of the firm which advertised. A "letter box" is placed in the classroom and all correspondence passes through it. The replies from the firm give an opportunity for the "interview".

The headmaster, or, better still, a business man from outside, interviews each of the six privately and assesses marks on the sheet prepared by the teacher. The boy obtaining the highest total receives a letter of appointment, to which he replies. All letters and interviewer's notes are placed before the boys and discussed in detail. In the final section of the lesson all points of failure are gathered together and from them a few general rules are framed to help the boys to make the most of all their qualifications when applying for a post.

The advertisement chosen is within the scope of an elementary schoolboy and relates to work which holds a general appeal. "Wanted. Smart boy to learn business. No premium. Write giving particulars. W. Evans & Co., Garage Proprietors, Dunhampton."

The replies are opened and marked on the following basis:—Handwriting and layout, 3. Mechanical rules of letter writing, 2. Informative matter, 3. Economy of phrasing and accurate spelling, 2.

One reply reads:—

27, Queen's Road,
Stanton,
Nr. Dunhampton.
12th December, 1937.

The Manager,
Messrs. W. Evans & Co.,
Dunhampton.

Dear Sir,

In reply to your advertisement on the 11th instant in *The Dunhampton Times*, I venture to apply for the vacant post.

I am fourteen years of age and eligible to leave Dover Road Senior School on the 21st instant. My height is five feet and my medical record is sound.

Enclosed is my detailed school report together with a letter of reference.

I am keen to obtain such work as you offer because my interest lies in that direction.

I am,
Yours faithfully,
William S. Brown.

The replies to the six selected for interview are typed on the school typewriter.

Station Garages,
Dunhampton.
15th December, 1937.

Mr. W. S. Brown,
27, Queen's Road,
Stanton,
Nr. Dunhampton.

Dear Sir,

Vacancy for Boy

We are in receipt of your letter of the 12th instant in connection with the above vacancy.

Will you kindly make it convenient to meet our representative in the headmaster's room at Dover Road Schools on Friday, 17th December, at 11.30 a.m.

I am,
Yours faithfully,
A. S. George.
Manager,
W. EVANS & CO.

Each interview follows identical lines.

1. *Impression conveyed by applicant's entry.*—Marks awarded on carriage, personal appearance, correct manners, expression; that is, visual impact on the interviewer. . . . 10 marks.

2. *Questions to put applicant at his ease.*—
   (a) What is your full name?
   (*b*) Your date of birth?
   (*c*) I see you live in Queen's Road. How far is your home from Station Garages?
   (*d*) Are your father and mother living?
   (*e*) Have you any brothers or sisters at work? . . . 5 marks.

3. *General Test.*—Now I want you to write down answers to the three simple questions on this paper.
   (*a*) What is the change out of a ten shilling note due to a customer who has purchased 3 gallons of petrol, a packet of 20 cigarettes and has made two telephone calls?
   (*b*) Give the addresses of the police station and doctor near your home.
   (*c*) You have been left in charge of the garage. A stranger comes to hire a car for the day. What would you do? . . . 10 marks.

4. Tell me your ideas of work in a garage. . . . 10 marks.

5. What do you do in your leisure time? . . . 5 marks.

6. Have you anything to tell me about yourself in addition to what you put in your application? . . . 5 marks.

7. *Impression on leaving.*—Correct leave taking . . . 5 marks.

The boy scoring the highest total of marks receives the following:—

Our Ref. ASG/V.

Station Garages,
Dunhampton.
17th December, 1937.

Mr. W. S. Brown.
27, Queen's Road,
Stanton,
Nr. Dunhampton.

Dear Sir,

Vacancy for Boy

I have to inform you that your application for the above post has been successful.

Your appointment will date from Monday, 27th December, 1937, at a wage of ten shillings per week.

Ask for me at the office at 8 a.m. on that date.

Kindly confirm this appointment by return of post.

I am,
Yours faithfully,
A. S. George,
Manager,
W. EVANS & CO.

The boy replies:—

27, Queen's Road,
Stanton,
Nr. Dunhampton.
19th December, 1937.

ASG/V
A. S. George, Esq.,
Manager,
Messrs. W. Evans & Co.,
Dunhampton.

Dear Sir,

I thank you for your letter of the 18th instant and note that I am to begin duties at 8 a.m. on Monday, 27th December, at a weekly wage of ten shillings.

I shall endeavour to give satisfaction in those duties.

I am,
Yours faithfully,
William S. Brown.

These letters are now written on the blackboard and the boys compare their efforts with those of the successful candidate. Points to remember are summarised as they emerge from the discussion. These are:—

1. *The letter of application.*—
   (*a*) This should be clearly written, with the address, endorsement, margins, paragraphs and signature arranged to give the letter a pleasing appeal to the eye.
   (*b*) Every detail of punctuation should be observed.
   (*c*) The matter should be a concise answer to the advertisement.
   (*d*) School records and letters of recommendation should be left to speak for themselves.
   (*e*) Phrases should be direct and free from adjectives.
   (*f*) Information should include physical as well as mental qualifications.
   (*g*) "Begging" language is read unfavourably.
   (*h*) Such phrases as, "If you were to appoint me I should . . ." should be avoided. An employer resents any attempt to influence him with promises.
   (*i*) The addressed envelope should be correct in every detail.

2. *The interview.*—
   (*a*) Clothing should be well brushed and tidy, with particular attention paid to boots, neckwear and hair.
   (*b*) When entering, the boy should use the mat and close the door; he uses "Sir" when replying.
   (*c*) His carriage should be upright and brisk. Hands in pockets or fidgeting with hands or clothing should be avoided.
   (*d*) He should speak clearly and look the interviewer in the eyes.
   (*e*) He should make all replies as briskly and briefly as possible but be sure that the reply answers the question fully.
   (*f*) Questions on name, address, date of birth, family, leisure, recreation, and ideas about the work are almost certain to be asked. The answers should therefore be prepared before the interview.
   (*g*) The leave-taking should be courteous, quiet and brisk. Points of personal appearance, speech and courtesy, however small, are important. It must always be remembered that an interviewer decides largely on what he sees and hears.

Forms for completion.—As concrete illustrations of the information employers require about applicants for employment and members of the staff, a number of forms in use by various firms are given. They include an application form for a junior seeking his first post; a form for an assistant who has had some experience; the letter of enquiry sent to a former employer or school, and a report form used in a large organisation to assess employees for promotion. Practice in filling up application forms may well be given in school. Forms may be duplicated and the pupils required to fill in the necessary information in the appropriate spaces. By this means they become familiar with the appearance and layout of an application form. They realise that space is limited and that neatness as well as accuracy is required.

APPLICATION FORM FOR JUNIORS

Brown & Co., Ltd.,
Stone Street,
London, E.C.1.

I (full name) ....

of (address) ....

hereby apply for employment as ....

I could begin work on ....

Date of birth: Day...................... Month...................... Year......................

Wages per week..

My educational record is as follows:—

Name and Address of	Approximate number of years at the school
Elementary school	
....	....
....	
Secondary or other school	....
....	
....	

Particulars of any scholarships or other successes ....

....

....

Evening classes attended, subjects studied and examinations taken:

....

....

Father's occupation ....

Signature..

ASSISTANT'S APPLICATION FORM

Service ....

Card No.........................

Brown & Co., Ltd.,
Stone Street,
London, E.C.1.

I (full name) ....

of (address) ....

hereby apply for employment as...

and shall be free to begin work on... at your

.... branch or elsewhere if required.

Date of birth: Day....................... Month....................... Year.......................

Wage per week...

Have you ever been employed by this company before?.......................................

If so, when and where...

PARTICULARS OF PREVIOUS EMPLOYMENT

If none, give the names and addresses of at least two responsible persons to whom reference can be made as to the general character of the applicant.

	Was there from about...............	To about	In what capacity	Cause of leaving
1. Name and address where last employed .... If at present in employment, are you under notice to leave?	....	....	....	....
2. Name and address of employer previous to No. 1	....	....	....	....
3. Name and address of employer previous to No. 2	....	....	....	....

If there was a break between leaving one position and taking up another, the applicant must state what he was doing between the times...

....

....

REFERENCE

Brown & Co., Ltd.,
Stone Street,
London, E.C.1.

Your Ref........................ Our Ref.........................

Private and Confidential

Dear Sir,

.... who has applied to us for employment as.. states that he was in your service as .... from.. to..

We shall therefore be much obliged if you will kindly answer the questions below, and return this form to us completed, in the enclosed stamped envelope.

Thanking you in anticipation of your reply, which will be treated in strict confidence,

We are,
Yours faithfully,
Brown & Co.

Are the particulars given above strictly correct?...

Did the employee leave of his own accord or was he dismissed?.......................................

If dismissed, please state reason...

What was the position held in your employ?...

Did you find the employee:—

Strictly honest? ....

Strictly sober?...

Competent and reliable? ....

Do you know of anything which would prevent you from engaging this employee again?..

Former employer's signature...

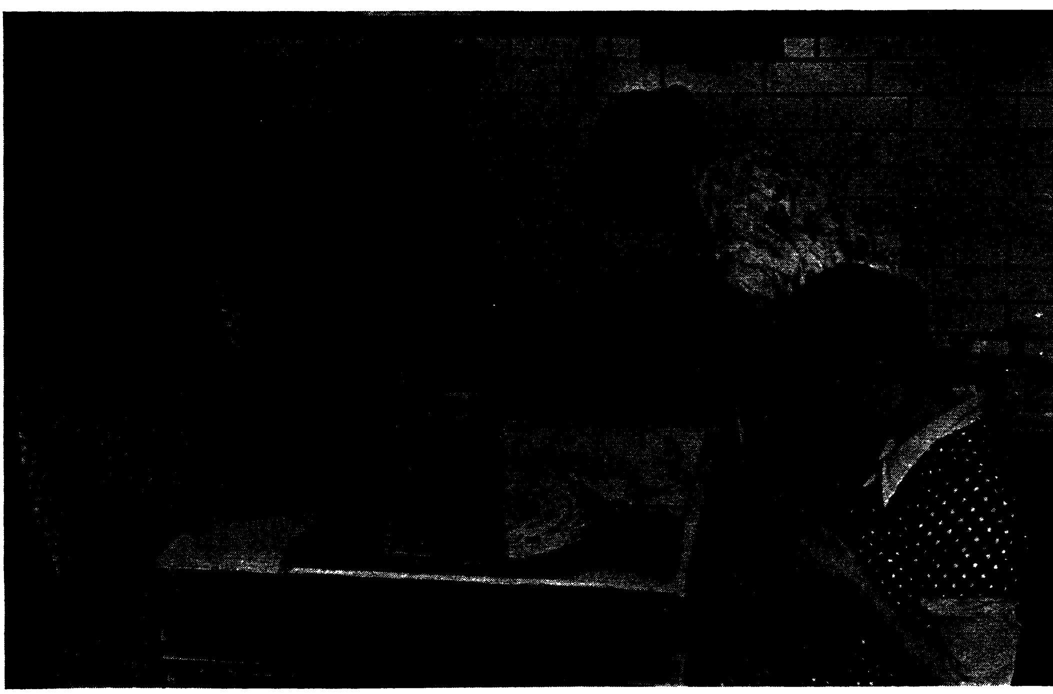
Date..

In large organisations great pains are taken to assess the work, capabilities and character of the employees. As a rule firms prefer, if it is at all possible, to make promotions from among their own staff, and in order to do this efficiently many firms use a carefully prepared report which managers of departments of the firm are required to fill in with respect to the employees working under them. The following is an example of a form in use.

CHARACTER	Excellent	Very good	Satisfact'y	Poor
1. Manner and address *How far is he/she personally presentable and agreeable and tactful in manner, and ready to co-operate with others?*				
2. Energy *Is he thorough in his work?*				
3. Courage *Is he ready to undertake a difficult job? Is he persevering under difficulties and does he stand up to difficulties or shirk them? Is he self-reliant?*				
3a. (For executive positions) *Does he gain the confidence of his staff? Is there a team spirit in his department? Is he able to organise his work?*				
CAPACITY				
4. Penetration *To what extent is he observant and interested in the work of his department and able to understand the purpose of the work?*				
5. Constructive ability *Does he accept things as they are or does he think out things for himself? Does he make suggestions on his work?*				
6. Judgment *Does he draw sound conclusions from the facts before him? Does he show judgment and commonsense in determining the relative importance of different aspects of his work?*				
PERFORMANCE OF DUTIES				
7. Output of work				
8. Quality of work				
9. Method *Does he set out things in the simplest way? Does he save himself and others unnecessary work?*				
10. Conduct *Is he punctual and regular in attendance at work? What amount of absence through sickness does he have?*				

[Fox Photos.

GIRLS AT WORK IN A LAUNDRY—THE RESEARCH DEPARTMENT



[Fox Photos.

THE POTTERY CLASS AT WORK AT THE GLAMORGAN COLLEGE FOR WOMEN, BARRY

Keeping the job.—Getting the job is only the first step; equally important is how to keep it, and some help and advice to juniors on this point are equally desirable. The average junior enters upon his work meaning to work hard and get on, but very often, especially when the work is of a routine character, as it generally is at first, he loses his early enthusiasm and tends to become slack. Promotion seems far off. The extra energy he has shown in his work does not seem to be appreciated by his superiors; it is all taken for granted. But he should remember that to be eager and energetic at his work is not a mistaken policy. If he keeps it up, he will either get promotion in his present firm or find a better post elsewhere. He must always remember that promotion does not, as a rule, come rapidly.

In addition, young people find it hard to realise that working life differs from school life in many respects. The school is primarily a place of learning and training; the office or workshop is a place where the boy's efforts are regarded from the point of view of what value they are to the firm, not to the boys or girls themselves. At work there is little regard for the worker's interests as an individual. No longer as at school is the youngster an object of skilled attention, interest and patience. He is but, as it were, the smallest cog in the machine of which, to a large extent, he does not understand the workings. And instead of extra care and attention being given to the slow and stupid, as is the case at school, at work the dunces are quickly thrown out altogether. Many firms do attempt to train their juniors, but it is with the main object of making them more useful at their work, and a junior's success will be marked rather by the way he fits in and uses his own initiative and self-reliance to learn the work. His superiors are very quick to discern a boy who is standing on his own feet and fitting in to his environment. While it would be foolish for a boy or girl to stay in work which they did not like or for which they were obviously unsuitable, there is no doubt that many youngsters change their jobs far too readily and without proper justification. The old system of apprenticeship by which a boy was bound to his employers for several years is largely out-of-date and non-existent, but many employers are suggesting that a less formal bond or engagement should be entered into by the newcomer to the firm in order to prevent unnecessary changes of work which are unsettling to the boy and wasteful for the firm. An engagement of this kind would make the boy realise that he was entering into a contract and he would not enter into it so lightly nor break it so easily.

Let us ask ourselves why young people leave their jobs, why some succeed and others fail. It may be due to one of several reasons; the boy or girl may be unsuitable for the work; they may be lacking in perseverance to overcome the difficulties of the work; they may not realise the necessity and importance for giving the job a fair trial. It is generally desirable to advise these young people not to change their post without a good reason, to be patient and try to overcome the difficulties and fit into the environment. It should be remembered that a few weeks in a job is a bad testimonial and will not help towards getting another post. The applicant will be regarded as fickle and restless. An adult applicant who has a record of a large number of positions, each for a short time, is very unlikely to be considered favourably for a worth-while post. What are the main reasons which employers give for their juniors leaving? The main are: inability to get on with other people; inability to work without close supervision; inattention to details; forgetfulness; laziness; insubordination; and indiscipline. It seems rare for employers to say that the junior could not do the work; that is, had not the ability to do the work.

What are the reasons that the boys themselves give for changing their jobs? The main reasons are: restlessness; they found the work too monotonous; they wanted a change; some did not like the work; others did not like to work by themselves; in some cases the money was insufficient, and in others the prospects of the occupation were poor. Few boys or girls realise that their work at first, until they get used to it, will probably be very monotonous and a great contrast to the variety of work they did at school. A boy who was working on repetition engineering work said he never thought the days could be so long; every day seemed as long as a week.

It is well to remember that it is not necessarily the cleverest boys and girls who get on. Employers want boys and girls they can trust to do their best and to work in the interests of the firm. It has been said with justice that hard work, good temper and punctuality must count in the long run. A famous writer has said that young people entering the world of work should remember that in the early years they are laying the foundations of a career which will occupy them the greater part of their lives. They should have long views, and, as he said, remember that they are planting the seeds of oaks and not of virginia creepers.

All older people realise that there is no royal road, no arterial road, to a successful career; but that success, which does not necessarily mean getting a great income, but rather leading a full and contented life, is achieved in various ways. Success at one's work is almost entirely necessary if one's life is to be reasonably successful, and as a guide to the boy or girl who wishes to make a success of his work, the following hints may be useful. They may be taken as the questions an employer should ask himself in regard to the members of his staff, and on the answers depend the employee's prospects of promotion:—

Is he, or she, energetic and thorough in his work, and does he get through the necessary amount of work?

Does he put his heart into his work?

Is his work carefully done?

Does he seem interested in his work?

Is he friendly and agreeable with other people? Does he get on well with others? Is he willing to co-operate with others?

Is he ready to tackle a difficult job or fresh kind of work?

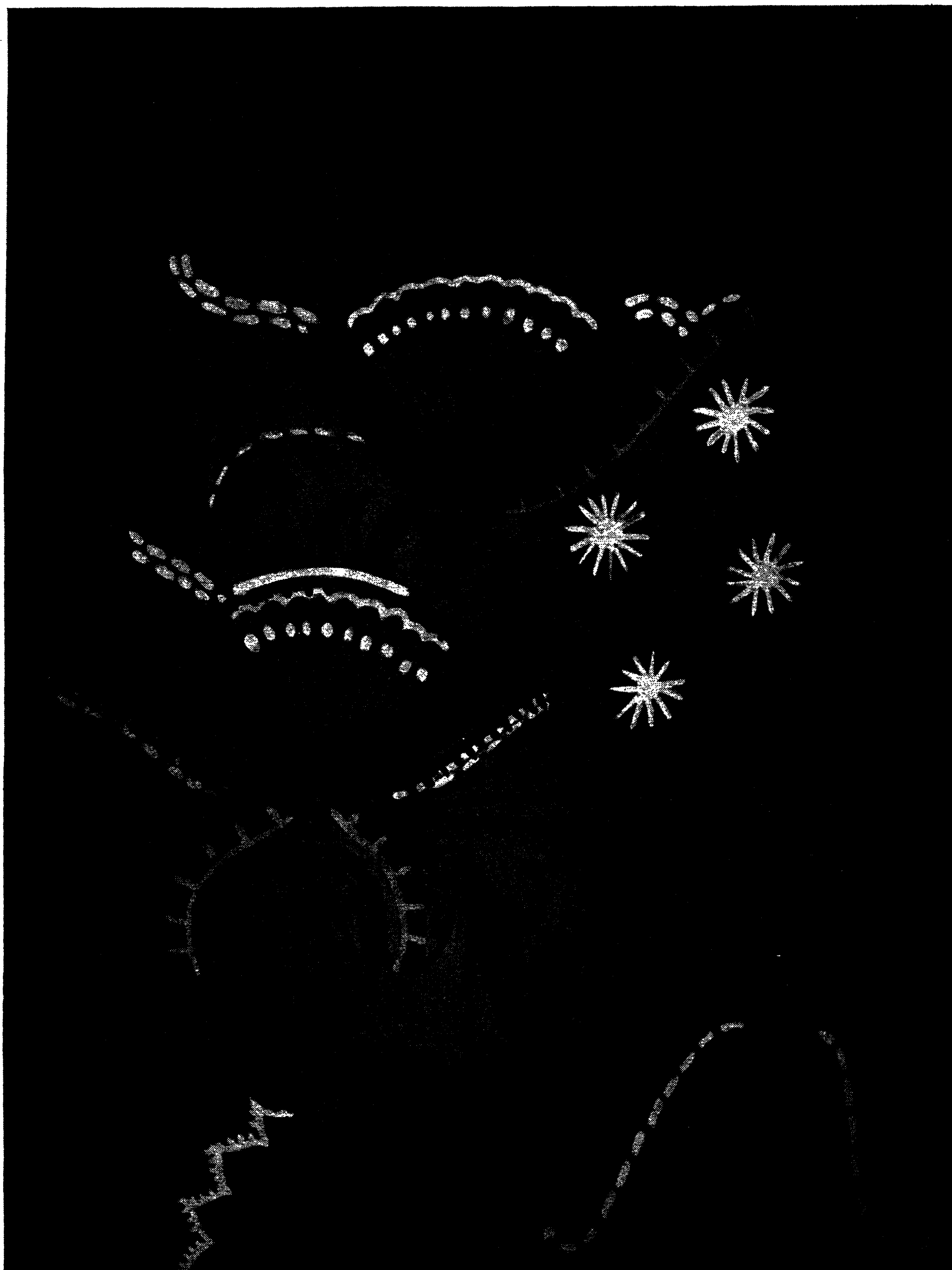
Is he self-reliant, and able to work without close supervision?

If the youngster can answer these questions satisfactorily, he may be reasonably sure that he will make a good job of his work. The readiness with which young people change their jobs is a matter of considerable gravity, and it would seem desirable for us to keep in touch with the youngsters for the first year or so of their working lives.

In comparison with school, there is considerable liberty at work. It is easy to become slack and idle. The junior's work is difficult to assess accurately. Supervision is often difficult and unless the boy or girl has the right attitude to the work, slackness may become a habit. But although supervision does not seem close, it is there, and more is noticed than the boy or girl thinks. A suspicion only of slacking is a serious bar to promotion. It is a good plan for the junior to cultivate pride both in his firm and in his work. No firm is perfect, but it is a very bad sign to hear a junior complaining and grumbling about his firm, and this attitude calls for the obvious answer: "If the firm is so bad, why do you stay with them?"

Square pegs in round holes are a source of unrest to youth and mal- or ill-adjustment to suitable occupations is one of the evils causing general unrest among young people and in extreme cases may result in want of balance and nervous breakdowns. It may fairly be said that as a rule the individual is not averse to work, and many people are discontented not because they have to work but because they are doing work which is not congenial to them. He was a happy man who told his employers that he liked his work so much that if they had not paid him to do it, he would do it for the love of the thing. This is an extreme case, for we must, most of us, work in order to live, but it does not seem impossible that there should be more agreement and harmony between the work and the worker. In this important social service, the schools can play a great part.

SCHOOL CLUBS AND SOCIETIES



[*Mary Brooks*

A DESIGN FOR WOOL EMBROIDERY BASED ON THE POPPY

The outline and filling of the spaces is carried out by means of a variety of stitches in coloured wools on a linen or crash background.

INTRODUCTION

THE majority of our modern senior and secondary schools employ a form of house or team system, and whatever system is introduced, it exists to create and foster that wholesome inter-competitive and co-operative system which does so much for the establishment of tradition.

Many and varied are the plans which may be tried. The small school can divide into two sections, while the larger school will often find it advisable to make as many as six or eight houses. These houses are frequently named after famous races, for example, Greeks and Romans; or after individuals of historical or literary note such as Raleigh, Wellington, Scott and Dickens; others adopt the name of the master in charge of the house or the name of famous or well-known people in the district. One of the most interesting systems is to utilise the names of parts of the British Empire, and to name each room according to choice, such as India, New Zealand. Team or house marks gained or lost may then be recorded each week on a map of the world. This latter system is a definite aid to the teaching of geography, for the occupants of the room must know a good deal about the name it bears—where it is, its towns, climate and crops, etc.,—and as the student progresses through the school, moving to new form rooms each year, he can amass a surprising amount of incidental information.

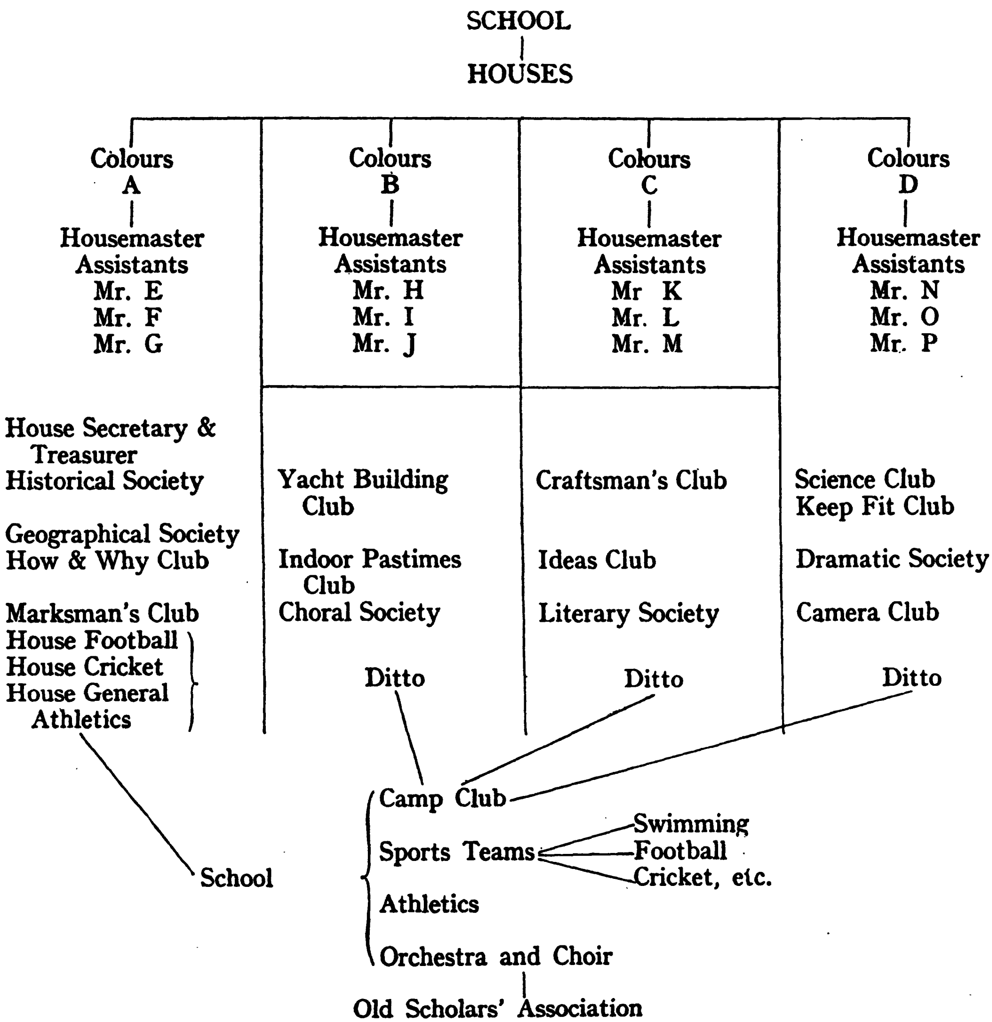
Organisation.—Let us consider the introduction of a house system into any school. A single sex school will be fairly easy to subdivide, but a mixed school will demand a little more organisation. Care must be taken when splitting up the children into the various sections that no house is "top heavy" with athletes, for it is all too easy to discourage the members of other groups by constant defeat and loss of points.

After determining the number in each house, house masters should be appointed, together with other members of the staff who will assist with the organisation and conduct of the work. House prefects as well as officials such as secretary and treasurer should be chosen by the committee of masters and boys. Colours and mottoes may also be determined.

The activities of each house should be left to those in charge, and a very wide range presents itself to the keen organiser. It will be found almost impossible to carry out all the programme in school hours and a considerable amount of leisure time both of the staff and pupils may have to be utilised. A practicable scheme has been to allow two afternoons each week, say Tuesdays and Fridays from 3 o'clock to 4.30, for House clubs and societies to meet; then the meetings may be extended after school hours if desired.

A suggested scheme for house organisation is given, and a glance at this chart will show what might be done in club time. The inclination of the history master will be to form a Historical Society in the house to which he is attached, or the geography master to form a Geographical Society. There may be little or no interest of this nature in other houses, and it is upon this factor that the formation of house or school clubs depends. Of necessity certain clubs and societies, such as cricket and football and general athletics, will have to be thrown open to the whole school in order to permit of general competition between schools; the Camp Club, Choral and Orchestral Societies should cater for all the pupils. Yet certain activities which appeal to a more limited number of boys may be carried out in the house clubs, a brief explanation of some of which is given later in this article.

Aim of clubs.—The aim of the boys' clubs is not so much to keep boys out of mischief



Scheme for House Organisation

and to lessen the work of our juvenile courts, although in some measure they help to do this, but they exist rather to educate modern youth for the fullness of citizenship. To organise club work without systematic method and clearly defined aims and principles would be to defeat these aims, and perhaps do more harm than good.

It is an admitted fact that the education of children is held to be of vital importance to national welfare, and the more we care to further their desire to assimilate knowledge, to create an interest in school and school activities, the easier this task is going to be. Whatever clubs are formed, they should be interesting centres where lads will attend voluntarily, and in many cases they should carry out more important branches of work than are usually dealt with in school time.

The true test of the success of the work will be found in the desire for lads to attend the clubs after their school life is over. The club then becomes the educational centre for the working boy, and its purpose will be to help the boy to mould and train himself for manhood, so that he will be able to appreciate to the full all that is best in life, and to contribute to the full all that makes for the best.

If the club is to succeed it must be efficient. This efficiency cannot be realised unless the organiser has a real and lasting interest in the welfare of those in his charge, coupled with the desire to take an active interest in all that is done.

It is not enough to have untold facilities at his disposal such as a fully-equipped gymnasium for physical training, boxing, or badminton; splendid changing rooms complete with shower baths; a cosy canteen, well-stocked library, rooms for group discussions, workshops for handwork and hobbies, science rooms, a large hall with properly lighted stages for dramatic performances. Unless there prevails that spirit of friendship and comradeship, of equal sharing on equal terms of boys and men of every class and kind; unless the members form themselves into a team bound together by a common aim, and a willingness to submit to such discipline as defined by the members themselves rather than by an outside authority; unless there is that freedom from constraint and compulsion—so often a contrast to school—the work carried on will be of little value.

Club life will differ largely from school life. Boys do not attend in order to be taught but in order voluntarily to learn. A compulsory programme similar to the school syllabus will defeat its own ends. Rather should the club set out to provide for its members such educational activities as the boys may themselves demand, even though this demand may not be inspired by the organiser. If complete freedom of choice is allowed, those under leadership will themselves choose to take advantage of the opportunities offered to them. This applies also, to discipline. There should be no compulsion from an outside authority, for it has been found that, under proper leadership and guidance, the average boy will submit to self-imposed discipline which he can approve and therefore accept, and which is accepted by the club as a whole.

Difficulties in the work.—The work often proves uphill and difficult, and there are many obstacles which impede it. The boy himself tends to be unstable at this age of adolescence and constantly seeks change and variation. After his day in school he frequently shows signs of inability to concentrate on one subject or for any long period. His environment is usually more of a hindrance than a help, for in the poor districts, which are only too numerous, conditions deny the boy what to others has proved to be a great influence—a home. He has perforce to cultivate the "street habit"—to play in the street, to lounge at street corners, and to enjoy all those many and varied excitements which happen there. His parents do not know or care much where he spends his leisure hours, and there is often a lack of co-operation between the parent and school, a co-operation which is so essential in child education.

Then again there is a lamentable lack of those willing to organise this type of work. It seems an almost hopeless task to find voluntary workers who are willing to devote a great deal of their leisure time to the work without remuneration. Those who are needed most are those men and women who in their "spare" time will, without any feelings of affectation or self-righteousness, quite naturally and simply share their leisure with the boys, and by their own earnest example strive to show them how to get the best out of life.

If the need for such out-of-school clubs were only realised, and the lasting benefits which they can render were understood; if only prospective club workers experienced the tremendous happiness they themselves would derive from the work, and if only they felt the potential greatness of this mighty fellowship of men and boys who share life together regardless of class or sect, they would not hesitate to throw themselves heart and soul into the work.

The club leader.—For the success of club work depends in the long run upon the personality and ingenuity of the person in charge—call him leader, warden, housemaster or whatever you will. His work will be to preside at meetings, to be the final arbitrator, and to accept the responsibility for what takes place during club time. His power must be recognised by colleagues and boys equally. He will be guided by their views and suggestions and will, as far as possible, fall in with the wishes of the majority. He will wisely distribute the actual work among his helpers, leaving himself a roving commission, ever on the alert to feel the pulse of the club and to diagnose and rectify any defect which he may observe. Whilst he must not let the club become a one-man show, he must be the most active of helpers. His functions are to understand and know every individual member, and to direct and organise the whole work so that it is carried out satisfactorily and efficiently and so that helpers and boys are working harmoniously and happily together.

Self-government.—Self-government is the basic principle of all club method, but it must be put into practice slowly and with due thought and consideration. It will always have to be under guidance and leadership. Where the tone and standard of the club is high the greater will be the control in the hands of the members.

The aim of self-government is to give responsibility to certain boys and so to train them in reliability and leadership, to inculcate a team spirit in the club and to instil initiative and a spirit of interdependence among the members. But it is well to bear in mind that nothing can be done in the way of self-government for the first few weeks that the club is started until the organiser is fairly certain of the material at his disposal, for it is often the case that boys react differently to club than to school.

The tone or spirit of the club must be created from the first night it is begun, and statutory rules—relating to the care of apparatus, clearing up the room used, etc., —must be carefully observed. If, for example, it is decided to observe the rule that all boys must change into vest, shorts and plimsoles before taking part in any physical work, this must be done at the outset for it is astonishing how lasting many of these first night traditions prove to be.

When the organiser is satisfied that he knows his members sufficiently well to be able to select officers and committees from them, a secretary, treasurer and committee should be appointed for a probationary period, say, of one month. If at the end of this time the services of one or more prove to be unsatisfactory, their places can be filled by others. The committee should meet at regular intervals, a careful record of such meetings should be kept, and their suggestions and criticisms discussed and approved or rejected as may be found necessary. From their ranks, a rota should be prepared and these responsible lads allocated to duties which they are capable of carrying out. One should be in charge of the attendance register; another, preferably the treasurer, should collect subscriptions and fees; while others should be made responsible for the games used and to see that the room is left tidy at the close of an evening.

As time goes on it will be found that the entire club can be run by a competent body of lads, and the true test of its functioning will be when the work can be conducted without the presence of a teacher.

SPORTS CLUB (OUTDOORS)

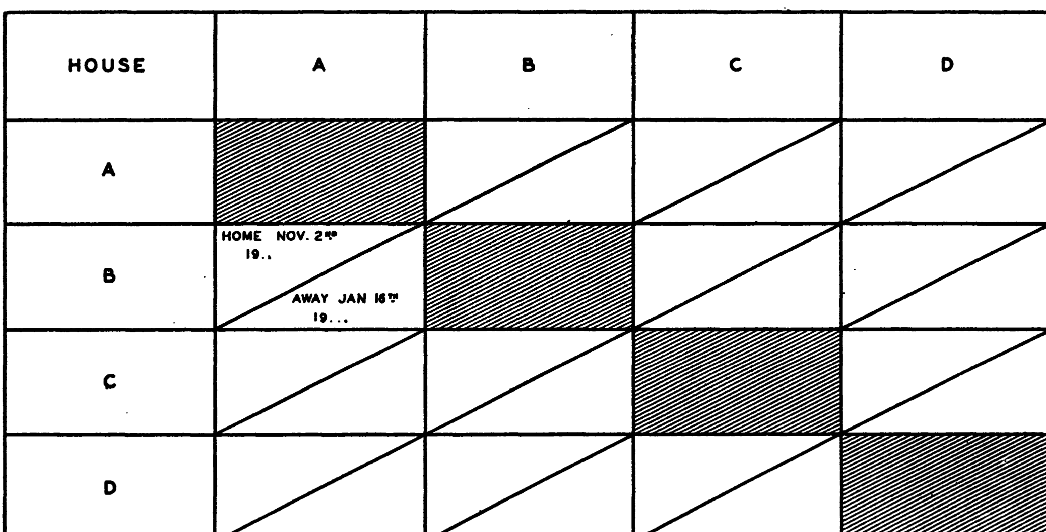
The question will be asked, "What activities shall be organised in each house or for the school?" This depends largely upon the inclination of those in charge and upon the needs of the lads they are handling; but the following suggestions may prove helpful.

The Sports Club should be organised to cover all forms of sport to which house members may be inclined. Football and cricket teams may be formed, and inter-house matches played for which some trophy may be given such as a cup or shield. A useful idea for making a permanent record board can be seen in Fig. 1, where the names of the various houses are shown as A, B, C, D, and the result appended in the appropriate spaces.

Some boys may prefer Association football, others Rugby; while again tennis, swimming, hockey or fives teams may be built up according to the season. Again, general athletics should not be neglected, and facilities for practices for various events might be given in preparation for inter-house sports. School sports days are invaluable, and as a rule are looked forward to both by parents and pupils as annual events. In the organisation of such days there is not a great deal of hard work entailed. A suitable programme of events should be prepared and might include the following:—

High Jump.
Long Jump.
Throwing the Cricket Ball.
Cross Country Run.
Obstacle Race (100 yards).
Hurdle Races (100 yards).
Relay Race.
Flat Events (usually 100, 220, 440 and 880 yards).

HOUSE MATCHES {Cricket / Football   SEASON 19.... to 19....



SEASON'S TOTALS: A...............points
B............... ,,
C............... ,,
D............... ,,
CHAMPION HOUSE: ....

FIG. 1. A USEFUL PLAN FOR A SPORTS RECORD BOARD

One or two events of an amusing nature —Parents' Race, Sir Walter Raleigh, Bicycle Races, Tent Pegging, Hurry to School Race —form a useful variation from the routine programme so often found.

Entries for the various events should be graded according to age and physique, a system of handicapping being used if necessary.

The preparation of the tracks will, of course, depend upon the size of the ground. A diagram of suggested arrangement is shown in Fig. 2.

For the elliptical track, there should be four or six lanes, 440 and 220 yards round, marked at two points for the start and finish, and at points midway between these for relay races. Across the centre of the ground should be the 100 yards track, which can also be used for hurdle races, the hurdles themselves being stood alongside until they are to be used.

The long jump pit and the high jump stands may be placed in their position as shown.

The obstacle races will need a special track, The following are suggested obstacles:—From the start, for 20 yards, run in sacks; then climb through suspended motor car tyres; crawl under a tarpaulin or net to eat the "treacly buns" which are hung in a line between two jumping stands; on to the buckets of water where a cork must be removed by the teeth only—an excuse for a very necessary wash after the treacle—and so to the finishing post.

Throwing the cricket ball may be held along the 100 yards track.

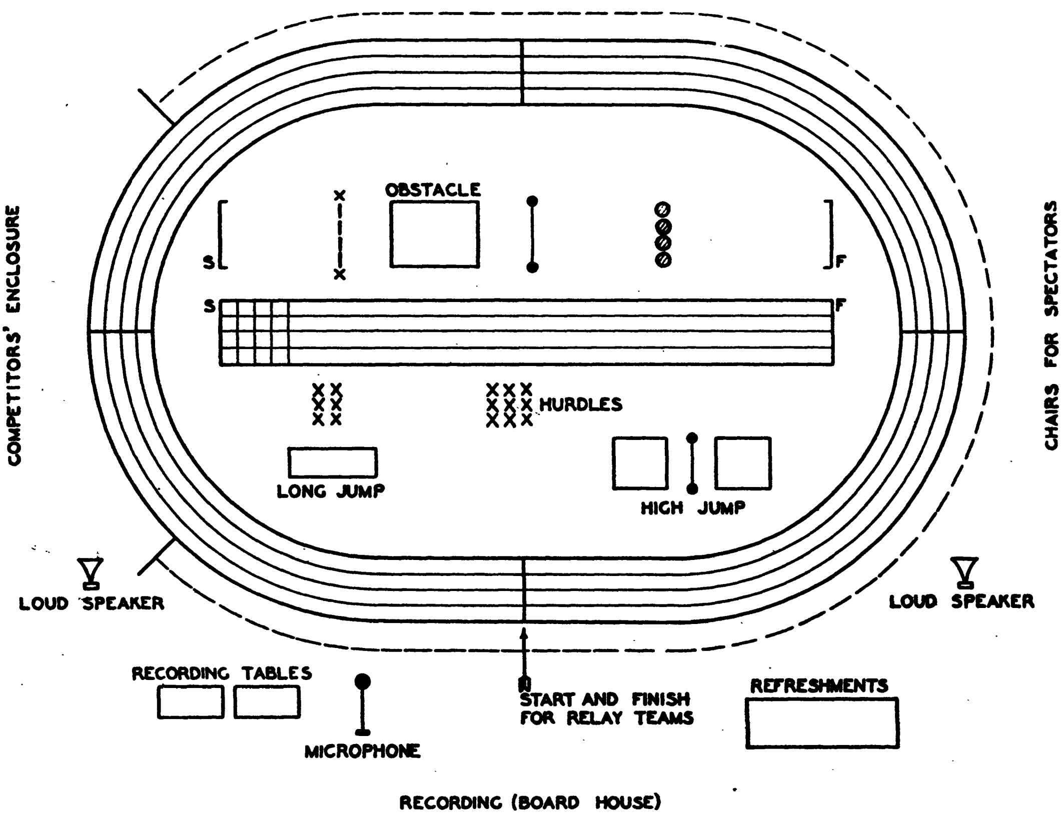


Fig. 2. Diagram of a Track for a Sports Day

On such a day as this, willing help is forthcoming from parents and friends of the school, who will be only too ready to act as officials, to mark out the ground or to provide refreshments.

It has been found that the formation of a Parents' Committee, which meets to discuss the preparation for events like this, can be of inestimable help. There are so many details to consider which may appear trivial at the time, but it is often the little things which are omitted which have a great bearing upon the success or failure of all projects. Insufficient seating accommodation, failure to provide shelter in case of inclement weather, undue pauses between heats and events may all tend to mar the enjoyment.

Parents are ever ready to respond to the request for prizes if it is decided to give individual records, and it has always been found advantageous to hold a prize distribution on a club evening succeeding the sports and to make this a social event rather than a formal ceremony which characterises the average School Speech Day.

MARKSMAN'S CLUB

This is a highly criticised section of club work for which there is a great deal to be said, for this activity interests a great number of lads who take part in no other sport, and the more numerous and interesting the opportunities extended to the boys, the better the results obtained in the long run.

This practice of rifle shooting has been deprecated by those with anti-war views—which of us does not share their outlook?—but the object of such a pastime is not to train lads in warlike practices, but to give to them a highly specialised form of hand and eye training.

The requirements for this club are small. The range itself should be about 30 yds. long. As only air rifles are to be used, the butts should be constructed of five-ply wood and each butt should be approximately 6 ft. by 5 ft. and be placed against a wall. If the shooting is to be done inside in the evenings, a corridor or two adjoining class-rooms may be utilised, or where possible the open space or garrets above the class-rooms. Where the space is accessible the rafters are boarded over so there will be no danger of lads stepping on to the plaster of the ceiling. Gym mats can be spread out on which the budding marksmen may lie when shooting.

Great care should be exercised in the conduct of the club. Preliminary talks on care needed in the handling of firearms, especially when loading, should be given, and the danger of pointing a rifle at anyone, even when it is known to be empty, should be emphasised. There must be certain fixed rules observed such as the following:—

1. No one must fire at a target if there is anyone in front of his rifle, even though he may be far to one side of the marksman.
2. No rifle may be pointed at a butt if a marker is pinning up a new target or checking scores.
3. Only slugs may be used for ammunition. Darts are too dangerous and much too expensive.
4. All rifles must be cleaned and put away after use.
5. Where boys bring their own rifles to school these must be brought in a case, or carefully parcelled in brown paper.

Ordinary standard targets should be used for both practice and competition use, and be marked with a bull, and inner and outer circles of five points each. The calling of positions of shots should be practised, such as "Outer—seven o'clock," "Five points—two o'clock," the positions being observed with a pair of field glasses if not visible to the naked eye.

In the course of the year it will be possible to arrange competitions not only among the members of the club themselves but also inter-club competitions, when some trophy may be awarded for the team securing the highest aggregate of points.

INDOOR PASTIMES CLUB

The aim of this club is to give recreation to the boys during the winter months when it is impossible to devote as much time to outdoor athletics as in summer. Naturally the scope is very wide, and may not be restricted to games. Many of the members may wish to include other activities in the programme, such as useful arts which can be practised at home, from the artistic covering of books to the making of useful household oddments.

But it is only natural that the recreative side will receive the more support, and the games available should include table tennis, "bull and bear", deck quoits, ring boards, bagatelle, and table games such as chess, draughts, lexicon. There is an almost unlimited choice. Care should be taken to see that an ample number of games is supplied to cater for the members, a rough estimate being one game for every two members. If then there are sixty lads, there should be at least thirty games of various types, ranging from table tennis to dominoes. But certain types of games will need quietness and, if possible, provision should be made for boys to use a classroom where draughts and chess may be played and where they may read or rest.

Throughout the season, running or American tournaments may be carried on, and club championships determined. Other clubs of the same nature may be challenged and many enjoyable evenings spent in competing with them.

During all club evenings an endeavour should be made to make the lads responsible for all material used, and it will be found an excellent practice, where possible, to store all games in one cupboard and place two boys in charge. Their duties will be to see that games are complete when issued and when returned to them, for it is often annoying as well as expensive to lose parts of games. One "man" lost will mean that a chess set is spoilt. Table tennis balls can be destroyed very easily, and if boys are allowed to help themselves indiscriminately from the store cupboard the club funds will need to be plentiful.

Then again, a rota for games should be prepared each evening the club meets—a duty which may be safely allocated to a dependable boy—in order to avoid confusion in the use of the various games. In some cases it has been found advisable to make a small charge for the use of materials such as table tennis balls, or to make a nominal charge for bagatelle. The money collected can be utilised to purchase new games and apparatus.

Of all indoor pastime games, those which depend upon skill are preferable to those which depend upon chance. It is true that some games of chance, such as cards, require a certain amount of skill, but the club is better without them. The club should do nothing to increase the gambling instinct which is a characteristic of the average boy.

CRAFT GUILDS

The purpose of craft guilds is to encourage keen boys and girls and to give them opportunities for extra experience and practice in woodwork, metalwork, needlework, etc. Members are able to do advanced work, beyond the scope of the training for less able children. Membership must be voluntary, so that there is genuine enthusiasm, proof of which will lie in the fact that the children are willing to give up an hour of their spare time for the guild's work each week.

No detailed comments on the work of the guilds are possible for by its very nature the work will depend entirely upon the technique and scope of the instruction in the school concerned. In some craft guilds, the children carry on with a piece of work they have started in school hours. In others their guild work is compulsorily quite apart from normal activities. In any case more latitude is given in regard to talking, wandering about, discussing each other's work, etc., than during lessons, so that there is an entirely natural atmosphere in the craft room, and the members of the guild feel that they have special privileges and can be trusted not to abuse them.

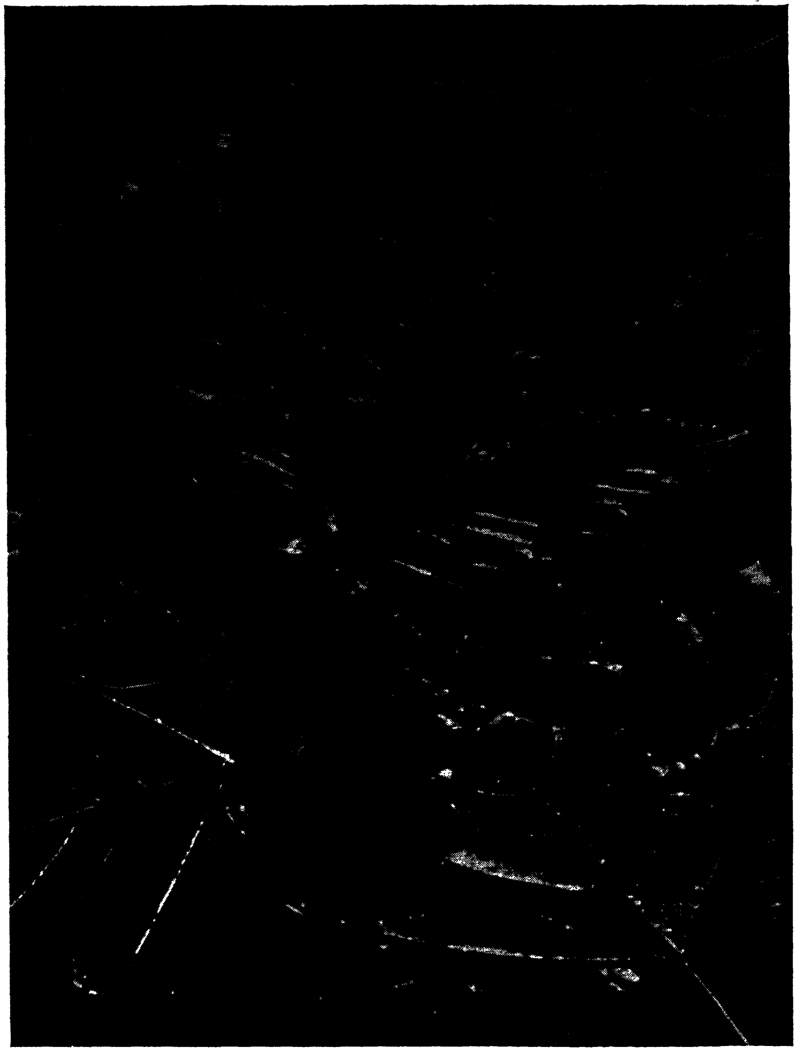
Special privileges for guild members might be devised; for example, visits to museums, exhibitions, craft workshops, etc., and the offering of an annual prize for the best example of craftsmanship, or contribution to a suitable trade magazine. Here is an extract from a school magazine, contributed by three guild secretaries—two boys and a girl.

"All our members are keen and we are very proud of our membership of the three Craft Guilds in our school. In woodwork, we make such things as wireless cabinets, step-ladders, cupboards and chair frames which we upholster. In metalwork, members make bowls, fire screens, ash trays, gongs, letter racks, paper knives, iron lanterns, chromium plated steel lamp standards, and so on. Our biggest job so far has been our six-foot working model of a three-colour traffic light, the electrical and timing apparatus for which was contributed by the members of the Scientific Society. In metalwork, too, we have designed and made badges for members, but the girls of the Needle Guild refuse to wear them. They have embroidered badges of their own. In the Needle Guild the girls do canvas embroidery and all types of appliqué work, needle-point lace, embroidered garments in delicate materials, hand-embroidered outer clothes, table linen, and much very interesting weaving and rug-making. The Craft Guilds are flourishing!"

ART CLUB

Purpose and formation.—An art club in a school offers to the children opportunities for further experience in various types of art and crafts, some of which are taken in school, and some for which there may be no time available during school hours. It can be used to encourage gifted children to extend their powers, and to attempt to find for less able scholars suitable media through which they may express themselves. The club is a convenient organisation for the arranging of valuable excursions to such places as art galleries, libraries, museums and local beauty spots, and the resultant criticisms and discussions should lead to greater appreciation of beauty in all its forms. The club also offers to children with an art or craft hobby a pleasant environment in which they may work.

In most lively and interested classes there are children who are willing and even anxious to finish some good class work in their spare time. These are the children who form a valuable nucleus for the club. Usually the



[*Photo: Ilford Ltd.*

ART IN NATURE

greatest difficulty is in restricting the number wishing to join. If the numbers tend to become unwieldy, creating a possible necessity for ordinary class methods, either the number of members should be reduced or, better still, the members should be grouped and allowed to attend alternate meetings or form sectional meetings, which all children interested in one particular form of art or craft attend on one evening.

The intention of the teacher to form an art club is best made known in the schools by a well-designed poster, followed by a talk to the various classes concerned. Much depends on this introductory talk, for those to be encouraged are the children the most interested, rather than the most talented. Talent can be acquired later, but there must be spontaneous interest and desire for membership if the club is to be on sound lines. A meeting of probable members is called, and officers are elected. It is usually found that the children who attend this inaugural meeting are interested in only one or two sections of the various types of art and crafts. If the number of children anxious to join the society permits it, sectional meetings are most profitable. The frequency of the meetings depends upon the keenness and available time of teachers and children.

Types of work.—The work of the art club will naturally be dependent to some extent on the type of work taken in school hours, for the members will generally ask for work involving processes which have been learned in ordinary lessons. They should, however, be encouraged to branch out along new lines so that the work of the club is not merely a reflection of ordinary work, but develops its own individuality and characteristics. Choice of work depends on the desires of the individual member, but in those cases where he selects some type entirely unsuited to his attainments, then it is for the teacher to suggest tactfully a more suitable project. For example, a member whose bookcraft technique is weak might bring a large volume from home to re-bind. In such a case the teacher might suggest that, first of all, he re-cover a small single-sectioned school book, and if that does not appeal, the co-operation of a more expert member might be invited.

At various times members will put aside their individual work, temporarily, and will attempt large projects, such as the making of scenery for a school or classroom play. If the members have some sense of responsibility and discrimination they can well be left to select their own part in this type of work. The talented ones will set themselves the most difficult tasks and the others will automatically see to the painting of large masses or to the cutting out of large areas of paper or cloth. Such work advances very quickly in a club, for the children are happy and confident because they are tackling work which is interesting and well within their powers, under natural conditions, without strain or stress, in an atmosphere of free talk and discussion—a co-operative effort which brings out the finest features of school society work.

In the early stages of the life of the club it is advisable to have a list of suitable models or exercises available, so that any member who finds himself without concrete ideas may select for himself from the list a job that he feels he would like to do. Every member is then sure that the club can offer him something attractive, interesting and purposeful. A Needle Guild can be profitably combined with the Art Club. Boys are usually interested in fretwork, not the intricate and delicate model-making so popular a few years ago, but in the actual sawing. This interest can be used in the making of a frieze of fretwork figures for classroom decoration. The figures should be painted in bright poster colours. Such schemes as a *Mickey Mouse* frieze, a jungle animal frieze, or soldiers and ships through the ages, work out very attractively. Certain figures can be used, too, for small calendars, and if sold will make a useful contribution to club funds. The financial aspect has to be considered carefully in connection with the more expensive craftwork, for it will be appreciated that dozens of models costing more than a few pence cannot be made without a market being found for them. The market is there if the models are suitable, for members should be encouraged to make objects which they or their parents or friends intend to buy. On the other hand, wallets, purses, book-covers, calendars, etc., may be made for sale at bazaars held in school or elsewhere, if the cost of materials is covered.

The school magazine provides an opportunity for club members to do some useful work. Since only the really interested children are enlisted in the club it can be taken for granted that most of them will attempt to produce something worthy of publication. It will often follow that the art editor of the magazine will be a club member and he will see that the assistance of the members is obtained. If he is a boy with initiative he will probably give individuals some work that is suitable for them to do, for example, allocating lino-cutting or pen sketching to those interested. The value of art clubs has increased since the advent of free-expression art teaching. The free discipline and natural atmosphere of the club is admirably suited to the type of work advocated in this new method, for the children approach it with the attitude of freedom and confidence which is so desirable. Results of work in the "New Art" are usually more satisfactory in the art club, because of this freedom, than in any other type of school art organisation.

Most teachers of art or crafts have found that there are periods, probably of about ten minutes' duration, in many art lessons when the children have no set work to do. There are many ways of keeping children profitably employed in these short intervals, and one of the best is the use of the *Spare-time Book*. This is a small drawing book in which the children may write an original continuous story and illustrate it with carefully arranged and framed drawings. The art club is an excellent place to begin this type of work, for the spare time books of members will be sufficiently attractive to give an impetus to the other children. There is no reason why interested members should not be allowed to continue this work in club time if they so desire for this simple project will give an opportunity of applying many processes learned in class, such as covering in boards, broad-nib lettering, design, illustration, stencilling, etc. If the class or the club approach this idea with freshness of mind and originality, the results can be very pleasing.

It is often found that the most popular section of the work of the club is outdoor sketching, particularly if the outings take the form of picnics. This approach, new to many of the children, stimulates interest and often brings freshness to school work. The value of these excursions is greatly increased if they are thoroughly prepared and taken with a definite purpose. An excursion planned to make studies of trees, cottages, or architecture, for example, is likely to provide material of greater value than one that is taken with no particular aim. The main characteristics of the object of study can be dealt with rapidly in the club beforehand, so that the members have definite knowledge upon which to build their impressions. A series of excursions such as the above will provide a number of sketch books full of interesting material which will be a pleasant record of the activities, and also be of value for reference in school lessons.

A similar definite purpose is desirable in the club members' visits to art galleries and museums, for if the purpose is aimless, the viewing will be aimless too. A previous visit by the teacher and, when necessary, co-operation with curators, will help in the formation of a clear aim for each visit by members. One school art club's members found themselves dissatisfied with their paintings of skies, clouds and seas. They had three separate visits to the local art gallery to study artists' interpretations of each of these three types of scene. No other aspect of art was even mentioned during the visits and it was afterwards found that the children's own technique had greatly improved. The small and convenient size of an art club makes possible such useful visits, when it is not possible for whole classes of children to adopt a similar method.

The majority of the work of an art club should have a practical purpose, as has been shown above, but it will be found that much of the work does not suit the purpose even though it may be of considerable artistic merit. An admirable way of showing appreciation of this work is to include it in an exhibition of club activities which might be held at term end or on open days. This is

From the picture by
J W Waterhouse, R A

ECHO AND NARCISSUS

[Reproduced by permission of the Corporation of Liverpool.

Narcissus, loved by the nymph Echo, did not return her love, and she died of grief As a punishment, the gcds caused Narcissus to fall in love with his own reflection in a spring. This fruitless love made him pine away, until he was changed into the flower that now bears his name.

an occasion on which members will feel justly proud and the teacher should make every effort to ensure a successful exhibition. Care should be taken to see that all work is displayed to the best advantage. A carefully prepared poster or large notice might draw the attention of visitors to the fact that they are viewing the special activities of the school's art club.

SCIENTIFIC SOCIETY

General note.—Science is so wide a subject, embracing so many separate sciences, that it is impossible to cover efficiently in school time all its branches, and the work of co-ordinating the various sections into a united whole is very difficult. In school time, teaching must necessarily be along certain well-defined paths, covering some parts of the subject and omitting others. A school scientific society proves a useful method of overcoming some of these difficulties, for it offers to specially interested children opportunities for work and research in one particular branch. In a large school it is possible to establish various sectional groups, each working on its own material and occasionally providing topics for a general meeting of the whole society, when each section might give a lecture or exhibition of its own work. By experience, the teacher of science will know the children who are keen on particular branches of the subject, and should nominate a small number from among volunteers to form each section. Some schools have ten members in each of five groups, giving a total membership of fifty. The head teacher of the school might be president, and the science teacher chairman, with an elected secretary for each group. There might be a general secretary and small committee to co-ordinate all the activities and keep records of general meetings and co-operative work, adopting the same procedure as is suggested for other societies. The sections to be operated will depend on the science teacher's personal interests and on the facilities available. A brief description of the work of a few sections is given here as an indication of the type of activities which might be undertaken. Further developments depend on local conditions.

A photography section.—All members should have access to a camera, and if one is permanently available in the school it can be used for recording many kinds of school work. An occasional talk by a professional photographer or by a skilled amateur would help the members to improve their technique and to develop artistic appreciation of good quality photographs, which, when made by the section, could be reproduced

for exhibition purposes and become the property of the society. A dark room is essential, and children might be appointed as supervisors or stewards of the dark room, with assistants if necessary. Members could build up their knowledge from talks by the teacher and from their own experiences, learning from their mistakes.

could be divided into various classes; landscape, seascape, portraits, nature studies, holiday snaps, trick photographs, and so on. Prizes might be given for the best work in each class, and such an exhibition could become a delight to each member, a matter of pride to the section and an asset to the school.

[*Photo: Ilford Ltd.*

SUNSHINE AND SHADOWS

A developing and printing service might be formed to provide funds for the extension of the work, such as the provision of an enlarger, or a bigger camera, and when the section becomes really ambitious, a ciné-camera and a projector. In time, this section could become entirely self-supporting with unlimited range and scope. An exhibition of photographs, held annually, would provide a useful stimulus. The exhibits

A gardening section.—A school in which gardening is a definite part of the curriculum might put aside one plot for the use of a gardening section of the scientific society. In others, a small piece of land might be available for the purpose. The section would have a head gardener with assistants, and would hold meetings to decide upon policy and the design of the garden, but the greater part of the work would be practical with occasional lectures on various gardening topics. At a later stage the building of frames or a small greenhouse would further extend the scope of the work. Where a large section of land is available the scheme could be more ambitious. Decorative gardens, with lawns, rockeries, pools and fountains would add very greatly to the interest of the members and to the prestige of the school. A small nursery garden could provide the necessary seedlings for transplanting, while a market garden could provide goods for sale to the public, the proceeds providing for further stocks of seeds and plants. The section could produce an interesting and useful folio of gardening information with cuttings from newspapers, many of which give a weekly article complete with illustrations. Each member might also make himself responsible for one topic in the folio, and by reading, research and other methods of collecting information become recognised as the section's expert. The secretary would keep a record of the meetings and a log book of work done, and of designs and plans. Such a scheme needs a teacher who has some knowledge of gardening routine, but where it can be developed it offers to the children concerned a chance for a useful and interesting lifetime hobby.

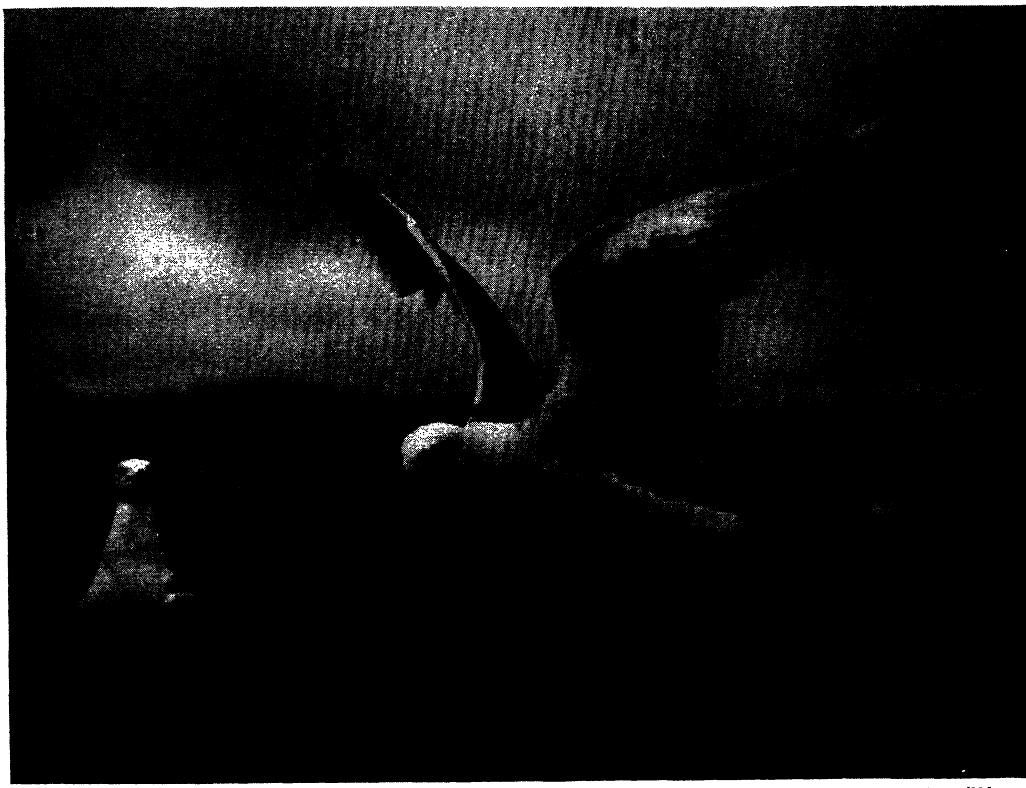
Nature study section.—This section would be a great factor in teaching a true appreciation of the beauty of nature and in opening up a new world to interested members. Collections of flowers, leaves and plants could be made and photographs of animal and bird life taken in co-operation with the photographic section to provide a permanent record of the work undertaken. Alternatively, each member might build up a personal folio of specimens and pictures about which he would be prepared to obtain some detailed knowledge. Such special study on individual lines should be encouraged so that in time each member could give a lecture to the section on his particular interest. Rambles could be organised with the purpose of collecting specimens for the various collections, each member seeking only samples for his own branch of nature study. Each such ramble should have this definite aim and purpose, and afterwards the material collected should be the object of much lively discussion.

If the teacher's interests lie in this branch of science, it might be possible to set up larvæ cages, aquaria, etc., so that studies of life histories could be made under the best possible conditions. A secretary would be required to record the activities of the section, and each collection would have its own "keeper" and assistant, whose work it would be to see that all specimens were properly positioned, labelled and catalogued. Some such scheme as this ensures plentiful variety for the members, opportunity for work within each member's interest and ability, and constant practical work which builds up an ever increasing foundation of knowledge.

Bird fanciers' section.—The first need of such a section is an aviary, which might be built in a school garden, adding greatly to its interest, or a window in the science room might be partitioned off to form a flight, with airy box-shaped sleeping accommodation provided alongside. The aviary should be as spacious as possible, and although many kinds of birds would live quite happily in the school and be objects of interest, it is probable that budgerigars are the best type to keep. These birds provide fine material for photographic studies, and useful data on their lives and habits could be collected. If one or more pairs of birds were kept, the life cycle could be studied from the egg stage onward, fundamental processes in reproduction thus being presented to the children in an impersonal manner. It is usually found that at holiday times children are willing to look after the society's birds when the school is closed.

Microscope section.—This is another example of a specialist branch of nature study, which can be most successful if the necessary apparatus is available. A microscope is essential, and perhaps a micro-projector could be made to give enlarged views. A simple and effective form of micro-projector can be made by placing a 6-volt or 12-volt car-headlamp bulb behind a slide in a darkened room, with a microscope in front. An enlargement up to about 12 in. diameter can be reproduced on a screen about 2 ft. away. The making and collecting of slides would be the work of each member, while a series of studies on the life-histories of microscopic flora and fauna could be arranged. A camera capable of being adapted to microscopic work would be an asset; here again the photographic section of the scientific society would find scope for useful effort.

In addition, garden pests could be collected and studied and the gardening and microscopic section could collaborate in the detection and destruction of such common pests as greenfly, red spider and others. Studies of the structure and function of living creatures could be made, thus forming an introduction to simple bacteriological work, which, though in its later stages is beyond the scope of the course, serves its purpose in presenting to the children yet another branch of scientific study.



[*Photo.: Ilford Ltd. and A. V. Bibbings.*

POISE

Electrical and wireless section.—As in other cases, this section is dependent on the knowledge and technical ability of the teacher, but if the one in charge is a knowledgeable enthusiast, this section will be a great success, for to those who have a sound groundwork of technical knowledge, wireless is a fascinating hobby. The members should collect old wireless parts, and could soon provide sufficient material for the construction of a simple receiving set, to be improved upon later as further parts become available. Classes in receiving and transmitting by means of the Morse Code could be held, the only apparatus needed being simple spring contacts and a flash-lamp bulb.

A discussion on the many branches of electricity and wireless reception is beyond the scope of this article, but it can be pointed out that, for reception of wireless transmissions of all kinds, a wireless set with plug-in coils for all wavelengths is the most suitable for the section. A single-valve receiver, with or without a low-frequency amplifier, would on the short waves, receive stations thousands of miles away, and in this country alone there are hundreds of amateur transmitters who, in return for a report on reception on 40 metres or 20 metres, would be pleased to send an acknowledgement on what is known as a *Q.S.L. card.*

If members can receive and report on transmissions on short-waves, the cards might become a fine collection, with stations received entered in a special log book. There is in this type of work a lively sense of exploration and a wide scope for experimenting in a comparatively new aspect of science. This section could also do much useful construction of the lighting arrangements for school scenery and might also be responsible for the maintenance of the wireless set and wiring used for the reception of B.B.C. programmes.

General activities.—Meetings of the sections might be held weekly, at pre-arranged times, each section having its own alloted place in the science room. Occasionally a general meeting of all sections might be held to co-ordinate the work, or for a talk or demonstration given by each section in turn. Visits to local works and places of interest, within the scope of each section's work, could be arranged by the officials of the sections. In a well-organised society these officials can relieve the teacher of much of the detail and leave him to act chiefly in an advisory capacity. If the study of science is developed on sectional and practical lines, the members of the society will have their creative faculties awakened, and from the wide range of material and practical work offered they may find an intellectual interest and a hobby that will be of permanent value to them.

HOW AND WHY CLUB

The name for the above club was suggested quite naturally by a boy at the conclusion of an informal group talk two or three seasons ago. Somehow the conversation had turned upon traffic lights which had then just been introduced, and an animated discussion was in progress as to their relative merits and demerits. Why were they being erected at cross roads, so creating traffic blocks and wasting motorists' time? Where were the policemen? Couldn't the motorists exercise enough care in crossing a road without having to depend upon such mechanical contrivances? What was going to happen at the junction of five lane ends, etc.? But, said some, any safety device, no matter how simple or complicated, is going to be useful now that so many new motor cars are being put on to the roads. They would leave the police more time to devote to their other duties. Eventually, the natural instinct of curiosity was aroused, and came the inevitable question, "How do they work, particularly the automatic type?" "Couldn't we find out?" inquired the tactful organiser, and as a result the "How and Why Club" came into being.

The secretary wrote to a responsible member of the local council, explaining that, in common with approximately thirty of his colleagues, they would like to find out more of the workings of traffic signals and to have the ideas fully explained. As a result, the ever-ready co-operation of the police force was secured, a local officer came along and gave a most instructive talk to the group, illustrated by models and drawings, after which the party was taken to one of the danger points, where much was explained to them about volume of traffic, traffic offences, causes of accidents, etc., a great deal of which was new to the teacher in charge.

At subsequent club evenings working models of these signals were made both of the "time" and the "automatic" variety, by means of using an old wireless transformer, 4-volt bulbs, an old brass curtain rod, ply wood and cardboard.

The automatic telephone had next to be explained. How were calls made? What was all this dialling business about? "Press button 'A'" and what happened? Actual calls were made from a near-by call box. The local exchange was called. Here were people thirsting for knowledge; what could they do about it? "Come along and see us," said the exchange, "and we will endeavour to explain this black magic." To the exchange we went, and traced the effect of dropping our two pennies into the slot, dialling our number, pressing button "A" or "B" as demanded. Apparatus for recording the number of pennies or sixpences inserted was inspected with great interest, and the sound system whereby a sixpence strikes a different note from the penny gone into thoroughly. The futility of budding criminals attempting to extract pocket money by pressing button B or in other ways was mentioned and the fact that public call boxes, which were for the convenience of the public in general and must therefore be respected at all times, firmly stressed. Innumerable questions were asked and answered, and eventually the boys were delighted to learn that they could borrow an experimental set of apparatus. This solved the problem of organisation during club evenings for some little while. (For an article on a Telephone Project consult Volume II.)

Gas meters, electric meters, electric irons, radiators and other electrical gadgets all came under consideration as they were suggested by individual lads. There was no dearth of material.

Not only were activities directed to the mechanical side, but questions were asked relating to a multitude of subjects. How were maps made, and books printed and bound? Some of the problems were answered by practical means, others by discussions and lectures; some by visits to places concerned, others were referred to other clubs for consideration.

The resultant work done in the course of the year was both instructive and useful and the boys amassed a great deal of knowledge of things around them which would serve them in good stead in later years. It can confidently be said that if there were more schemes of work in science and handwork based on the same lines as these, much more satisfactory results would be achieved.

CAMP CLUB

This must function definitely as a school club, and is one of the most important of the activities carried out. It is a true saying that the week or more of camp life is more important than the rest of the school social work which is carried on throughout the year. It is not merely a glorious holiday and a health-giving recreation, but rather the foundation of the school's spirit and tradition. It is here that the true spirit of comradeship and friendship is learnt and where a spirit of self-government can show itself at its best.

The sense of anticipation of the school camp gives almost as much pleasure to those who are going as the realisation and memories of it. It forms the topic of conversation for the whole year and is a wonderful disciplinary measure, for there is no greater punishment meted out to a lad than to erase his name from the camp register.

[*Photo: Kodak Snapshot*

THE BLACKSMITH

At no time does one get to know a boy so well as when he is living under canvas, for it is then that the boy shows himself as he really is. He is more natural than in his home environment, and his nature is either at its best or worst when in camp. We seem to notice more of his behaviour, and it is often the case that the weak, insignificant boy proves himself a leader full of energy and power, while the leading boys in school show themselves as members of the herd. Many lads will look back, usually with lasting gratitude, to their first week in camp as being the changing point in their lives. It is here the bully and grouser comes into his own, but at the same time the characteristics of the happy, unselfish and charitable lad are made more manifest.

A full description of camp organisation and suggestions for its conduct are given elsewhere in this work, and it is only to be hoped that even more schools will organise their individual camps in years to come and test to the full the effect of this activity upon the subsequent work and tone of the school. (For an article on The School Camp consult the *Index*.)

SCHOOL SAVINGS CLUB

It is appropriate here to mention a method adopted in some schools to encourage children to join whatever form of thrift organisation is in the school, and to assist in maintaining their interest.

Each child who joins becomes a member of the club, and can buy for a few pence a special badge. The club members meet once a month, and at the meeting the club secretary reads out the total contributions and withdrawals from each class, and the names of new members; the method by which he declares the winner of the championship is very simple. Each child bringing a contribution receives one mark, whatever the amount of money brought, whether it be a penny or a pound. This is an important point, for the child then feels that the school is primarily interested in him rather than in his money, and the child from a poor home has an equal chance of assisting his class with the child of richer parents.

In each class there is an appointed child secretary, who writes in a special notebook the marks won each week. These marks are added to form a progressive total, and at the end of every four weeks the class secretary hands his book to the club's general secretary, who, in the monthly meeting of all members, announces which class has the highest number of marks. This class is then the champion class of the club, and holds a banner or shield in the form room until the next meeting. Four weeks is sufficient time for the duration of a championship, so that every class can feel that opportunities for winning it recur frequently. The name of the champion class could be affixed to the banner or shield to form a permanent record of past victories.

There is useful incidental propaganda for the school's savings club in a simple subsidiary scheme by which a *star* and a *diamond* are awarded each week to the two classes having the greatest number of contributors that week. The star and diamond are about 6 in. long, and could be cut from metal, or brightly painted cardboard, or stitched in contrasting colours on two cloth flags or banners, to be hung in the two form rooms for the week. The class secretaries accept the tokens with due ceremony in a school assembly each Friday afternoon, thus providing an unobtrusive reminder to all the school that on Monday morning will come fresh opportunities for new members to join and for more marks to be obtained.

The star and diamond classes might receive a few minutes' extra play in recognition of their achievement. Whatever reward is offered, it should be given to the whole class, and not only to members, for this is a club which many children would like to join but may be prevented by the poor circumstances or lack of interest of the parents, and it is undesirable that they should be penalised.

LITERARY SOCIETY

Aim and formation.—The aim of a school literary society is to develop in those children who are specially interested in literature and play-acting a more extensive experience than is possible in ordinary classroom lessons, and to give them a happy atmosphere in which they can develop a spirit of co-operation and self-confidence. Membership must be voluntary and should be limited to twenty or twenty-five children. It is a good plan to compile a waiting list of children who will automatically become members as others leave school or find interests outside the society. All members of the staff taking English or having experience in dramatic work should be co-opted and appointed vice-presidents, with usually the head teacher as president.

At the first meeting a child secretary should be appointed to keep a minute book or other record of the society's activities, and when the aim and suggested work of the society have been discussed, a small committee of four or five scholars should be appointed to assist the teacher who will act as chairman. The committee then proceeds to draw up a definite programme of activities for the ensuing month. An attractive notice board with the name of the society in bold lettering should be placed outside the classroom in which the meetings will be held, and on it might be placed a list of officers, the provisional programme for the session, notices of future meetings and advertisements of future performances or rehearsals.

The activities of the society fall into two divisions, the study of literature, and the reading and acting of plays. In the first section, co-operation with the local library is desirable, and opportunities are afforded for reading and discussing books and authors in a more extensive and free way than is possible in school lessons. Members can be led to find out the shortcomings of some of the books and periodicals which they read, and to discover new authors who are introduced in lectures by members of the society. These lectures might take the same form as the book talks given by the B.B.C. in certain of their literature broadcasts, that is, the gist of the story can be given in readings from the most exciting parts of the book to whet the appetite of the hearers for the remainder. This method offers a wide range of material. If each member can be persuaded to give a paper on some author or book, the necessary preliminary research in the world of books will have a beneficial effect on the taste of the readers, and widen their field of vision, though it must not be expected that members can be led to appreciate advanced classics.

Care must be taken that the chief aim shall be the cultivation of good taste and understanding in reading. The works of modern writers should be dealt with, rather than classics, and there should be constant effort to maintain freshness of appeal and of interest, with a friendly relationship between teacher and members. The society provides an opportunity for the cultivation of a sense of judgment and discrimination with regard to newspapers. An interesting activity is to take three different newspapers on the day of the society's meeting and to study their varying attitude toward political and social events of the day. If the children can be led to realise that an incident which one newspaper regards as a calamity, is looked upon by another as a triumph, the society is doing much to cultivate in the members a valuable sense of independent judgment.

Play acting and reading.—The reading and acting of simple plays should be one of the most enjoyable and entertaining parts of the society's programme, especially when every member has developed confidence through experience. For readings, the cast should be chosen by the committee, and it is desirable to hold at least two rehearsals. A stage manager and property master are elected, who should prepare a list of everything necessary for the smooth running of the play. If a stage is available in the school hall, the reading can be advertised, and members of other societies can be invited to attend the performance. If a classroom only is used, the furniture should be arranged to give adequate stage space, at the same time allowing for the comfort of the audience. Costume and scenery are unnecessary in a reading, although, if employed, they add to the enjoyment. The only necessity is a side screen or chairs to mark entrances and exits. The chief advantage of play readings is that they can be put on with a minimum of preparation. In fact, many successful readings take place with the readers sitting in a semi-circle, without movement or action. By this method the members can be introduced to a wide variety of plays with little effort.

In the case of fully produced plays the society should be the most important source of entertainment for the school concerts, and when the members are sufficiently skilled in dramatic work there is no reason why they should not enter for local dramatic festivals and competitions, though this must not be the primary object of this aspect of the work. One fully produced play each term is the maximum that can be expected, but if the numbers are large enough the society can be split into teams, each of which produces its own play, thus introducing a useful spirit of emulation and friendly competition. There is an ever increasing number of plays available, and if no charge is made for admission and the performance is private, most plays can be used without the payment of copyright fees. Original sketches by members can be tried out, with helpful criticism offered by members on composition, style and production. A property box should be kept, to which all members contribute, and from this, costumes may be adapted by the girls or by the mothers of boys. Make-up is usually undesirable. The maintenance of the property box and the making of scenery offer activity for those members who do not act. The ideal literary society is one in which every member takes a useful and active part in the work.

Outside activities.—There are, in most areas, frequent opportunities for observing the efforts of adult literary and dramatic societies. Seats are often obtainable at reduced rates for school parties, and a group of members viewing such performances would not only increase their own experience, but also have material for much interesting discussion and criticism on various aspects of the play, acting, scenery, lighting, and the general production. The visits of companies producing Shakespearian plays also offer similar opportunities. The films, too, sometimes reproduce famous novels and plays, such as those of Shakespeare, Dickens, Dumas, Wells and others. Members would find much of interest and educational value in a group visit to such films. The homes of famous authors, and the museums which are sometimes contained in them, if there are any available in the district, provide good material for visits and for later discussion.

If these varied society outings are to fulfil their true purpose there must be preparation beforehand, and there should be opportunities for expression by the children afterwards. The preparation will be simple and lightly dealt with, for the close and concentrated attention necessary in classroom lessons is undesirable in a society composed of volunteers. The follow-up work after a visit should also be of a friendly and social nature, with brightness and humour predominating. The educational purpose of the society must be unobtrusive: the first essential is that members shall feel that in all their activities they are part of a friendly and happy community.

Keeping records.—The appointed secretary should be a child of strong personality whose written English is of good quality. He will keep the minutes of all business meetings; these should be read and approved at the outset of each subsequent meeting. At first he will probably need assistance, but with practice he should become independent. In addition to the minutes of meetings a complete record of all the society's activities should be kept. These might be a list of actors in each reading or play production, programmes of concerts, written accounts of visits, photographs of members in costume and of places of interest visited, together with pictures, illustrations and newspaper and magazine cuttings referring to any author, book or play which has come within the scope of the society's work. At the end of each term a pleasant feature might be the issuing of a printed or cyclostyled report of the term's activities to all members. Such a record is of interest to the older members and to potential members, and is a further method of building up the essential community atmosphere.

SCHOOL HISTORICAL SOCIETY

Introduction.—Among the many organised activities of the modern senior school, place should always be found for a school historical society. Such an institution, strong and flourishing under the vigorous and enthusiastic leadership of a member of the staff specially interested in the subject, will prove to be of the utmost value in engendering in the minds of the children a real and lasting love of history, and in teaching them to appreciate and conserve the material remains of the past with which our land is so richly endowed.

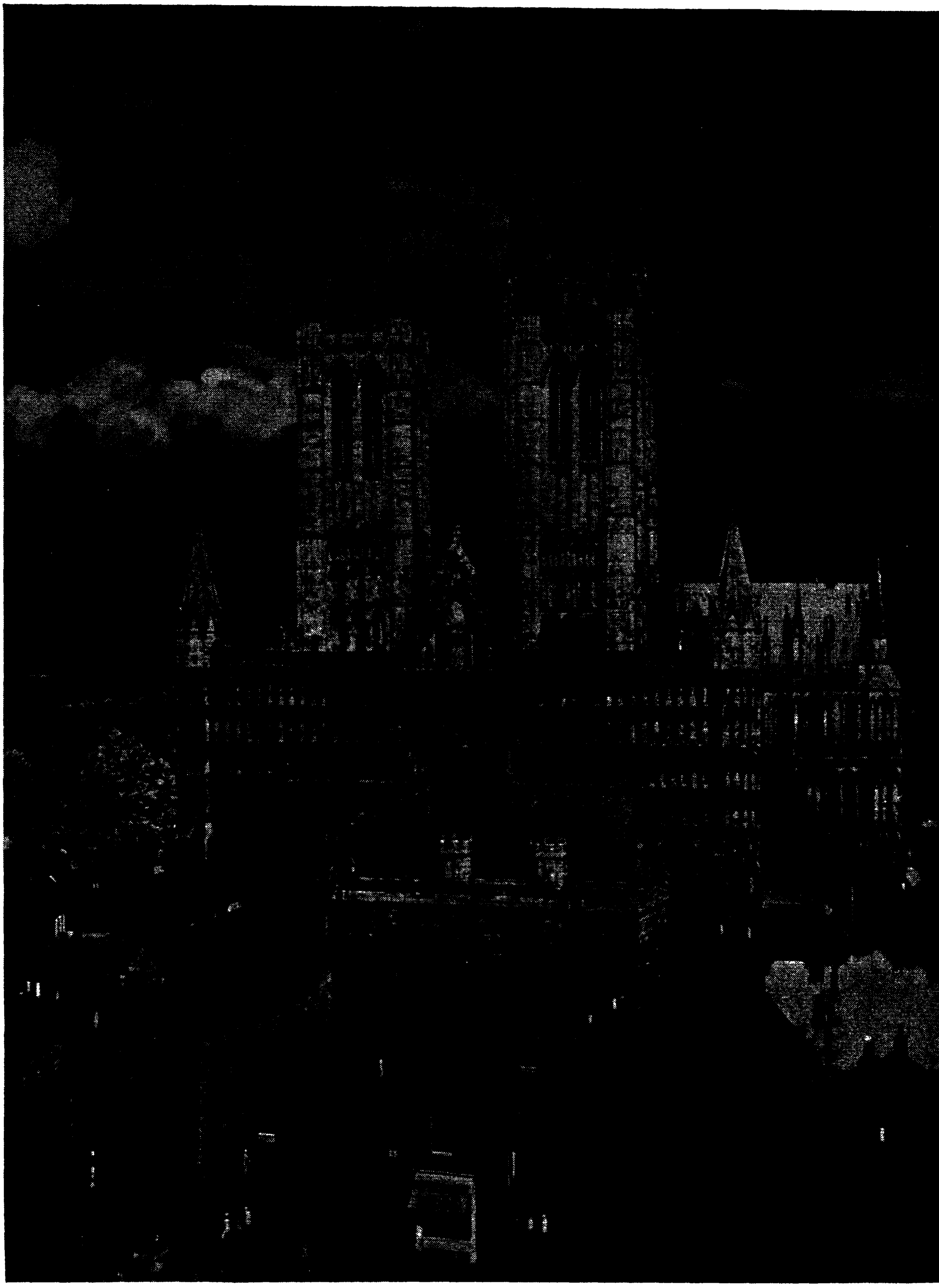
The society should not be too large, indeed it should rather tend to be exclusive, for then the children who are among its members will set greater value on their membership, will feel that they are enjoying a privilege, and will be much keener to take part in all the society's activities. It is suggested that the number of members be limited to between thirty and forty, for more than that number will be found difficult to handle on an outdoor excursion. During the winter, however, more children may be accommodated at indoor lectures, and thus about twenty of the younger ones may be admitted to the society as associates, individuals who, though they may join in the winter activities, may not take part in the summer excursions until they have been elevated to the rank of member.

Officers.—The officers of the society will usually consist of a president, vice-president, a chairman, a secretary or recorder, and a small committee. It is suggested that the president and vice-president be members of the school staff who are interested in the well-being of such a society. The chairman, recorder and committee will be selected by the members. It will be the duty of the chairman to preside at the meetings, and introduce the speakers. The recorder or secretary will keep the records, and be responsible for the drawing up of the notices relating to the various activities. The committee will decide upon the topics of the winter lectures, the arrangements for the summer excursions and will also choose suitable associates to become full members as vacancies occur.

The society should, if possible, hold its meetings in a room in the school building, and preferably in the classroom specially set apart for the teaching of history, where there will be an atmosphere of history and where useful apparatus will always be ready to hand.

It is suggested that in the history room there be exhibited, preferably under glass, the one-inch ordnance survey map of the district, and somewhere nearby a sketch map of the same area, showing the location of the local earthworks, castles, abbeys, cathedrals, village churches and other interesting historical features. Other excellent maps which the members will find of great use, are the ordnance survey maps of Roman Britain, and seventeenth century England.

In or near the history room should be the *notice board* of the society, upon which will be exhibited the list of officers, members and associates, the syllabus of activities for the session and all notices of meetings and excursions. A second board, or preferably glass case, nearby, may be reserved for the exhibition of pictures and cuttings which



[*Photo: Ilford Ltd. and Frank W. Musk.*

LINCOLN CATHEDRAL

refer to events of topical interest, points touched upon in lectures, and local places of historical interest to be visited. Such a feature will be found to be valuable in stimulating interest, and members will be ever on the look out for suitable material for exhibition.

Record of activities.—It is essential that a careful record should be made of all the activities of the society. This record may be kept best in a large loose-leaf book, which may be made by one of the members during a bookcraft lesson in the craft room. It is suggested that the book should be big enough to hold sheets of drawing paper eleven inches by seven inches, upon which necessary sketches may be made, the written record being entered upon sheets of narrow lined foolscap cut to the same size.

This record should contain the list of officers, members and associates, the rules as they are formulated, and an account of all business and activities.

When writing up an account of a lecture, the recorder or secretary should note the date of the meeting, the number of members present, and any business discussed, together with a synopsis of the lecture, and a list of the slides shewn, if a lantern is used to illustrate the discourse.

In the case of outdoor excursions the recorder will note the date, the number of persons joining in the trip, the route taken, and details of the places visited. Sketches made by the members taking part in the outing, will be inserted after the written record.

Lectures, and other winter activities.—The meetings of the society should be held upon some definite evening each week or month, and it is advisable to draw up and exhibit on the notice board the full list of the activities for the session early each term.

During the winter months, lectures given by teachers or members of the society will naturally be of first importance. If possible, these should be illustrated by means of lantern slides, or by pictures thrown upon the screen by the epidiascope, for an appeal to the eye will create much more interest than a formal talk on any subject.

The subject matter for these lectures will more or less follow the personal inclination of the lecturer, but some attempt should be made to see that the subjects are not of one period and that they adequately cover a wide field to suit all tastes. Among the lectures, several dealing with the duties of a citizen in this modern world, and others about local remains might usefully appear; the latter will prove of great use as preparation for the outdoor excursions during the summer term.

Other winter activities might include play readings, the development of historically connected hobbies, and an afternoon visit to a local museum.

It is possible to steer into historical channels some of the members' hobbies, such as the collecting of stamps and cigarette cards, and the cutting of fretwork models and figures. Some accurate sets of cigarette cards, such as those depicting the Kings and Queens of England, Naval Dress, Historic Costume, and Wonders of the Past are of great value and look very attractive when mounted and exhibited in the history room. Similarly there are some interesting sets of postage stamps which members might like to collect and exhibit on loan in one of the society's show cases. Some suggested sets of stamps are the Portuguese series of *Vasco da Gama*, the United States *Columbus* set and the Greek issue illustrating the *Olympic Games*. Many useful and attractive cut-out figures may be made with a fretsaw. These, properly coloured and wearing the appropriate costume of their period, may be grouped and exhibited in a show case to form such interesting tableaux as *A Viking Raid*, *A Miracle Play*, *The Canterbury Pilgrims*, or *Elizabeth Knighting Sir Francis Drake*.

The wintertime, too, is perhaps the best season of the year for paying an afternoon's visit to a local museum. If such a winter excursion is undertaken, however, the children should go to the museum with the special object of seeing and sketching certain definite exhibits and should not wander aimlessly round the show cases.

Organising a summer excursion.—During the summer months, excursions to places of historic interest will be of first importance. The value of such visits, however, will be very small unless they are carefully organised and full preparation is made beforehand.

The first point to be settled is the size of the party, which will largely depend upon the kind of transport available. If the excursion is to be made on bicycles, a dozen members are quite enough for one teacher to supervise, especially if part of a busy city has to be crossed. If the party is proceeding by bus or train, then the number may be increased to between twenty and thirty.

The excursion should always be preceded by a talk, and the route taken should be studied beforehand, as many interesting objects may be seen from the windows of a train or bus. Further, pictures of the main points of interest should be exhibited in the history case, and the children should know exactly what to look for when they arrive at their destination.

It might be well at this point to draw attention to the facilities granted to parties of school children visiting buildings and monuments in the charge of His Majesty's Office of Works. Such parties from grant-aided schools will be admitted free, providing that:—

1. The party is not more than one hundred strong.
2. Teachers accompany the children in a ratio of not more than 1 to 20, and not less than 1 to 30.
3. A special educational permit is produced.

Such a permit may be obtained from H.M. Office of Works, Westminster, London, S.W.1, but application should be made a full fortnight before the date of the visit.

Visiting a historic building.—Throughout the country there are many thousands of village churches, and many hundreds of earthworks, castles and monastic remains; thus in nearly every locality there will be, within easy reach, some interesting examples which will well repay study. The following points to note when examining such remains are suggested:—

When approaching a village church one should keep a lookout for such objects of interest as a lych gate, the village stocks, yew trees, or a mounting block. On entering the churchyard it is as well to make first of all an examination of the outside of the church, and note the different periods of building, as shewn by the exterior architecture. The party should then in a similar way inspect the interior fabric, and finally note the monuments, woodwork, and other objects of interest. After this general tour of inspection the party may split up to allow individual members to make sketches of some of the interesting features. The teacher in charge, however, should bear in mind that it is essential to obtain permission from the vicar or some other responsible person before sketching or taking rubbings *inside* a church.

When visiting monastic remains, the party might begin with the church, the most important building in the monastery, noting the site of the altars, position of the choir and the situation of the night-stair leading from the monks' dormitories into the church. From here a visit could be made to the cloisters, the chapterhouse, refectory and kitchens. The party might be split into groups for sketching various sections of the monastery, including the ruins or sites of such outer erections as the infirmary, the guest house, barns and store houses. Such notes and sketches would then be inserted in the society's record book, on return.

If a castle is to be visited, it is advisable to give in the classroom talk beforehand the

ALPHABET OF ARCHITECTURE—I
(Class Picture No. 71 in the Portfolio)

main points of the castle's history. When the ruin is reached, the best method of procedure is first to examine the earthworks, then to visit the keep or other remains of outstanding importance, and later to take features of lesser importance such as the ruins of the domestic buildings. As in other visits, sketches, plans and notes should be made by separate groups, each detailed to examine a particular section of the remains. The children will find great interest in studying the two Class Pictures Nos. 71 and 72 in the Portfolio—ALPHABET OF ARCHITECTURE. A Note on these illustrations is appended.

Other historical remains which might be visited, if within reach of the school, include such prehistoric antiquities as hill forts, stone-circles, cromlechs, and such Roman

Alphabet of Architecture—2
(Class Picture No. 72 in the Portfolio)

remains as are found, for example, at Caerleon, Wroxeter, Bath, St. Albans, Porchester, York and many other places. Our great cathedrals and walled towns also provide wide scope for society visits. It is always advisable for the members to study the local ordnance survey maps of the area to be visited, and to attempt to visit all the remains marked thereon. Many of these have not yet been surveyed, and by making plans and sketches, and taking photographs, some valuable historical research may be undertaken. Whatever activity the society's members initiate, a complete and attractive record should be made as indicated above.

Note.—The illustration, *The Alphabet of Architecture*, shows the following typical forms:—

PLATE I

1. AISLE—the wing or side passage of a church.
2. APSE—an arched recess at the east end of the choir of a church.
3. ARCADE—a series of arches, either open, or closed with masonry, supported by columns or piers.
4. BASE—the foot, or lower part of a pillar.
5. BATTLEMENT—parapet on top of a wall or building, with openings, or embrasures, formerly used by sentries and bowmen.
6. BOSS—raised ornament, or knob, placed at the meeting-points of the ribs of a ceiling.
7. BUTTRESS—projecting support built on to the outside of a wall.
8. CAPITAL—the head or top part of a column, or pillar.
9. COLUMN—a round pillar.
10. COPING—the capping, or covering course of masonry of a wall.
11. CORBEL—a projecting stone, or piece of timber, which supports a weight above it.
12. CORNICE—the level moulding at the top of a wall, generally beneath the eaves.
13. DOME—a large cupola; a structure raised above the roof of large buildings, generally half-circular in shape.
14. FOILS—the *spaces* between the cusps, or projecting portions of feathered arches.
15. FLYING BUTTRESS—an arched buttress built to support certain parts in the outside of a wall.
16. GABLE—the part of a wall, above the eaves, which is shaped to conform to the slope of the roof which abuts against it.

PLATE II

1. GARGOYLE—a projecting spout used to throw the water from the gutter of a building off the wall.
2. LANTERN—a small structure on the top of a dome to give light and to crown the fabric.
3. MOULDING (Egg and Dart)—ornamental projections, or cavities, forming the outline of cornices, capitals, bases, etc.
4. NEWEL—the central column round which the steps of a circular staircase wind.
5. NICHE—a recess in a wall for a statue, vase, or other similar ornament.
6. OYLET—a small opening, or loophole, to admit light, or for the discharge of missiles in the walls of fortifications.
7. PARAPET—a breastwork, or low wall, used to protect the ramparts of military structures, and the gutters, roofs, etc., of churches, houses, and other buildings.
8. PEDIMENT—the triangular termination used in Classical architecture at the ends of buildings.
9. PILASTER—a square pillar usually attached to a wall.
10. PILLAR—the column supporting an arch.
11. PINNACLE—a small turret, usually tapering towards the top, often placed above a buttress.
12. PISCINA—a shallow stone basin, placed near the altar, with a hole in the bottom to carry away any water which may be put in it by the priest, after washing his hands, etc.
13. SPIRE—a tower of a church, or building, ending in a point, usually very high.
14. STEEPLE—the tower of a church, or other building, which may include a spire or lantern above it.
15. TRACERY—ornamental stonework in the upper part of windows.
16. VAULTING—arched roofing.
17. ZIGZAG—a decorated moulding running in zigzag lines, specially used in the early Norman style of architecture.

GEOGRAPHICAL SOCIETY

Introduction.—The chief aim of the Geographical Society should be to extend to those pupils who show keenness to enlarge their knowledge of the subject the necessary facilities for doing so, and much useful and pleasurable work may be carried out in the time devoted to the various activities which are at the teacher's disposal. The value of the work cannot be over-estimated, and avenues may be explored which are not to be found in the school syllabus.

The activities of the club should be guided by the teacher in charge but left largely to the general inclination of the members or to a committee of students. Summer and winter programmes should be mapped out, but whatever plans are made should have alternatives and be very elastic. There is no need for all the members to be engaged in the same way, or to meet at set times. Optional periods should be arranged, utilising school and leisure time, and provision should be made for numerous trips to places of geographical interest.

School excursions. — School excursions always prove a source of attraction to children, and provided that these are carefully planned they are of great educational value. The place or building to be visited should be carefully chosen, and be of geographical importance, the reason for its choice being carefully explained to those who will be making the journey. There will of necessity be a certain amount of preparation on the part of teacher and scholars in order that all may know which salient points to observe and which minor details to ignore. Instances have been recorded where children have been unable to reproduce facts of importance after a visit of this nature. For example, a party was taken to Windsor and Runnymede, and when one member of the expedition was asked what he had seen and done, he stated that he had seen some very beautiful swans and had had two ice creams. Which shows that the journey may not have been entirely educational!

There must, then, be preparation. For example, if the expedition is to the docks, a simple questionnaire such as the following might be written out:—

Docks . . . .
Name of river . . . .
Width and depth of river . . .
 Dredging . . . .
Boats seen . . . .
 Lines . . . .
 Destination . . . .
 Goods . . . .
Warehouses . . . .

Bearing in mind what to look for, the child will direct his attention to the necessary facts. After the journey there should be a discussion on the trip, at which accounts may be read, pictures and photographs reproduced by means of an epidiascope, and a description prepared for the school magazine.

In considering the actual expense of these excursions, it may be found that the cost is too much for some of the pupils to bear, and it may be advisable to consider the formation of a *Ramblers' Club*. This, in effect, is a savings account into which money may be paid weekly throughout the year, and so the costs of journeys may be defrayed.

The choice of such journeys will depend upon the type of district in which the school is situated. In a manufacturing district, a study of the types of factory to be found, their products, how these products are made and above all why they are made at that particular place, should be discussed. How many boys, for example, who live in the heart of a coal-mining district have ever visited a mine for the purpose of detailed study? They may perhaps have gleaned a little information from those with whom they come in contact, but little or no definite knowledge—other than the fact that they will one day be called upon to work there—has been assimilated. Some interesting results could be seen if a class of fourteen year old boys who live in a mining village were asked to write a composition on "Coal and how we get it." The results would be surprising! Many erroneous impressions, such as the fact that all mine ponies are blind, or that men remove coal in dark narrow passages, foul with dust, could be rectified by seeing how the work is carried on. In some rare cases the latter fact is true, but not in many.

A party of boys conducted over one of the modern up-to-date mines would see much to interest them, from the modern winding room, with its beautifully kept machinery and scientific instruments and devices, to watching a coal cutter at work. They would descend the mine in charge of an official, and trace the production of the coal, from the coal "face", where it is obtained either by "hewers" or coal cutters, to the tubs into which it is loaded for transport to the bottom of the shaft. And so to the surface where it is weighed by a mine's representative called the "check weighman", emptied on to moving bands of metal or "scrum" where the stone and other impurities are removed by hand and where it is graded into various sizes, and finally where it is washed and mechanically loaded into trucks for transport.

If there is a by-products works attached to the mine, further development of the coal industry may be studied. Here it can be seen how benzole, tar, gas, etc., is extracted from the raw product.

First-hand knowledge is always best. Journeys made in schooldays are always remembered in later years and, what is more important, give training in what to observe in the great journey of life.

Local geography.—The following are some suggestions for the study of local geography:—

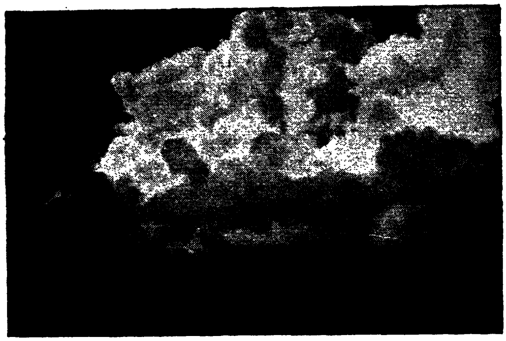
1. *Position.*
   Parish? Borough?
   Boundaries. Area. Surface and drainage. Soil.
   Height above sea level and highest buildings.
   Viewpoints and landmarks.
   Study of local maps.
   Direction. Road and crossroads.
2. *Local weather.*
   Weather observations.
3. *Means of communication and transport.*
   Roads, railway, tramways, sea, air, canals.
4. *Occupations of people.*
   Farming. Arable farming.
   Market gardening.
   Dairy and stock farms.
   Fishing.
   Mining. Coal and other minerals.
   Manufacturing. Cotton, wool, silk.
5. *Population and its distribution.*
6. *Human activities.*
   Towns.
   Water supply.
   Local government.
   Pleasure and health. Education. Religion. Art.
   Comparison with other districts.

Rambles in the home district.—One of the most interesting avenues of work to explore will be the more specialised study of the home district, and a great deal of useful incidental knowledge can be acquired by the boys while engaged in what may be classified as a hobby.

Map observation.—Such a study should begin with a more specialised form of map observation, and this can best be acquired by practical means. The school grounds and buildings could be surveyed by means of plane table, chain and tapes; then the survey could be extended to the roads or lanes surrounding the building. By enlisting the aid of the handicrafts instructor and the science master, most interesting models of the immediate surroundings can be made and it is possible to build from the boys' own data a miniature of the district showing hills, roads, particularly crossroads, streams, fields and buildings of interest. Buildings and houses may be made of ordinary six-

[Photo: Ilford Ltd. and H. G. Bilbe.

THE POOL



Cumulo-Nimbus

'Mares' Tails"—Cirrus

Cumulus

TYPES OF CLOUDS

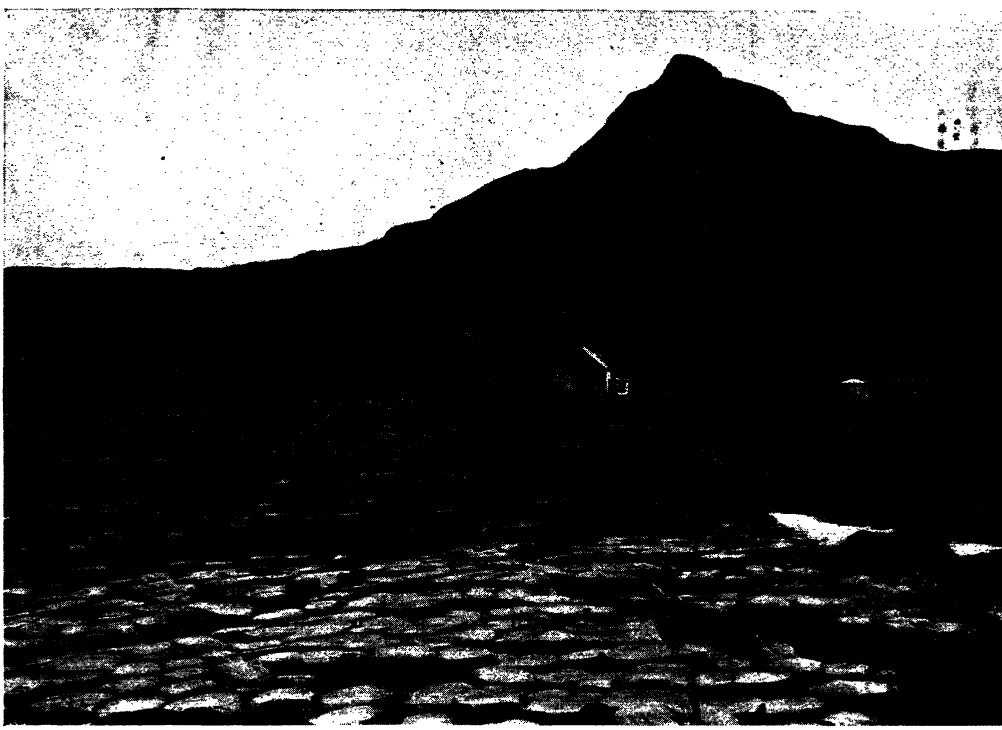
(From photographs by Mr. G. A. Clarke, Aberdeen.)

sheet card; roads from strips of grey tape of various widths; rivers and streams can be shown by using silver foil, the contours being outlined and built with paper pulp.

A further study of the home area should be made from the one-inch ordnance survey map. Pin the map to a large drawing-board and take it to a place from which a good view can be obtained—the top of a hill or church tower serves this purpose admirably. If the board is turned so that the directions are the same as the real directions, much can be observed. The map may be orientated by means of placing a pin in the spot marked on the map where the observers are standing, and another in the position of some church or other landmark which is visible. Keeping the map horizontal, look along the line as defined by the two pins until they are both in line with the chosen landmark. Much can be observed from the vantage point. How many roads, streams, churches can be recognised? How are they marked in the map? Is there any difference in the marking of a church with a steeple and one with a tower? Measure the distance by means of using the map scale, and from this estimate the distances of other landmarks. How are bridges, footpaths, main roads, cuttings, lighthouses, marshes, woods, marked in the map? Refer to the map only and describe briefly the type of scenery met in walking from one point to another. Check the description with the actual view obtained. Exercises of this nature will amplify the knowledge of the locality and give wide practice in map reading.

Physical features.—The physical features of the district and a simple study of its rocks will interest many. Where rocks are explored—in quarries, cuttings, cliffs, streams—rock samples can be collected, tested and named. Are any of these rocks commercialised? Is sand used for moulding or pottery? Is clay used for bricks, or limestone for the manufacture of lime? Little by little the collection of specimens will increase and should include the well-known British rocks—granite, gravel and sand, shale, iron ore, slate, limestone, sandstone, salt.

A discussion of rocks will naturally bring up the question of the type of soil which is found in the neighbourhood. Samples of soil can be obtained from various parts, dried and placed in tin trays or large tin lids.



[*Reproduced by courtesy of L. M. S. Railway.*

GIANT'S CAUSEWAY

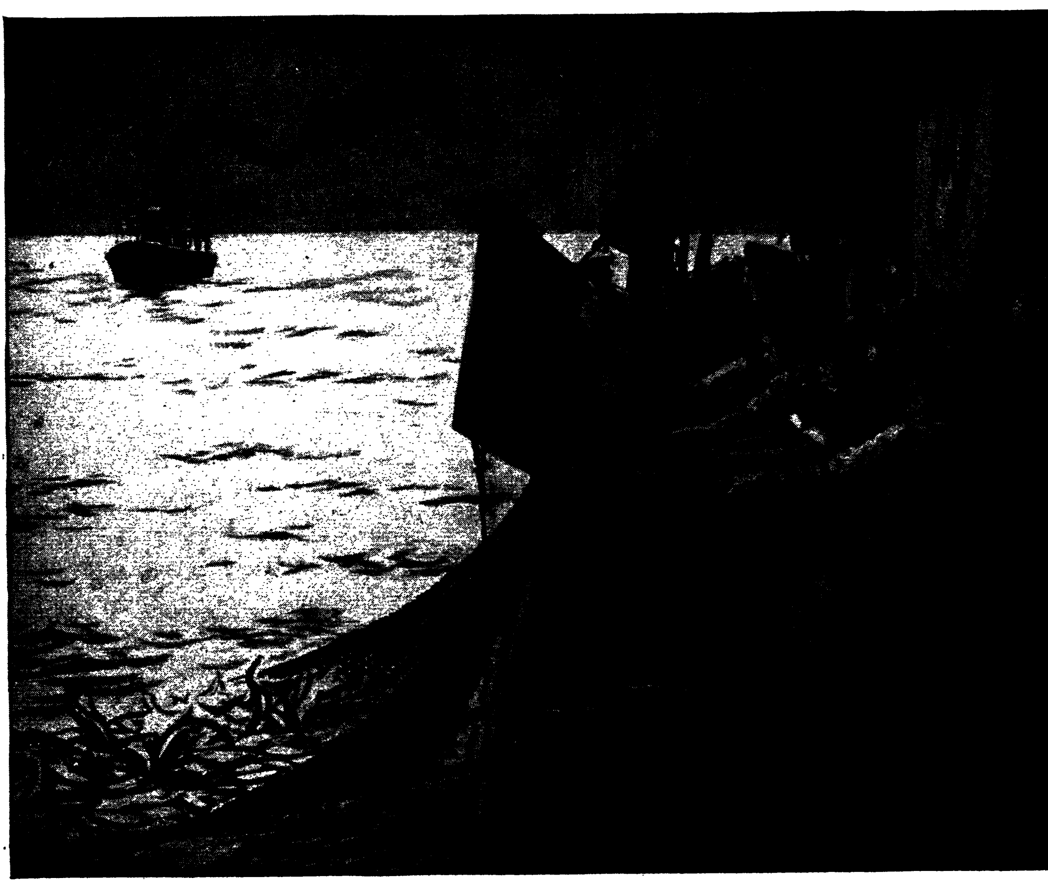
These samples should be examined, and the presence of sand, clay and humus (fragments of twigs or leaves) noted. If tested with dilute hydrochloric acid, and the soil effervesces, limestone or chalk are present. If the earth is black in colour, vegetable matter is present in large quantities; while if yellow, red, or brown the colouring is due to oxides of iron. No opportunity of discussing soils with farmers or gardeners should be missed. They will be able to say which kinds of soil are suitable for certain plants and how to treat them with lime, sand, or manures to render them more fertile. Farm or garden produce depends upon the quality of the soil as well as upon climate, and the study of soils tells the farmer what to grow in them and how best they can be improved. Root crops flourish in soils containing mineral products. Oats require little or no minerals ($1\frac{1}{2}$ to 2 per cent), whilst wheat needs more (4 to 8 per cent). The depth of "soil" is often important, while the study of subsoils—clay, gravel—is essential to the understanding of drainage.

Local industries.—It is upon the physical features and soil of the district that the types of farming carried on depend. Arable farming, that is the growing of crops for profit, is the most important, and crops may be studied by visiting a number of fields not under grass to find out what is grown on each. It is interesting to find out when the crop is sown and reaped, if it is sold and where, or, if used by the farmer, for what purpose he uses it. Thus the various processes throughout the year may be observed, and the rotation of crops noted, whether they be root crops or cereals. A comparison of the built-in areas and the agricultural areas should be calculated from the one-inch ordnance map.

There may be extensive market gardens. What are the chief crops? Possibly the produce may be used locally or sent to destinations farther afield. Extensive areas may be devoted to the rearing of plants under glass or in hot houses, as in Cambridge and Essex. On the other hand, early vegetables and cut flowers may be reared out of doors, as in the Channel Isles and Cornwall.

In the case of dairy and stock farms, the greater part of the land is pasture land or meadow. Cows, bullocks and pigs are reared, yielding milk, cheese, meat and hides, pork and bacon. Cheshire is famous for its dairy produce; the hides from the Midlands go to the huge shoe factories at Northampton, Wellingborough, Leicester, etc.

Fishing may be a staple industry of your home district, for it is one of the most important of British industries. Approximately 14,000 of our fishing boats land some 16½ million pounds of fish annually. It will be of interest to know what types of fish are caught, and the quantities of each. They can be classified as bottom or middle water fish. Some of it may be transported, some of it tinned. The types of boats, whether they are "trawlers", "drifters", "bawleys" or "smacks" should be observed, as well the method of fishing. Valuable



HAULING IN THE TRAWL

information can often be gained from chats with fishermen.

Weather observations should be taken, readings of wind direction and force, pressure, hours of sunshine, temperature and rainfall being recorded daily. More important still is the effect of local weather upon local occupations.

On the other hand your district may be devoted to mining and manufacturing, and coal, lead, or tin be found there. The study of these industries will be rich in geographical data.

Population.—Then again, the population of the district should be observed. At what part of the town or locality do most people live? Where is the residential area; i.e., where are the better class of houses built? Where are the homes of workmen? Compare the values of property. On a map of the district ask as many pupils in the school as possible to mark the position of their homes with a red dot. If possible procure maps or photographs of the town or district ten years ago. Note developments. What was the population five, ten, fifteen years ago? What is it now? If possible ascertain what the suggested future town planning will be and note how it will affect the distribution of dwelling houses. Many more such queries should be made, and detailed observations noted.

The population will need water and electrical supplies and sanitary arrangements, and must have local laws passed by the Council. The æsthetic side of human life must be catered for by the building of churches, museums, art galleries and, for the education of the children, schools.

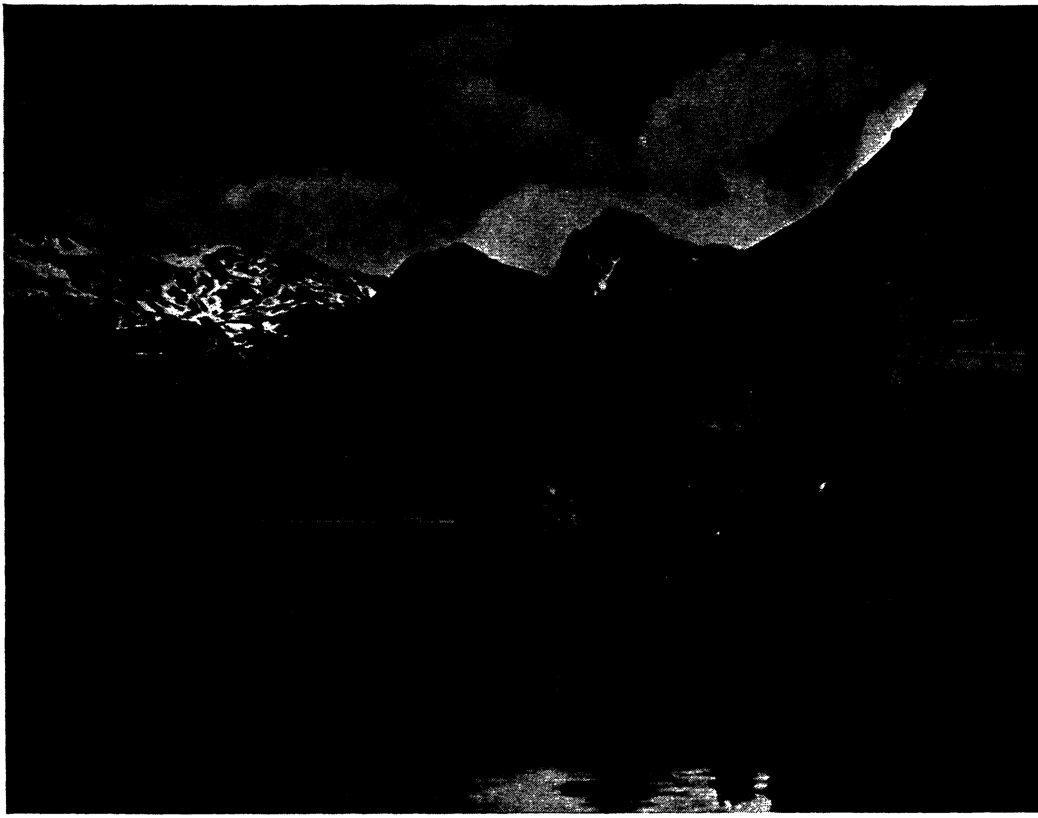
Finally there should be comparison drawn with other districts, both near home and farther afield.

Study of river, lake and sea.—The study of the home district naturally progresses from the point of the consideration of the drainage systems. A great deal can be learnt from more detailed study of such rivers, streams and lakes which may be found in the neighbourhood.

Rivers and streams.—From the observation of a stream, the work and utility of greater rivers may be deduced. A profitable day's outing is to explore a stream bed from source to mouth. Usually, no matter how small the stream, the same characteristics may be seen which are apparent in the course of a river. For example, the source, may be traced to springs, and the rock stratification particularly above the spring should be noted. "Mountain track" or "hill track" will be characterised by the rapid flow of the water and the narrow V-shaped bed of the stream. Erosion here will be greater than in the lower reaches, and the force of the current is sufficient to carry with it large stones and a vast amount of sediment. If conditions of this nature exist in any river, it would be obvious it would be of no real value for navigation, but here and there, particularly where falls and rapids may occur, the water power as such may be utilised for the generation of electricity or for the generation of power for factories. Here and there tributaries can be seen entering the main stream, adding to the volume of water but in many instances checking its speed. Notice where these enter, for a certain amount of coarser sediment is deposited and forms a bar extending a short distance into the main stream.

And so to the valley track of the stream. As the current of the river is dependent on its slope, it will be noticed that there is a considerable decrease in the rate of flow, as a result of which larger stones and rocks are deposited, but the fine alluvial sediment which is held in suspension is carried on. There is, too, a change in shape of the river bed. It becomes slightly broader and is slightly U-shaped, but again is practically valueless for navigation.

Next to the "plain track". The stream becomes much more shallow and flows slowly. Instead of its course being straight, it meanders. At times the loops of these meanders may join so that the stream becomes straight. These loops of land which



[Photo: Ilford Ltd. and Miss Hearmon.

A MOUNTAIN LAKE

are left are known as deserted ox-bows, which, owing to their moist and fertile condition, are generally covered with a surface of lighter green grass interspersed with wild flowers which depend for their existence upon excessive moisture. The U-shaped body of water which is left surrounding this is known as a *mortlake.* It is in this part of the stream that the fine alluvial matter which has been held in suspension is deposited. Eventually the mouth of the stream—this may be where it enters one of its larger brethren—is reached and here delta formation may be seen.

Observations which have been made should be carefully noted and applied to the study of the world's rivers.

Lakes.—Perhaps to the more fortunate, opportunity may be given to study lakes. The question may be asked, have these lakes been formed by glacial action or by the damming of some low-lying stretch of land by moraine deposits? How are they fed? How are they emptied? What are the other names for lakes? (Lochs, meres, tarns, ponds, reservoirs.) Is anything known of the depth of the lake? Notice how its level rises and falls according to rainfall. Some lakes are used and have been enlarged artificially to supply large towns with water. In certain lakes excellent examples of delta formation may be found, and cases have been known where a delta has divided the lake into two parts, as in Lake Derwentwater, so forming two lakes, Derwentwater and Bassenthwaite.

The sea.—To those who are living near the sea coast, frequent outings and excursions should be made. The nature of the coast should be noted; whether it is cliff bordered, high and precipitous as in Devon and Cornwall, or whether it is low lying as in the coasts of parts of Yorkshire and Essex. Is the beach composed of sand and shingle? Are there any signs of tidal erosion? Much valuable information may be gathered from discussions on tides with fishermen and such as depend upon the sea for their livelihood.

A difference between spring and neap tides should be discussed. What time is high tide? What time is low tide? Is there any variation between the high water mark and the low water mark? These heights should be observed over a period of weeks and the results recorded. Observations should be made of the type of craft seen at various times of the day. Are they cargo boats, pleasure steamers, liners? How can they be identified? The study of funnel markings and flags provides an all-absorbing hobby. A telescope mounted at some suitable vantage point will enable these to be clearly read and identified, while on a map of the world can be traced the routes of such boats, and a short description of cargo can be appended. This is made more interesting still if the world position of boats observed is followed from the shipping lists found in some of the daily papers.

More detailed observations of the home district are very valuable, but other activities of the Geographical Society which are more practical and cover a wider field must be described.

Correspondence nights.—One of the most helpful activities is what might be called "correspondence nights," which are definite aids to gaining first-hand information about various regions of the world. Take a rough outline map of the world and tear it up into as many strips as there are members of the group, taking care that there is at least a small area of populated territory on

FREETOWN

each strip. Fold up the pieces of paper, place them in a hat, and let each boy draw one. His particular section of land is purely a matter of chance, and this is a time of great excitement. "I've got a bit of the Gold Coast," cries one. "Hudson Bay Territory," exclaims another. Then there is a feverish search for large scale or detailed maps of the districts concerned, for each lad knows what his job is—to select a town or towns and endeavour to correspond with some member of that particular community in order to get descriptions and reliable information about the area concerned. He must of course return the compliment in kind. Some of the replies have been most entertaining, in others the language question creeps in; but as all involve a study of distance, postage and the discovery of many other facts, it is well worth the time spent. These should be filed together and placed at the disposal of all for private reading.

Collections.—Numerous collections of various sorts can be made in this way. Stamp collecting—a most absorbing hobby—can be turned to good account from the geographer's standpoint if a thorough study of the positions of points of despatch and routes taken to arrive in the country is made. Stamps should be mounted around and on a large outline map of the world (which may be folded for storage purposes if necessary) rather than in individual albums. An unique map was made on one occasion by covering all the land masses where possible with stamps which had been collected, a great area of the earth's surface upon the map being marked in this way.

Poster collecting is always a source of great interest. Local posters, perhaps designed by the lads, can be made or requested from the information bureau (if any); posters from cathedral cities, from seaside resorts, holiday resorts, not only in our own country but also from abroad, may be obtained. Exhibitions of such works of art—for many of them are of great artistic value—should be given, and parties of visitors from other houses or schools should be conducted round the display and have the various posters explained to them, the collectors themselves acting as guides. Outstanding features should be discussed, the products, districts or industries they advertise explained.

The "Geographical Museum" should not be forgotten, and additions of interesting articles are made with great frequency when outside sympathy is enlisted. Provided all exhibits are properly indexed, described and mounted, this "museum" can be most instructive. Collections of rocks, shells, photographs, etc., should all find a place therein.

Geographical instruments.—The practical work of the club should not be neglected. All forms of geographical instruments such as surveying instruments, levelling rods, clinometers, plane tables, etc., may be made, and it may be advisable to request the use of the handwork centre from time to time, and the assistance of the instructor if it is available. Models may be made ad infinitum, but care should be taken that these are not "unrelated", that is that they must have some bearing on either the classroom work of the pupils or upon their club work. It is not sufficient for models to be pretty; they must serve some useful purpose.

A little thought in the preparation of the work will render it unique in its way. If we consider the construction of a weather vane it is quite possible to make it so that, as the vane revolves, the wind direction is recorded on an illuminated dial in the geography room. This was actually done in one school. The vane was mounted on the roof and revolved on an old bicycle wheel hub, complete with ball bearings. A metal arm rotated upon a set of studs (taken from an obsolete wireless set) and a sixteen-strand wire conducted the current to the recording box. Four-volt flash lamp bulbs, fed by the ordinary electric current, cut down to the requisite voltage by an old transformer, completed the apparatus which was infinitely more interesting than the old type.

Many other appliances of the same nature —more advanced steps in the construction of apparatus for which time is lacking in school hours—can be prepared. The simplest forms of tellurion and orrery may be manufactured with nothing more than a sorbo ball and pieces of wire and cardboard.

Map making.—By far the most interesting occupation is the making of maps of which, to misquote the old adage, there is no end. Maps of the world can be made either to cover a floor or a page in an exercise book, and done in either thin sheets of plywood or cardboard. Sectional maps are simple to construct provided that the outline of each section is prepared beforehand. Many useful materials, some home-made, may be used to build up continents, sea beds, or mountains; and some exceedingly good ones are already on the market. Ordinary "Aloplast" gives an excellent surface, but by far the most successful material, and the cheapest, is made by folding a newspaper tightly, pressing it in a vice, and rasping the paper into a fine powder or "fluff". When a sufficient quantity has been filed, mix with ordinary size or a weak solution of glue, adding a small piece of sodium potash. The paste so formed can be easily modelled into mountain shapes, and when dry adheres tightly to the surface to which it has been applied; it is very hard, and can be coloured with ordinary poster colours, water colours or enamel as required.

All types of maps—those showing trade routes and volume of trade along such routes, isothermic maps with wire which can be bent to form any shape, and moved to any position on the map to show seasonal temperatures, superimposed maps with features marked on tracing paper or tracing cloth and laid over an outline which has been prepared—form a source of attraction to those engaged upon their manufacture. One of the most interesting maps made by one club was of the world drawn on a 6 ft. by 5 ft. sheet of plywood, and replicas of ships' funnels, 3 in. by 1 in., mounted in suitable places, showing the most important shipping lines and the routes along which they travel; this map was mounted at an angle to the wall, and proved an attraction to all who saw it. Jig-saw maps are easy to make and very instructive when completed, especially if the completed map is cut up into sections, along the lines of latitude and longitude, which may be fitted together by reference to an atlas map to find out the positions of the sections concerned. A contour map makes an excellent puzzle of the various ranges of hills, and mountains are built up independently of the main map and applied last as part of the puzzle itself.

Outdoor maps may be constructed during the fine light evenings when club meetings take place. A plan of the district laid down by means of white paint, properly orientated, will find pleasurable work for many hours. Relief maps may be made of cement or clay, but care must be taken to ensure the fact that where the former are placed there is likely to be no difficulty in their removal! Cement has a habit of adhering to tar-mac or concrete surfaces where it is inadvisable to use a pick to dislodge ranges of mountains!

Bridge building.—Why not a study of the world's bridges or of the development of the bridge from earliest stepping stones through its many stages to its present perfection of structure, as shown in the wonder of engineering which spans Sydney Harbour or, in our own country, the river Tyne? Many examples of bridges can be made in the classroom or handwork room, utilising only the simplest forms of material and yet getting wonderful results. A model seen some time ago showed the track of a river from almost source to mouth with a great number of bridges spanning it. The model of the river bed was painted on several long pieces of straw board. In the hill track were examples of the old "hump back" bridge, rope bridges which are often seen in India spanning almost impossible ravines. Lower down were suspension bridges, truss

MODEL OF THE QUEBEC BRIDGE; THE MODEL RAILWAY TRACK MAY BE SEEN IN THE BACKGROUND

bridges and swing bridges, and in each case it was stated where such a bridge could be seen. But these models were very small.

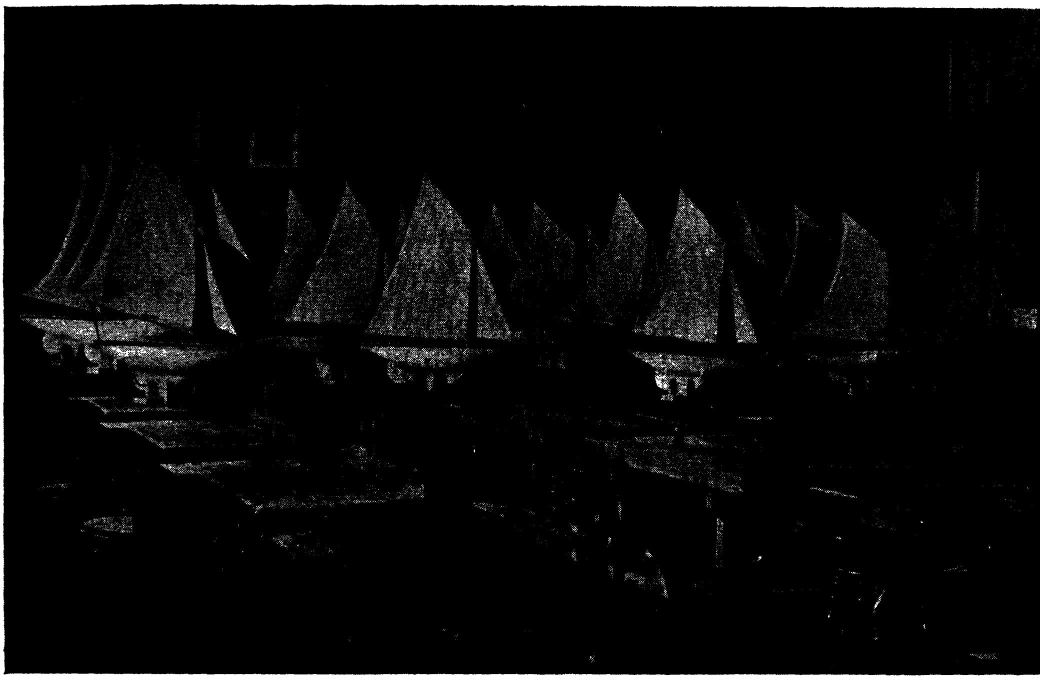
Why not attempt an experiment of this kind on a larger scale, and run a railway track round the geography room or hall with larger examples of bridges supporting it? The starting point is to affix a wooden shelf of $\frac{1}{2}$ in. deal to the wall just above the pin rail. Naturally the shelf will end where doors and windows occur. Next have an exhibition of photographs of as many types of bridge as can be collected, and discuss each with a view to discovering why the type is used in that special place, its difficulties of construction and the possibilities of making a model for the classroom railway. The approximate scale should be determined in relation first to the track itself and secondly to the other bridges to be constructed. Rough sketches, followed by more detailed plans, can be prepared. If, for example, the Quebec bridge is to be copied, and the material to be used in its construction is $\frac{1}{2}$ ft. by $\frac{1}{16}$ ft. square stripwood, the amount of wood must be reckoned.

A suitable scale would be $\frac{1}{800}$; that means that the model, a photograph of which is appended, would be 15 ft. long and stand 18 in. high. The supports may be made of cement.

Other types of bridge can be added to the model track. There is one point which may constitute a difficulty, and that is to carry the actual line above the doorway. This may be accomplished by the construction of an alpine loop.

Model craft and aeroplanes.—A study of the different types of craft used in the world, from the felucca to the modern liner, gives excellent material for a club project. Model craft building always arouses the enthusiasm of boys.

Boats may be made of hollowed-out pieces of thick timber, built up in stripwood framework with canvas stretched over them, or of cartridge paper which has been



MODEL YACHTS BUILT BY BOYS DURING THEIR CLUB TIME

cellulosed. The accompanying photograph is of model yachts made by the members of a craft club. These boats were formally christened and raced on the local river.

Model aeroplanes are easy and inexpensive to construct. A study of their types, markings, routes and uses will always appeal to the modern boy.

A SCHOOL CORRESPONDENCE BUREAU

The following extract is taken, by permission of the author and publishers, from *The Organisation of School Societies*, by G. H. Holroyd, published by Sir Isaac Pitman & Sons, Ltd. The book can be recommended to all interested in school societies.

"It has long been the practice of many schools and colleges, where foreign languages are part of the curriculum, to have a Correspondence Bureau for the benefits received by foreign correspondence. There are few schools, however, where no foreign languages are taught, which have indulged in this project. It is irrefutable that one of the weaknesses of the modern youth is that he is unable to write a letter in good style. The importance of letter writing cannot be exaggerated, and yet in schools how often do we find that it is the most neglected branch of our English studies. An occasional letter written in an exercise book with lines, to an imaginary cousin in a phantom town with an impossible climate, forms the basis of many schools' letter writing. . . . We almost ask the impossible when we set a child to write a letter in an exercise book to a fictitious person. The idea is too unreal to produce a display of personality, eccentricity, humour, or whatever you name that something which makes a letter.

"As a directly beneficial project, a Correspondence Bureau aids the study of geography, the art of letter writing and English studies generally. Indirectly it helps many other subjects. In every part of the globe there are English speaking communities, and wherever these are there are possibilities for correspondence. In the interest of geography it is well to have your correspondents in different parts of the world. In Canada I have found it desirable to have three Correspondence Bureaux, one on the West coast, one central, and a third in the East. The environments are so varied that all three centres sent in different accounts.

"To start such a bureau, take down your atlas and pick out the towns you think are suitable. Next, announce your list of towns to the scholars and obtain lists of children desirous of corresponding with each town. Let each child join three or four groups. You will not find that every town to which you write will like your idea; there will be certain gaps which you will have to fill by writing to similarly placed towns. When you have made out your lists, make copies to send with your letter of introduction. The list might read like this:—

	Age	*Attainment*	*Hobbies*
George West	12½	Most intelligent	Scouts, camera, etc.
John Brown	11	Rather backward	Pets
Joan Smith	13	Average	Reading

"Accompanying this list, letters might be written as follows:—

The Chief Education Officer,
....
W. Australia.

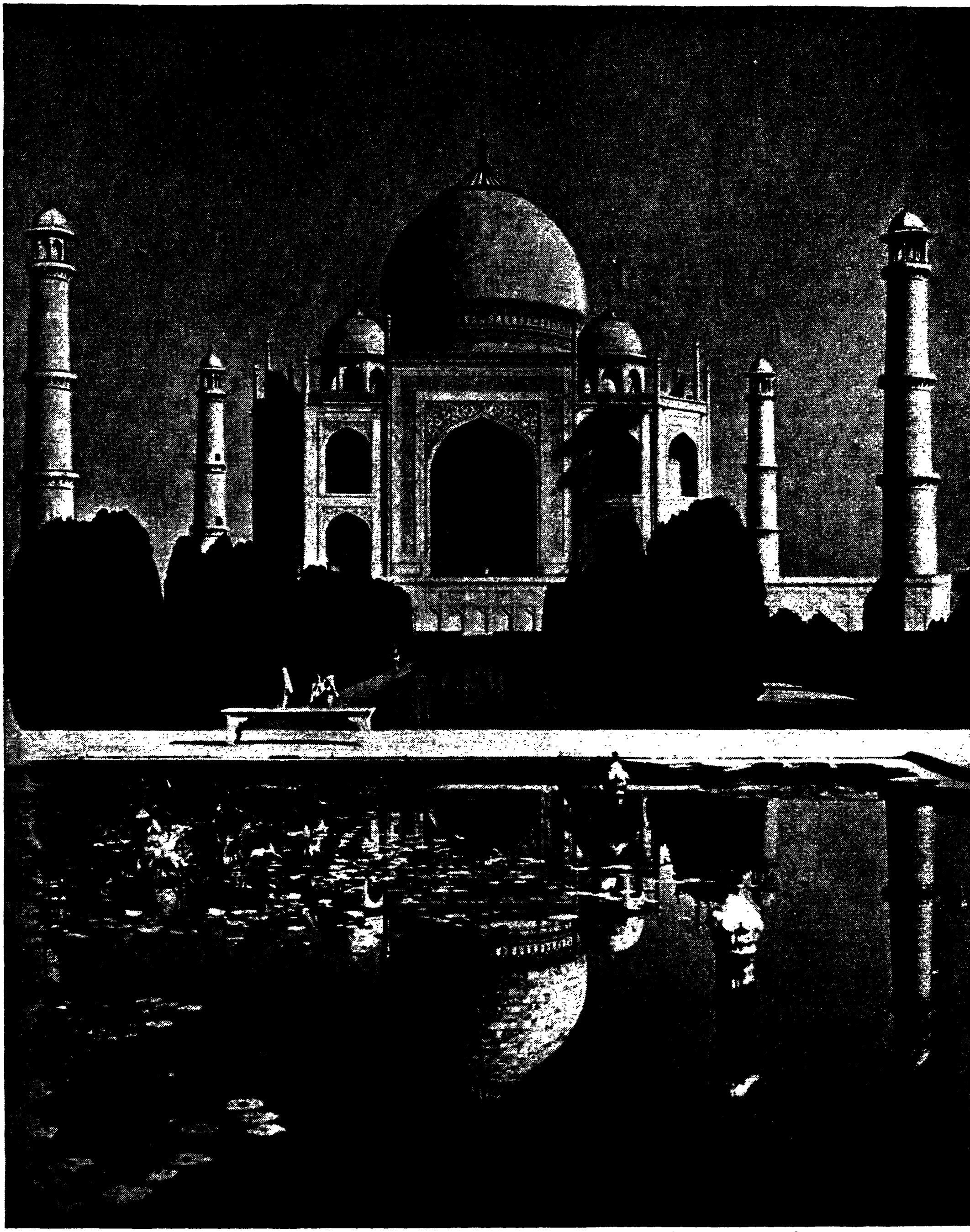
Dear Sir,
I am endeavouring to form a Correspondence Bureau at the above school, and I should be grateful if you would pass on enclosures, after perusal, to some Head Teacher in your town whom you think would be interested in the project.

The Head Master,
..............School,
....

Dear Sir,
Enclosed you will find a list of twenty scholars of mine who would like to correspond with twenty of yours. I am of opinion that the project would be mutually beneficial, for my scholars intend to write on the geography of the neighbourhood, and current news; they hope later to exchange with your scholars photographs of the neighbourhood. You can rest assured that nothing undesirable shall be sent, for I shall have read personally each letter before it is sent. If by return, therefore, you could send me your list, my scholars will write their first letters, which shall be sent in one parcel with as little delay as possible.

"Two letters in this strain will usually get the correspondence going. The title of the chief education officer varies in various countries. In Canada one usually writes to the Superintendent of Schools, in Australia to the Chief Education Officer. If in doubt always use the latter title. Many are the souvenirs which can be exchanged and which help to make the correspondence real. I have received school magazines, journals, newspapers, picture postcards, seeds, leaves and pressed flowers. It is well to keep a register accounting for letters sent out and replies received. One should also arrange that mailing days are spread out so that they do not all occur in one week. A large map of the world should be drawn, and flags placed on the towns with which correspondence has been arranged. A poster on the notice board announcing that the Durban mail leaves to-day will invariably create a desire for many participants. If interest seems to flag at all, it is quickly revived by the arrival of a parcel.

"Some of the countries with which correspondence is possible are as follows:— Canada, Newfoundland, U.S.A., West Indies and Jamaica (British schools), Australia,



[*Reproduced by the courtesy of Indian Railways Bureau.*

THE TAJ MAHAL
(See Note on the next page)

New Zealand, South Africa, Kenya, India (British schools in large towns), and with soldiers' children at British garrisons. The Education Officer is the person to whom one should write for Gibraltar, Malta, Alexandria, etc.

"Much of the utility of a Correspondence Bureau is, however, lost unless the scholars have definite instruction in letter writing. They should know how to encourage their correspondents to give them the information they desire. They should know how to 'draw out' the personality of their correspondents. To this end an occasional detailed study of first-rate letters will be useful. It will also be found an interesting experiment for the teacher, for he will naturally correspond with the other teachers. . . . If all the letters for one school are sent in a parcel it will be found that the cost of postage to each pupil will usually be about one halfpenny.

"A school Correspondence Bureau will present geography in a most interesting guise. It will make it a reality, vivid and picturesque. Pupils will be more ready for a teacher's supplementary information. Letter writing will become an absorbing pastime, and, again, it will be real and enjoyable; and when you have made a school subject real and pleasurable, you are making progress."

POSTSCRIPT

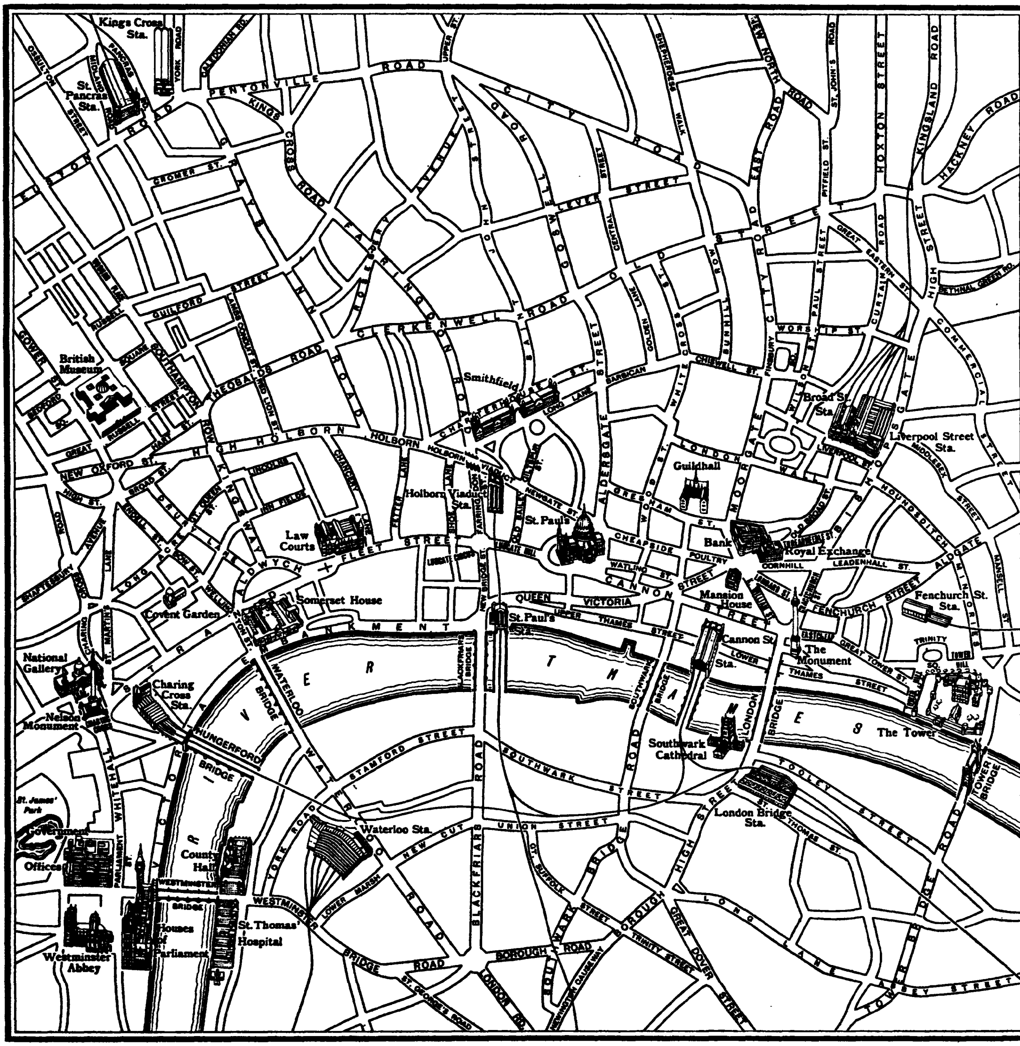
The need for clubs.—The opportunity for club organisation is becoming greater with the passage of years as the inestimable good which is being done in these out-of-school hours is becoming more apparent. The great and practical value of the work is that it gives to the boys new activities which awaken new interests and teaches the correct use of their leisure time.

And because of this, a larger task lies before those who are vitally interested in the growth of the movement. Because of the increased interest and enthusiasm, there is evident necessity for more activity in the organisation of more and more clubs to meet the needs of the coming generation. It is a field for vital service which should appeal to many thoughtful teachers who are willing to invest their time in a work which will yield valuable return. If the lasting benefits which clubs can render were more widely realised, if men and women could experience the tremendous happiness they themselves would derive from the work, and if only they realised the mighty fellowship of adult and child who share life together regardless of class or sect, they would not hesitate to enter into this movement and earnestly endeavour to create newer and more successful clubs in all parts of the country.

NOTE

The Taj Mahal.—This building, the most beautiful in all India, stands in the city of Agra. It is a tomb built by one of the Mogul emperors, Shah Jehan, to be the last resting-place of his beloved queen, Mumtaz-i-Mahal, who lies with her husband in a vault underneath it. The Taj Mahal is of dazzling white marble, and has a graceful dome in the centre with smaller domes round it. At the four corners are four slender towers. It is surrounded by trees and flowers, fountains and lily ponds. Set in the walls are precious stones of rare and delicate hues. For over twenty years (1629-1650) 20,000 of the best workmen in India chiselled the marble into screens which look like fairy lace, and they covered every part of the building with wonderful patterns made by inlaying tiny pieces of coloured stone. Over the entrance is an inscription which reads, "Only the Pure in Heart can enter the Garden of God"; and set in black marble round the arches of the windows and doorways are texts from the Koran, the sacred book of the Mohammedans.

THE SCHOOL CAMP AND THE LONDON JOURNEY



Map of London
(Class Picture No. 76 in the Portfolio).

THE SCHOOL CAMP

Introduction.—Few avenues of school life offer greater interest to the enthusiastic teacher than the organisation of a camping holiday for the boys, or girls, as the case may be, and if one considers the relative value of such a project to the school it will be found that the work entailed in such organisation is well worth while.

"But what," says our friend the critic, "is the use of giving up a week of your holidays to spend the time doing work you're busy with all the year round?"

"Why spend one's nights in an insect-infested tent, cook one's own meals, and, generally speaking, suffer the tortures of the unhallowed when you could be having a jolly good time in a first class hotel at——?"

But has our friend experienced a camping holiday? Probably not. It is not a question of depriving oneself of a well-earned rest, but of having a much more enjoyable week or fortnight in congenial company than is usual. Handling boys "under canvas" is vastly different from the daily round in the classroom. To *know* boys, try living with them away from their home environment when they have to depend largely upon themselves and each other for their individual needs. To the criticism of the tent—what bed is comparable to a palliasse in a tent on a perfect summer night? If it is insect-infested it is usually due to the want of care on the part of the occupier.

The annual camp is of immeasurable importance. Not only does it provide an open air holiday for many lads who would normally be unable to afford one, but it strengthens the relations between parent and school, and, more important still, between teacher and child, and gives to each an invaluable understanding of the other. As an educational outing it opens up branches of study in history and geography and in practically all other school subjects. If the preparation is adequate it should provide a useful basis for club work in school for the entire year.

The camp as a school project.—In fact, to go further, it would be possible to prepare schemes of work as a basis for all school work for the particular group of boys concerned, to use the camp as a project which would appeal to all boys. The class arithmetic could contain a study of the economic side—the consideration of distances; railway fares; the simple banking system together with the investment of money and the interest thereupon; cheques and their uses; quantities of food stuffs; market prices and invoices; mensuration and the calculation of areas of tent space; air capacity of tents; volume of cooking utensils—all these studies could be included in such a course, the teaching of which would be not only much easier and more enjoyable, but certainly more effective if conducted along practical lines. The old type of problem—to wit, "A garrison of 301 men has food to last it 10 days. How long would it last if 20 more men were added to this number?"—would lose its terrors very quickly, and instead of the boy shuddering at the πr^2, he would face it with a new interest if to him it had something to do with his new home while away on a wonderful adventure. The preparation of bills would not appear so boring as in past lessons, while "train" sums with their consideration of time-tables would be done with a definite object in view. Nor would the fund of material be easily exhausted, for after calculating to the nearest mile the distance and cost of transport, other problematic situations could be introduced by thinking of other fictitious camp locations, other numbers of boys, etc.

The English syllabus could be made very interesting. Correspondence could be dealt with by the boys themselves. Many and varied debates could be introduced, short lectures and discussions held. A place could be found in the literature lessons for stories of the west country.

There is no subject in the curriculum

which could not, with a little thought, be adapted to meet the needs of the pupils engaged in the preparation for camp life.

Organisation.—The organisation is perhaps a little more difficult than that for scouts or guides, for the major part of a scout's training is to fit him for an open air life and it gives him a useful training in all the details of camp life, from the tying of knots to cooking his food. Many of the boys in school will have had no previous experience of a holiday of this nature—perhaps have never been away from home or parents before. They will probably have no idea of how to light a fire, much less to prepare a meal which they must eat, or of how to make up a bed on which they must sleep. Such things have always been done for them. There will be much to teach.

Having decided that there shall be a school camp, what resources have you at your disposal? Let us assume that your equipment and camp funds are nil, and consider how, with only the lively interest in the project as a starting point, a successful camp can be planned and carried through.

Assistants.—One of the first considerations which will have to be studied is the actual amount of support and co-operation which will be forthcoming from your colleagues on the staff. The more assistance there is the easier will be the supervision, and it is well to bear in mind the fact that there should be, in addition to the organiser, one assistant for each ten boys taken. The list of those willing to help perhaps includes friends and their wives. If the ladies of the party, if any, do not wish to share the "discomforts" of camp life, accommodation can be found for them at some neighbouring farm, bungalow, or inn. There may, too, be elderly members of the staff who wish to follow this example and lend their services in camp during the day time.

Location.—Then there is the choice of location. This will depend largely upon the situation of the school, for the town boy will prefer a country village or a seaside resort, the country boy will be anxious to visit the coast; the "dweller of the plain" will want to climb mountains, and so on. It is as well to choose some place which is as far as possible the antithesis of the boy's home environment, and one which is not lacking in geographical and historical interest. The distance from home will be determined by financial standing. A meeting of all boys should be held and the project explained in full.

In order to render the explanations of facts more clear, let us suppose for the sake of convenience that your school is on the outskirts of London and that you choose as your location the lovely Cheddar district, and that you propose to pitch camp near to one of the small villages not far from the town of Cheddar.

Members of the camp.—And now that staff and location have been decided, the number of boys wishing to attend should be ascertained. This number will probably exceed all expectations, and it may be found necessary to state a definite limit. The written sanction of parents should be obtained and a printed or cyclostyled letter should be circulated to them, stating the proposed dates of the camp, the venue, and the approximate cost for each individual.

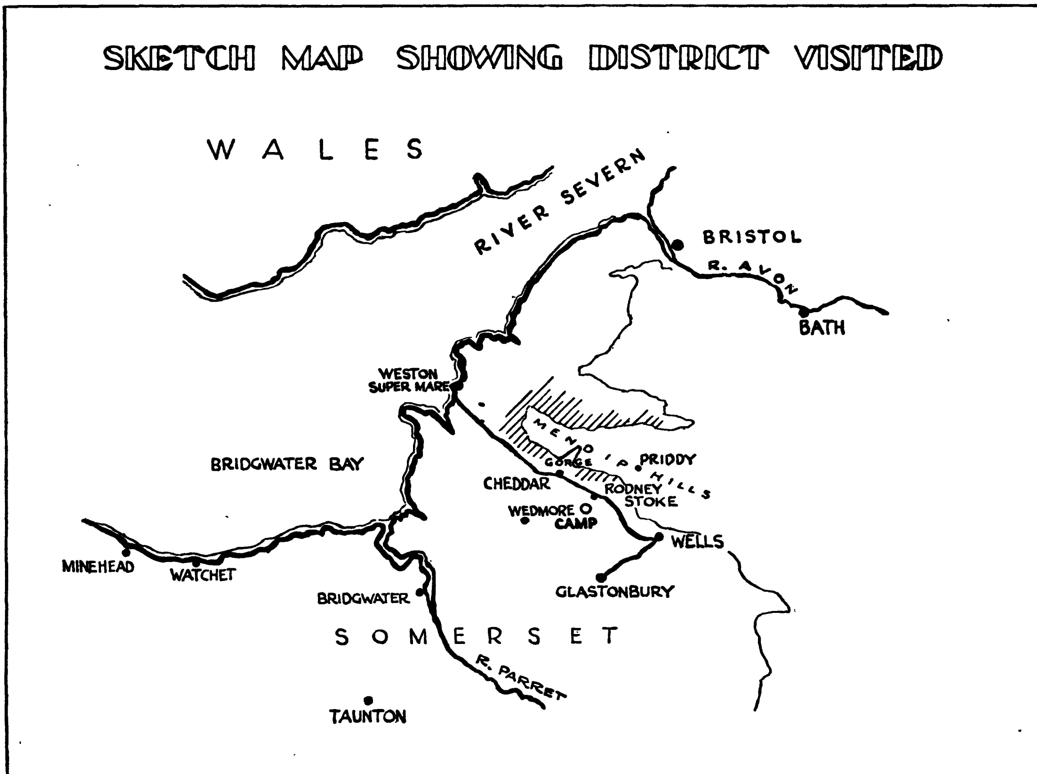
The following is an example of the letter to be sent to the parents:—

> It is proposed to hold a school summer camp in the Cheddar district from — July to — August, ——. It is estimated that the approximate cost for each boy will be between £1 10*s.* 0*d.* and £2.
>
> If you wish your son to attend, will you kindly complete the form below and return it to me at your early convenience.
>
> *Signed*...................
> (Camp Organiser).

....

> I do (not) wish my son to attend the school camp to be held at Cheddar from July — to August —, 19—— (inclusive).
>
> *Signed*........................
> (parent or guardian).

Camp site.—Arrangements will have to be made for the camp site itself. Here you will find it quite a good scheme to enlist the co-operation of some of the head teachers of schools in the Cheddar area. A study of the ordnance map shows numerous villages nestling at the foot of the Mendip Hills—Draycott, Rodney Stoke, etc., and a letter to the heads of the schools or to the parish arrangements personally with the land-owner for the rental of the field, supply of milk, butter, eggs, firewood, and hay for the palliasses. There are certain features of an ideal camp site which should be borne in mind when your choice is made, and it is astonishing how a small factor can affect the general enjoyment of the whole camp. The field should be large enough to accom-



SKETCH MAP SHOWING DISTRICT VISITED

priests will always, as has been found, meet with the greatest consideration. You will find that numerous sites will be suggested, each with its particular advantages stressed. Armed with these addresses, emdeavour to arrange to visit the farmers mentioned. Perhaps one of the staff possesses a car, and a week-end expedition for the purpose can be made most enjoyable; in any case it is advisable to *see* the site and make modate all the tents and to leave a convenient area for games. It should slope slightly and be well drained. The most satisfactory condition is where there is a slight level plateau where the tents may be pitched. The field should be sheltered by a high hedge on two sides, while the surface should be free from ruts or bumps, and covered with short grass; if there is a coming hay crop perhaps the farmer might be prevailed upon to move it before the tents are pitched. We are assuming then that a site has been fixed near to the village of Rodney Stoke.

Needless to say all enquiries cannot be made on such a short visit and here again the valuable assistance of one of the profession in the area will prove of value. You will want to know such facts as:

1. The name of the nearest place of worship, the name of the rector and times of services.
2. The nearest stores.
3. The nearest post office, telegraph office, telephone.
4. The nearest doctor and hospital.
5. Whether there are facilities for bathing near the camp site.
6. The names of local cricket teams who might appreciate matches.
7. Whether the villagers would like a concert given by the boys, the proceeds to be in aid of a local charity.
8. Whether there is a hall or schoolroom which could be used for this purpose and by the boys in case of inclement weather.
9. What accommodation can be had for wives of the masters of the staff.

Activities in school.—Activities in school should now begin in earnest. Frequent staff meetings and of the staff and boys are necessary to discuss all details. The lads should be divided into groups or "tents," and a master placed in charge of each group. Duties should be allocated to meet as far as possible the individual wishes of those in charge.

For instance:—

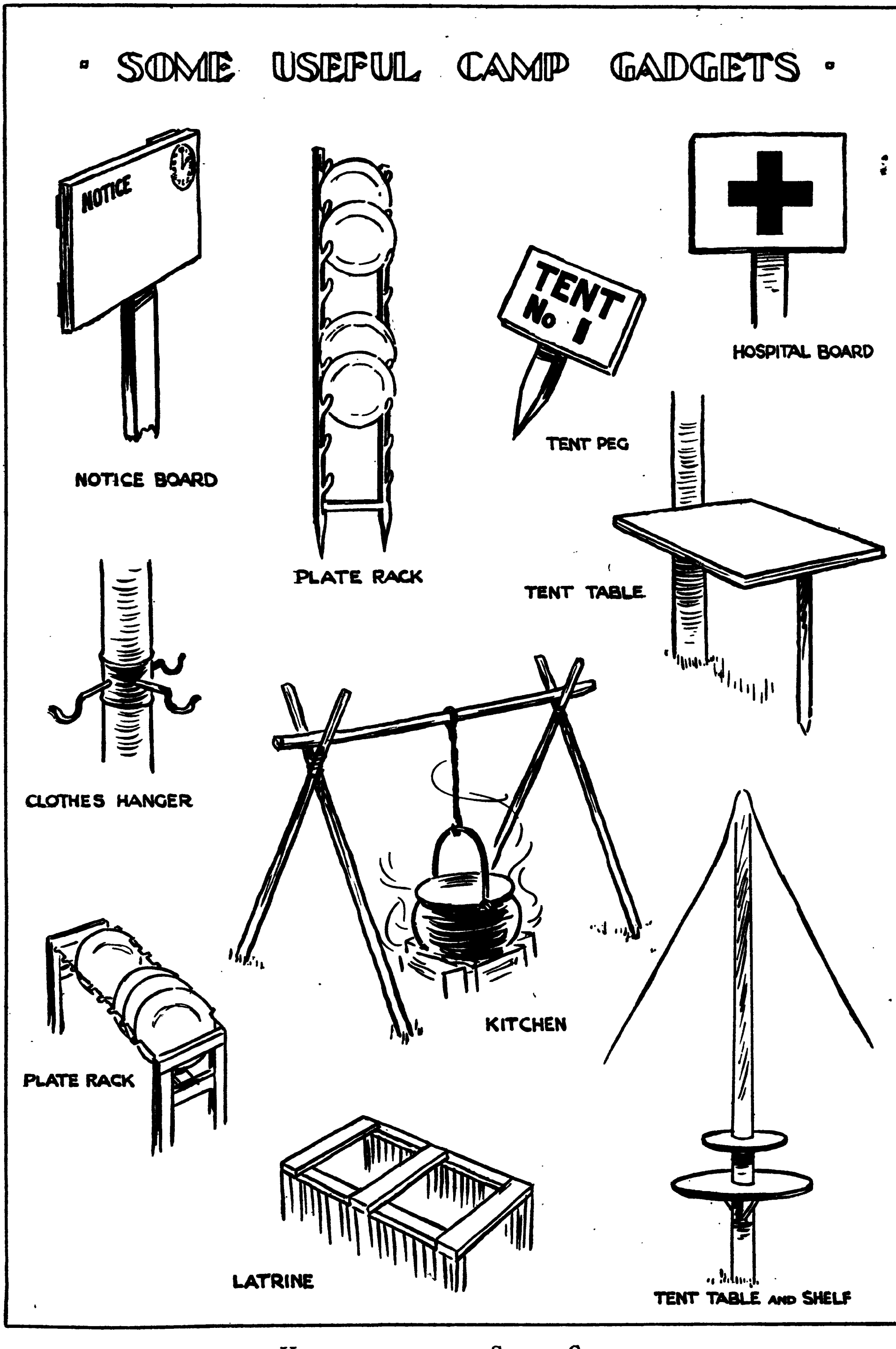
Mr. A.—Photography
Tent 1. 10 boys.
Mr. B.—Historical Interest
Tent 2. 10 boys.
Mr. C.—Geographical Interest
Tent 3. 10 boys.
Mr. D.—Stores and First Aid
Tent 4. 10 boys.
Mr. E.—Sports
Tent 5. 10 boys.
Mr. F.—Camp Bank
Tent 6. 10 boys.
Mr. G.—General Equipment and Repairs
Tent 7. 10 boys.
Mr. H.—Camp Secretary
Tent 8. 10 boys.

A general course of preparation should be taken, either in groups or with all boys assembled. Much of this work may have to be done in "club" time, particularly the talks to the boys on what to do and how to do it and, more important still, what *not* to do. There will of necessity be a minimum of rules and regulations to understand, hints to be given on the care of personal possessions and the packing of kit. Toothbrushes and boot polish do not go well together, and it is inviting trouble to wrap up cricket shirts in a towel. A useful idea would be to prepare a list of topics for discussion; e.g.—

1. How to erect and strike a tent.
2. The care of the tent; ventilation; guy ropes and wet weather; cleanliness.
3. How to pack a kit bag.
4. How to prepare a palliasse.
5. How to light a fire; gather wood; care of trees and fences, etc.
6. First Aid.

There are innumerable text books dealing with the details which ought to be known by all before setting off for camp but lengthy explanation will be necessary.

A tent leader or captain and tent "scribe" should be appointed. The former should be a boy who possesses the qualities of leadership, who would be responsible for the general welfare of his tent mates, and to whom the younger members could turn for help and advice in case of need. It should fall to the lot of the "scribe" to record any events worthy of mention and the collection of descriptions of outings written by the boys. Such diaries are generally full of humour and mention is often made of incidents which do not as a rule come to light. From one tent log of a past camp



HANDICRAFT FOR THE SCHOOL CAMP

comes the following: "Smith has no money left and cannot buy sweets. Tried to eat his tooth paste because it tasted nice." Again, "Mr. X (the science master) tried an experiment to-day. The weather was so hot that the jelly would not set. Mr. X's experiment was not a success, so we drank it". . . .

Handicraft in school.—The special rooms should be hives of industry at this time. From the handicraft centre should come gadgets of all descriptions,—plate-racks, tent pole pegs, boxes to hold goods in transit, collapsible tent tables, notice boards, tent number boards, etc.

There should be two aims in mind when these things are being made. They should be necessities and, secondly, as compact as possible. The plate rack, for example, which is invaluable for tidily storing the plates in each tent and preventing them from becoming covered with pieces of grass and fragments of earth from the tent floor, and from becoming lost when most wanted, may be constructed of half inch oak which has been well oiled, and a heavy gauge wire bent to form the loops which serve to hold the plates in position. If the ends of this wire are fixed by staples, it is possible to fold the loops towards the centre of the framework and so make a compact article which is easy to pack. The points which are to be driven into the ground should be either tarred or creosoted.

The sides of the boxes used to hold goods and equipment should be hinged, not jointed, so that they can open out flat to make useful tent boards or seats when the grass is damp.

One inch battoning is useful for the making of latrine frameworks which support the screen. Here again thumb-screw bolts should be used in preference to joints and numerous cross struts added to strengthen the structure. The covering should be made of sacks which have been cut down the side and sewn one to another until the desired area of screening has been made. For transport the whole thing can be taken to pieces, the sacking wrapped round it and stored in a convenient space.

It is advisable to make the seats of 1 in. by 1½ in. deal. They should be fastened together in the same way as the screen framework.

There is one point which must be remembered; the initial work has to be done only once and these articles which are more or less indispensable to the general welfare of the camp may be stored and used for other camps in subsequent years.

Music and dramatic lessons.—Music and dramatic lessons should fit the boys for camp songs and playlets in readiness for the camp fire or village entertainment. There is no more enjoyable way of passing an hour before turning in at night than to sit round the camp fire and to sing well-known choruses, such as *Ten Green Bottles*, *Birds in the Wilderness*, *John Brown's Motor*, etc., and to thrill the younger members of the expedition with *Two Women sat at the Churchyard Gate*. Sea shanties, folk songs, part songs such as *Drink to me only* and national songs should all find a place in the repertoire.

When the camp location is near a small village, it is usual to invite the residents to the final camp fire, which as a rule takes place the night before the party leaves for home. It is astonishing what a wonderful impression such an evening makes upon the lads—and adults—and the amount of enjoyment derived from hearing the local padre, squire, shopkeeper, innkeeper, farmer and farmworkers join in in their various basses, tenors and other less harmonious variations. In the midst of it all the "Rodney Ghost" must of course appear, a very secretly and most specially rehearsed occurrence. Weird and hair-raising howls emanate from different points of the field, an eerie glow is seen at its darkest corner, trees glow with pale green and red lights, and the risen Rodney, a white sheeted figure glowing with light (supplied by the aid of flashlamps), slowly approaches,—hair raising and very thrilling.

The programme for the entertainment in

the schoolroom or hall, which the villagers always appreciate, needs careful thought. Simple sketches such as *Doctor Knockem orf, The Gasman,* etc., rich in comic element, should be included, and individual items have always a warm reception. Playlets and topical monologues can be written by the boys for these occasions.

Art work.—Those in the art room should be engaged with printing of circulars to parents, luggage labels, and any lettering on notice boards, boxes, or signs which may be necessary. Stencils should be cut of the name of the school, destination, etc., and all boxes and packages clearly marked. The bookbinding section can prepare covers for the writings of the tent scribe, the camp log, records of outings; loose leaf folios for the collection of photographs, which for tent and general camp use are indispensable, and an excellent collection can be made if the boys and staff are asked to give one print of each photograph taken for use in the general log, and for reprinting in the school magazine. In subsequent winter evenings these scenes can be projected on a screen by means of an epidiascope at informal camp club meetings in school.

Even the school garden can do its bit. Fruit and vegetables carefully selected and packed should be dispatched a day or two before the departure of the advance party.

History.—The history specialist may assist with a description of the district. Cyclostyled copies of this should be distributed to all in preparation for a little of what is to be seen. The boys should assist in compiling this article, and write for guide books, brochures, etc., from the publicity bureaux of the places concerned. An example of such an article is given below:—

SPEAKING HISTORICALLY

One obvious difference between our own district and Somerset will be, of course, the scenery. A still greater difference will be seen when the places are considered historically. Twice was the destiny of England decided among her fens. . . . For Somerset, fair though she be, has seen sights of which no man may tell, has witnessed scenes that must have made the angels weep. Look in the museums of Glastonbury and Wells if you wish to learn of prehistoric man. See, too, how the Romans were attracted by the mineral wealth of the Mendips and the health-giving springs of Bath. The Saxons were responsible for its very name—Somerset, the home of Sei-mere-saetan, the dwellers by the sea-lakes. Making a great leap to Elizabeth's reign, it was then that four thousand stout hearted yeomen of Somerset marched up to London to defend their queen and country. The last battle fought on English soil was at Sedgemoor. And bound up with secular history is the history of religion. Glastonbury is the very heart and shrine of Somerset and the cradle of Christianity in England. Ruins of monasteries, priories and abbeys are scattered up and down the length and breadth of Somerset. It will be evident then, that in one short week of camp life, only the very edge of the ocean of historical wealth can be explored, and the following short report deals with places which might be visited.

RODNEY STOKE.—Rodney Stoke, the village in which the camp will be situated, is described as "a delightful little village nestling at the foot of the hills." The camp itself is not 200 yards from the very interesting parish church. Here are the tombs of the Rodney family, from which the village took its name. Another matter which will claim the visitor's attention is a beautiful window in this little church. It was placed there in thanksgiving, because of all the men who went to the Great War from the parish, every one returned in safety.

PRIDDY.—Since Roman times Priddy has been the centre of the lead industry and the whole of the area around it is scarred with surface workings. The village itself stands right in the midst of Mendip, remote and self-centred. There, too, are

Central Press Photos

COX'S CAVE, CHEDDAR

Cox's Cave was discovered accidentally in 1837. It is considered to be one of the finest of its kind in the world, and is now lit by electricity. There are seven chambers, in which stalactites and stalagmites of every shape and size reflect all the colours of the spectrum. This picture shows the Fourth Chamber.

the "barrows," where "the forefathers of our race sleep their long last sleep."

CHEDDAR.—Cheddar is about three miles from the camp. The village and district is for the geologist rather than for the historian, though to both the famous caves are majestic, awe-inspiring and informative. There is history there if one studies the "finds" that have been made in the caves, especially that of 1905, when the skull of a pre-historic man, 60,000 years old, was accidentally made during excavations in Cox's Cave. The Gorge itself, as it towers up immense and splendid, has a story to tell, for at some remote age it was a cave, and an underground river swept along where now the road winds. The roof fell in, leaving the cave open to the sky and forming the impressive gorge we see to-day.

WESTON-SUPER-MARE.—This is a popular town. It has no real history and until the first quarter of the nineteenth century it was nothing more than an insignificant village. In 1819, a visitor to the place wrote as follows, "Inquired for books. There were but two in the town—the Bible and *Paradise Lost.*"

WOOKEY HOLE.—This cave has an ancient story to tell. We must go back before even the Legends of Glastonbury. The caves were occupied by Ancient Britons, who lived there in unbroken occupation from 250 B.C. From discoveries of their tools, needles, iron and bronze work, we can reconstruct the story of fights with wild animals. The river Axe flows along inside this cave. The noise made at certain times was noticed by Clement of Alexandria in A.D. 189. He likened it to clanging cymbals. Even now they are heard when river conditions permit.

The *Witch of Wookey* story makes an interesting example of how legend is often related to fact.

WEDMORE.—This name is one of the first to be mentioned in history books of our land. It is, of course, associated with the famous treaty made between Alfred and the Danes, which temporarily broke the power of the latter. In the village of Wedmore there is a very fine fourteenth-century cross with a canopied head on which are carvings of the Madonna and Child, the Crucifixion, a Bishop and a Knight. It was here that the infamous Judge Jeffreys hanged a doctor because he had bound up the wounds of one of Monmouth's soldiers.

BRISTOL.—Bristol has had books written about its history so that it is not surprising if comparatively little history is absorbed when that great city is visited. Right back in the days of Domesday it was a royal borough. In the fourteenth century it was noted for its trading and manufacturing

[*By courtesy of the L.M.S. Railway*

THE AVON GORGE, CLIFTON BRIDGE, BRISTOL

activity, which extended to the Baltic. It also exported to France, Spain and the Levant. At this time the famous St. Mary Redcliffe Church was rebuilt.

Not only is it a trade centre but its religious history is even more noteworthy. Here Whitfield and Wesley began their great work. Here is the Cathedral, on a site which was formerly the abbey of St. Augustine (1142). The following churches are all worthy of study:—St. Stephen's (fifteenth century), St. John's (fifteenth century) and St. James's (1130), with its fourteenth-century Norman tower.

Historical interest also attaches to the Merchant Venturers' almshouses. Whilst Colston Hall (1700), the Exchange (1743), and the Council House (1827) are relatively modern, yet even they appear almost venerable when compared with local architecture. And all around are objects of historical interest. For instance, a bank near St. Stephen's Church claims to have originated the first savings bank established in England (1812). The city free library (1613) is considered to be the original of its kind. Educationally, the famous university buildings have a story to tell, whilst the harbour and docks are all wonders which date back for a considerable time. Perhaps the impossibility of even commenting on Bristol is best seen by thinking of the variety of its industries, which range from shipbuilding to chocolate factories, from tobacco mills to glass works, from chemical works to saw-mills, from anchors to breweries.

WELLS, THE CITY OF PEACE.—To think of Wells is to think of a cathedral. Again, to describe in a few sentences such an edifice is impossible. The son of Alfred the Great founded the bishopric of Wells, and Athelm, a monk of Glastonbury, became its first bishop in 909. Later, the bishop's see was transferred to Bath, but three centuries later the throne was returned to Wells. The Saxon font in the southern transept is all that is left of the early church of the eighth century. The wonderful Jesse window, the Lady Chapel, the canopied tomb of Bishop Beckington (1443–64), the marvellous roof-vaulting, these and many other objects all have a story to tell. The clock, built by a monk of Glastonbury in 1325, is also an object of interest. The crypt, built about 1280, and the octagonal Chapter House have to be seen. Outside, the wonderful western façade, with its hundred and fifty kings and queens and hundred and eighty Biblical characters, is a monument to the art and ardour of Bishop Jocelyn (1206–42).

Then there is the Bishop's Palace, where resided notable characters including Wolsey, Cranmer and Laud. While walking the terrace of this very place, Bishop Ken composed the famous hymn, *Glory, to Thee, my God, this night.*

There are other interesting visits to be made in this mediaeval city. Were it not a trifle overshadowed by the cathedral, the beautiful church of St. Cuthbert would have more attention given it.

"Ancient gateways, a street of fourteenth-century houses, a fifteenth-century Deanery with walls built for defence, these all adjoin the cathedral and combine to form a picture of mediaeval interest not to be surpassed even by Canterbury or Chester."

GLASTONBURY.—The Home of Legend is packed with interest. When William the Conqueror lived, the Abbey was nine hundred years old. If the tradition is true, the man that stood by the cross, Joseph of Arimathea, built on this selfsame spot the first Christian church of our land, perhaps of the world.

The Lady Chapel, roofless, but well-preserved, was built after the terrible fire of 1184. In the cemetery, at a depth of seven feet, a large flat stone was discovered on which were cut the words:

HIC JACET SEPULTUS INCLYTUS REX
ARTHURUS IN INSULA AVALLONIA.

(Here lies buried in Avalon Island the renowned King Arthur.)

Nine feet lower down an enormous coffin

was found containing the king's bones and those of Queen Guinevere. The monks also asserted that here were buried St. Joseph of Arimathea, St. Patrick and St. Dunstan, beside the Saxon kings, Edmund the Elder, Edgar the Peaceable and Edmund Ironside.

After the fire, Henry II began to rebuild the Abbey, but it was a hundred years before the work was completed. At the dissolution of the monasteries some excuse was found for arresting the Abbot, Richard Whiting. He was dragged on a hurdle to the top of the hill, hanged and quartered. After the dissolution, some of the stonework was actually uprooted and whole portions utilised as building material. In 1551, the Flemish weavers were permitted to make the Abbey itself the centre of their activities.

In 1907, the site was purchased for the nation for £30,000 and the ruins are now at least "holy ground" once more.

The famous Glastonbury Thorn must be mentioned, for "St. Joseph planted his staff, which straightway took root and budded and made the practice of celebrating every Christmas Day by bursting into flower."

GLASTONBURY TOR.—This is an obvious landmark for miles around. Originally a church to St. Michael was built at its top. St. Patrick at the end of the fourth century rebuilt it. One hundred years later a monastery was also built. An earthquake destroyed a church there in 1276, but another was built and the tower stands to this day and may be seen for miles around. Over the doorway is a carving of St. Michael weighing a human soul, and one of a woman milking a cow, the latter being the representation of a soul that tries to get the very utmost out of life. And so, from the top of the Tor we leave Glastonbury.

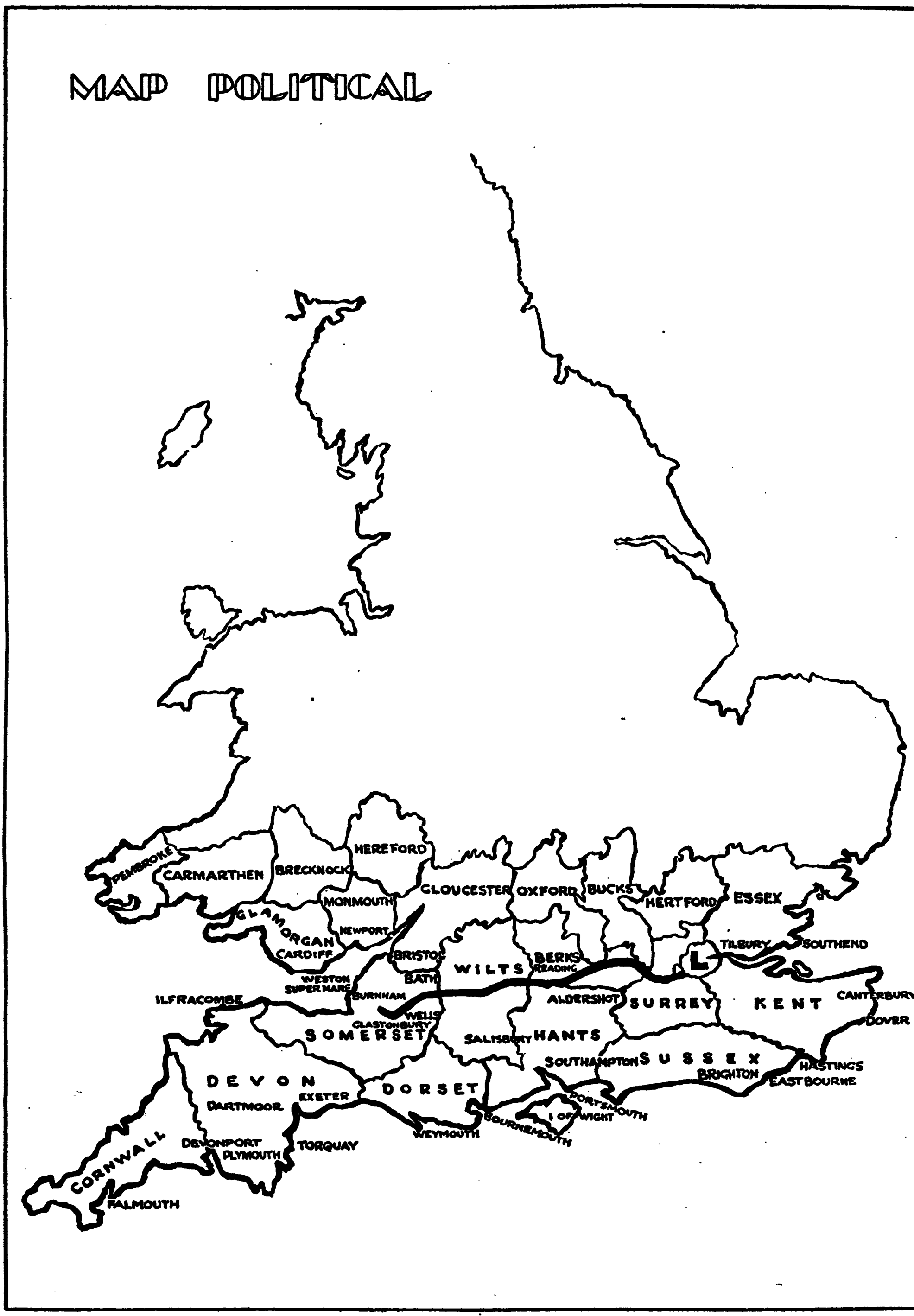
And so we come to the end of our survey, all too sketchily described. However, it does surely show:

Ef you do ax vor sturdy men
Wi' zyve or plough, vor sword or pen—
Goo to the West, vor there, I'll bet,
You'll vind 'em down in Zummerset.

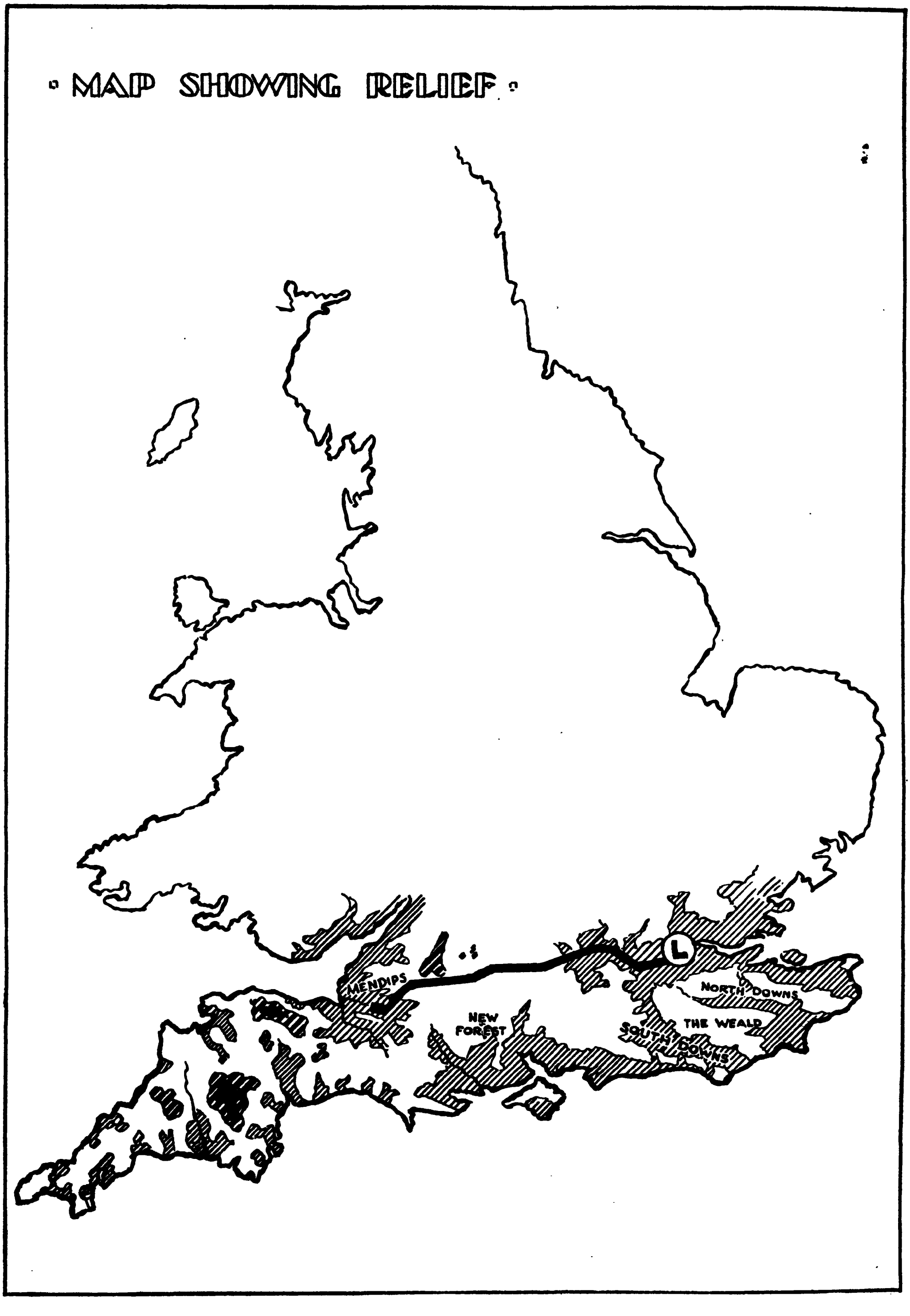
Geography.—The geography room should play no small part. Maps should be prepared, both physical and political, of the journey from school to Rodney Stoke, marking along the route chosen the places of interest which are worthy of observation, distances, chief towns and rivers, hills, etc. For so many people take journeys nowadays either by car, coach or rail, and see little or nothing of any real interest. A happy impression of scenery, a glimpse of a town, or a building which conveys no definite information to them is a small reward for such outings. The habit of observing with understanding should be inculcated in all children, and no pains should be spared in the preparation of data to this end. The Automobile Association and Royal Automobile Club route descriptions may be taken as a useful basis for detailed descriptions of the right kind.

From the six inch ordnance map of the district, detailed sketch maps as well as relief models should be made. Proposed journeys should be marked showing distances and approximate cost together with the chief reason for visiting the town concerned; e.g., Wells—cathedral; Bristol—port; Priddy—mines. A suggested model of the camp ground should be built. This latter model will help the lads to understand the layout of the camp, and will be useful when explaining any points of organisation which may be necessary.

To the budding geologist a description of the rocks to be found and how to collect them will not come amiss, while the keen members of the party may wish to prepare for a regional survey. Provision must be made for daily weather observations, which should be recorded on the notice board together with the forecast for the following day. The record should include wind direction and force according to the Beaufort Scale, rainfall, temperature (maximum and minimum), hours of sunshine.



Southern England



Southern England

Observations on local geography should include a study of:—

1. The activities in the district, such as farming, the type of crops grown, sheep rearing, dairy farming, soils.
2. Relief and natural vegetation.
3. Mining.
4. Manufactures; e.g., cider.
5. Roads and towns.

The financial side of camping.—And now let us turn to the financial side of the camp. Funds for general camp use can be raised in a variety of ways. School concerts, whist-drives, physical training displays, sales of work, rummage sales, private subscriptions—all play their part. The camp bank should be opened as early in the year as possible. Boys will be enabled to bank money at the times stated by the treasurer and so save to pay their fees, as well as to have pocket money for journeys to places of interest. A saving's card should be issued to each boy, and later, when in camp, he can draw his money by using imitation cheques. Journeys to such places of interest should be discussed, and aims of each journey, approximate time taken up and cost fully explained, and the choice left to the boys themselves.

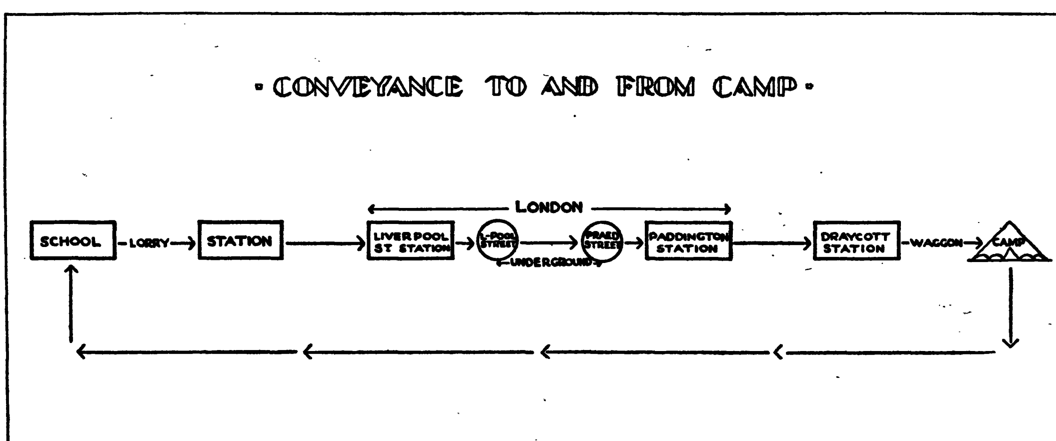
The actual cost of the camp, which will determine the standard fees paid by each boy, will depend upon the following factors:—

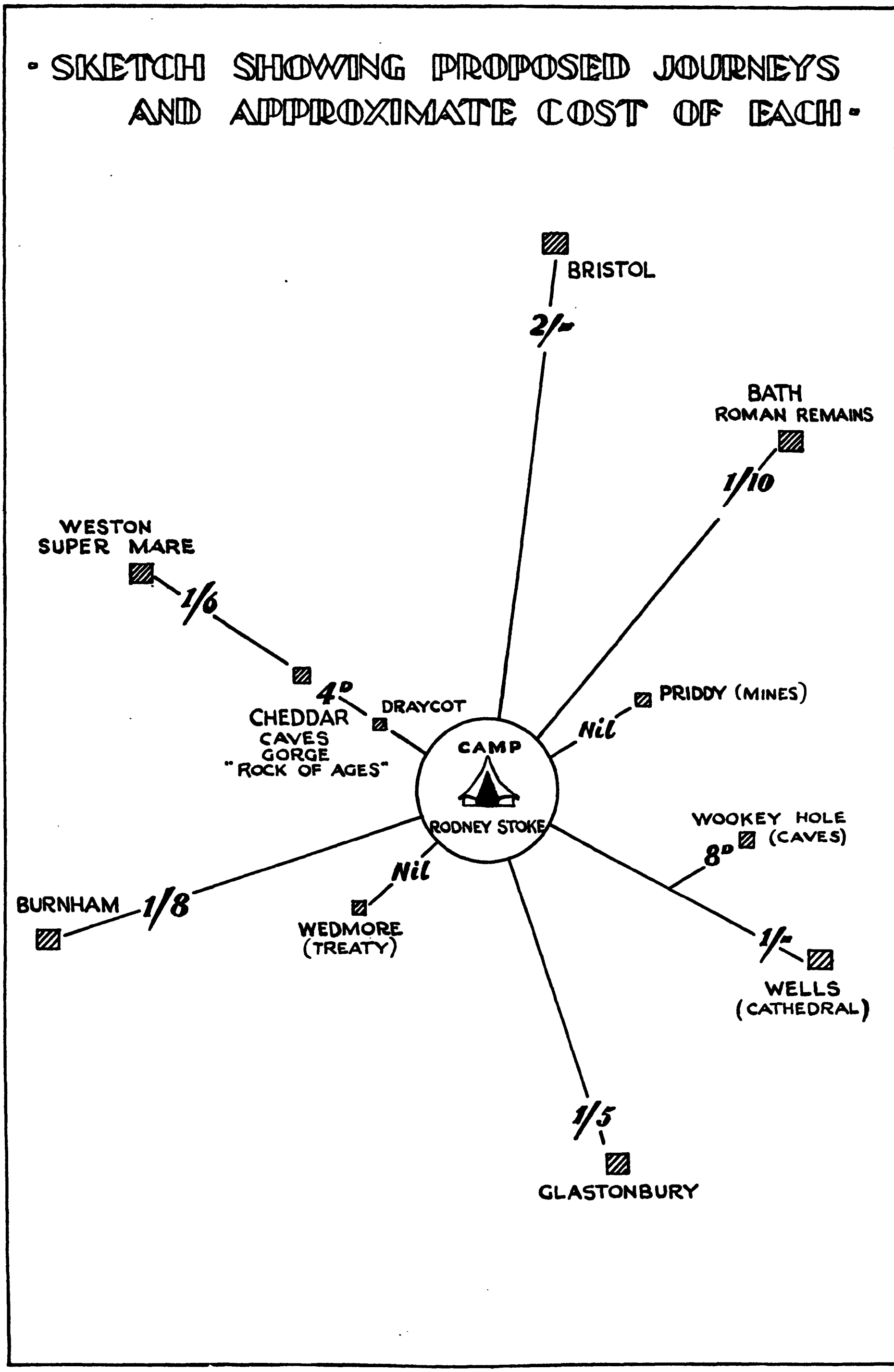
1. Distance from the camp site—transport.
2. Cost of equipment.
3. Cost of camp site.
4. Insurance.
3. Catering—food.
4. Unforeseen expenses.

Let us take each of these items. Estimates for transport should be obtained from the local omnibus services' offices and a further estimate from the information bureau of any large London station. The former method will be simpler but perhaps a little more expensive. Taking into consideration the fact that there will be a great deal of luggage to take and that our advance party of masters and boys will have to travel a day or two before the main camp, a train journey may prove more advantageous.

If it is decided to go by train it will be necessary to hire a lorry to carry all equipment from the school to the station, to procure a detailed time-table from the company and, if possible, to secure a special corridor coach. From Draycott, the nearest station to the camp ground, a farm waggon may be chartered. The average return fare should be 11s. per boy.

The general equipment will need careful consideration. Assume that eighty boys and eight members of the staff decide to go. In





SKETCH SHOWING PROPOSED JOURNEYS
AND APPROXIMATE COST OF EACH
BRISTOL
2/-
BATH
ROMAN REMAINS
1/10
WESTON
SUPER MARE
1/6
4D
CHEDDAR
CAVES
GORGE
"ROCK OF AGES"
DRAYCOT
PRIDDY (MINES)
Nil
CAMP
RODNEY STOKE
WOOKEY HOLE
(CAVES)
8D
BURNHAM
1/8
Nil
WEDMORE
(TREATY)
1/-
WELLS
(CATHEDRAL)
1/5
GLASTONBURY

this case eight bell tents will be required for the boys and four "squatter" tents for the staff. In addition, there will be one small squatter tent to be used as a hospital tent in case of need and one large "Icelander" for stores. Many of these may be borrowed from Scout or Guide Troops, from the lads themselves, or hired at a reasonable rate.

The equipment for each tent, most of which should be forthcoming from the parents, will be reduced to a minimum and should include:—

2 pails—1 for washing, 1 for drinking water.
2 large dixies, 1 large kettle and 2 pans.
1 length of rope—this may be used to fasten gear in transit.
Electric torches.
Number board for each tent, or tent name.
Plate rack.
Pan holders.
Pan rack.
1 Primus stove, to be kept in a "lean to" outside the stores tent.

For general camp use, the following will be necessary:—

Flag and flagstaff.
Notice board and clock.
Sports material—to suit individual needs.
Dish cloths, tea cloths and scourers.
First Aid box, with a plentiful supply of olive oil.
Mending materials.
Rain gauge, thermometer, tape, prismatic compass and other surveying instruments.

Regarding the *individual needs of the boys* it will be as well to send a circular with a list of those to each parent; e.g.—"Below is a list of articles which will be required by each boy:—

Ground sheet.
1 large or 2 small blankets.
Soap, comb, 2 towels, toothbrush.
Knife, fork, spoon, enamel plate.
1 pair plimsoles, 1 pair stout boots or shoes.
2 pairs shorts and 1 jacket.
2 cricket shirts.
Bathing costume.
Overcoat and mackintosh.
Handkerchiefs.
Boot cleaning material.
Sweater.
Pyjamas—optional.

There is no need to spend much on the above. Take care that the blankets, towels and cricket shirts are the oldest you have. The only expense you will have will, in all probability, be the ground sheet which is obtainable from 2*s.* 9*d.* upwards.

Each article must be clearly marked with the boy's camp number."

Rent and Insurance.—*The rent of the camp site* is usually about £3 but this will not include hay for palliasses, firewood, etc.

Insurance of the staff, boys and all equipment will not be an expensive matter, and it is advisable to take out a policy. In doing so it is necessary to state the name and address of the person in charge of the camp, and the number of boys and teachers attending. It should be clearly expressed that the project is in the nature of a holiday camp, with exact dates given, and that the insurance is desired to cover the travelling from home to camp and back again. Boating and bathing should be allowed only where parties of boys are in charge of a responsible person. It is well, too, to bear in mind that when the railway company issues cheap tickets their ordinary liability for accidents does not apply. A statement to parents should be issued stating that whilst every care and precaution will be taken, the organiser of the camp cannot accept any responsibility for accident or loss.

Tents and equipment will be insured under a separate policy. A "Jupiter Pluvius" policy which insures against the holiday being spoilt by rain is a proposition to be considered.

Food.—Then there is the question of food. Camp life means a healthy appetite, and a plentiful, plain, wholesome diet is advocated. Nor yet are we to look upon the cooking as a trial and tribulation, but at the same time it must be remembered that in a holiday camp it is not desirable to have to spend a great deal of leisure at this pastime. Joints should, for example, be bought ready cooked, and it is quite possible to have these delivered hot at the right time. On the other hand, if camp ovens are available it is quite easy to cook by them.

Most of the supplies such as tinned beef, jam, tea, cocoa, can be purchased at wholesale prices, but it is a useful practice to buy as much as possible at the local stores. Potatoes, eggs, milk, vegetables, can be supplied by the farmer. A suggested menu for the week would be:—

SATURDAY.—Meal on arrival at camp (prepared by the advance party): Hot beef stew; bread, butter, cheese.

SUNDAY.—*Breakfast:* Cold ham; bread, butter; tea or cocoa.

Dinner: Roast beef (cold); potato salad; stewed fruit and custard.

Tea: Cake; bread and butter; tea or milk.

Supper: Cocoa or milk; bread and butter.

MONDAY.—*Breakfast:* Bacon, bread and butter; tea or cocoa.

Dinner: Irish stew; boiled currant pudding.

Tea: Bread and butter; paste (meat or fish); tea or cocoa.

Supper: Cocoa or milk; biscuits and butter.

TUESDAY.—*Breakfast:* Shredded wheat; boiled eggs; bread and butter; tea or cocoa.

Dinner: Liver and bacon; potatoes, cabbage; fruit tart.

Tea: Bread and butter; jam; cake; tea or cocoa.

Supper: Cocoa or milk; bread and butter.

WEDNESDAY.—*Breakfast:* Corn flakes; fresh fruit; bread and butter; tea or cocoa.

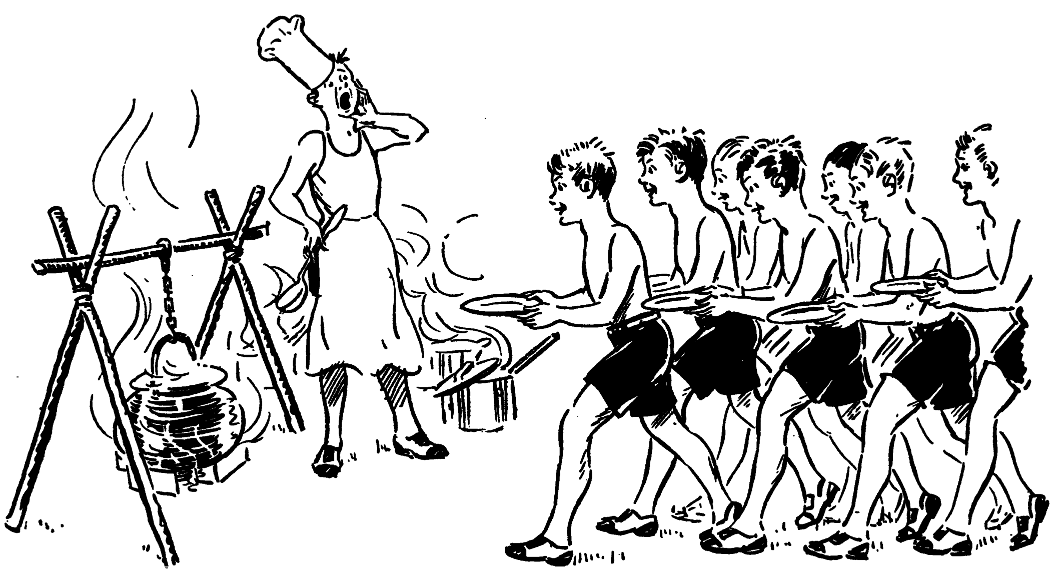
Dinner: Roast beef: potatoes; blancmange and jelly.

Tea: Tea; biscuits; bread and butter; cheese.

Supper: Cocoa or milk; biscuits.

THURSDAY.—*Breakfast:* Bacon and eggs; bread and butter; tea or cocoa.

Dinner: Stewed beef; peas and potatoes; stewed fruit and custard.



ONE-WAY TRAFFIC

Tea: Cake, bread and butter; jam; tea or cocoa.

Supper: Cocoa or milk; bread and butter.

FRIDAY.—*Breakfast:* Shredded wheat or cornflakes; kippers; bread and butter; tea or cocoa.

Dinner: Boiled cod; potatoes; rice pudding with raisins.

Tea: Cake; jam; bread and butter; tea or cocoa.

Supper: Cocoa or milk; bread and butter.

SATURDAY.—*Breakfast:* Cold beef; bread and butter; jam; tea or cocoa.

In your estimate for quantities allow for each boy:—

Butter	..	3 ozs. daily.
Milk	..	1 pt. daily.
Bread	..	⅓ quartern loaf daily.
Tea	..	½ oz. daily.
Sugar	..	2 ozs. daily.
Cocoa	..	½ oz. daily.
Meat	..	4 ozs. uncooked weight.
Fruit	..	4 ozs.
Potatoes	..	6 ozs.
Custard	..	¼ pint.
Cake	..	2 ozs.
Bacon	..	2 oz.
Fish	..	4 oz. uncooked weight.

In addition to the staple diet there is no reason why boys should not be allowed to bring "luxuries" with them such as tins of fruit, salmon, etc. The camp number should be scratched on each tin, then all can be packed together and issued on request or at the discretion of the master in charge, and consumed only after inspection.

Thus in estimating the cost per boy in a camp of eighty boys make a food allowance of 11*s*. per boy.

To summarise it and establish a definite charge we can say that Fares would cost 11*s*. (including lorries).

Food allowance 11*s*.

Insurance, 4*d*.

A maximum for hire of tents and equipment 2*s*.

Other expenses, 8*d*.

Total, 25*s*.

This is of course exclusive of outings and entertainment.

Outings from camp.—To return to the preparation in school, it may be as well at this juncture to consider the outings from the camp as well as the "duty rota," and in doing so it will be advantageous to consult the wishes of the staff, as some of the members will have preference for various types of journey—some preferring long tramps, others wishing to see places of historical interest, and so on. It will be necessary, too, to think of camp supervision during the day. To suit all needs is almost as difficult a task as the preparation of a specialist time-table! Remember the younger members of the staff should be given free evenings wherever possible and that those on duty from 6 a.m. to 2 p.m. will be responsible for the greater part of the cooking. Some may prefer to spend the major part of their time in camp. A detailed list should be prepared:—

OUTINGS FROM CAMP

SUNDAY

Church Parade	All staff less Messrs. C. and B.
Short walk	All staff less Messrs. C. and B.
Church (optional)	All staff less Messrs. H. and F.
Short walk	All staff less Messrs. H. and F.

MONDAY

Priddy (all day)	Messrs. B. and E.
Glastonbury (all day)	Mr. C.
Wookey Hole Caves (afternoon)	Messrs. G. and D.

TUESDAY	
Bath (all day)	Mr. G.
Bristol (all day)	Mr. C.
Weston-super-Mare (all day)	Messrs. B. and F.
Cheddar (afternoon)	Messrs. H. and E.
WEDNESDAY	
Wells (all day)	Mr. D.
Priddy or Cheddar (morning)	Messrs. B. and C.
Lead mines (morning)	Messrs. H. and E.
GARDEN PARTY (afternoon)	All staff, less Mr. D.
THURSDAY	
Burnham	Mr. C.
Cheddar and caves, and CRICKET MATCH	All available staff.
FRIDAY	
OPTIONAL PARTIES	
Wedmore (morning)	Mr. A.
Camp fire	All staff.

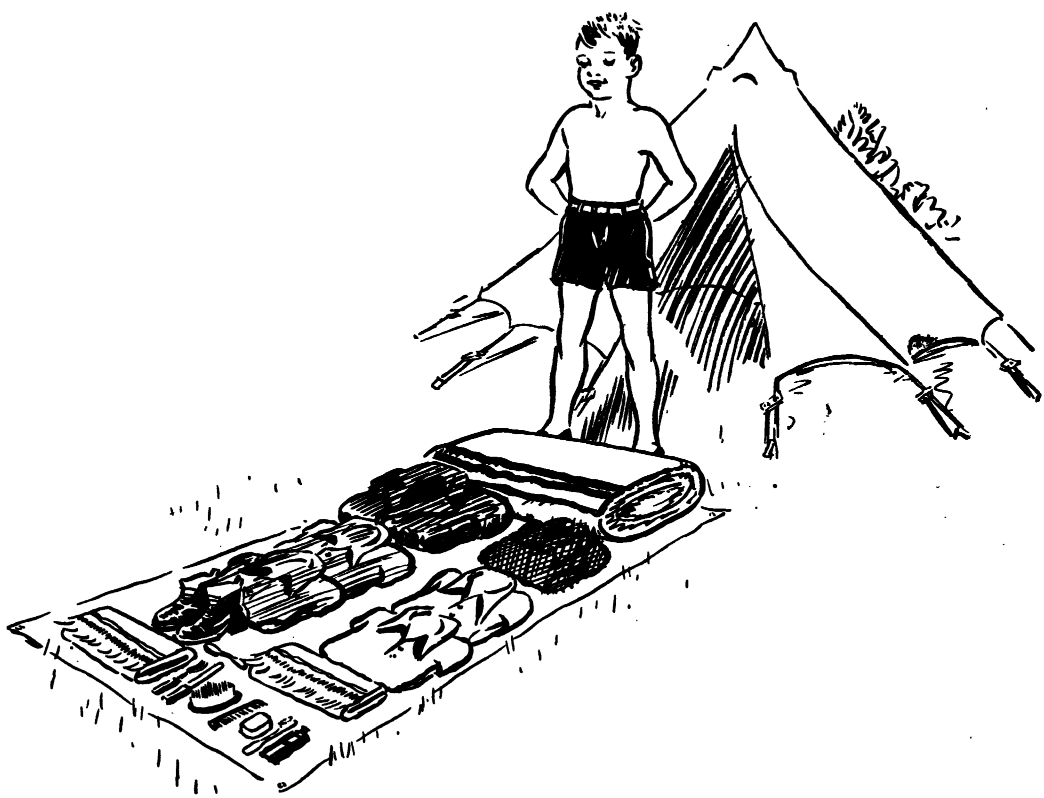
Daily routine.—Running parallel with this, and there ought to be no overlapping of duties, will be the duty rota for those in charge of the camp during certain parts of the day. Two masters should be allocated to each period of duty, but as a rule so few boys are left in camp between the hours of 9.30 a.m. and 6 p.m. that it is often possible for one person to take charge, or for the organiser to step in and take over. Such a list is entirely provisional:—

CAMP ROTA

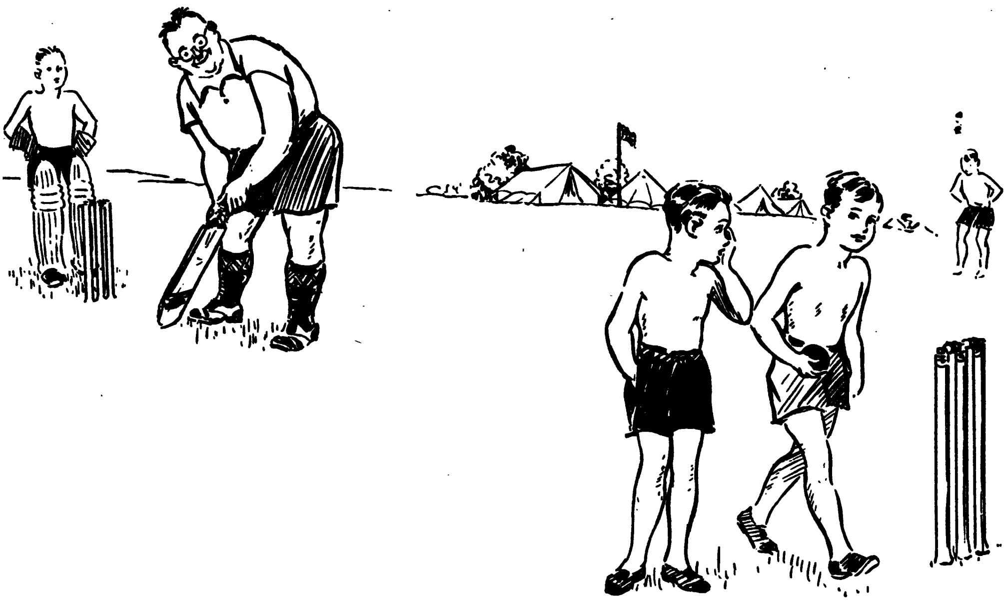
SATURDAY	
6 a.m.— 8 p.m.	Mr. G. and Mr. B.
8 p.m.—12 p.m.	Mr. E. and Mr. D.
SUNDAY	
6 a.m.— 2 p.m.	Mr. C. and Mr. B.
2 p.m.— 7 p.m.	Mr. A. and Mr. E.
7 p.m.—12 p.m.	Mr. H. and Mr. F.
MONDAY	
6 a.m.— 2 p.m.	Mr. G. and Mr. D.
2 p.m.—12 p.m.	Mr. A. and Mr. F.
TUESDAY	
6 a.m.— 2 p.m.	Mr. H. and Mr. E.
2 p.m.—12 p.m.	Mr. E. and Mr. A.
WEDNESDAY	
6 a.m.— 2 p.m.	Mr. A. and Mr. F.
2 p.m.— 7 p.m.	Mr. A. and Mr. G.
7 p.m.—12 p.m.	Mr. C. and Mr. H.
THURSDAY	
6 a.m.— 2 p.m.	Mr. B. and Mr. D.
2 p.m.—12 p.m.	Mr. A. and Mr. G.
FRIDAY	
6 a.m.— 2 p.m.	Mr. C. and Mr. E.
2 p.m.—12 p.m.	Mr. D. and Mr. F.
SATURDAY	
All the staff.	

This very naturally brings along the discussion of the average day's routine. There are several essential points to impress, as will be seen. At 6 a.m. the master on duty arouses the fatigue party, which has been chosen the day before from those boys who are not taking part in the day's outings, the fires are replenished and the cooking of breakfast got under way. Stores are issued, and it is a good plan to have eight boxes or packing cases in the stores tent, into which the separate supplies for each tent can be placed ready for distribution to the individual tents. At 6.30 the main camp rises and here, if you have a bugler amongst the lads, he may be called into service, otherwise a whistle will answer the purpose. The boys don shorts and sweaters, roll the tent walls and either hang up or spread their bedding outside the tent to air. They then repair to the brook or trough to wash, then assemble in a group for morning prayers—a short service which can be taken by the organiser or by the various members of the staff in rotation. After prayers comes kit inspection.

All kit should be laid out on a ground sheet and carefully inspected by the master in charge of the tent, and great care should be taken to see that no damp garments are rolled up, and that forks, plates, etc., are clean. During inspection—and this is the only occasion in the course of the day when this is essential—strict discipline should be enforced and every lad in the camp should stand to attention at the side of his kit, and be prepared later to act on any advice given. A system of merit marks could be introduced with advantage, any boy with a "perfect" kit to receive a stated number of marks, such marks to be aggregated at the end of the week and some special concession granted to the winning tent; e.g., half an hour's postponing of turning in, a "mid-night" feast, etc. Such a system of marks could be extended to personal and tent cleanliness. Then comes breakfast (7 o'clock) and as a rule all are ready for it. If you have not been able to secure a marquee, meals should be eaten in the open, ground sheets being spread in front of the tents. When the washing up has been done—each lad being responsible for his own "crockery" —there should be a compulsory rest of fifteen minutes. At 8 a.m. the post is distributed —with it the joy of enclosed postal orders— and the camp bank opens, when the lads line up, present their cheques and receive the value stated thereon. During this time the masters on duty, assisted by the fatigue party, issue packets of sandwiches to those boys who are going on trips. The master



KIT INSPECTION



"Bowl for catches, Charlie—you'll never get a break to go round Schoolmaster."

in charge of each party hands in a list of names of boys in his particular group, signs the log book and states the time of departure, and the party leaves for its destination.

8.45—12. The fatigue party cleans and tidies the camp where necessary; collects and stacks firewood and cooks the midday meal for those who remain in camp.

1—4. Camp duties, games, etc.

4—4.30. Tea.

4.30—5.30. The meal for those returning to camp from journeys is prepared.

6. Evening meal.

6.30—6.45. Rest.

6.45—8.15. Games, rest, letters written, washing and mending.

8.15—8.30. Boys wash, prepare beds, slacken guy ropes and generally prepare the tents for the night.

Then a light supper is served, after which evening prayers are taken by the master inside each tent.

9. Turn in.

9.30. Lights out.

9.45. Silence.

If the lads have an idea of the daily routine before they go you will be surprised how smoothly things will work, and how little confusion there will be.

Each boy attending the camp should be medically examined by the school doctor not more than a week before leaving for camp. This precautionary measure guards against the carrying of infectious diseases or taking boys who suffer from some physical disability, such as a weak heart, which may bring about serious consequences.

The parents' interest.—The interests of the parents must not be overlooked—an interest which is very deep and very real. Here is an extract from a letter written by the father of a senior school boy who was attending his first camp:—

Thursday, July ....
19....

MY DEAR ERIC,

I haven't written to you lately and think it is a good opportunity to send you a line on the eve of what is really your big adventure in life, for you will be away from home for the first time.

Now I'm not going to write you a lot of "Don't do this" and "Don't forget that," chiefly because both Mother and I have every confidence in you. I have had very good reports, son, of your help to Mother in my absence, and I am not at all worried about you being all we would wish you to be when in camp.

I have never been to Cheddar, so can't tell you anything about it, but other parts of Somerset I know, and from what I have heard from people who have been to Cheddar, make me sure that you will like the place very much. The caves are very wonderful, and the Stalactites too. I believe they are formed by some chemical process caused by the water mixing with the particular soil in those parts, but you will no doubt have it all explained to you on the spot. As for the famous gorge, well, I should think that would be difficult to explain or describe even by those who have seen it, which I haven't, although I have seen similar places in Devonshire. In fact, you will find the West of England very different to the part you have known up till now, for your own county is very flat comparatively, whereas the West is very rugged and magnificent, such as to make one awed by the wonders of Nature, and realise how puny we all are in comparison. I've no doubt that the hills you will tackle and the different air, will result in you not wanting any rocking to get to sleep at nights, even though you won't have a spring mattress to lie on, but then, son, you won't have to think about tumbling out early in the morning and chase round with papers before commencing school.

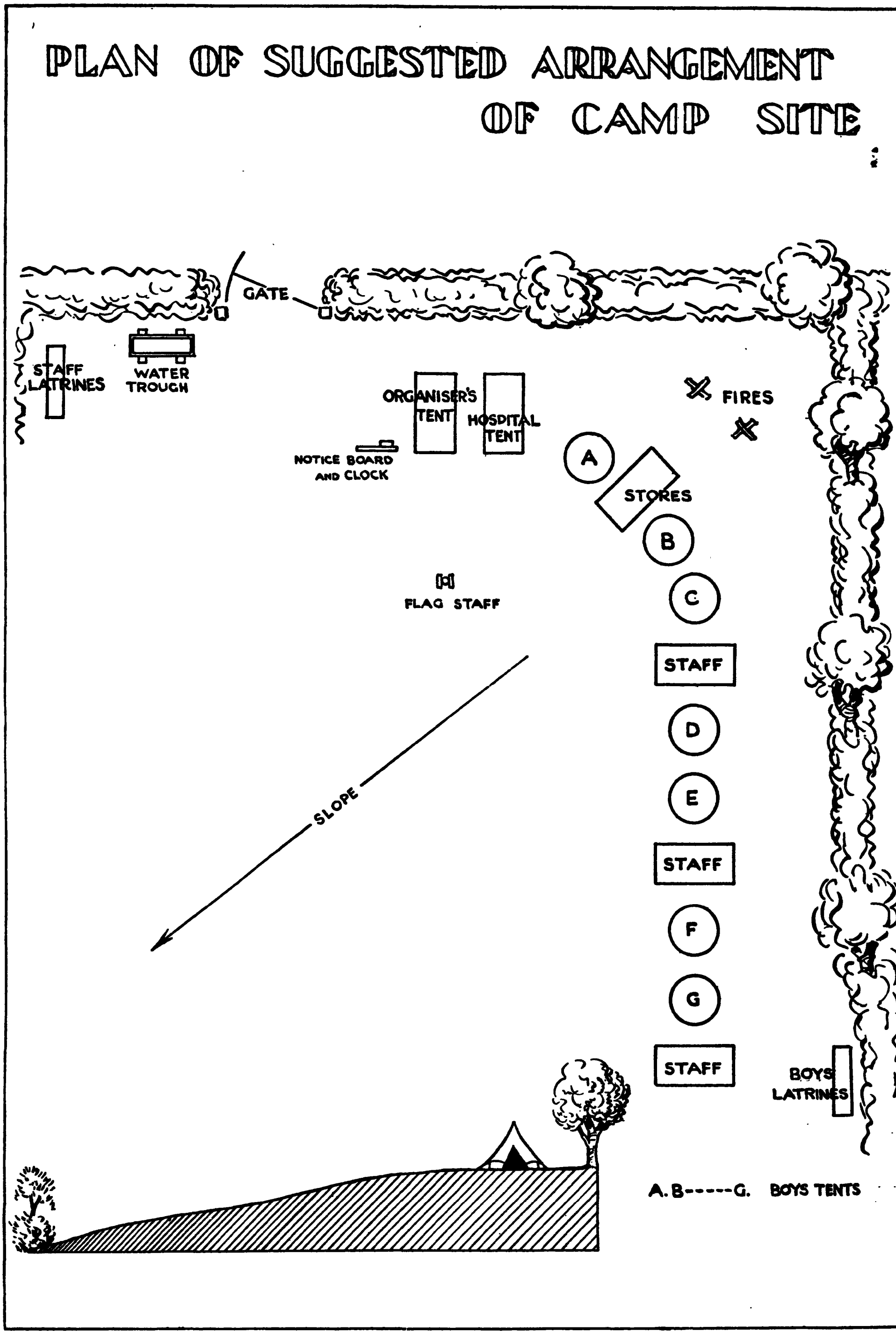
Such interest in any project is indeed inspiring, and parents will appreciate the opportunity of discussing many points with those in charge of the camp. They should be given the opportunity of coming along to school at stated times to interview the organiser and staff. They may, too, wish to visit the boys while in camp and a visitors' day could be arranged with advantage. While the boys are away, a daily bulletin, containing a report of weather conditions and camp life could be telegraphed to some obliging friend who would make himself responsible for seeing that it is posted on a notice board outside the school where parents could see it.

The departure for camp.—And so we come to the actual departure. The night before the advance party is to leave their kit will be inspected and a short service held by the camp chaplain. The following morning the equipment for the main camp will be packed on to the lorries and the advance party—ten boys and two members of the staff will leave—the remainder of the lads to entrain on the following day.

No matter how carefully arrangements may have been made or how meticulously detail may have been studied, hitches do occur as this account written by one of the advance party shows:—

Outwardly calm, but inwardly bubbling with excitement, the little band of pioneers left the station at 12 noon.

On arrival at Liverpool St. Station, we superintended the unloading of our baggage and equipment and then set off by Underground for Paddington. There, with an hour to go before re-entraining, we were able to refresh ourselves with tea, ices, etc. Then finding our baggage had arrived by lorry we saw it safely loaded on the train. Next, we searched for our two reserved coaches—in vain, for "someone had blundered". As the train was full almost to capacity we decided to look after our kit by sitting on it and so made ourselves as comfortable as possible in the luggage van. Then followed a fast trip to Frome, which we found to be a typical small country station where it is so delightful (?) to have "only an hour to wait". As it was then raining we stretched our legs by playing "Marker" on the platform. Eventually



THIS PLAN IS NOT DRAWN TO SCALE. THE TOP IS THE WEST.

we were off again and began to take an interest in the scenery as we were nearing the Mendip Country—previously we had not been able to see much from the luggage van. At Wells, although not having to change trains, we found we had another long wait. As it was now fine we were able to wander round, but finding our driver to be of a friendly disposition, most of us managed to ride down the line on the engine. "Mike" eventually finished the journey from Wells to Draycott on the foot-plate.

We arrived at Draycott at 8.30 only to find after unloading our kit on the platform, that the promised lorry had failed to arrive. After a quarter of an hour, during which we played farmyard cricket with one or two village boys and maidens, a farm cart arrived, as the lorry had broken down. This we loaded and set off on a slow mile and a half to the camp ground, which we reached at 9.30. Then the hustle began. We hurriedly sorted out our requirements and managed to pitch three tents in semi-darkness. Fortunately two lamps supplied us with sufficient light to get ground sheets and bedding down. Then in the darkness, we managed, with the aid of torches, to make tea and cook bacon on the Primus stove. And so to bed just before midnight, though to sleep very fitfully.

At daybreak we heard the unwelcome sound of rain on the tents but by 5.30 a.m. it had cleared so we commenced our day's work. What a long day it seemed! Even though we were busy the whole time fetching and carrying, helping and hindering, digging, etc. At 11 o'clock, Mick enquired if it was tea-time yet. The sixteen tents were at last pitched and pegged down, a task which had been made no easier by a slight gale springing up. The party took their turn with pick and shovel digging trenches for fires, etc.—an all-day task for we were digging in very hard ground!

By 6 o'clock we were able to ease up and have a stroll round the village with Mr. —— who had arrived by road. We then got everything ship-shape and expectantly awaited the arrival of the main party at 9 o'clock.

Those in charge of the advance party will of course carry with them a detailed plan of the distribution of tents in the field. It will be advisable to take full advantage of the slope of the ground and to erect the tents with the entrances in a set direction and in a stipulated order. The organiser's tent should be nearest the gate which leads into the lane. Next to this should be the hospital tent. The tents for the boys are interspersed with the stores tent and the squatter tents in which the staff are quartered. The most suitable positions of the latrines, fire trenches, notice board and flagstaff can be seen if reference is made to the accompanying diagram (which is *not* drawn to scale). The distances between each tent should not be less than 10 feet while the latrines should never under any circumstances be less than twenty-five yards from the nearest tent.

The conveyance of the main camp—seventy boys and six masters, is rather a greater undertaking. The lads assemble in the hall, complete with personal kit bags and parents and friends who have come to see them off. After a few words from the organiser about conduct in the train, and to the parents in reference to camp bulletins, the party files out through the main gates of the school to the station. The train arrives and amidst great excitement the seats in the reserved compartments are taken and the great adventure has after all begun. The journey to Liverpool Street is familiar to most, and numbers of the boys take the opportunity of disposing of their lunch so as to waste no time in London.

The underground journey to Praed Street is a novel experience to many who have had no previous experience of travelling by this railway, and embarking and disembarking has to be rapid, and frequent warnings given about sliding doors, nearness to the platform edge, etc.

Arriving at Praed Street the lads shoulder their kits once more and make their way to Paddington where in a quiet corner the luggage is piled, two boys are left on guard while the others disperse in parties under the masters to make small purchases and to see whatever this great terminus has to show them. Tremendous interest is taken in the various engines, in the time boards, maps of districts served by this extensive railway, and long before they have seen all they would wish the lads have to be recalled in readiness for the advent of the Wells train.

Although the journey to Liverpool Street was not a new experience the second stage to Wells is a positive adventure into new lands. The river, Reading with its factories and seed nurseries and other looked for features will be commented upon. A long wait at Frome enables them to stroll about the town and they gather from the dialect of the porters and shopkeepers that they are in a new country. A further train journey—none of it dull or uninteresting—Wells and eventually Draycott. Only a short time now before the destination is reached. Kits are shouldered with gusto and the mile tramp to camp and supper begin, and although the lads will be weary after their long journey, their fatigue vanishes when they are met by the advance party who by this time will be old campaigners) and escorted to their tents. After spreading their ground sheets and preparing their palliasses, they wash and have supper and after prayers turn in.

But not to sleep. Their first night is usually somewhat restless and disturbed and although they are very tired they are too excited to rest, and the greater part of the night is spent in retrieving lost blankets and ragging in general. This life so full of new experiences promises well and they mean to enjoy it to the full, so why waste time in sleeping?

But the morning brings with it a different tale. A heavy eyed camp, sluggish in its movements sits down to breakfast, and the fifteen minutes compulsory rest after this meal threatens to be prolonged. Many ask if they may be excused Church parade—but the wise C.O. gives a polite negative, and at 10 a.m. they line up for Church. During the sermon one or two threaten to besmirch the honour of the school by dropping off to sleep and earn unobtrusive nudges from their colleagues.

But by dinner-time appetites are good, and a well-cooked and plentiful meal disappears with gusto. And now they will be excused their after meal rest and go for a long walk up the Mendips! "Can't we stay in camp and read, sir?" is the anxious request. "Walk!" orders the C.O. and they walk. At 6 p.m. after tea, all boys who wish to "turn in" for the night are allowed to do so, and at 6.15 a great peace descends upon the camp for all the boys are sound asleep! But it is with confidence that those in charge realise that they will awake refreshed and invigorated ready for their outings and adventures the following morning.

There are one or two points which need close attention in the days which follow. Outings which may be of a pleasurable and educational nature must be supervised with great care. A complete list of those attending the individual journeys together with times of departure and return should be logged, and the account of the journey entered. This account should furnish proof of what has been seen and understood. Below is a typical example of a journey to Bristol, written by one of a party, describing a visit to the famous Wookey Hole Caves:—

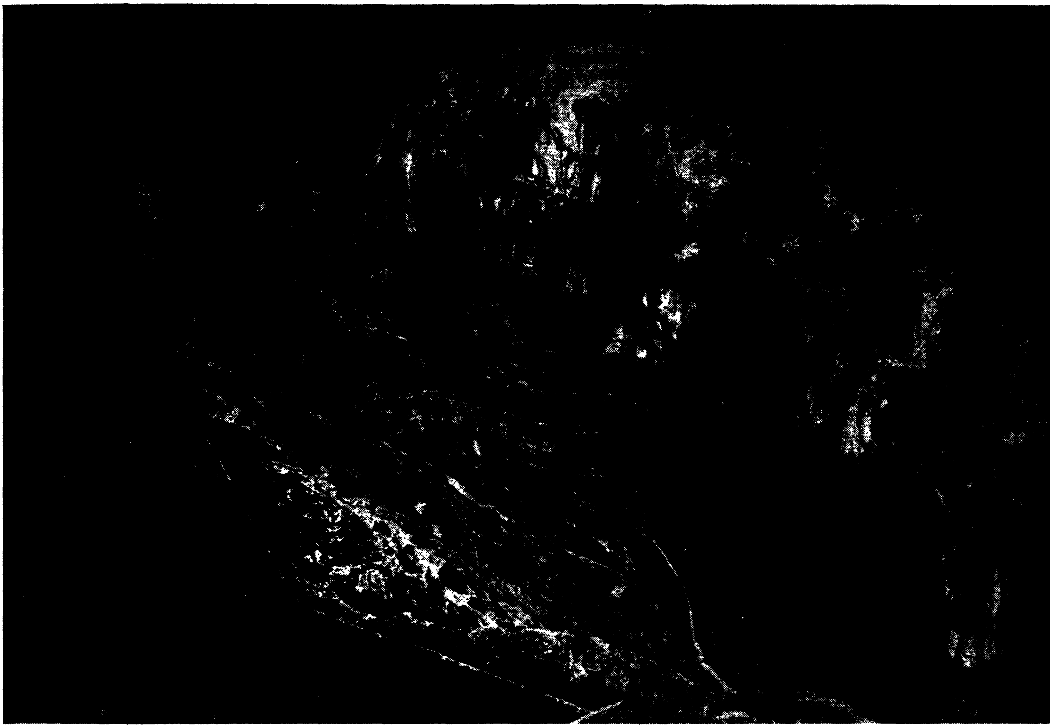
A DAY IN BRISTOL

On Tuesday, a party of sixteen boys, under the charge of Mr. A. left Camp at 8.50 a.m. bound for Bristol, the metropolis of the West. They travelled by train from Draycott, keeping to the beautiful Cheddar Valley route through Cheddar and Axbridge as far as Yatton Junction, where the branch line gives way to the main line to Bristol from Weston-Super-Mare. A distant glimpse of the famous Clifton Suspension Bridge was caught from the neighbourhood of Ashton, just outside the city.

Temple Meads Station—and the day's pocket money disbursed—the party made quick tracks for St. Mary Redcliffe church, the fabric of which is now undergoing external renovation. This noble pile of Gothic Architecture which Queen Elizabeth proclaimed to be "the goodliest parish church in all England" was first of all photographed with the Chatterton (boy poet) monument in the foreground, and then inspected as closely as time would allow. The boys were fascinated with the beauty of the interior, and when the organist of the church who happened to be practising, invited them to gather round him while he explained and demonstrated the "working" of the new console with all the latest electrical couplings, their delight knew no bounds.

A walk along Redcliffe Street with a brief halt for a peep into Canynge's house, and Bristol Bridge was reached. Here a call was made at the offices of the Bristol Development Board where sufficient literature for the whole party was secured gratis and willingly. Across the Bridge and up the High Street to the Dutch House, at the heart of the city where once stood the High Cross (now in College Green), a stroll along Corn Street past the Council House and the Corn Exchange (with the four bronze "tablets" ranged in front) and the Tramways Centre (St. Augustine's Bridge) and Floating Harbour came into view. Here is a centre of interest where much time could be spent with profit; but after a hasty reading of the plaque to the memory of John Cabot, it was deemed advisable to board a tram for Hotwells in order to see something of the Avon Gorge.

A ride to Hotwells on top of the tram affords a splendid view of almost the whole length of the Floating Harbour and such shipping terms as "dry dock," "launching slip," "basin," "lock," and "floating platoon," soon come to have real significance for the boys. Upon arrival at the Gorge, lunch was taken at the foot of the cliff, almost underneath the Suspension Bridge, the height and span of which without visible support did not fail to impress the boys from "low lying" Essex. After lunch, the sluggish river Avon which was previously at lowest ebb was now found to be in flood, and the boys were favoured with a close-up view of one of P. & A. Campbell pleasure steamers negotiating this tortuous river in a minimum "draught" of water. The party now split up, nine of the boys making the ascent of the rocks by the Clifton Rocks Railway, while the other seven toiled with their teacher up the "zigzag" path. All the boys met at the top and inspected the hydraulic means by which this unique railway is worked. The boys then grouped for a photograph near the pillars of the Suspension Bridge which was afterwards crossed and recrossed. Such landmarks as Dundry Tower (5 miles distant) were easily visible and the Observation Tower and its underground opening in the cliff were seen to full advantage. The next hour or so was spent in a leisurely stroll along the beautiful tree-lined Clifton Promenade as far as Victoria Fountain, and then past the Zoological Gardens and across the Durdham Downs to the Tramway Terminus at the top of Blackboy Hill. Here we cried a halt for tea which was served much to our liking at a café near by—and right well did the boys conduct themselves. A tram ride down to Whiteladies Road as far as the Victoria rooms and a walk along Queen's Road and through Berkeley Square and we found ourselves at Brandon Hill, at the summit of which stands the famous Cabot Tower. All the boys climbed both flights of steps and saw from the top that very wonderful panoramic view of the city on the one hand and on the other the river Avon, the Severn estuary and the Bristol Channel. The boys were especially interested in the direction and distance markings engraved on the four brass plates. After coming away from Brandon Hill one would have liked to have shown the boys round the Art Gallery and



[Photo: Aerofilms Ltd.

CHEDDAR GORGE

Museum—but the day was far spent, so with just an outside view of these buildings, together with those of the Grammar School and University we wandered down hilly Park Street to College Green. Here we halted at High Cross from which could be seen the Lord Mayor's Chapel and the Cathedral and the Abbey Gateway with its Norman Arch. The famous Merchant Venturers' Technical College along a turning hard by was indicated and after very little further walking, the boys recognised that they were once again back at the Tramways Centre—where ships appear to anchor in the streets. Most of the boys having spent their last halfpenny, the party had no alternative but to walk to the station along Baldwin Street to Bristol Bridge and then along Victoria Street, where the boys took a keen interest in the leaning Tower of Temple Church, to Temple Meads. A comfortable train ride with a change of train at Yatton Junction, and a pleasant walk from Draycott station brought the party in full song into Camp at 7.30.

A TRIP TO WOOKEY

At about 3.30 p.m. on the Wednesday of our Camp week, fifteen boys, headed by Mr. and Mrs. —— left Rodney Stoke for Wookey Hole Caves.

Their journey lay along the main road through Westbury and Easton, and it was decided to walk there and back for two very good reasons:—(1) to save bus fares, and (2) to obtain exercise. With regard to (2), it may be said here and now that they succeeded beyond their wildest dreams.

The party proceeded then to Westbury,

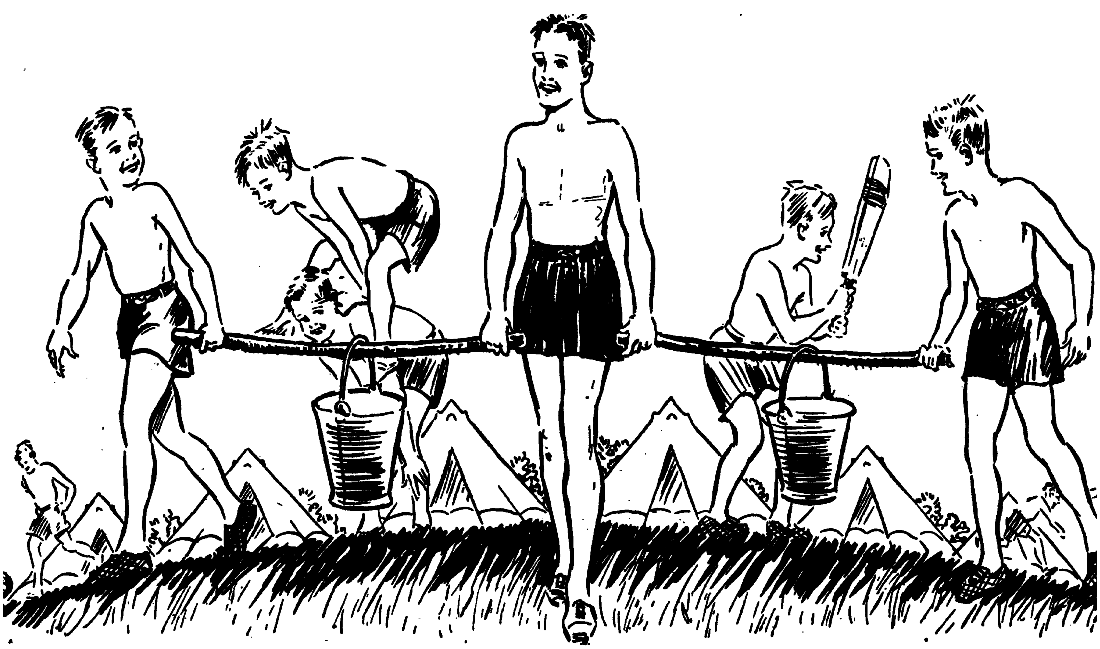
where a halt was made for sweets and drinks. It was here that a snap was taken of the party adorning the steps of a stone monument, the Butler Cross, in the village. The trek to Easton was then continued, and here the party turned northwards and ascended a steep hill over the Mendips. The burden of this wearisome climb was somewhat relieved by a meeting with a homeward bound party led by two other members of the staff. These cheery travellers were at the time singing lustily—not so much from pure pleasure, but rather to encourage the weary among them to quicken their flagging steps.

Not long afterwards the road dropped suddenly towards our destination and the party soon found themselves entering gardens of tropical luxuriance. The entrance of the caves reached, the guide—a polite and entertaining man—took charge, and the boys penetrated the gloomy and chilly interior hundreds of feet below ground level. The gloom was lightened by many electric lamps, whose number and brilliance however was not enough to destroy the natural charm of the place. Stalactites and stalagmites abounded everywhere, while exquisite colourings, revealed by powerful spotlights, entranced the eye.

The boys were warned to mind their heads and their steps, for the path was slippery and the roof at times very low. The guide's information was interesting and his stories good. He pointed out the huge silent rock shaped like a nag's head and called the "Witch of Wookey". This overlooked the beach leading to that terribly silent underground river—the Axe—whose history runs back thousands of years.

Its course is in the Mendips, and it leaves the Caves to drive the machinery of the old established paper mill near the entrance to the Caves.

The party penetrated still further, and entered the third chamber the acoustics of which are naturally perfect. Any sound in them produces no echo, and for this reason it was possible to broadcast, a few months ago, a programme by the Wookey Male Voice Choir.



A further chamber is not accessible except by boat at low water, but it is possible that the field for exploration of these fascinating Caves may be yet further extended.

They have boasted human and animal inhabitants for thousands of years as a visit to Wells Museum will show.

The party left Wookey with reluctance after purchasing postcards and souvenirs. The trek "Cheddarwards" was then commenced, and except for an exciting adventure with cows "en route," during which one boy precipitated himself hastily into a front garden, nothing further worth noting occurred. Camp was reached at about 7.30 p.m. and full justice was done to a hot meal.

Individual troubles.—Then again one must always be on the lookout for individual troubles amongst the boys. Simple ailments—usually cured by the addition of a small quantity of epsom salts to the morning tea ration—minor injuries such as foot blisters, sunburn, can easily mar happiness. It should be a definite rule of the camp that all injuries or ailments, no matter how small, should be reported to the master in charge immediately. It may be a good plan for the organiser to be ready to see any boy who wishes to interview him at a set time each day—say half an hour before turning in. Little troubles sometimes arise and these can usually be straightened out with tact.

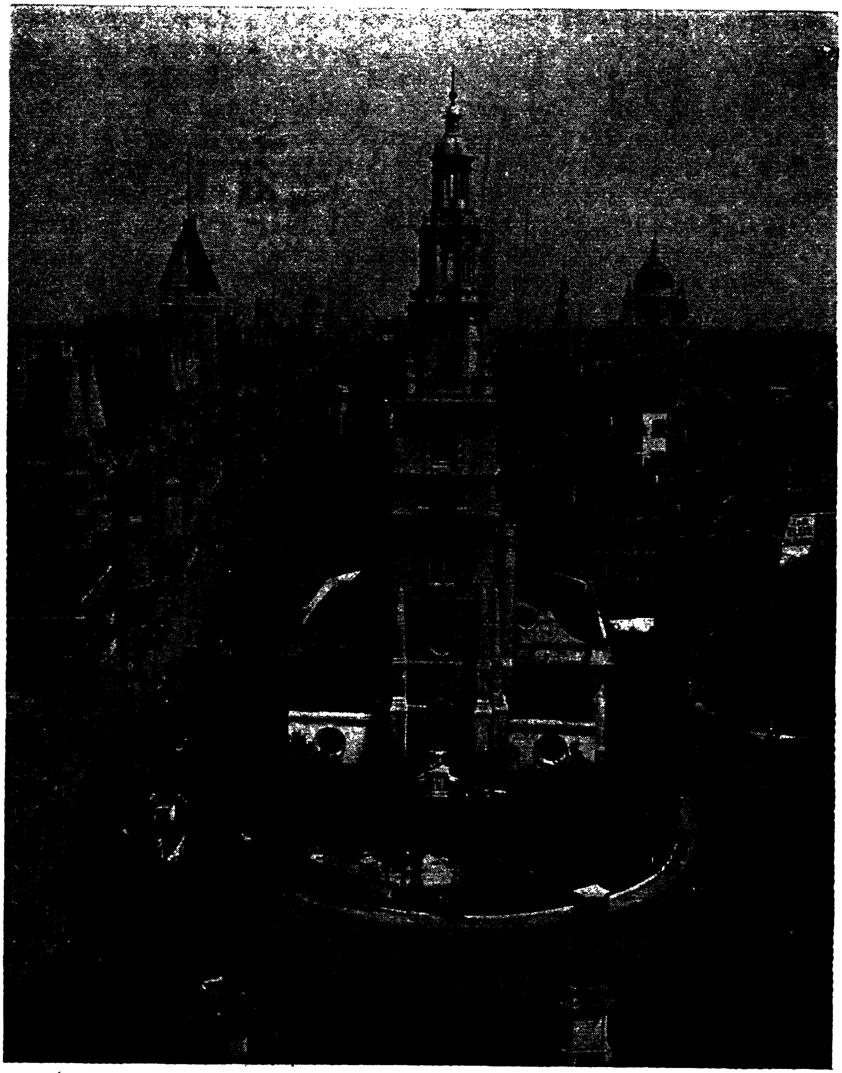
* * *

And so the holiday goes on—a week or more of healthy rambles and games; of open air life and friendly association with one's colleagues. The educational aspect—accounts of journeys, regional surveys, etc.—will be happily studied and much good work done. New friends will be made and a happy bond of fellowship will in after years cement together those who have been, even for such a short time, members of the school Camp.

THE LONDON JOURNEY

Introduction.—London is the Mecca of every school-boy's hopes and an educational El Dorado for the teacher. The benefits resulting from a carefully planned tour of the metropolis are enormous and lasting. Let London have a real chance and it will repay you a hundred-fold for all the hours of preparation you can give to it. Given the time, it can lay the foundation of dozens of history lessons from the Tower, the Abbey, Whitehall, Windsor, and Hampton Court; geography galore in a dock visit, a river trip, Billingsgate and Covent Garden at sunrise (yes, we really mean that hour); a due sense of civics cannot be missing in a child who has visited the Houses of Parliament with his own M.P.; architecture, from the Roman wall at Aldgate to the imposing Shell Mex building on the Embankment, awaits you everywhere; literature, very real and human in the Old Curiosity Shop, the "Cheshire Cheese," Fleet Street, and the Open Air Theatre in Regent's Park; a sound gleam of pageantry in St. Paul's, Poets' Corner, the Cenotaph, and the Horse Guards Parade; natural history abounds delightfully in the Zoo, South Kensington, and the parks; and so on for ever and a day. London enfolds it all comfortably, and literally invites you to see it. Whereever you go you are ushered along by the police and other uniformed officials, who seem to enjoy making a children's party their special regard, which indeed they do.

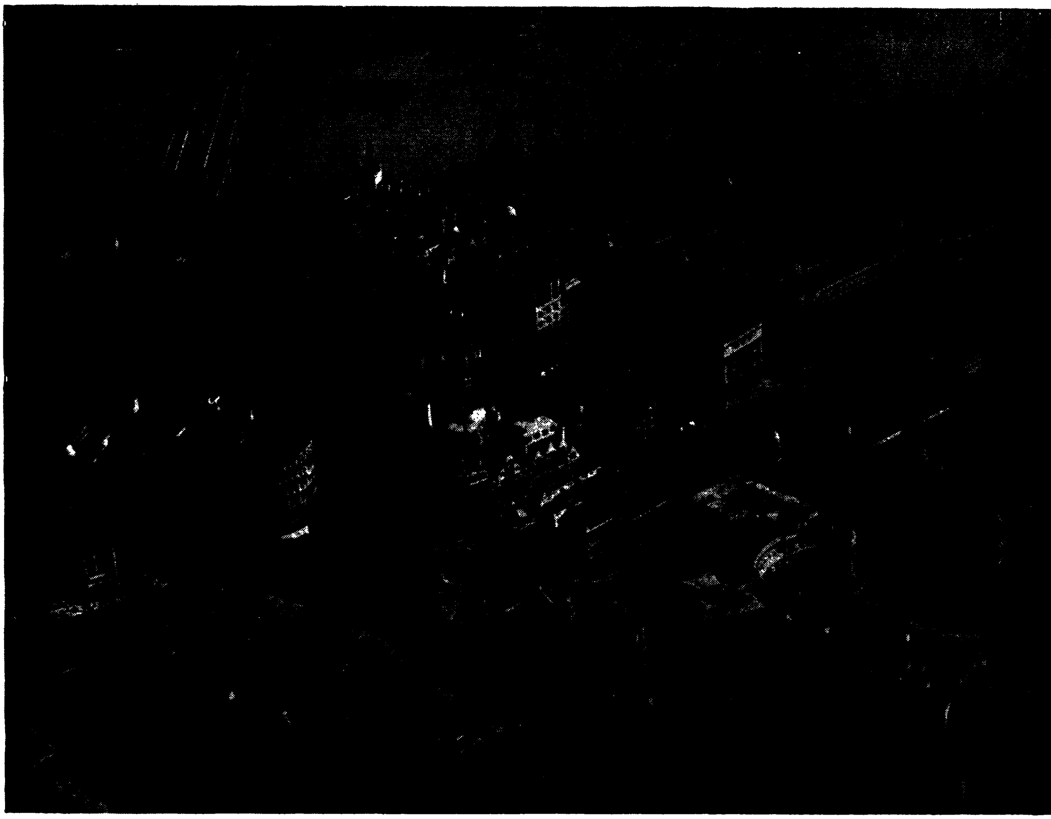
In spite of all that has been said to the contrary, London is definitely easy for school journey visitors, but it cannot be rushed. Any temptation to join a huge conducted tour of one day's duration should be quickly dismissed from the mind of a



[*Photograph: D. McLeish*

LOOKING UP FLEET STREET FROM ST. CLEMENT DANES

teacher who contemplates introducing children to London. There is a vital difference between a trip and a school journey. The former spells excitement only, the latter aims solely at education. Trying to push two days into one, gazing at exteriors (however famous the buildings are), instructing children from the windows of a moving coach, and generally attempting an "American rush" visit is a total waste of time, energy, and money. There must be ample time to absorb facts and for the child eye to have its fill. Ignore these points and your group will retain as its one doubtful asset a mass of blurred and worthless recollections of grey walls, busy streets, moving



[Photo: Aerofilms Ltd.

AERIAL VIEW OF TRAFALGAR SQUARE

crowds, and perplexing noises. London in a day fulfils no educational motive whatsoever.

A short period stay in a London hotel is another matter, for then there is no need for hurry and you can avoid every semblance of it. This is not a difficult matter with a prepared programme if you let the city workers get safely encased in their offices and workshops before you start. Make 9 a.m. to 9.30 a.m. your hour for commencing work and you will find the streets and tubes relatively clear until midday. Shun the main nerve centres at noon and 5 p.m. to 6 p.m. and all will be well. Thus you are left with fully seven hours of each day to pilot your little group about the best regulated city in the world. Its broad pavements are spacious enough for a hundred parties of your type and the tubes, trains, and buses are yours for the asking. The movements of your young enthusiasts become an insignificant trifle in London's traffic and you are free to teach what you choose as easily there as you would do within the four walls of your classroom.

Preparations.—Anyone desirous of planning the London school journey for Whitsuntide or midsummer must begin at once with preliminary preparations. Two problems, which are really complementary, ask for solution first and these are: (1) The cost per head; and (2) length of visit.

Our estimate of costs, based on several experiences of this kind, for a five days' stay has been £2 10*s*., inclusive of (a) return railway journey from Bingley (Yorks) to St. Pancras, (b) all hotel expenses, (c) bus, train, and tube fares whilst in town, (d) incidental expenditure, *e.g.*, gratuities, entertainments, and so on. In other words, you will undoubtedly be on the safe side if you reckon, as the basis of your costs, 7*s*. 6*d*. a day, plus return railway fare. In some areas this money will be available for such a purpose with little or no effort on the part of the teacher; in countless schools the problem of raising money is sure to be acute, but it is well worth while to explore every known means of creating a school bank balance to meet requirements. Let us first consider a few methods.

Personal thrift must be the mainstay in all cases. When parents and children feel that this particular school journey is projected, the prospect of London acts as a powerful magnet and an incentive in itself to save. We have known many relatively poor children bank up very successfully by their own legitimate efforts on the golf links and other varied part-time labours. It should not be forgotten either that school savings schemes over long periods appeal very strongly to working-class parents who, on the other hand, might protest strongly if met with a demand for a sudden disbursement of treasury notes within a few days of the proposed journey. As most of our schools have a children's branch of a savings bank, the fullest possible use should be made of this from the outset.

The school itself, of course, needs a respectable reserve fund for which any of the well-known methods come in very handy and it can be safely left to the school journey enthusiast to choose from amongst them the ones which appeal the most. School concerts have the advantage of being in themselves educational and the children co-operate in full in their own interests, doubly urged. Parents often like to figure prominently in arrangements too, and we have heard of surprising sums of money being raised by private persons interested in the school life and at the same time equally allured by the social aspect and enjoyment provided by such functions as whist drives, bijou garden parties, and so forth. Even the proletarian "jumble sale" with such a motive as ours, although unfortunately devoid of any scholastic contact, can be made cheerfully remunerative.

Whatever method be adopted, the success depends upon the bold enthusiasm of the promoter. Parents as a rule are only too willing to follow up such efforts, which are made in the interests of their children, and it is as well to remember that small suggestions mooted in parents' meetings sometimes convert themselves very acceptably into terms of £ s. d.

Having decided within your own mind upon a set, definite plan of campaign, the time has come that you be severely practical and reasonably cautious in your outlook, and a general note, typewritten or cyclostyled, to *all* parents will tell you exactly where you stand. It might follow these lines, for example:

...............School.
Date.

DEAR SIR (OR MADAM),

Please state below if you are willing to allow your child.................... to be a member of the School Journey to London from........................ to.....................

The following places of interest will be visited:

St. Paul's.
The Tower of London.
Hampton Court.
South Kensington Museums.
Houses of Parliament.
Zoological Gardens.
Windsor Castle.
The Parks.
Dock Visit or a River Trip.
Westminster Abbey.

Agreement

I agree to allow my child.............. to accompany the................School Journey from............ to .... on the understanding that the inclusive cost shall be.................

Signature of Parent.

N.B.—You are invited to a parents meeting to be held...................... in the..............School on............ at............to discuss matters relating to the London School Journey.

It will be a surprising state of affairs if your meeting is not well attended, if only from reasons of curiosity as to the nature and scope of your proposed venture. Try it and see.

The length of the visit is the next urgent consideration, and if it is possible at all, plump for six days, inclusive of the journey to and from London. In the case of a five-day trip Windsor will have to disappear entirely and it is wiser to omit this rather than to dovetail five days into six. Four days means further curtailments and you will probably forgo a museum or a dock visit.

Itineraries.—Three suggested itineraries have been drawn up below, for five, six, or four days, respectively. They have been fully tested from the experiences of several journeys on the grounds of economy, both of time and money. Also they will be found to have the useful advantage of a regular alternation from the city street to the open spaces. Therefore, if any amendments or omissions are found necessary, beware of confining your pupils to long protracted periods of mere city sight-seeing. Everyone knows that London can impose an agonising strain upon the unaccustomed visitor who trails its hot baking streets aimlessly. Strive only at a definite survey of points of educational interest and the close of each day should leave your young charges in just that state of fatigue which a complete night's rest will effectually dispel. This can be accomplished by shunning the rush by bus, train, or tube from one end of the city to the other in search of glimpses of this and that under a severely restricted time limit. A calm perusal of picture post cards is surely worth more than that

FIVE DAYS' ITINERARY

PROGRAMME I

First Day—

A.M.

As Programme II.

P.M.

As Programme II.

Second Day—

A.M.

9.30: Tube to Bank. Guildhall, St. Paul's, 10.15.

P.M.

Bushy Park and Hampton Court.

Third Day—

A.M.

Tower of London (1½ hours).
Lyons (Mark Lane), Lunch, 11.45.

P.M.

The Zoological Gardens.

Fourth Day—

A.M.

1. Houses of Parliament and Westminster Abbey.
2. Westminster Cathedral.

P.M.

South Kensington Museums.

Fifth Day—

A.M.

1. Changing of the Guard.
2. Selfridge's Store.

P.M.

Return home.

SIX DAYS' ITINERARY

PROGRAMME II

First Day—

A.M.

Train journey to London.
By tube to hotel.

P.M.

Centre for lunch.

Evening Walk, 6 p.m. approx., to South Kensington, Albert Memorial into the parks to Peter Pan. Walk along Serpentine bank—Hyde Park Corner—Green Park—Buckingham Palace—St. James's Park, Horse Guards Parade—Big Ben.

Second Day—

A.M.

Windsor Castle.

P.M.

Bushy Park and Hampton Court.

Third Day—

A.M.

Tower of London (1½ hours).
Lyons (Mark Lane), Lunch.

P.M.

12.30: Walk to Tower Wharf—river trip to Woolwich, returning to Westminster Bridge. Return to centre for tea.

Fourth Day—

A.M.

9.30: Tube to Bank. Guildhall, St. Paul's *via* Poultry and Cheapside.

P.M.

The Zoological Gardens.

Fifth Day—

A.M.

1. Houses of Parliament and Abbey.
2. Westminster Cathedral.

P.M.

South Kensington Museums.

Sixth Day—

A.M.

1. Changing of the Guard.
2. Selfridge's Store.

P.M.

Return home.

FOUR DAYS' ITINERARY

PROGRAMME III

First Day—

A.M.

As Programme II.

P.M.

As Programme II.

Second Day—

A.M.

Changing of Guard. Houses of Parliament. Westminster Abbey.

P.M.

The Zoological Gardens.

Third Day—

A.M.

Tower of London. Lyons (Mark Lane), lunch, 11.45.

P.M.

Hampton Court.

Fourth Day—

A.M.

Selfridge's Store, 9.15.
St. Paul's Cathedral.

P.M.

Return home.

Correspondence and organisation.—Those provincial teachers with a general notion only of the geography of the London area will at the moment be rather perplexed as to how to perform the above programmes, but the next section of this supplement will, we hope, remove the majority of their doubts. An evening or two spent in the company of a Ward Lock guide (3*s*. 6*d*.), street and Underground maps will familiarise the salient routes, if they are studied in conjunction with the detailed itineraries below. The information, given freely on request, from the following sources is invaluable and should be sought by all London school journey projectors:

The General Secretary (*Mr. H. W. Barter*), 35 *Park View Road, Addiscombe, Croydon.*

School Journey Association. Single members 3*s*. 6*d*.

Affiliated School Subscription 12*s*. 6*d*.

Information *re* journey and suitable hotels which cater for parties, insurance, etc.

*The Chapter Clerk and Receiver, The Chapter House, London, E.C.*4.

Permission to view the Whispering Gallery and crypt.

(Stamped addressed envelope for reply.)

The Commercial Manager, London Passenger Transport Board, 55 *Broadway, Westminster, S.W.*1.

Request for Underground and bus maps, with literature.

*The Publicity Offices, Port of London Authority, London, E.C.*3.

Request for literature and permission to view a dock (if desired). Suitable addresses for river trips of any length will be supplied, if asked for.

*The General Manager, Zoological Gardens, Regent's Park, N.W.*8.

Request for tickets for a group. Stress educational visit.

The General Manager, Lyons & Co., Ltd., Orchard House, 30 *Orchard Street, London, W.*1.

Request for tea-room centres, tariffs, and other literature.

H.M. Office of Works, Hampton Court Palace, Middlesex.

Request for permit to view Hampton Court Palace.

H.M. Office of Works, Windsor Castle, Berks.

Rates of charges to the Castle and literature.

*The Receiver-General and Chapter Clerk, The Sanctuary, Westminster Abbey, London, S.W.*1.

Permission to view Royal Chapels, *etc.*

The Resident Governor, H.M. The Tower of London.

Rates of charges to the Tower and literature.

The Secretary, 66 *Victoria Street, London, S.W.*1.

Request for tickets for a party to visit the Royal Tournament, Olympia. (Evening.)

Madame Tussaud's, Baker Street.

Rates for party of school children. Stress educational visit.

*General Manager, Selfridge & Co., Ltd., London, W.*1.

Enquiries for lunch charges and tariffs.

Divisional Superintendent's Office, Waterloo Station, London, S.E.

Enquiries *re* special party rates to Windsor and Hampton Court, *via* Southern Railway (Twickenham route.)

Useful "Free" Days.—The replies follow in due course and with them a few minor snags which will probably mean modifications or slight adjustments of your time-table here and there. Our plan has been to write to our local M.P. first and ascertain whether he is willing to escort the party round the Houses of Parliament and, if so, fix a suitable time for this. If he is unable to do so, this visit must be either a Whit Monday or any Saturday between the hours of 10 a.m. and 4 p.m. It is useful, too, to note from the Ward Lock Guide the "free" days for the Tower of London, Westminster Abbey, for expense can be possibly saved there, e.g.:

Westminster Abbey.—Mondays, 9.30 a.m. —6 p.m. daily.

Tower of London.—Saturdays.

N.B. Windsor Castle.—(Not open on Fridays and during periods of royal residence.) 11 a.m.—4 p.m.

Hampton Court.—Sunday (free), but a permit for an educational party may be obtained on any day except Fridays, 10 a.m.—6 p.m. (summer).

St. Paul's.—About 10.15 a.m.—6 p.m., apart from services.

When these limitations have been noted and arranged for, the rest of the programme can be allocated accordingly. For general guidance it will be seen that London's sightseeing begins approximately at 10 a.m. and continues in summer time until 6 p.m. in most cases.

Journey routine day by day.—Taking the six-day journey as our example and assuming the base of operations to be Russell Square or Westminster, the following routine is strongly advised:

First Day.—

The Parks

Underground.—Westminster to South Kensington (District Railway). Russell Square to South Kensington (Piccadilly). Walk to park and enter at the Albert Hall—Albert Memorial, crossing to Peter Pan statue. Then follow the Serpentine to Hyde Park Corner—cross to Green Park to Buckingham Palace—through St. James's Park to Westminster or the Horse Guards Parade.

Two hours easy walking in all.

Russell Square—return by tram from the Embankment under Big Ben.

Second Day.—

Windsor and Hampton Court

To Waterloo—walk from Westminster Bridge (south side).

Russell Square—to Waterloo by tube. Change at Leicester Square.

An early enquiry from the Southern Railway (address: District Superintendent, Waterloo) will give full details, voucher for travel and reservations for a circular route as below:

9.30 a.m. Waterloo to Windsor. Inspection of Castle until 12.30 (approx.).

Train to Teddington—*via* Twickenham.

Lunch at Teddington—apply Lemon's, caterers, 100–102 High Street.

Walk through Bushy Park to Hampton Court.

Return 6–7 p.m. Hampton Court to Waterloo.

A thoroughly enjoyable day.

Third Day.—

The Tower of London

Westminster to Mark Lane (District Railway).

Russell Square to Mark Lane—change at Holborn (Central London Railway) and Liverpool Street (Metropolitan Railway).

Make arrangements beforehand for lunch at Mark Lane Depot (Lyons & Co., Ltd.).

AFTERNOON

River trip or dock visit (apply by previous letter—Port of London Authority).

Fourth Day.—

Westminster to Bank (District Railway).

Russell Square to Bank—change at Holborn (Central London Railway)—view Bank of England, Royal Exchange and Mansion House exteriors—to Guildhall *via* Princes Street.

Walk to St. Paul's *via* Poultry and Cheapside. Note on the way (right): Wood Street ("Reverie of Poor Susan", Wordsworth); (left) : Bread Street (birthplace of Milton).

St. Paul's Cathedral—Whispering Galleries, Nave, and Crypt.

Return to Centre for lunch—*via* (a) Westminster—Blackfriars (District Railway); (b) Russell Square—Post Office (Central London Railway to Holborn).

AFTERNOON

Zoological Gardens

Russell Square—use No. 169 bus direct to main entrance.

Westminster—tram (by Kingsway Subway Nos. 33 or 35) to Southampton Row—then bus to main entrance of the Zoo.

OR Tube from Westminster (District Railway) to Camden Town—change at Charing Cross (Edgware, Highgate, and Morden Line)—then 1d. bus, No. 74, to Zoo.

Fifth Day.—

Houses of Parliament—Entrance by public door near Victoria Tower—inspection of the Lords and Commons Chambers, Westminster Hall.

To Westminster Cathedral, if desired, *via* Victoria Street (half-mile walking).

Russell Square route—by tram (Kingsway Subway) Southampton Row to Westminster Bridge.

Return to Centre for lunch.

AFTERNOON

South Kensington Museum. As first day by Underground Railway. Choice of museum at teacher's discretion.

Sixth Day.—

During the King's residence in London the Changing of the Guard takes place at Buckingham Palace—otherwise at St. James's Palace.

Horse Guards—Whitehall, 10.30 a.m.

Selfridge's Store—Oxford Street. Russell Square to Marble Arch—change at Holborn (Central London Railway).

Westminster to Marble Arch—change at Charing Cross (Bakerloo Line) and Oxford Circus (Central London Railway).

In all the above routine the Underground system may appear bewildering, but a little practice and cool nerves soon overcome the initial worries. The use of pocket maps (supplied by the London Passenger Transport Board—see above) and the ample directions in the passages are sufficient for all purposes. Above all things, refuse to be hurried when in doubt. There are plenty of trains all day and night long.

Evening routine.—No evening trips have been mentioned as yet and these, together with a visit in the early mornings to the great markets, lie at the discretion of the teacher. On certain days, however, a little tour can be arranged for the evening and the following are suggested:

1. Madame Tussaud's — Baker Street Station.

Westminster to Baker Street by Underground—change at Charing Cross (Bakerloo Line).

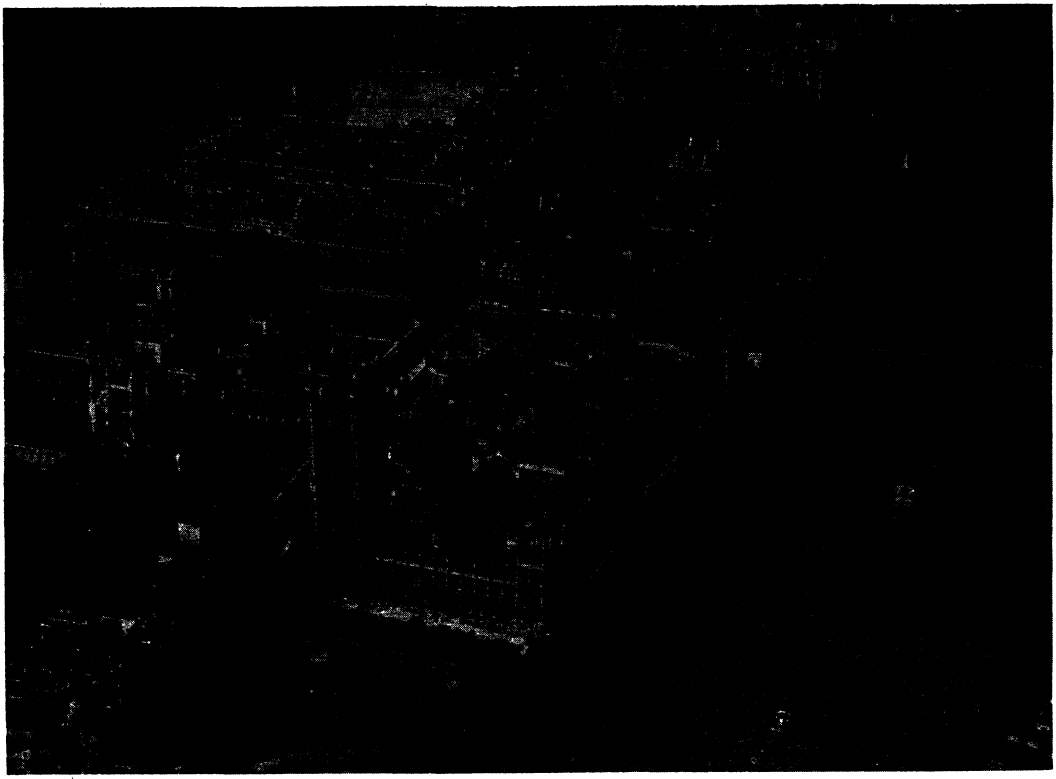
Russell Square to Baker Street—change at King's Cross (Metropolitan Railway).

Children's parties are often given reduced rates if previous application has been made.

2. WALKS.—

(a) Westminster area—Lambeth Bridge, I.C.I. door, Thames Embankment.

(b) Whitehall, Trafalgar Square, Strand, Kingsway, Old Curiosity Shop, Aldwych,



[*Photo: Aerofilms Ltd.*

LOOKING DOWN ON THE HOUSES OF PARLIAMENT

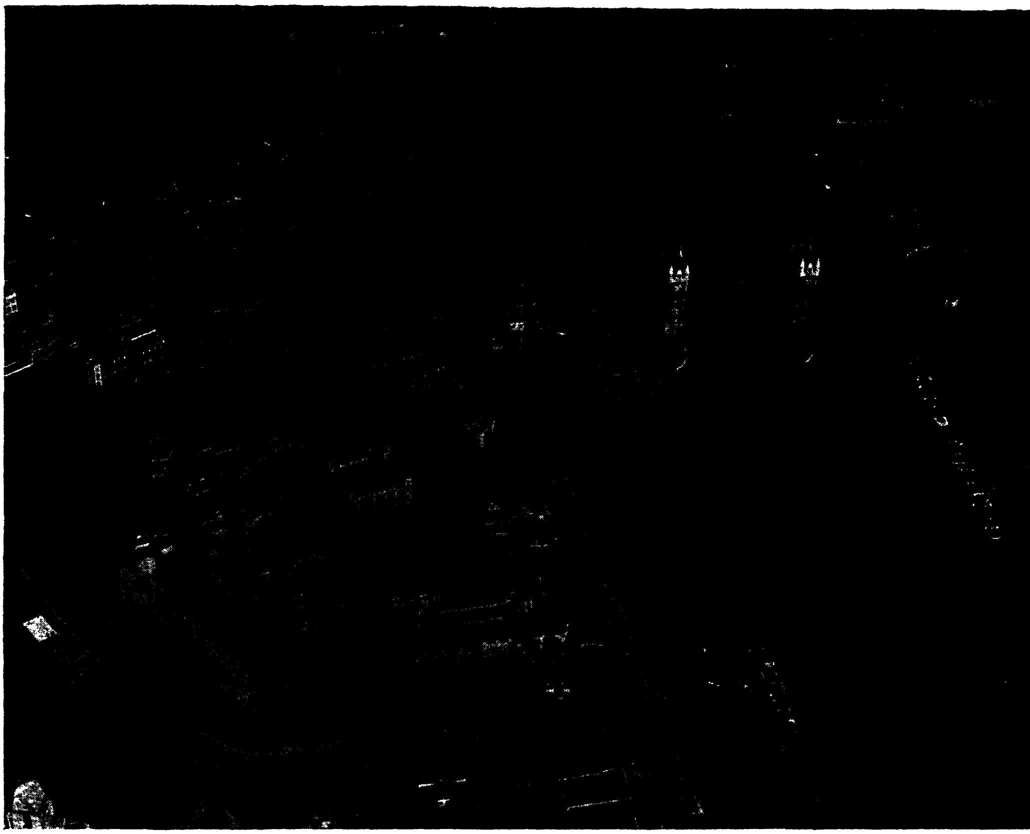
Drury Lane, Covent Garden, Strand—return home.

(c) Whitsuntide—Olympia—Royal Tournament. Apply to London Passenger Transport Board for voucher for party to Addison Road Station. Westminster to Addison Road—change at Earl's Court (District). Russell Square to Addison Road—change at Earl's Court (Piccadilly). Previous arrangements for tickets (2*s.* 6*d.*) must be made to Royal Tournament, Olympia.

(d) Evening walks from Russell Square—as above but the reverse way *via* Southampton Row to Kingsway (omitting Whitehall only).

(e) Billingsgate Fish Market, early morning. It is easily possible to take half a dozen boys at a time to Billingsgate—(*via* Monument Station) between the hours of 6 and 7.30—walking single file through the market itself. Similarly, Covent Garden Market can be undertaken—a unique experience for older scholars.

Class preparatory work.—The stimulus on the school life when a London journey is anticipated is most marked, and the interest extends even to those children who are not going. You have, if you wish, an excellent "project"; indeed, it would be hard to find a more attractive model than London from all the phases in which you shortly propose to study it. Crafts has its share in the guide books—a very necessary part of each pupil's equipment—and there is unlimited scope for artistic design, pictorial illustration and sketch mapping in close correlation. The Port of London Authority literature provides



[*Photo: Central Aerophoto Co., Ltd.*

AERIAL VIEW OF THE THAMES AND TOWER BRIDGE

geography on the spot, and we have seen an hour's mental arithmetic extracted from Lyons' tariff cards. As the children on tour could to advantage on one or two occasions order their own lunches in the teashop, the preparatory oral work mentioned above is certainly not out of place.

Perhaps the most interesting study of all arises from the Underground maps, which can be had in abundance from the London Passenger Transport Board, 55 Broadway, Westminster, S.W.1. We have seen very strong interest and sound common sense evinced by rural school-children in writing answers to questions such as these:

1. How would you travel from King's Cross to Mark Lane by Underground?

2. Where would you change, *en route*, travelling from Russell Square to Westminster?

3. What is the route and where are the termini of the Bakerloo route?

4. Which routes would you take from Westminster to (a) Arsenal football ground, (b) the Zoo, (c) St. Paul's Cathedral?

Apart from the fact that this is very essential "land drill" before you take a practical plunge into the maelstrom of the "tube" system, the exercise is in itself an obvious test and quickener of a child's intelligence. Youngsters certainly revel in such a lesson.

We do not propose to make any further

suggestions in the matter of correlation of school work to the London journey. Many phases of history, art, and science are easily adaptable and a simple course of civics, personal and otherwise, can be devised without an unusual strain upon the imagination. These points are a matter for a teacher's personal taste, to maintain a due proportion as he wishes.

One thing we would stress emphatically and that is the avoidance of any last-minute arrangements. The success and smooth running of your journey depend *entirely* upon the fullness of your preliminary preparations. Follow your first intentions implicitly and do not on any account be tempted to "change horses in midstream," as it often causes other dislocation and hitches which impair the comfort of both teachers and scholars alike.

The connexion between the journey and English subjects deserves a special mention, as this concerns the guide book—surely the keystone of your project.

This is a job for a staff member who, let us hope, has the pen of a Macaulay and the energy of a Caxton. Such a person is in clover at this task and should have full scope to give his ideas full rein to produce a lively booklet which does not overload its pages with wearisome rules and regulations. The normal school discipline will stand the strain of any out-of-door work, and you have no space for monotonous moralising.

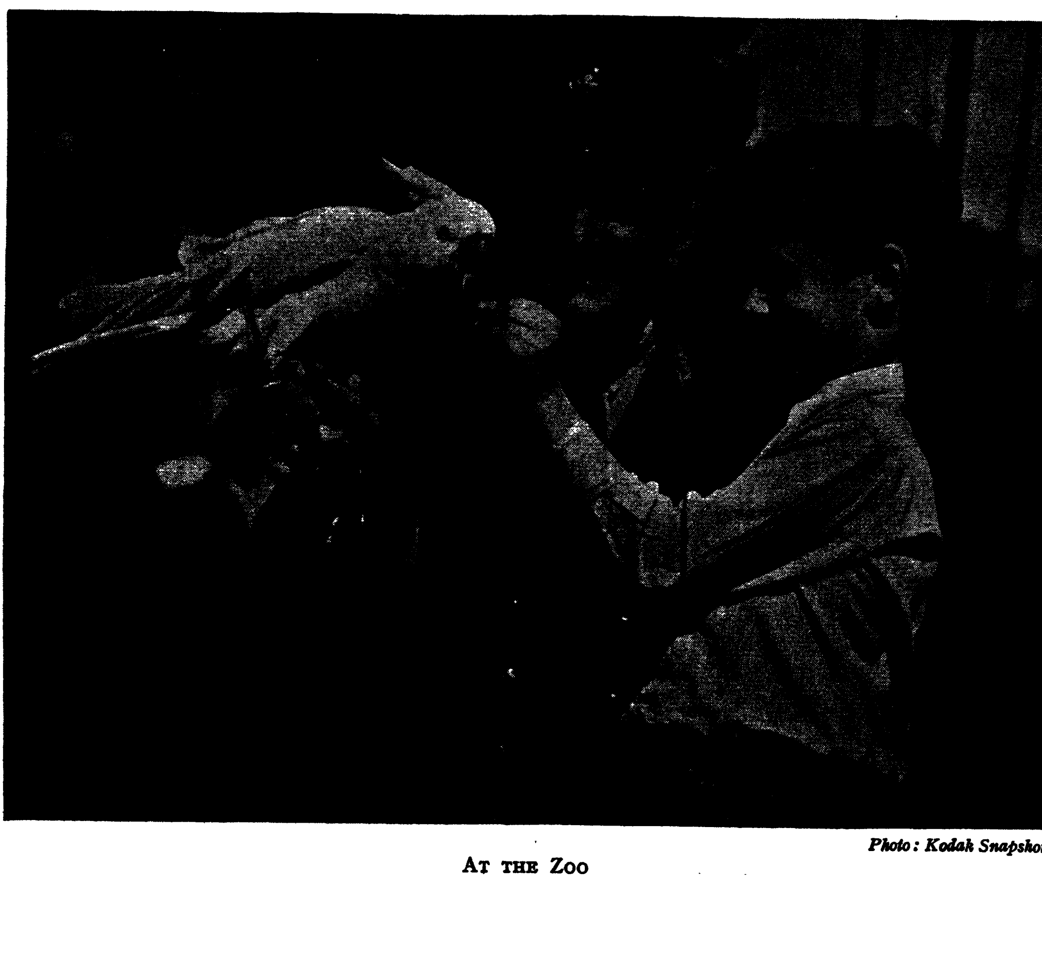


Photo: Kodak Snapshot.

AT THE ZOO

SOME NOTABLE LONDON BUILDINGS

Buckingham Palace is the London residence of the sovereign. It has a fine situation in the West End of London between St. James's Park and the Green Park.

In the early 17th century the site of the palace was a fashionable pleasure resort called Mulberry Gardens. Later, a house was built which became the residence of the earl of Arzington in the time of Charles II. In 1703 this house was pulled down and a new building designed by a Dutch architect was built for John Sheffield, duke of Buckingham and Normandy. George III bought the house in 1761 for £21,000, and went to live there, since when it has been the London residence of the sovereign. The palace was reconstructed and enlarged in 1825 for George IV by John Nash. In 1846 the great eastern wing (360 ft. long) which now forms the front of the palace was added by James Blore and in each succeeding reign additions have been made.

In front of the palace is the memorial to Queen Victoria (unveiled in 1911). Sir Thomas Brock was the sculptor, and it is chiefly of white marble with steps leading up to the central pedestal, which is crowned by a figure of Victory; at the base is a statue of Queen Victoria.

In 1913, to form a fitting background for the Victoria memorial, a new front was built to the palace from designs by Sir Aston Webb. The front is of *Renaissance* style and faced with Portland stone.

The chief state apartments are the throne room, the drawing room and the picture gallery, which contains many works of the English, Dutch, Flemish and French schools, including works by Reynolds, Wilkie, Rembrandt, Rubens and Watteau, the collection having been begun in George IV's reign.

Foremost among the events of the London season are the "Courts" which are held at the palace, and the garden parties in the beautiful grounds.

St. James's Palace is in Pall Mall and therefore not far from Buckingham Palace. The fine brick gatehouse and Chapel Royal are all that remain of a small palace built by Henry VIII on the site of a leper hospital dedicated to St. James-the-Less. Other parts have been added by later sovereigns—Charles I, Anne, George I, etc.

After 1698, when Whitehall was burnt, until 1837, St. James's Palace was a royal residence. Royal levées are still held here and it is to the Court of St. James's that foreign ambassadors are accredited. In 1919, the prince of Wales took up his residence at York House in Ambassadors' Court.

Charles I slept in the palace the night before his execution, and Charles II, Mary, mother of William III, James II, his son, the "Old Pretender," Mary II, Queen Anne, and George IV, were born here. Queen Victoria and Prince Albert were married in the Chapel Royal, and also later, the duke of York (afterwards George V) and Princess Victoria Mary of Teck.

A wing connected the palace with Marlborough House, but this was burnt down in 1809 and now a road separates the two. Marlborough House was built by Wren for the first Duke of Marlborough. It became the residence of Queen Alexandra after the death of King Edward VII.

St. Paul's Cathedral is the largest in Britain. The present building is the third which has been built on the present site. In the early 7th century a cathedral was founded by Ethelbert, king of Kent, on the traditional site of a Roman temple to Diana. This church was dedicated to St. Paul, and after many changes was demolished in A.D. 1083 to make room for a new cathedral.

The new building rose slowly; in 1135 much of it was damaged by fire, but the building was not finished till the end of the 13th century. Early in the 14th century a spire was built. It was then a magnificent monument of Norman and Early English architecture. In 1561 the spire was struck by lightning which caused the church to take fire. The cathedral greatly needed repair when the Great Fire of London in 1666 almost destroyed the building.

The present building was designed and built by Sir Christopher Wren between the years 1675 and 1710. Thus it has stood for over 200 years, a grand building in the heart of the busy city of London, at the top of Ludgate Hill, commanding a view of Fleet Street.

The cathedral measures 513 ft. from east to west, and 248 ft. from north to south across the transepts. The top of the cross is 363 ft. from the pavement and the dome is 145 ft. in diameter (external measurement). Only three existing churches are larger than St. Paul's, these are St. Peter's in Rome, and the cathedrals of Seville and Milan.

The dome, the commanding feature of the metropolis, consists of (1) an inner brick dome which is pierced at the top to render the lantern visible from below; (2) a brick cone which supports the lantern; (3) the outer dome which has a wooden framework covered with lead. Inside the dome, around the lower part, is the famous circular Whispering Gallery. This gallery is 100 ft. above the pavement and 108 ft. in diameter. It is known as the Whispering Gallery because words whispered near the wall on one side can be distinctly heard at the other side. The gallery is a favourable position from which to see the monochrome paintings on the dome. The paintings depict scenes from the life of St. Paul and are by Sir James Thornhill, who died in 1734. The north tower contains a fine peal of twelve bells. Great Paul in the south tower weighs nearly seventeen tons.

In the crypt, which extends beneath the entire area of the cathedral, are buried many famous men. Nelson, Wellington, Wolseley and Wren are buried there, also many famous painters including Reynolds, Landseer and Turner. The cathedral contains many memorials to those buried in it and elsewhere. Wren's grave is marked only by a plain slab with a Latin inscription meaning, "If thou seekest his monument, look around thee."

Westminster Abbey.—The Abbey of St. Peter, which is England's great national shrine, occupies a site on which a church was first built in the 8th century. It is the most widely celebrated church in the British Empire. The site was originally an island surrounded by marches, and the first church, a Benedictine abbey, was dedicated to St. Peter and named West Minster, probably because of its position west of the city of London.

Edward the Confessor rebuilt the abbey and associated it with a royal residence so that it became a Chapel Royal. Only remnants of the foundations of Edward's abbey have survived. The present building, with the exception of Henry VII's chapel, is one of the finest examples of Early English architecture in England, and was built chiefly by Henry III in honour of St. Edward. When the church was built and consecrated, St. Edward's body was transferred to a magnificent shrine behind the high altar. From this time onward, kings and queens of England were buried in the abbey until the time of George II, since when sovereigns have been buried at Windsor. Additions to and restorations of the building were carried out by succeeding monarchs. The two western towers, designed by Wren, were added as late as the 18th century.

The abbey is cruciform in design, and is 531 ft. long, and 203 ft. broad across the transepts. The nave, 102 ft. high, is the loftiest Gothic nave in England. Each transept has a beautiful rose window. Henry VII's chapel is virtually a separate church, with nave, aisles and five small chapels, and is a fine example of late-perpendicular architecture. The chapel was intended for a royal mausoleum but later became the chapel of the Knights of the Bath. A splendid series of carved oak stalls lines each side of the nave, and above them hang the banners of the knights. The fan-traceried roof is exquisite.

Sovereigns of England have been crowned before the high altar of the abbey since the days of Harold. Under the coronation chair is the "Stone of Destiny," brought from Scone, in Scotland, by Edward I after his invasion of that country. The sword and shield of Edward III are still used at the coronation ceremony.

The abbey contains the tombs of many statesmen including Pitt, Fox and Gladstone. In Poet's Corner, in the south transept, lie Chaucer, Spencer, Browning, Dryden, Tennyson, Dickens and many other famous writers. Other notable men buried in the abbey include Handel, Darwin, Lord Lister, Newton and Lord Kelvin.

Near the west door is the grave of "An Unknown Warrior" where "rests the body of a British Warrior unknown by name or rank brought from France to lie among the most illustrious of the land. . . . November 11th, 1920."

Whitehall is the famous London street extending southwards from Trafalgar Square and Charing Cross to Parliament Street. It contains the government buildings.

The name Whitehall is that of the palace built there about 1532 by Henry VIII. The importance of Whitehall may be said to date from the time of Wolsey, who lived at the mansion, then called York House, when archbishop of York. After his fall the property was taken by the crown, renamed Whitehall and the palace built. It was the chief residence of the court during the reigns of the Tudors and Stuarts, but was destroyed by fire in 1698, except for the banqueting hall, which is still standing.

The banqueting hall was built for James I by Inigo Jones in 1622 and is in the Palladian style of architecture (named after Andrea Palladio, the Italian architect who introduced it). The hall is one of the noblest buildings in London, and is a constant inspiration to architects. The scaffold for Charles I's execution was erected in front of this hall and the ill-fated king stepped out to his execution from one of the windows. In 1724 the hall became a Chapel Royal, converted for the purpose by George I. At the present time it is a museum known as the Royal United Service Museum, and contains military and naval exhibits.

On the opposite side of Whitehall (W. side) is the Horse Guards. The building dates from 1750 but took the place of an older building erected in 1641 as a guard-house for the palace of Whitehall. The building has two wings connected by a clock tower arch. This archway opens on to the Horse Guards Parade where tournaments took place in Tudor times, hence the original name Old Tilt Yard. The parade is the scene of the ceremony of "trooping the colour" which takes place on the king's birthday. The changing of the Horse Guards is a daily ceremony and is as familiar a sight as the changing of the guard at St. James's and Buckingham palaces.

The building itself has been the headquarters of the commander-in-chief of the home forces since 1904.

Among other famous buildings in Whitehall the Admiralty offices, designed by Thomas Ripley were built early in the 18th century as the headquarters of the navy. The War Office, designed by William Young, is a new building erected 1900–05. It replaced an older one called the Old Ordnance Office in Pall Mall. The secretary of state for war is head of this state department, and, with the other members, regulates the affairs of the British Army.

The Home Office, Treasury and Ministry of Health form three great blocks of government buildings, and in Downing Street alongside the Treasury is the official residence of the prime minister. The India Office, Colonial Office and many other important buildings are in this famous thoroughfare.

Parliament Street is a continuation of Whitehall and at the end of it is Parliament Square in which are statues of five prime ministers of the United Kingdom: Peel, Palmerston, Derby, Beaconsfield and Canning.

In the centre of Whitehall is England's Great War memorial, the Cenotaph, erected in memory of all British men and women who died in the Great War (1914–1918). The word cenotaph means "empty tomb" and is derived from two Greek words:—*kenos*—empty; *taphos*—a tomb. It is a name given to a monument erected to those whose remains are buried elsewhere or are irrecoverable.

The day before Peace Day, July 19, 1919, a temporary structure was unveiled in Whitehall in memory of those who fell in the Great War. Later, this was constructed in Portland stone after the design of Sir Edward Lutyens and was unveiled by King George V on Armistice Day, November 11, 1920. It is a large rectangular structure 33 ft. high and surmounted by an altar. Wreaths are carved on the sides and flags are fixed on the face. Its striking simplicity, dignity and proportion lift it above the level of the host of memorials that followed the war. Inscribed on the monument are the words "The Glorious Dead." The burial of the "Unknown Warrior" in Westminster Abbey took place on the same day as the unveiling of the Cenotaph.

Since 1920, on each Armistice Day, wreaths have been placed on the base of the Cenotaph by the king (or his representatives), by many other important personages and by various regiments. At the same time a short, impressive religious service is held.

The Tower of London is an ancient fortress on the east side of the city of London and on the north bank of the Thames. It was built on a slight elevation known as Tower Hill and was protected by the river and surrounding marshes. Tradition asserts that Julius Caesar was the founder; but although Roman fortifications have been found beneath the site, the oldest portion, namely the magnificent White Tower, is of the Norman period. The site was an excellent one to fortify London against invasion by approach up the Thames.

The building of the White Tower was begun in 1078 by Gundulf, Bishop of Rochester and was not completed till early in the next century. This tower is the central building, and is surrounded by a double ring of fortifications consisting of walls and towers gradually added until Henry III completed the fort. The White Tower is 90 ft. high and its outer walls are 15 ft. thick; the exterior was restored by Wren in the reign of Charles II. In one of the rooms on the ground floor are instruments of torture, the rack, thumbscrews, and irons, used in bygone days to compel accused persons to confess their crimes. Guy Fawkes of the Gunpowder Plot was one who suffered torture.

St. John's chapel, on the first floor, is one of the most perfect examples of Norman chapels in England, and for many years state papers were housed here. The banqueting hall is now called the Armoury, and contains a fine collection of arms and armour. Rooms in the Bloody Tower and in Wakefield Tower are said to have been those occupied by Sir Walter Raleigh during his periods of imprisonment, which totalled about thirteen years.

Many of the surrounding buildings of the inner ward are barracks, but one is the church of St. Peter-ad-Vincula (St. Peter-in-the-Fetters) dating from the early part of the 14th century, but much altered in Tudor times. Near by is the Tower Green, peaceful enough to the eyes of present-day people, but the railed enclosure is a reminder of those who met their death on the headsman's block which occupied that site. Their names include Sir Thomas More 1535, Anne Boleyn 1536, the Countess of Salisbury 1541, Catherine Howard 1542, Lady Jane Grey and her husband 1554. They were buried in the church of St. Peter-ad-Vincula. On the door of the church a brass plate bears the names of those who were executed outside the Tower on the public scaffold on Tower Hill. The site of this scaffold is marked just inside the railings of Trinity Square.

The inner or ballium wall surrounds the inner ward and has thirteen towers at intervals. One of these, the Wakefield Tower, houses the crown jewels, chief of which are the regalia used at coronations. The Beauchamp Tower was for many years the chief prison for captives of rank, and the walls of one of the rooms are covered with inscriptions made by such important prisoners as Lord Guildford Dudley, husband of Lady Jane Grey. In the Bloody Tower the young princes Edward V and his brother were murdered in 1483. Outside the ballium wall is the outer ward and then comes the outer or second line of fortifications. The moat, which was originally filled with water from the Thames and was an additional protection, is at the present time a drill ground. Entrance to the Tower is by the Middle Tower across the moat and through the Byward Tower to the outer ward. The present ticket office is near the site of an outer gate called the Lion Tower, because the king's menagerie was kept there from Norman times until 1834.

The Tower was a prison from Norman times until the 19th century. It was not only a fort and prison but also a royal residence from the reign of Stephen to the time of the Stuarts, the palace being demolished by Cromwell. The attendant staff, a corps of the "Yeomen of the Guard," are familiar to many as "Beefeaters."

The nickname "Beefeaters" had its origin in 1669, when Count Cosimo, grand duke of Tuscany, was in England, and, writing of the size and stature of this magnificent Guard, said, "They are great eaters of beef, of which a very large ration is given them daily at the court, and they might be called 'Beefeaters'."

The Yeomen of the Guard were the first permanent bodyguard possessed by the king of England and were created by Henry VII apparently from among the men who had been into exile with him and fought with him at the battle of Bosworth in 1485. Their original duties were of the most comprehensive nature. They were the king's personal attendants, day and night, at home and abroad, responsible for his safety on journeys, on the battle field and within the precincts of the palace. They continued to guard the sovereign's person in war throughout the Tudor reigns. The real fighting days of the Guard ended with the Tudor period, although as late as 1743 they accompanied George II to the battle of Dettingen. Now they attend on certain state occasions like the distribution of the Maunday Money and to search the vaults at the opening of parliament—a custom dating from the time of the Gunpowder Plot.

During the Great War, the Tower was again used as a prison; the ancient fortress has now resumed its position as an interesting relic of bygone days, and is annually visited by thousands of sightseers.

The Houses of Parliament, or the New Palace at Westminster, where Great Britain's laws are made, are situated on the left bank of the Thames and extend along the riverside from Westminster Bridge southwards for over 300 yards. They form the largest modern Gothic building in the world and are the noblest group of buildings in London. The site is the old palace of Westminster, in which parliament met and which was destroyed by fire in 1834. The new buildings, designed by Sir Charles Barry, R.A., cover about eight acres. Little wood was used in their construction, the framework being of iron to safeguard against fire. There are eleven courtyards, and eleven hundred rooms, with a hundred staircases and two miles of passages.

The Clock Tower at the northern end is a well-known structure. It is 40 ft. square and 318 ft. high and each of the four clock faces is 23 ft. in diameter. Big Ben, the famous bell on which the hours strike, weighs 13½ tons; it is now known in all corners of the land by those who have never seen the Clock Tower, but who put their watches right by the time as broadcast by Big Ben. The clock is called Big Ben after Sir Benjamin Hall, First Commissioner of Works at the time that the clock was erected.

The Victoria Tower at the south-west end is 336 ft. high and the Middle or Lantern Tower 300 ft. The most imposing view is from the river, where the frontage is unbroken for 940 ft.; its decorations are the statues, shields and arms of the kings and queens of England since the Norman Conquest. The buildings are of stone, early Tudor in style, and the details are beautifully executed.

Some of the apartments in the building are elaborately decorated. The King's Robing Room, the Royal Gallery and the Prince's Chamber are at the southern end. The first is decorated by frescoes illustrating Arthurian legends, the second has a gilded ceiling, and the third contains portraits of sovereigns of the house of Tudor.

The House of Lords may be considered as one of the most beautifully decorated rooms in the country. It is 97 ft. long, 45 ft. wide and 45 ft. high. The stained glass windows contain figures of all the English sovereigns since the Conquest, and between the windows are statues of the barons who signed Magna Carta. The thrones of the king and queen and the prince of Wales are at one end, and in front is the Woolsack of the lord chancellor. On each side of the House are the government benches. The peeresses' galleries are around the chamber and the distinguished strangers' gallery above the thrones. The House of Commons is rather smaller, being 70 ft. long, 45 ft. wide and 41 ft. high. The speaker's chair is at one end, the benches for members on each side and the ladies' gallery above the speaker's chair. Four corridors leading to all parts of the building meet in the central hall, an octagonal chamber, beautifully decorated —stone statues of English sovereigns occupy the niches—and a much frequented part of the building. To the west is St. Stephen's chapel, in which the Commons sat from 1547 till the fire of 1834. Westminster Hall differs from the rest of the building in that it is part of the old palace of Westminster, and the only part which escaped the fire of 1834. Originally it was built for William Rufus and was completed in 1099. From 1394 to 1399 Richard II remodelled and enlarged it, adding the north porch and towers, raising the walls and constructing the oaken hammerbeam roof. The roof strengthened by steel still remains, elaborate repairs being made in 1914 and in later years. Westminster Hall has been closely associated with the history of the land. From 1225 till 1882 (when the Law Courts in the Strand were opened) it was the chief law court of England and in it many famous people were tried, among them Sir William Wallace, Sir Thomas More, Anne Boleyn, Lord Strafford, the Seven Bishops, Warren Hastings and Queen Caroline. Richard II was deposed by the Lords of the Council in 1399 and later Charles I was condemned in Westminster Hall. Coronation banquets were held here till the time of George IV. The bodies of King Edward VII and William Ewart Gladstone lay in state here: and, more recently, the bodies of the victims of the R101 airship disaster lay here after being brought from France. Thus Westminster Hall is one of the chief centres of English history.

The Mansion House.—The Mansion House is the official residence of the lord mayor of London and is therefore an important and interesting building. The lord mayor is associated in the minds of London children with the great procession which passes through the streets once each year, on November 9, a few weeks after the election of the new mayor. In this procession all the officials of London take part, and the decorated cars which delight the children sometimes illustrate events in the history of the great city. Such an important person as the lord mayor needs a house in which he can hold receptions and banquets. Before the Mansion House was built the banquets were held either at the lord mayor's private residence or in one of the halls belonging to a city company.

The Mansion House is in one of the busiest parts of London and right in the heart of the city. It is at the junction of two streets, Poultry and Cornhill, and opposite to it is the Bank of England. It was designed by the architect, George Dance, and though begun in 1739 was not completed until 1753. To make room for the Mansion House a market for fruit and vegetables called the Stocks Market had to be pulled down. The fruit market was built on the site of a fish market which was burnt in the great fire of London, 1666. The Stocks Market was so named because before the first building was erected in 1282 the "Stocks" of London Town occupied this site. Therefore many must have suffered punishment on the spot where now lives the head of the corporation, the governing body of the city of London. Such a building as the Mansion House costs an enormous amount of money, and this was obtained in a very unusual manner. It was money accumulated as fines imposed on those who refused the office of sheriff of the city of London. By 1736, £20,700 had been accumulated in this way. The procedure was finally declared illegal.

The building, built of Portland stone, has an imposing front, with a portico of six fluted Corinthian columns. Within the pediment, i.e. the triangle above the portico, the sculpture designed by Sir Robert Taylor shows a female figure crowned with turrets. This is a symbol of the city of London. Inside the building are many reception rooms, of which the chief is the Egyptian Hall. This room, designed by the earl of Burlington, was modelled on an Egyptian chamber described by Vitruvius, a Roman architect. It is 90 ft. by 60 ft., and has a gorgeously decorated roof which is supported by columns. The names of some of the other rooms are: the Long Parlour, the Venetian Room and the Old Ball Room. Above the building flies the flag of London showing on a white ground the cross of St. George and the sword of St. Paul.

The Royal Mint.—At the present day when money is used in all parts of the world it is not easy for us to think of the possibility of purchasing things without it. In very early times when a man needed goods from a neighbour he carried out his purchase by exchange, or by barter. Such a method led to difficulties; a standard measure of value was soon needed, and so money came into use. Many different things have been used as money in different parts of the world—cattle, sheep, salt, tea, ivory, shells, etc. Indeed, in parts of Africa nomadic peoples still reckon wealth according to the number of cattle a man possesses. Gradually money has come into use in all parts of the world, and coins such as we use to-day were made in ancient Greece.

Herodotus tells of the establishment of what was probably the first mint by Gyges, in Lydia, in the 8th century B.C. The Greeks introduced the art into Italy and other adjacent countries, but it was the Romans who developed the art and laid the foundations of modern minting. At first iron was used, but because of its weight it was superseded by gold and silver. At first coins were made of pure gold and silver, but copper was added by the Romans. This was done intentionally, partly because copper was cheaper, but also because the alloys of gold and copper, or silver and copper, are harder than the pure metals. To-day a definite proportion of gold is used in the alloy; e.g., in Britain twenty-two parts of pure gold out of a total of twenty-four is the standard fixed by the government.

In Britain gold and silver coins were minted before Roman times, and in Norman times there were about seventy mints in different parts of the country. These were reduced until by the 18th century all coins were minted in London, at the Tower. In

1810 the Royal Mint was removed from the Tower to the present building, an imposing structure on Tower Hill. The site of the Mint was that of a Cistercian abbey called St. Mary Graces, founded by Edward III about 1350. Sir Isaac Newton was Master of the Mint from 1699–1727 and he is said to have invented the milling of the edges of coins to prevent fraudulent clipping. The office of master has been merged with that of the chancellor of the exchequer; but the building is really controlled by the deputy master, who is a civil servant. There are branches of the Mint at Melbourne and Perth in Australia, and at Ottawa in Canada.

The method of making gold and silver coins and the machinery used are very interesting. The refined metal is melted and cast into bars. It is then sent to the "draw-bench," a wonderful machine which rolls out the metal to the exact thickness required —marvellous when it is realised that a hair's breadth difference will affect the weight of a gold coin. The next machine punches circular discs from the metal sheets, cutting out several hundreds a minute. The discs are known as blanks, and the next step is to raise the edges of them, thus forming a rim to prevent too rapid wearing. The blanks are baked or annealed in a furnace and are then cleaned, after which they are ready to be stamped. Until the Middle Ages coins were struck by hand hammers and in Roman times large coins were often cast. The modern method as used in England is carried out by an ingenious machine which stamps both sides of the coins at once, feeds itself with the coins to be stamped and strikes about sixty coins a minute. Each blank is placed on a fixed die and pressed with a second. To prevent the coin squeezing out it is held in a collar, the inside of which is cut in fine grooves which form the milled edge. The coins are finally tested and weighed automatically by machines which reject them if they are too light or too heavy. Sample coins are taken in a pyx or box and weighed annually by the Goldsmiths' Company. The test is called the "trial of the pyx." Coinage is the prerogative of the crown acting through parliament.

The British Museum.—A great many people make collections of things which interest them. Many hobbies take the form of collections such as postage stamps, china, pictures, etc. If similar collections are made by a public body of people such as a town or a nation, the collection may be large and include all kinds of relics of interest to the people. A suitable building is needed to house the collection and thus a museum is formed.

The British Museum, in Bloomsbury, London, is one of the greatest treasure houses in the world. It originated in 1753 when Sir Hans Sloane's collection of books and MSS., coins and medals, and many other specimens, was purchased by the nation. Montague House, on the site of the present building, was purchased to house this collection, and that of Sir Robert Cotton, which had been presented to the nation in 1700. The museum was first opened to the public in 1759, and since 1810 has been accessible to all, free of charge. Other collections were quickly added to the original ones, either by bequest, gift or purchase, and during the years 1828–57 the old Montague House was pulled down and the present building erected. Additions have been made since; e.g., the King Edward VII Galleries in 1914.

In the centre is the circular domed reading room 106 ft. high and 140 ft. in diameter. Its dome is second in size to that of the Pantheon, in Rome. The library is the largest in the world; it contains about 4,000,000 volumes on fifty miles of shelves. Its catalogue consists of more than 1,000 volumes arranged on shelves round the desks in the centre. The number of books is rapidly increasing. This is easily understood when we remember that a copy of every book or pamphlet published in the United Kingdom must be sent to this library. The great reading room seats four hundred and fifty-eight readers, and in addition there is an inner ring within which the officials carry on their work. Many rare books are housed in the north library.

The many treasures of the museum, housed in a series of exhibition galleries, tell the story of civilisation without need of words. They include relics of Assyrian, Egyptian, Greek, Phoenician and Roman civilisations, collections from India, China and Japan, books, pottery and prints from all periods to the present day. The sculptures from Nineveh from the palace of Sennacherib and Ashurbanipal include those which represent the capture of Lachish described in the Bible in the Second Book of Kings. These people who lived nearly 3,000 years ago wrote their records on clay, which was then baked hard and so has been preserved. Some of the tablets tell the stories of the Creation and the Flood, as they were known to the Assyrians. Among the Babylonian treasures is a cast of the stone on which were carved the laws of Hammurabi. The Egyptian treasures include numbers of mummies and mummy cases, many of which are 3,000 years old. The Egyptians, believing that the souls of the dead would return to reinhabit their bodies, practised embalming on an elaborate scale, and buried with the dead many things used in daily life in Egypt. From these much has been learnt of early Egyptian civilisation. In the Elgin room are the remains of sculptures by Pheidias and his assistants from the Parthenon at Athens. They were brought to England in 1801 by Lord Elgin and are called the Elgin Marbles. The frieze has been arranged around the walls of the room. It represents the Pan-Athenaic festival procession and the presentation of a new robe to the image of the goddess.

In other parts of the museum there are wonderful collections of pottery, coins, weapons and manuscripts.

Lambeth Palace.—Before the days of the steamship and factory the banks of the river Thames at London possessed some of the finest residences in the country, including a series of riverside palaces. Only two of these, Lambeth Palace and Somerset House, are still standing. Since the days of Edward I, Lambeth Palace has been the residence of the archbishops of Canterbury. The palace is on the right bank of the river, south of Westminster.

The building occupying this site was originally known as Lambeth Manor, and the nearness of what was the village church is a reminder of the old manorial system. Hubert Fitzwater, archbishop of Canterbury, secured the building at the end of the 12th century. Nothing of the original edifice exists; the present one, partly of red brick and partly of grey stone, varies from Early English to Late Perpendicular architecture. The old brick buildings are the earliest examples of brickwork in London.

The chapel stands on a crypt said to belong to the old manor house and is the oldest remaining part of the palace. The chapel was built in 1245 but has been altered considerably and has a modern roof and modern stained glass windows. The library housed in the Great Hall contains 30,000 books, including many treasures such as the Gospels in Irish which once belonged to Athelstan and the Gutenberg Bible on vellum. From the river, the huge gatehouse called Morton's Tower, the Great Hall and the so-called Lollards' Tower can be seen. The last named, dating from 1440, was often used as a prison, but it is unlikely that the Lollards, followers of John Wycliffe, were imprisoned here.

In the chancel of St. Mary's church five archbishops are buried. Beatrice of Modena, wife of James II, sheltered under the porch from a storm when she fled from Whitehall in 1688.

Part of the grounds belonging to the palace have been made into a public garden which is known as Archbishop's Park.

The Zoological Gardens.—The name is given to land used for the exhibition and study of living animals. In London the Zoological Society was formed in 1828, and the gardens, which are in Regent's Park, contain a living collection of most kinds of mammals, birds and reptiles from all parts of the world. The collection began in 1828 with the old Tower menagerie and gifts from explorers, naturalists and others, as a nucleus. Now, the area covered is about thirty-five acres and the collection has always been the finest in existence, if species and rare animals be considered rather than the number of individuals. The Gardens are arranged in two sections, an oblong abutting on the Albert Road and a southern triangular section, the two parts being connected by subways under the Outer Circle Road. There are about seventy enclosures, houses, dens, aviaries, pools, etc. The monkeys, always ready to be fed with dainty morsels, attract many visitors, young and old. The lions include playful cubs which have been bred and reared in the gardens. The Mappin Terraces allow the bears, deer, goats, etc., greater freedom than is possessed by many of the other animals. The terraces consist of a series of tiers of open enclosures with footpaths along the base outside the railings. The various bears, which are untiring in sitting up to beg for food, are the chief attraction of the terraces.

The Aquarium, containing over 3,000 fishes, was added in 1924 and is a marvellous achievement, the most up-to-date inland aquarium. The fish are exhibited in huge tanks with glass fronts, lighted from the top, thus affording excellent views of all the specimens as they swim about. In the fresh water room, specimens of all kinds of fresh water fish of British and European waters may be seen. The wonders of the sea are shown in the marine room, and the tropical specimens include some very small, brightly coloured fish and others of huge size. The sea water was brought from the Bay of Biscay for the tanks, and both the fresh and the salt water in the aquarium are prevented from becoming stagnant by continual circulation. Should copper or zinc come into contact with the sea water the fish would quickly die of metallic poisoning, therefore great care is given in the construction of tanks and pipes, to choose the right metals for the purpose. The piping is made of chemically pure lead or of iron lined with glass enamel. The water is oxygenated by passing compressed air directly into the show tanks, and by discharging the water into the tanks with great force through a narrow nozzle, causing what looks like a smoke cloud of bubbles. Great care is given to keep the water in the temperate aquaria at a temperature of about 60° all the year round; both heating and refrigerating systems have to be used to ensure this. A series of filters is used for cleaning the water, and some is stored in the dark in order to kill obnoxious bacteria.

The Insect House shows all stages in the development of insects. Interesting specimens include leaf and stick insects, water boatmen, bird-eating spiders, etc.

Rare animals include the takin, a large goat-antelope from Tibet, an albino African monkey, Indian flying foxes and the Wallick's deer. Many of the animals, birds, etc., are displayed among surroundings suggestive of their natural environment. This is especially noticeable in the Reptile House, in which each enclosure contains suitable plants and a natural arrangement of rocks, rock pools, logs, etc.

The Zoological Society has bought a property of nearly 500 acres in the Chilterns, thirty miles from London, to develop an open-air Zoo. Here, at Whipsnade, wild animals live, as far as possible, a life of freedom; and visitors may watch the habits of many wild creatures living a natural life.

Kew Gardens.—Kew Gardens is the popular name for the Royal Botanic Gardens at Kew near London. " Come to Kew in lilac time." So say the posters on the Underground Railway stations in all parts of London. In lilac time, namely, in the month of May, the gardens are a wonderful sight with laburnum, hawthorn, chestnut, gorse and many other trees and shrubs in full bloom. Almost every month of the year brings its wealth of flowers—crocuses, daffodils, tulips and rhododendrons in spring, roses and many others in summer, Michaelmas daisies, chrysanthemums and dahlias in autumn. In winter-time, when all the flowers have faded and most trees are bare of leaves, greenness is still to be seen, for the evergreen pines, firs and many other trees keep their leaves through the winter. Winter and summer the hothouses are full of plants of other lands; and some of these hothouses are gardens in themselves. The largest, the palm house, contains towering palm trees and so many creepers that they almost form a leafy roof under the glass one. The temperate house seems to have some interesting flowers or fruits at all seasons. One house has plants from the wet tropical forests, another is full of begonias and a third has many peculiar plants called "insectivorous" as they live on insects.

The gardens, which have an area of 288 acres, were formerly the grounds of Kew House, and a botanic garden was formed here by Lord Capel and extended by Princess Augusta, mother of George III. From 1772–1820 Sir Joseph Banks was honorary director of the gardens and introduced plants from abroad. In 1840 the gardens became a state institution and under the directorship of several famous botanists such as Sir W. Hooker, Sir J. Hooker and Sir David Prain, have attained the foremost rank among the botanical gardens of the world. The aim of the institution is the advancement of the study of plants and the directors are advisers of the government on all matters concerning plants. The introduction of new plants into Britain or into other parts of the empire is an important side of the work at Kew. In 1860 the cinchona plant from which quinine is obtained was introduced into Ceylon from South America, and in 1875 rubber from Brazil was planted in Malaya—both introductions were carried out by the directors of Kew Gardens.

Within the grounds are about 24,000 different species and varieties of plants arranged systematically. In addition to the hothouses there are museums containing products of plant life from all parts of the world, also a library and herbarium. The pagoda, designed by Sir William Chambers, was built in 1761 and is 165 ft. in height. It is not a true copy of a Chinese pagoda because it has English windows and the angles of the roofs differ from those in a true pagoda. The new flagstaff of the gardens was erected in 1920. It is 215 ft. high and was the gift of British Columbia. It is one of the tallest flagstaffs in the world. This straight "stick" of Douglas fir travelled 9,000 miles by sea from the forests of British Columbia which contain innumerable tall fir trees covering thousands of acres.

SCHOOL TIME-TABLES

(In the following pages are set out a number of time-tables from schools in different areas. The following notes were supplied by the head teachers whose time-tables are reproduced.)

I. SENIOR GIRLS' SCHOOL—SUBURBAN AREA OF CITY

This time-table is in use in a non-selective senior girls' school in a working-class neighbourhood. When the girls leave school a small percentage will work in offices, but most of them will be employed in shops, laundries, factories and the needle trades. Ample time is given for a thorough training in domestic subjects, needlework and handwork, and a fair amount of time is spent on academic and cultural subjects.

The day is divided into seven periods, all of 40 minutes, except the second period in the morning which is 45 minutes. This makes for simplicity and ease of arrangement for specialisation.

Various factors had to be taken into consideration in framing this time-table. The largest classes are at the top of the school, 3a and 3b, so it was necessary to halve these classes for biology, science and art as well as for handwork. Then with specialisation, lessons must be arranged when the specialist teacher is free to take them.

There are two well-equipped domestic subject rooms, and two teachers, so that a whole form is able to go to domestic subjects for a day, one half class occupying one room, and the other half the other room. All girls over twelve years of age, that is in their second year at this school, take domestic subjects. First-year girls who do not take domestic subjects have hygiene lessons. There are subject rooms for art, science and history. The science room is also used by the half handwork class taking bookbinding.

The school building stands in a playing field, and various games such as netball, stoolball, rounders and shinty are played in the physical training periods. Matches against other schools in the district are played after 4 o'clock, and occasionally on a Saturday morning.

The specialisation is arranged in two streams; for example in history, one teacher takes 3a, 2a, 1a, and another teacher takes the "B" stream, 3b, 2b, 1b. Other subjects in which this arrangement is followed are geography, science, biology, art, physical training and music, so that two teachers are responsible for the work in each of these subjects. Each form mistress takes her own scripture and mathematics wherever this is possible, and because English is so extensive a subject three teachers are responsible for it. They arrange the work as they wish in their periods, but give at least one period a fortnight to dramatic work.

As there are no classes in domestic subjects on a Friday, the two teachers in that section are carrying out an experiment this year with forms 1b and 2b. Those forms go into the domestic rooms for practical arithmetic on Friday morning, a half class to each room. There they use weights and measures—weigh dry goods and measure liquids for recipes, reckon out costs, learn how to halve and quarter recipes, how to increase them, how to measure windows for curtains, tables and chairs for covers and cushions, floors for staining, etc. Some lessons are devoted to shopping, and simple household budgets, costs of coal, coke, gas and electricity, etc. (All these fuels, are in use in the domestic rooms.) In the afternoon the domestic subjects teachers take needlework.

The staff of this school is comprised of nine teachers and a head mistress. Six of these teachers are form mistresses, one is not attached to a form and there are two domestic subjects teachers.

II. SENIOR GIRLS' SCHOOL—COUNTY BOROUGH

The school, serving a congested area of a large county borough, is a modern building recently reconstructed to afford full opportunities for senior work. It easily accommodates a yearly average of about 400 children.

There are ten classrooms, one science laboratory for forty children, an art room and two domestic science rooms fully equipped for laundry and cookery. For organised games a playing field is available within an easy distance of the school. The staff consists of ten class teachers, including specialists in history, art, physical training, science, geography, music, Dalcroze eurhythmics, and two domestic science teachers.

The three years of the school are each divided into "A," "B" and "C" streams, the classes of Year III being numbered 1, 2, 3, and so on. No. 7 is the special class having its own syllabus of the project type compiled to provide suitable interests for these children. Thus science is not the school course but the natural history of animals connected with the geography project, "the animals of the world." In the general science two teachers are available for each class of forty, the senior mistress demonstrating, the junior then supervising the work of half the class. The art classes are superintended by one teacher, the "A" and "B" streams of each year being under the charge of the senior mistress, and the "C" streams of each year of the junior. In general the work is so arranged that each teacher will have on an average three free periods in each week for preparation work and for marking books.

Although in attempting to meet with the needs of the children there is a general bias in the curriculum towards handicrafts and domestic work, special emphasis is given to English. In the subject, besides the usual sub-divisions, dramatic work and puppetry form a considerable feature.

In this period shown on the time-table the first Monday in each month is devoted to "house" meetings (four houses). On the others the children arrange for the work to be undertaken by each club and group themselves accordingly. The following clubs are being strongly supported: First Aid, Physical Training, Art and Craft (2), Garment making for Waifs and Strays, Knitting, Sweet-making (2), Nature Study, Science (Wool dyeing), Drama. A special Darts Club has been organised by the special class. There is a very enthusiastic attendance, the result being a marked improvement in subtraction.

Taken altogether, the time-table has proved smooth in working and has given very satisfactory results.

III. SENIOR GIRLS' SCHOOL—SEASIDE RESORT

The school is a modern one of the verandah type with accommodation for 240. There are six classrooms, one of which is also a practical room. There is also one domestic room and a small playing field. A large hall is available for five half days a week (boys have the use of this the rest of the week).

The staff consists of a head mistress, six class mistresses and a domestic science mistress. Most of the work of the school is specialised, art, handicraft, needlework, music, history, geography, hygiene and science being entirely taught by specialists. The physical training is taught by the three youngest class mistresses. Each mistress is responsible for the arithmetic of her class and for most of the English. With no extra mistress available, some odd lessons are unavoidable, but these odd lessons are all English and usually a special branch of the subject, such as dramatic work or poetry. One mistress is responsible for all the handwork of the "A" classes, and one for the

"B" classes. Needlework and craftwork are grouped together as handwork on the time-table, the mistress in charge using her own discretion as to when she takes the various branches.

Community singing is not shown on the time-table but it is taken weekly in one scripture period and fortnightly instead of one ordinary music period.

The children move from room to room, the mistresses generally staying in their own classrooms which are more or less special rooms; e.g., class 5 room is the history room because class 5 mistress is the history mistress. This moving by the scholars is quite successful in a school of this type, especially as the time-table is so arranged that the chief moving takes place at the beginning of the session or after recreation.

Each class has one English lesson in the hall so that dramatic and group work can be taken. Each class has at least one physical training lesson and two music lessons in the hall.

The domestic room is used every day from 9.30 onwards. The third-year girls spend one whole day a fortnight in this room, whilst the second-year girls spend one half day every week (one week in the morning and the next in the afternoon). The first-year girls get a slight introduction to the subject by spending one half day every fortnight in the domestic room (first in the morning and then in the afternoon). In addition to this, during their last term the leavers, one at a time, spend one whole week in the domestic room, having an intensive course. When half classes are in the domestic room opportunity is taken for half classes in handwork and art.

In general the time-table is so arranged that each class mistress has at least 2½ hours free time during the week. (This includes two scripture periods). One of the free periods is a long one of 50–75 minutes and comes as soon as possible after the written composition lesson to give the teacher an opportunity for marking.

This is not claimed to be an ideal time-table, but it has been carefully prepared and tried out. It works quite successfully and much use has been made of the individual talents of the teacher so that the children derive the benefit. Whenever a weakness appeared in the original time-table it was discussed and revised. This constant examination and revision has been rewarded by very satisfactory results.

IV. SENIOR MIXED SCHOOL—SUBURBAN AREA OF CITY

This time-table has been tried out successfully by a senior mixed school which has been reorganised for eight years. The district surrounding the school is populated by people of all classes and of nearly all walks of life and, as it was formerly a residential quarter of the prosperous middle classes, it is without a native staple industry. Many of the parents of the children hold positions in shops, warehouses and hotels, while a few are public servants of the postman status. The children leaving school likewise choose so wide a variety of occupations that it would be difficult to make any general classification.

The aim of the school is to equip the pupils to live a full life and, to this end, every opportunity is taken by the staff of relating work in the classroom to life in the world outside. The syllabuses are compiled to arouse the co-operation of the children by investing the subjects with a new interest derived from a viewpoint widely different from that of the junior school.

The classes are organised according to age groups. The children begin their senior school course in either 1a or 1b, being graded according to merit and, for the first two years, the classes are mixed. In the third year, however, the girls and boys are separated into third-year girls and third-year boys, and, before leaving, every pupil is expected to spend the last term in either of these classes, whatever his or her ability. To ensure that, as far as is practicable, only those pupils who are leaving in the near future are on the roll of these classes, there is a mixed third-year "remove" class to absorb any other pupils who are in their third year.

In drawing up the time-table this school suffers in having to use handicraft and domestic economy centres which are not on the school premises. Since other schools share in the use of these centres, these subjects occupy more or less fixed positions in the time-table.

After consideration of these extraneous conditions, the qualifications of the staff must be taken into account. Specialisation in senior school subjects has been encouraged and to maintain this policy two members of the staff, one of whom specialises in science and the other in art, alternate one with the other in dividing their duties between this school and a neighbouring senior school. This mutual arrangement means that these subjects need special consideration when the time-table is arranged.

The basic subjects; viz., arithmetic and English, naturally occupy important positions in the time-table, but it should be noted that since considerable attention is paid to the practical side of the former and to the dramatic form of the latter, more flexibility of position and time can be obtained. Recreation and religious instruction are limited to time and place by custom or by regulation, and it has not been thought necessary to depart from normal practice.

Music is very successfully taught owing to the enthusiasm of a talented member of the staff and therefore it takes a prominent place in the time-table. As far as is practicable, this subject, which is taken by combined groups of two or more classes in one of the two school halls, has been placed at the beginning of a session in order to bring the pupils into a happy frame of mind. There is no doubt that the singing of the large repertoire of songs, many of which are poems learnt by the children during the English lessons and set to music by the teacher, is a much enjoyed feature of the curriculum.

Handwork usually plays an important part in the scheme of work of any senior school and no less in this school. Two of the classrooms have been fitted for practical work and in them the chief subject taken is bookbinding. This is practised by all the pupils in the first and second years but in the third year the girls take advanced needlework instead.

The physical training lessons are arranged as far as possible at the beginning or end of a session to prevent waste of time in changing and arrangements are made so that all the boys and girls of a particular year have physical training at the same time to overcome the difficulty of mixed classes.

When all these factors have been taken into account, the time-table is completed by fitting in the remaining subjects of the school curriculum at those times when the specialists in them are free.

V. SENIOR BOYS' CENTRAL SCHOOL—INDUSTRIAL AND COMMERCIAL AREA OF CITY

The school for which this time-table is designed is an admirably equipped non-selective central school in a densely populated industrial and commercial area.

The boys' department occupies the ground floor of a main building and the whole of a smaller building that stands in one corner of the playground. This smaller building contains the handicraft, science, art, craft and medical rooms. Incidentally it reduces the playground to very small dimensions. This is to some extent offset by the nearness of a public park, where a playing field has been secured. There are six classrooms and a large hall in the main building and a seventh classroom in the small building. The hall is used, in addition to its normal functions, as a gymnasium, and it is generously equipped with wall bars, ropes and all the necessary portable apparatus. Conveniently near are changing rooms and shower baths.

One of the classrooms is used also as a geography room, one as a history room and one as a music room.

The school is organised in eight classes of approximately forty boys—an "A" and "B" class for each of the four age groups. There being only seven classrooms, one of the senior classes utilises a "special" room for housing its books and other equipment.

The time-table is an experimental eight-day arrangement. Its construction is conditioned by:

(*a*) The normal curriculum requirements of a senior school—so far as those requirements are at present known.

(*b*) The decision to make the fullest possible use of the handicraft room.

(*c*) The necessity for overcoming the difficulty of using a hall as a gymnasium.

(*d*) The full utilisation of the special capabilities of the staff.

(*e*) The necessity for accommodation with the girls' department so that each department can utilise the whole playground during "break."

The eight-day period is to allow of alternate handicraft periods for each class. Handicraft is worked in conjunction with science. One half of a class does the former whilst the other half does the latter in the morning, reversing subjects in the afternoon. Halfway through the year morning classes become afternoon.

With other subjects the normal lesson period is 45 minutes, the only exceptions being a daily scripture period of 30 minutes and a daily afternoon period of 20 minutes for English expression exercises.

There are in the eight-day period four periods for each of history, geography, music and art, seven mathematics periods and six English periods for each class. The five physical training periods include one class for organised games. Each "gym" period is divided thus: 5 minutes at the beginning to change, 30 minutes for the actual lesson, and 10 minutes for shower bath and change.

One period only is allotted to "craft"—bookbinding here. More is not expedient at present since geography, history and science have the option of using the craft rooms. And the additional science period is for this purpose or for exercises.

The long science period has not proved too long, since it is divided up thus—discussion of the problem; experiment and demonstration; notes and exercises.

One improvement has suggested itself—double periods for art, but for various reasons it has not been found possible to make the necessary alterations yet.

The time-table, which embodies various slight adjustments in the early stages, has worked smoothly and satisfactorily.

VI. SENIOR BOYS' SCHOOL—CONGESTED INDUSTRIAL AREA

The school for which this time-table has been compiled is situated in a thickly congested artisan area. A falling birth-rate and emigration to the suburbs have caused the roll to drop from 406 in April, 1932, to 209 in February of this year. This rapid fall, and the consequent reduction of staff, has been kept in mind in the drawing up of the time-table. The school is graded on a six-months age basis.

The staff, composed of a headmaster, seven full-time assistants, one half-time assistant (in the afternoon) and a woodwork instructor, specialises in one or two subjects each and the time-table is so arranged that as great an advantage as possible may be taken of this fact.

The time-table is drawn up with the following points in view:

(*a*) Each class must have a physical exercises or swimming or games lesson each day.

(*b*) Each class must have a craftwork and a woodwork lesson each week, the craftwork and woodwork masters being responsible for not more than twenty boys at a time. (The woodwork lesson lasts for the whole of the session.)

(*c*) Each class must have two music and singing periods during the week. (In this connection classes are grouped in three, allowing two masters for conducting and accompanying and releasing one master for any extraneous duties or for "marking.")

(*d*) Opportunity must be made for the choir to meet once a week under the direction of its conductor and accompanist. Since the choirs of several famous city churches are largely recruited from amongst these boys, and since their conductor and accompanist act in like capacity for the local schools music festival, the choir practice and music lessons play a very prominent part in school life.

When these points have been satisfied and the periods marked in the time-table, the headmaster completes each class time-table with the exception of those of the leavers' class and the open air class. These have a measure of freedom in choice of subject and time owing to the special nature of the two classes.

Complications in the time-table arise from the following causes:

(*a*) On Mondays a class composed of boys from the leavers' classes, 3a and 3b, is taken by coach to an open air school built on the fringe of the city, returning to school at 4 p.m. in the afternoon. Special lessons are given. On fine days field work is done, to be reduced to tables and graphs, etc., on wet days when the class is confined to its classroom. The masters from classes 3a and 3b are responsible for this composite class at the open air school. The boys (from the three classes) remaining at school are in the charge of the master responsible for the leavers' class during the morning session. In the afternoon they have a special craft-work lesson followed by an art lesson.

(*b*) The woodwork centre has accommodation for twenty boys only. With the exception of the leaver's class and class 3a, two small classes, and of class 1, accommodated at an "outside" centre, all classes have woodwork lesson in two sections. Class 3b is divided for woodwork as follows:—Those boys who formed part of the special open air class on Mondays, form the woodwork class on Wednesday afternooons. The rest of the class, augmented by the boys from the leavers' class who attended the open air school on Monday, form the woodwork class of Thursday morning. Class 2a is so arranged that all choirboys from this class attend the woodwork centre on Thursday afternoon, while the rest attend on Tuesday afternoon, the day of the choir practice. Class 2b attends in two halves on Monday and Wednesday mornings. On Tuesday there is a special woodwork class drawn from the leavers' class. During this period the class concentrates upon the production of science apparatus.

(*c*) Swimming is the responsibility of one master only. The classes are divided into two groups. On Tuesdays, classes composed of leavers, 3a and 3b occupy the baths, followed on Thursdays by classes 2a, 2b and 1.

The period of instruction, 10–11 a.m., is divided into two lessons. During the first lesson, boys qualifying for Life Saving Awards are instructed in life saving methods. At the end of half an hour, these boys are released for free swimming (or to dress, at the discretion of the teacher) while a class of beginners, brought to the baths by another class master, is instructed in swimming. The third master is responsible for games in the playground with those boys who, for one reason or another, have been excused swimming. The alternatives in the time-table cover this group or the whole of the three classes during inclement weather.

(*a*) The open air class has nothing to do with the special open air class. The former is a normal feature of the school and is recruited from time to time from the weaker boys in the school. On four days a week the class travels by tram to its site in the nearest park, where it remains all day in charge of its specialist master. On Friday the class remains at school (1) so that the boys may feel they are part of a larger body; (2) in order that they may attend the woodwork centre in the afternoon; (3) to facilitate the collection of registration "returns."

(*b*) The special open air class was drawn originally almost entirely from one class. The six-monthly promotion, together with the desire that the personnel of the class shall alter as little as possible, have made it necessary to draw the boys now from three different classes. Average boys were chosen.

VII. SENIOR BOYS' SCHOOL—SEASIDE RESORT

This time-table is simple in outline and is the result of a six-year test, very few amendments having been found necessary—these being mostly as a result of our playing fields being varied by the Council.

In the working of the school our main difficulties have been (*a*) one hall for two departments; (*b*) the playing fields are 1–1½ miles away.

The first of these may be eliminated when a promised gymnasium is in being, but the other will never go.

On the face of the time-table it appears that a large proportion of time is given to mathematics. In practice we find this is not too much as in our experience the boys who come to us are not ready to start our course and we reason that, if a boy is to satisfy our aims, we have four years' work to do in two and a half years (average). Believing that the well-trained mathematical mind is to be of great value in development, we put every effort to this side. Old fashioned? Perhaps. But it pays.

The study of English, spoken and written, is a very good second, and no effort is spared to make its teaching effective. Encouragement is given to every boy to express himself to the best of his ability. Though we believe in nicely set out exercises, speech with good articulation and enunciation is recognised as the boys' main requirement in life.

Good books are read and discussed. Debates are held and everything is done to encourage the boys to listen to their own voice. Opportunities are taken for dramatisation in all subjects.

In handwork we teach only in soft woods. As soon as a boy knows his tools he has to use hard wood, and our experience has been that the added interest with the good boys, and the larger range of useful goods that can be made, have brought the boys on by leaps and bounds.

Metalwork at the moment is an extra, only for those boys who have done especially good woodwork. In the provision for the 1936 Act, we shall have a fully equipped metal workshop, and we shall use it to the limit. The older boys already associate science and handwork and make their own instruments.

In class subjects as such, we aim at principles equally with information. Wireless lessons are taken in conjunction with the time-table but are not limited by it. This is a service for general use and we take our full share.

The radiogram and gramophone help us in musical appreciation.

House efforts in sport and academic results are assessed monthly and the competitive spirit, properly controlled, is good.

Our main aim is to turn the baby we receive into the embryo man, prepared for the world he will know, and though simplicity is our attitude, I believe we are succeeding.

VIII. SENIOR BOYS' SCHOOL—SUBURBAN AREA OF CITY

This is a five-day, eight-form time-table for a senior boys' school in an urban area. (Roll 290–320.) The school is in a modern building with science laboratory, two craft rooms, eight classrooms, hall with stage and playing field on the same site. The form marked "Prep." consists of "under elevens"; Year I, of eleven plus to twelve plus, Year II of twelve plus to thirteen plus, Year III of thirteen plus to fourteen plus. There is a fourth-year group in 3a which becomes a separate form in terms when numbers warrant. Most of these work on separate and some on individual time-tables.

The staff is a specialist staff, with the exception of the form master of the "Prep." who is responsible for the work of that form as a whole. The broadcasts for schools are used and a double period is given over to the re-grouping of pupils as far as possible according to interests in a free-choice attendance at clubs. These include Travel Talks, Current Events, Drama and Debates, Art, Music, Science Lectures, Craft. A whole form attends craft at the same time, each room being equipped for twenty children who work on parallel courses. For certain periods art and science take half classes with a compensating change-over. There is no gymnasium but moveable apparatus is used in the hall, or on the playing field in suitable weather. Two periods only per form are given for scripture (three in the "Prep.") since these periods are of 40 minutes each and there is so much opportunity throughout the whole of the course for the kind of instruction associated with the scripture lesson.

Forty minutes is the basic period on which this time-table is built. Changing of rooms and of dress for physical education and games take something off this period in practice. Three consecutive periods are allocated to craft and each form has, as far as possible, one and a half or two consecutive periods once a week at art and science, and a double period once for English.

Certain broad and general principles have to be borne in mind with regard to the placing of subjects during the day and week. There is the question of fatigue, related to degree of concentration rather than to length of time spent on a subject. The "daily production curve" is highest at about 10 o'clock in the morning, is higher at the beginning of the afternoon than at the end of the morning, but drops to its lowest point (for school purposes) at the end of the afternoon session. As the curve of physical power reaches its highest in the late afternoon, everything suggests that this is a good period for the games.

In a specialist time-table, however, considerations of principle have often (perhaps mostly) to give way to considerations of expediency. First draw up the allocation of teaching duties for the staff, according to the prime needs of the school itself, and then the staff interests, and desires and specialist qualifications, as far as possible. Then fix any tied periods, such as the times for the broadcast lessons. Next deal with the use of specialist rooms, make what arrangements are possible for periods of high concentration, and so proceed to balance out principle and expedient as far as you can. The foregoing time-table is built up on these lines.

IX. SENIOR BOYS' SCHOOL—COUNTY BOROUGH

The school is situated in a thickly populated area of a large county borough and contains a yearly average of 400 children mostly from skilled artisan and commercial families.

It is admirably equipped with ten classrooms, a science laboratory, an art room, and a special building fitted with workshops adjoins the main block. A large sports ground within a few minutes' distance is also available for organised games.

The staff consists of ten class assistants, including specialists in English, science, art and music, and two teachers of metalwork and woodwork.

The time-table has undergone a searching test over a period of at least six years and the results have given the greatest satisfaction to all concerned. It may appear to be somewhat rigid compared with ultra-modern tendencies, but it is based on the fundamental needs of the children on entering the school, whilst affording as much assistance as possible for the commercial life that most of them lead on leaving. Thoroughness in the essentials is the basic principle and accordingly emphasis is placed upon English, mathematics and handicrafts.

Sport is very well catered for, the team spirit being fostered throughout the school year on the field, and swimming being a feature of the summer season. Out of school, enthusiasm is well maintained by a number of clubs that are well attended.

X. SENIOR BOYS' SCHOOL—URBAN AND RURAL AREA

This time-table is compiled for use in a boys' senior school which is fed by town and rural boys. It is a six-day cyclic one with three-quarter hour periods.

Before the type of time-table suitable for this particular school was decided upon, several important factors had to be considered.

(*a*) The staff at the disposal of the headmaster.

(*b*) The qualifications of the staff.

(*c*) The area served by the senior school, having regard to any bias it was desirable to introduce.

(*d*) The number of "breaks" likely to be caused by occasional holidays, or any particular type of instruction; e.g., the use of the projector which, until further developments in this sphere of teaching, must take the place on the same day in each week.

After these considerations, it was easy to see many advantages of the schedule, for so such time-tables become.

(*a*) If it is at all necessary for the handicraft teachers to take subsidiary subjects it is impossible for 400 boys to receive instruction in the handicraft room in a week of five days. (Each room is equipped for twenty boys.)

(*b*) Every qualified specialist master should be used to advantage; this may mean that a certain schedule of work cannot be operated in five days. On the schedule submitted science and biology are separated owing to the special qualifications of two masters trained under different conditions.

(*c*) Should there be any particular bias in the school it may be necessary to lengthen the time of the schedule. A school whose contributory schools are town and rural must cater for the needs of both. This means the introduction of gardening and other rural pursuits.

(*d*) Occasional breaks caused by music festivals, athletic meetings, etc., do not mean a break in the syllabus of work; thus at the end of term the head can examine with the knowledge that each master and each class has had its complete time to work the specified syllabus.

Lastly one must confess that the "Friday-afternoon feeling" is non-apparent.

The only great disadvantage is that the broadcast talks of the B.B.C. cannot be used to the full.

Three-quarter hour periods are used in order to make interchange of lessons easy. The period has not been found too long for physical training when the boys are encouraged to change for this lesson.

The schedule is built up on full specialisation except in a few instances where a lower class is taken by a master who perhaps has an odd period to fill in.

The school is a three-form entry one with accommodation for 400 boys. Provision is made for a fourth-year class of boys who may have to stay one term, or elect to stay on for a longer period. In some instances the lessons for this class are arranged to suit the potential future employment of the boys; thus commercial subjects are introduced with an option.

Teachers and Specialisation. Number of Masters: 11 + Head.

1. Geography + Physical Training
1. English ("A" stream) & History ("A" stream) + ½ English ("C" stream)
1. English ("B" stream) & History ("B" stream) + ½ English ("C" stream)
1. Arts and Crafts + History ("C" stream)

Teachers and Specialisation. Number of Masters: 11 + Head.

1. Science	+ Physical Training	+ Part "C" stream Maths.
1. Music		+ Part "C" stream Maths.
1. Gardening		+ Part "C" stream Maths.
1. Maths. ("A" stream)	+ Physical Training	
1. Biology	+ Maths ("B" stream)	
1. Woodwork		
1. Woodwork	+ Allied subjects; e.g., Practical Drawing and Geometry	

All boys of the same age take mathematics at the same time and three rooms are set apart for this. This enables a boy who is above average in English subjects but weak in mathematics to join with a class working to a lower standard or even a different syllabus. The opposite applies where a boy is weak in English subjects but strong in mathematics.

The mathematics "A" stream and "B" stream are both in the hands of two masters who are specialists in this subject. It is considered that it is not absolutely necessary for this to apply to the "C" streams; these lower boys are taught by one master in the first year, another in the second year, and by a third master in the last year. The masters taking them have this subject as subsidiary.

I. SENIOR GIRLS' SCHOOL—SUBURBAN AREA OF CITY

		MORNING						AFTERNOON			
	Class	9.0 - 9.40	9.40 - 10.25	10.25 - 10.40	10.40 - 11.20	11.20 - 12.0		1.50 - 2.30	2.30 - 3.10	3.10 - 3.20	3.20 - 4.0
MONDAY	3 A	D O M			S U B S.			D O M.	S U B S.		Mus.
	3 B	Half Class Sci. Half Class Maths	Maths. Sci		Geo.	Scrip.		H. work.	Half Class B bind Half Class Weav.		P.T.
	2 A	Scrip.	Maths.		Eng.	P.T.		A r t			Geo.
	2 B	Scrip.	Maths.		P.T.	Sci.	L	Hist.	Mus.		Eng.
	I A	Scrip.	Maths.		Geo.	Eng.		Eng.	Hist.		P.T.
	I B	Scrip.	Maths.		A r t		A	N.work.			N.work.
TUESDAY	3 A	Half Class Sci. Half Class Maths	Maths. Sci.		Geo.	P.T.		N.work.			N.work.
	3 B	D O M.			S U B S.		V	D O M.	S U B S.		Mus.
	2 A	Maths.	Mus.		Eng.	Bio.		Hist.	P.T.		Eng.
	2 B	Scrip.	Maths	N	A r t		R	H.work.	Half Class B.bind. Half Class Weav.	N	Eng.
	I A	Scrip.	Maths.		P.T.	Eng.		N.work.			N.work.
	I B	Scrip.	Maths.	O	P.T.	Geo.	E	Eng	Hist.	O	Writ.
WEDNESDAY	3 A	Half Class Bio. Half Class Maths	Maths. Bio.		Hist.	Scrip.		H.work.	Half Class B.bind Half Class Weav.		Mus.
	3 B	Scrip.	Maths.	I	Half Class Art Half Class Eng.		T	Mus.	P.T.	I	Eng.
	2 A	D O M.			S U B S.			D O M.			S U B S.
	2 B	Hymn Prac.	Maths.	T	P.T.	Bio.	N	Hist.	Eng.	T	Geo.
	I A	Hymn Prac.	Maths.		Bio.	P.T.		A r t			Eng.
	I B	Hymn Prac.	Eng.	A	Maths.	Mus.	I	P.T.	Geo.	A	Eng.

Day	Class										
THURSDAY	3 A	Hymn Prac.	Maths.	RECESS	Eng.	Hist.	LUNCH	Eng.	P.T.	RECESS	Geo.
	3 B	Hymn Prac.	Maths.		Half Class / Half Class	Eng. / Art		Geo.	Eng.		P.T.
	2 A	Hymn Prac.	Maths.		P.T.	Sci.		H.work.	Half Class B.bind / Half Class Weav.		Hist.
	2 B	D O M.			S U B S.			D O M.			S U B S.
	I A	Sci.	Maths.		P.T.	Eng.		Mus.	Hist.		Writ.
	I B	Eng.	Maths.		Sci.	Eng.		Hist.	P.T.		Hyg.
FRIDAY	3 A	Scrip.	Maths	RECESS	Half Class / Half Class	Art / Eng.	LUNCH	Half Class / Half Class	Eng. / Art	RECESS	P.T.
	3 B	Half Class Maths / Half Class Bio.	Bio. / Maths.		Hist.	Eng.		N.work.	Half Class / Half Class		DOM. Room1. / DOM. Room2
	2 A	Scrip.	Maths.		Geo.	Eng.		N.work.			N.work.
	2 B	Prac. Maths. in Dom. Room	Eng.		Geo.	P.T.		N.work.			N.work.
	I A	Scrip.	Maths.		Hyg.	Geo.		H.work.	Half Class		B.bind.
	I B	Scrip.	Prac. Maths. in Dom. Room		P.T.	Bio.			Half Class		Weav.

TIME PER WEEK FOR EACH SUBJECT

Class	Art	Bio. and Sci.	Eng.	Geo.	Hist.	H.work.	Hyg.	Maths.	Mus.	N.work	P.T.	Scrip.	Writ.	DomSubs	Total
3 A	80	80	160	80	80	80	—	160	120	120	120	80	—	240	1400
3 B	80	80	160	80	80	80	—	160	120	120	120	80	—	240	1400
2 A	80	80	160	80	80	80	—	160	80	120	120	80	—	280	1400
2 B	80	80	160	80	80	80	—	160	80	120	120	80	—	280	1400
I A	80	80	200	80	80	80	40	160	120	120	160	120	40	—	1360
I B	80	80	200	80	80	80	40	160	120	120	160	120	40	—	1360

II. SENIOR GIRLS' SCHOOL—COUNTY BOROUGH

		MORNING								AFTERNOON			
	Class	8.55–9.0	9.0–9.30	9.30–10.10	10.10–10.50	10.50–11.0	11.0–11.30	11.30–12.0		1.55–2.0	2.0–3.5	3.5–3.15	3.15–4.20
MONDAY	1	EARLY REGISTRATION	PTURE	Arith.	Eng. / PT.	ATION	Eng.		INTERVAL	EARLY REGISTRATION	Eng. (25) / Hist.	ATION	CLUBS and SOCIAL ACTIVITIES
	2			Hist.	PT. / Eng.		Sci.				Eng. (25) / Geo.		
	3			Cook. and			Laundry				PT. (20) / N.work.		
	4			Eng.	Arith.		PT.	Hist. (40)			Eng.		
	5			Arith.	Eng. / PT.		Art				N.work.		
	6			Arith.	Eng.		PT.	Sing.			Eng.		
	7			Arith.	Eng.		PT.	Sing.			Art		
	8			Arith.	PT. / Eng.		Sing.	Eng.			Eng. / Gen. Knowl. Dom. Sci.		
	9			Arith.	Geo.		Sing.	PT.			Eng.		
	10			Eng. / PT.	Eng.		Art				N.work.		
TUESDAY	1			PT. / sci. notes	Hist.		Eng.	Sing.			Cook. and		Laundry
	2			Arith.	PT. / sci. notes		Eng.	Sing.			Art		Art / Euryth.
	3			Arith.	PT. / Eng.		Eng.	Sing.			Art		Eng.
	4			Arith.	Eng. / PT.		Sing.	Eng.			N.work.		N.work.
	5			Arith.	Geo.		Sing.	Eng.			Sci.		PT. / Euryth. / Eng.
	6			Cook. and			Laundry				N.work.		Eng. / PT. / Eng.
	7			Arith.	Eng.		Eng.	PT.			N. work.		Spec. Proj. work / Eng.
	8			Arith.	sci. notes / PT.		Geo.	Eng.			N. work.		Euryth. / Eng.
	9			Arith.	Eng.		sci notes / Art				Eng. / PT. / Eng.		Hist. / Eng.
	10			Eng. / PT.	Arith.		Eng.				Hist. / Eng.		Sci.
WEDNESDAY	1			Eng. / PT.	Arith.		Geo.	Eng.			Eng. (25) / Art		Art / Euryth.
	2			Arith.	Geo.		PT.	Eng.			N.work.		N. work.
	3			Arith.	Eng. / PT.		Sci.				Euryth. / Hist.		Eng.
	4			Arith.	PT. / Eng.		Eng.	Geo.			Cook. and		Laundry
	5			Arith.	Hist.		Art				Geo. / Eng.		PT. / Eng.
	6			Arith.	Eng.		PT.	Eng.			Art		Eng.
	7			Cook. and			Laundry				PT. / Eng.		Spec. Proj. work / Eng.
	8			Arith.	Eng.		Sing.	PT.			Sci.		Eng. / Hist.
	9			Arith.	Eng.		Sing.	Eng.			PT. / N.work.		N. work. (45) / Eng.
	10			Arith.	Eng.		Eng.	Sing.			Eng. / PT.		Eng. / Geo. (45)

Day	Class	Assembly and Scripture		Recreation		Lunch	Assembly and		Recreation	
THURSDAY	1		Arith. / Eng.		Eng. / Sing.			P.T.(20) / N.work.		N.work.
	2		Arith. / Eng.		P.T. / Sing.			Cook. and		Laundry
	3		Arith. / Eng. / P.T.		Eng. / Sing.			Art		Eng.(20) / Geo.
	4		P.T. / Eng. / Hist.		Sing. / Eng.			Eng.(20) / Art		Art / Euryth.
	5		Arith. / sci. notes / P.T.		Sing. / Eng.			N.work.		Hist. / Eng.
	6		Arith. / P.T. / sci. notes		Sci.			Hist. / Eng.		Art
	7		Arith. / Eng.		Eng.			N.work.		Games
	8		Arith. / Eng.		Art			Eng.		Games
	9		Cook. and		Laundry			Sci.		Games
	10		Arith. / Eng.		Eng. / Art			N.work. / Euryth		Games
FRIDAY	1		Geo. / Arith.		Sci.			Eng.		Games
	2		Eng. / Arith.		Hist. (40) / Eng.			Eng.		Games
	3		Arith. / sci. notes / Eng.		Eng.			N.work.		Games
	4		Arith. / Eng. / sci. notes		Eng.(20) / Geo.			Sci.		Games
	5		Cook. and		Laundry			Eng.		Games
	6		Arith. / Geo.		Sing. / Eng.			N.work. / Euryth		Games
	7		Arith. / Eng.		Sing. / P.T.			Eng.		Art
	8		Hist. / P.T. / Eng.		Art			N.work.		Geo. / Eng.
	9		Arith. / Eng.		Eng. / P.T.			Art		Euryth. / N.work.
	10		Arith. / P.T. / sci. notes		Eng. / Sing.			Cook. and		Laundry

TIME PER WEEK FOR EACH SUBJECT

Class	Scrip.	Arith.	Eng.	P.T.	Games	Sci.	Hist.	Geo.	A and C.	N.work	Dom.work	Sing.	Euryth	Clubs and Social Act.	Recreation.	Total.
1	150	160	345	80	65	80	80	70	85	110	130	60	20	65	100	1600
2	150	160	280	90	65	80	80	80	110	130	130	60	20	65	100	1600
3	150	160	350	80	65	80	45	45	130	110	140	60	20	65	100	1600
4	150	160	315	80	65	85	80	70	90	130	130	60	20	65	100	1600
5	150	160	265	80	65	85	80	80	120	130	140	60	20	65	100	1600
6	150	160	335	100	65	85	45	40	130	110	140	60	20	65	100	1600
7	150	160	410	120	65	—	Spec.Proj.work 70		130	130	140	60	—	65	100	1600
8	150	160	350	90	65	85	80	80	120	130	45	60	20	65	100	1600
9	150	160	330	100	65	85	45	40	105	135	140	60	20	65	100	1600
10	150	160	395	80	65	85	45	45	90	110	130	60	20	65	100	1600

III. SENIOR GIRLS' SCHOOL—SEASIDE RESORT

		MORNING							AFTERNOON						
	Class	9.0–9.30	9.30–9.55	9.55–10.20	10.20–10.45	10.45–11.0	11.0–12.0		2.0–2.15	2.15–2.45	2.45–3.15	3.15–3.25	3.25–3.55	3.55–4.25	4.25–4.30
MONDAY	1A		Half Class H.work.				In Art		DOM. Room H.work.				All H.work.	Day. Games	
	2B		P.T.	H.work.			Eng.		Mus.	Geo.			Eng.		
	3A		Arith.	P.T.	Mus.		Geo.		Eng.				Eng.	Mus.	
	4B		Arith.		Mus.		Hist.	L	Art				Eng.		
	5A		Arith.		P.T.		H.work		Hist.				Eng.		
	6B		Arith.	P.T.	Eng.		Sci.	A	H.work.				Hyg.		L
TUESDAY	1A		Eng.				Eng.		Hist.				Eng.		A
	2B		Half Class H.work.				In Art.	V	DOM. Room H.work.				All H.work.	Day. Games	S
	3A	INSTRUCTION	P.T.	Arith.			Sci.		H.work.				H.work.	Mus.	S
	4B		Arith.	Eng.		N	Geo.	R	Eng.		P.T.	N	Eng.	Mus.	I
	5A		Arith.		P.T.		Eng.		Art				Mus.	Eng.	M
	6B		Arith	P.T.	Arith.	O	H.work.	E	Eng.			O	Mus.	Eng.	S
WEDNESDAY	1A		Arith	P.T.	Mus.		Eng.		Art				Eng.		I
	2B	RELIGIOUS	Eng.		Mus.	I	Arith.	T	Hyg.			I	P.T.	Eng.	D
	3A		Half Class Eng.				In Art.		DOM. Room H.work.				Half H.work.	Day. Games	
	4B		Arith.		P.T.	T	Sci.	N	H.work.			T	H.work.	Mus.	D
	5A		P.T.	Eng.			Hyg.		Mus.	Geo.			Eng.		N
	6B	AND	P.T.	H.work.		A	Eng	I	Hist.			A	Eng.		A

Day	Class			RECRE		LUNCH		RECRE		PRAYERS
THURSDAY	1A	REGISTRATION	Arith. / P.T.		Sci.		H.work.		H.work. / Mus.	
	2B		Eng.		Hist.		Art.		P.T. / Mus.	
	3A		Hist.		Hyg.		Eng.		Art.	
	4B		Half Class Art		In H.work.		DOM. Room H.work.		Half H.work. / Day. Games	
	5A		Sci.		H.work.		Eng.		Mus. / Eng.	
	6B		Arith. / Eng.		Art.		Mus. / Geo.		Mus. / Eng.	
FRIDAY	1A	ASSEMBLY	Arith. / P.T.		Hyg.		Mus. / Geo.		Eng.	
	2B		Arith. / Eng.		Sci.		H.work.		H.work. / Eng.	
	3A		P.T. / Arith.		H.work.		Eng.		Eng.	
	4B		Hyg. / P.T. / Hyg.		Eng.		Eng.		H.work.	
	5A		Half Games. / Class In Arith.		D.O.M. Art		Room Half Day Once A H.work.		Fortnight. Eng.	
	6B		Eng. / Half Class Art In		DOM Eng.		Room Half Day Once A Eng.		Games Fortnight / Eng.	

TIME PER WEEK FOR EACH SUBJECT

Year	Class	Religious Instruct.	Eng.	Arith.	Geo.	Hist.	Mus.	H.work and Art	Sci. Hyg. and Dom. work	P.T.	Total
Year III	1A	150	375	125	60	75	70	300 (Av)	255 (Av)	90 (Av)	1500
	2B	150	330	110	60	60	70	350 (Av)	270 (Av)	100 (Av)	1500
Year II	3A	150	$352\frac{1}{2}$ (Av)	125	60	75	85	$307\frac{1}{2}$ (Av)	255 (Av)	90 (Av)	1500
	4B	150	320	125	60	60	85	360 (Av)	245 (Av)	95 (Av)	1500
Year I	5A	150	410 Av	$137\frac{1}{2}$	60	75	75	$296\frac{1}{4}$ (Av)	202 (Av)	$93\frac{3}{4}$ (Av)	1500
	6B	150	$447\frac{1}{2}$ (Av)	125	60	75	75	$282\frac{1}{2}$ (Av)	$187\frac{1}{2}$ (Av)	$97\frac{1}{2}$ (Av)	1500

Owing To Half Classes In Dom. Room Average Time Per Week Is Given.

IV. SENIOR MIXED SCHOOL—SUBURBAN AREA OF CITY

	Class	MORNING									AFTERNOON					
			9·0–9·30		9·30–9·50	9·50–10·45	10·45–10·55	10·55–11·30	11·30–12·0			2·0–2·25	2·25–3·20	3·20–3·30	3·30–4·0	4·0–4·30
MONDAY	3B	TION AND PRAYERS	IPTURE	AND CLOSING REGISTERS	P.T.	Arith.	EATION	Geo.		INTERVAL	FINAL MARKING AND CLOSING REGISTERS	Mus.	H. work.	EATION	Eng.	
	3G				P.T.	Arith.		Eng.				Mus.	Geo.		N.work.	
	3R				P.T.	Arith.		Eng.				Mus.	Eng.		H.work.	
	2A				Mus.	Arith.		N.work.				Eng.	N.Study		Geo.	
	2B				Mus.	Arith.		Geom.				Eng.			H.work.	
	1A				Hist.	Arith.		N.work.				P.T.	Eng.		Eng.	P.T.
	1B				Eng.	Arith.		Sci.				P.T.	Eng.		Hist.	P.T.
TUESDAY	3B				Eng.	Arith.		Hist.				Eng.			Art	
	3G				D O M.			E C.				Eng.	Hist.		Geo.	
	3R				Eng.	Arith.		Geo.				Eng.	Sci.		Hist.	
	2A				P.T.	Arith.		Eng.	Hist.			Mus.	Hist.		N.work	
	2B				P.T.	Arith.		Art				Mus.	N.Study		H.work.	
	1A				Mus.	Arith.		Geo.				P.T.	Eng.		Hist.	
	1B				Mus.	Arith.		Art				P.T.	N.Study		Eng.	
WEDNESDAY	3B				P.T.	Arith.		Eng.	Hist.			Eng.			Hyg.	O.G.
	3G				P.T.	Arith.		N.work.				Art.			Eng.	
	3R				P.T.	W.work.		and Dom.	Ec.			Girls. Boys.	N. work. Geom.		N.work. Hyg.	O.G.
	2A				Eng.	Arith.		Sci.				Geo.	Eng.		N.work.	
	2B				Dom.	Ec.		Boys.	Hist.			Eng.			H.work.	
	1A				Eng.	Arith.		N. work.				Mus.	H. work.		Art	
	1B				Eng.	Arith.		Eng.				Mus.	H.work.		Eng.	

Day	Class												
THURSDAY	3B	REGISTRA	RECESS	MARKING	Wood.	RECESS	Work.	LUNCH	REGISTRATION	P.T.	Eng.	RECESS	Sci.
	3G				Eng. / Arith.		Eng.			P.T.	Eng.		N.Study and Hyg.
	3R				Eng. / Arith.		Hist. / Eng.			P.T.	Eng.		Geo.
	2A				P.T. / Arith.		Art.			W. work.			and Dom. Ec.
	2B				P.T. / W. work.		Geo. Study / Hist.			Eng.	Geo.		Eng.
	1A				W. work.		Geo. / Eng.			Girls. Dom. Ec. / Boys. Arith.			N. work.
	1B				Eng. / Arith.		Hist. / Geo.			Eng.			Geom. Draw.
FRIDAY	3B	ASSEMBLY		FINAL	Eng. / Arith.		Eng.		ASSEMBLY AND	Mus.	Art		Geo. / Music
	3G				Eng. / Hist.		N.work.			Mus.	Arith.		O.G.
	3R				Art.		H. work.			Mus.	Arith.		Eng.
	2A				Arith.		Eng. / P.T.			Eng.			Eng.
	2B				Eng. / Arith.		Eng. / P.T.			Hist.			Sci.
	1A				P.T. / Arith.		Eng.			Girls. N.Study and Hyg			Eng.
	1B				P.T. / Arith.		Geo.			Boys. H. work.			Eng.

TIME PER WEEK FOR EACH SUBJECT

Class	Eng.	Arith.	Sci.	Geo.	N.Study	Dom.Ec. W.work	N.work	H.work	Swim.	Hyg.	P.T.	O.G.	Scrip.	Hist.	Mus.	Draw.	Recreation	Total
3B	415	220	60	105	—	180	—	55	—	30	95	—	120	95	70	115	90	1650
3G	310	220	—	115	30	180	190	—	—	30	105	—	120	110	70	80	90	1650
3R	310	220	55	125	—	180	140	125	25	—	45	30	120	95	70	75	90	1650
2A	290	295	65	85	55	180	185	—	—	—	70	—	150	85	65	65	90	1650
2B	330	220	40	90	55	180	185	60	—	—	70	—	120	110	65	65	90	1650
1A	265	300	80	60	—	180	190	55	—	—	100	—	120	80	65	60	90	1650
1B Girls.	420	275	—	95	135	—	125	55	—	—	100	—	150	65	65	65	100	1650
1B Boys.	420	275	65	95	55	—	—	135	—	—	100	—	150	65	65	125	100	1650

Science, hygiene and nature study, in actual working, are grouped under one heading. Times are apportioned to the various divisions to meet with the differing needs of boys and girls.

V. SENIOR BOYS' CENTRAL SCHOOL—INDUSTRIAL AND COMMERCIAL AREA OF CITY

		MORNING						AFTERNOON			
	Class	9·0–9·30	9·30–10·15	10·15–10·30	10·30–11·15	11·15–12·0		2·0–2·20	2·20–3·5	3·5–3·15	3·15–4·0
DAY 1	I A	Scrip.	H.craft. Sci.	ROTATION	H.craft. Sci.	H.craft. Sci.	INTERVAL	Sci. H.craft.	Sci. H.craft.	ROTATION	Sci. H.craft.
	I B	Scrip.	Eng.		Art	Hist.		Diary	Maths.		P.T. (O.G)
	2 A	Scrip.	Maths.		Geo.	Mus.		Diary	Eng.		P.T.
	2 B	Scrip.	Hist.		Maths.	Geo.		Diary	Art		Eng.
	3 A	Scrip.	Maths.		B. bind.	Geo.		Diary	P.T.		Mus.
	3 B	Scrip.	Maths.		P.T.	Eng.		Diary	Hist.		Art
	4 A	Scrip.	P.T.		Sci.	Maths.		Diary	Geo.		Mus.
	4 B	Scrip.	Maths.		Mus.	Art		Diary	Hist.		Eng.
DAY 2	I A	Scrip.	Art		Eng.	Maths.		Diary	Hist.		P.T. (O.G)
	I B	Scrip.	Maths.		P.T.	Mus.		Diary	Geo.		Eng.
	2 A	Scrip.	Geo.		Maths.	Hist.		Diary	Art		Eng.
	2 B	Scrip.	B. bind.		Maths.	Geo.		Diary	Mus.		P.T.
	3 A	Scrip.	P.T.		Maths.	Hist.		Diary	Eng.		Art
	3 B	Scrip.	Geo.		Maths.	P.T.		Diary	Mus.		Sci.
	4 A	Scrip.	Art		Maths.	Mus.		Diary	Eng.		Hist.
	4 B	Scrip.	H.craft. Sci.		H.craft. Sci.	H.craft. Sci.		Sci. H.craft.	Sci. H.craft.		Sci. H.craft.
DAY 3	I A	Scrip.	Mus.		Hist.	Maths.		Diary	Eng.		Art
	I B	Scrip.	H.craft. Sci.		H.craft. Sci.	H.craft. Sci.		Sci. H.craft.	Sci. H.craft.		Sci. H.craft.
	2 A	Scrip.	Eng.		Hist.	Art		Diary	Maths.		P.T. (O.G)
	2 B	Scrip.	Maths.		Mus.	Geo.		Diary	P.T.		Eng.
	3 A	Scrip.	Geo.		Maths.	Hist.		Diary	Art		Eng.
	3 B	Scrip.	Maths.		P.T.	B. bind.		Diary	Mus.		Geo.
	4 A	Scrip.	Maths.		Art	Hist.		Diary	Eng.		P.T.
	4 B	Scrip.	P.T.		Sci.	Maths.		Diary	Geo.		Mus.
DAY 4	I A	Scrip.	Maths.		Geo.	Mus.		Diary	P.T.		Eng.
	I B	Scrip.	Geo.		Eng.	Art		Diary	Hist.		Maths.
	2 A	Scrip.	B. bind.		Geo.	Maths.		Diary	Mus.		P.T.
	2 B	Scrip.	Maths.		P.T.	Eng.		Diary	Hist.		Art
	3 A	Scrip.	P.T.		Sci.	Geo.		Diary	Maths.		Mus.
	3 B	Scrip.	Mus.		Art	Maths.		Diary	Eng.		Hist.
	4 A	Scrip.	H.craft. Sci.		H.craft. Sci.	H.craft. Sci.		Sci. H.craft.	Sci. H.craft.		Sci. H.craft.
	4 B	Scrip.	Eng.		Hist.	Maths.		Diary	Art		P.T. (O.G)

DAY 5	1A	Scrip.	P.T.	RECRE	Sci.	Maths.	LUNCH	Diary	Geo.	RECRE	Mus.
	1B	Scrip.	Art		Maths.	Mus.		Diary	Eng.		Hist.
	2A	Scrip.	H.craft. Sci.		H.craft. Sci.	H.craft. Sci.		Sci. H.craft.	Sci. H.craft.		Sci. H.craft.
	2B	Scrip.	Eng.		Hist.	Art		Diary	Maths.		P.T. (O.G.)
	3A	Scrip.	Mus.		Geo.	P.T.		Diary	Maths.		Eng.
	3B	Scrip.	Maths.		Art	Hist.		Diary	Eng.		Geo.
	4A	Scrip.	B.bind.		Mus.	Geo.		Diary	Maths.		P.T.
	4B	Scrip.	Maths.		P.T.	Eng.		Diary	Hist.		Art
DAY 6	1A	Scrip.	Eng.		Geo.	Hist.		Diary	Art		Maths.
	1B	Scrip.	Mus.		Maths.	P.T.		Diary	B.bind.		Geo.
	2A	Scrip.	Eng.		P.T.	Maths.		Diary	Hist.		Art
	2B	Scrip.	P.T.		Sci.	Geo.		Diary	Maths.		Mus.
	3A	Scrip.	Art		Maths.	Mus.		Diary	Eng.		Hist.
	3B	Scrip.	H.craft. Sci.		H.craft. Sci.	H.craft. Sci.		Sci. H.craft.	Sci. H.craft.		Sci. H.craft.
	4A	Scrip.	Eng.		Hist.	Art		Diary	Maths.		P.T. (O.G.)
	4B	Scrip.	Geo.		Mus.	Maths.		Diary	P.T.		Eng.
DAY 7	1A	Scrip.	P.T.		Maths.	Eng.		Diary	Hist.		Art
	1B	Scrip.	Sci.		P.T.	Maths.		Diary	Geo.		Mus.
	2A	Scrip.	Art		Maths.	Mus.		Diary	Hist.		Eng.
	2B	Scrip.	H.craft. Sci.		H craft Sci.	H craft Sci.		Sci. H.craft.	Sci. H.craft.		Sci. H.craft.
	3A	Scrip.	Hist.		Eng.	Art		Diary	Maths.		P.T. (O.G.)
	3B	Scrip.	Mus.		Eng.	Maths.		Diary	P.T.		Geo.
	4A	Scrip.	Geo.		Hist.	Maths.		Diary	Art		Eng.
	4B	Scrip.	B.bind.		Maths.	Geo.		Diary	Mus.		P.T.
DAY 8	1A	Scrip.	Maths.		B.bind.	P.T.		Diary	Mus.		Geo.
	1B	Scrip.	Maths.		P.T.	Eng.		Diary	Art		Hist.
	2A	Scrip.	P.T.		Maths.	Sci.		Diary	Geo.		Mus.
	2B	Scrip.	Art		Maths.	Mus.		Diary	Eng.		Hist.
	3A	Scrip.	H.craft. Sci.		H.craft. Sci.	H.craft. Sci.		Sci H.craft.	Sci. H.craft.		Sci H.craft.
	3B	Scrip.	Hist.		Eng.	Art		Diary	Maths.		P.T. (O.G.)
	4A	Scrip.	Maths.		Eng.	Geo.		Diary	Mus.		P.T.
	4B	Scrip.	Hist.		Geo.	Maths.		Diary	Eng.		Art

VI. SENIOR BOYS' SCHOOL—CONGESTED INDUSTRIAL AREA

		MORNING									AFTERNOON					
	Class	9.0–9.40	9.40–9.45	9.45–10.15	10.15–10.20	10.20–10.35	10.35–11.5	11.5–11.30	11.30–12.0		2.0–2.5	2.5–2.40	2.40–3.10	3.10–3.20	3.20–4.0	4.0–4.30
MONDAY	L	Scrip.		O.G. or Arith.			O.G. cont. or if wet Eng.		Eng.			W.work.			W.work.	
	3A	A section from each class at Open Air School.		Remainder of classes combine with leavers for rest of morn. sess.			At Open Air School		O.G.			At O.A. School N.study | Folk Danc.			Return to school by coach	
	3B						Prac. Arith. & Mensuration					At School:- C.work.			Art.	
	2A	O.G. or Scrip.		O.G. or Arith.			O.G. or Eng.	Eng.				Arith.	Geo.		Hist.	Mus.
	2B	Scrip.		Arith.			Eng.					Arith.	P.T.		Sci.	Mus.
	I	Scrip.		Arith.			Eng.					Art			P.T.	Mus.
	OA	Scrip.		Travel to park.			Arith. or Alg.		P.T.	L		Eng.	N.study		Geo.	Travel home
TUESDAY	L	Scrip.		Arith.	L		Swim. or O.G.		Eng.			Art	Mus. or Eng.		Eng.	Mus.
	3A	Scrip.		Arith.	L		Eng.		P.T.	A		Art	Mus. or Eng.		Hist.	Mus.
	3B	Scrip.		Arith.	I		Swim. or O.G.		Hist.			Radio Talk	Mus. or Eng.		Alg.	Mus.
	2A	Scrip.		Arith.	R		Swim. or O.G.		Eng.	V	N	Eng.	Mus. or Eng.		C. work.	
	2B	Scrip.		Arith.	D		P.T.	Eng.	Geo.			Arith.	Mus. or Eng.		Hist.	Eng.
	I	W.work.		W.work.		N	W.work.			R	O	P.T.	Mus. or Eng.	N	Geo.	Hist.
	OA	Scrip.		Travel to park	K		Arith. or Alg.		P.T.			Hist.	N.study		Reading	Travel home
WEDNESDAY	L	Scrip.		Arith.	L	O	Eng.			E	I	Games	Art	O	C. work.	
	3A	Scrip.	D	Arith.	I		Eng.		P.T.			C. work.			Eng.	
	3B	Scrip.	E	P.T.	M	I	C. work.			T	T	Geo.	Radio Talk	I	Eng.	
	2A	Scrip.	S	Arith.			P.T.	Sci.				Geom.	Geo.		Hist.	Mus.
	2B	Scrip.	O	Arith.	B.	T	Eng.			N	A	Alg.	P.T.	T	Eng.	Mus.
	I	Scrip.	L	Arith.	M.		Eng.		Alg.			Geom.			P.T.	Mus.
	OA	Scrip.	C	Travel to park	M.	A	Arith. or Eng.		P.T.	I	R	Geo.	Eng.	A	Games	Travel home

Day	Class		REGISTERS		INTERVAL FOR	RECRE			LUNCH	REGIST			RECRE		
THURSDAY	L	Scrip.		Arith.			Sci				Art			Eng.	Mus.
	3A	Scrip.		Arith.			Swim. or Eng.	Alg.			Art			Hist.	Mus.
	3B	Scrip.		Arith.			Eng.				Geo.	P.T.		Eng.	Mus.
	2A	Scrip.		P.T.			Alg.	Eng.			Eng.			C.work.	
	2B	Scrip.		Arith.			Swim. or Games	Geo.			Geom.			Hist.	Eng.
	I	Scrip.		Arith.			Swim. or Games	Eng.			C.work.			Geo.	Hist.
	0A	Scrip.		Travel to park			Arith. or Geom.	P.T.			Draw.			O.G.	Travel home
FRIDAY	L	Scrip.		P.T.			Eng.				Free time table			class chooses its own P.S.	
	3A	W.work.		W.work.			W.work.				P.T.	Eng.		Eng.	
	3B	Scrip.		Art			Arith.	Geom.			Eng.	Folk Danc.		Eng.	
	2A	Scrip.		Arith.			Eng.	P.T.			Arith.			Art	
	2B	Scrip.		Arith.			O.G. or Eng.	Eng.			C.work.			Art	
	I	Scrip.		Arith.			O.G. or Eng.	Eng.			Eng.			Sci.	Eng.
	0A	Scrip.		Arith.			Eng.				W.work.			W.work.	

TIME PER WEEK FOR EACH SUBJECT

Class	Eng.	Arith.	Scrip.	Hist.	Geo.	Art	W.work	P.S.	P.T.	Sci.	C.work	N.study	Mus.	Geom.	O.G.	Alg.	Swim	Draw	Radio Talks	Folk Danc.	Travelling	Recreation & milk	Register	Reading	Total
L	310	90	200	–	–	120	135	145	30	85	70	–	90	–	120	–	55	–	–	–	–	150	50	–	1650
3A	280	145	120	80	–	100	155	–	95	–	65	35	90	–	30	30	55	–	–	30	140	150	50	–	1650
3B	300	170	160	30	70	100	–	–	60	–	150	–	90	30	30	40	55	–	65	30	70	150	50	–	1650
2A	270	190	160	80	60	70	–	–	90	55	140	–	90	35	100	55	55	–	–	–	–	150	50	–	1650
2B	325	220	200	80	60	70	–	–	90	40	65	–	90	65	55	35	55	–	–	–	–	150	50	–	1650
I	295	120	160	60	80	65	155	–	115	40	65	–	90	65	55	30	55	–	–	–	–	150	50	–	1650
0A	175	150	200	35	75	–	135	–	120	–	–	60	–	25	80	50	–	65	–	–	240	150	50	40	1650

Note:– Alternative Subjects Taken When Special Conditions Prevent O.G. or Swim.

VII. SENIOR BOYS' SCHOOL—SEASIDE RESORT

	Class	MORNING 9.0 – 9.30	9.30–10.0	10.0–10.30	10.30–10.45	10.45–11.30	11.30–12.0		AFTERNOON 2.0 – 3.30	3.30–3.40	3.40 – 4.30
MONDAY	3 A	ASSEMBLY HALL. Repetition, Etc.	Maths.			P.T.	Hist.		Geo.		P.S.
	3 B		Maths.			Local Hist.	Eng.		Hist.		Hyg. or Eng.
	2 A		Maths.			Geo.			Eng.		Hist.
	2 B		Sec. A. Maths. / Sec. B. Maths.	Sec. A. Man. I.		Sec. A. Man. I. / Sec. B. Sci.			Sec. A. Sci. / Sec. B. Man. I.		P.S. / Man. I. — Eng.
	1 A	Sec. A. Man. I.	Sec. A. Man. I. / Maths.	Maths.		Eng.			Hist.		Art.
	1 B	GENERAL IN Scripture,	Maths.			Eng.	P.T.		Art		Geo.
	2C		Maths.			Eng.			Eng. or Art		Geo.
	4		Maths.			Geo.			Civics.		As for 3A or 3B
TUESDAY	3A	OLD TESTAMENT.	Maths.			Eng.			Art.		Eng.
	3B		Maths.			Eng.			Geo.		Art.
	2A		Sec. A. Maths. / Sec. B. Maths.	Sec. A. Man. I.		Sec. A. Man. I. / Sec. B. Sci.			Sec. A. Sci. / Sec. B. Man. I.		Eng. / Man. I. — Eng.
	2B		Maths.			Eng.			Geo.		Eng.
	1 A	Sec. B. Man. I.	Sec. B. Man. I. / Maths.	Maths.		Eng.			Eng.		Hist.
	1B		Sci.			Hist.			Eng.		Eng. or O.G.
	2C		Maths.			Art.			Nat. Talk and Geo.*		Eng.
	4		Maths.			Hist. *		INTERVAL	Eng. *		Opt.
WEDNESDAY	3A	GENERAL ASSEMBLY IN HALL. Hymns, Anthems, Etc.	Man. I. Notes			Sec. A. Man. I. / Sec. B. Sci.			Sec. A. Sci. * / Sec. B. Man. I.		Singing (In The Hall)
	3 B		Maths.			Hist.			P.T. — Geo.		
	2A		Maths.			Geo.			Art		
	2 B		Maths.			P.T.	Hist.		Art.		
	1A		Sci.			Maths.			Geo. — P.T.		
	1 B	Sec. B. Man. I.	Sec. B. Man. I. / Maths.	Maths.		Eng.			Hist.		
	2C		Maths.		ATION	Art	P.T.		Hist. *	ATION	
	4		Man. I.			Work			P.T. with 3B — P.S.		

Day	Class			R E C R E		L U N C H		R E C R E	
THURSDAY	3A	NEW TESTAMENT	Maths.		Geo.		Eng.		P.T. or Hyg.
	3B		SecA. Maths. Man I. / SecB. Maths.		SecA. Man I. / SecB. Sci.		SecA. Sci. / SecB. Maths.		H.work Notes
	2A		Maths.		Hist.		Eng.		Art
	2B		Maths.		Geo. *		Eng. / Hist * / Eng.		Art
	1A		Maths.		Hyg. Eng. (alt. weeks)		Art		Geo.
	1B	Sec. A. Man I. / Maths.	Maths.		Hyg. Eng. (alt. weeks)		Geo.		Eng.
	2C	With 3A and 3B	Maths.		Eng.		H.work.		Gen. Knowl.
	4		Maths.		W.work.		W.work.		W.work.
FRIDAY	A	GENERAL ASSEMBLY IN HALL. Hymns, Anthems, Etc.	Maths.		Hist.		Art.		Singing (In The Hall)
	3B		Maths.		P.T. or O.G. / P.S.		Art.		
	2A		Maths.		Eng.		P.T. or O.G. / Hyg.		
	2B		Maths.		Hist. / Eng.		Travel or Top Talks * / P.T.		
	1A		Maths.		Eng. / P.T. or O.G.		Eng.		
	1B		Maths.		Art		Eng. or H.work.		
	2C		W.work.		W.work.		H.work.		
	4	Sci. H.work.			Sci. H.work.		Civics.		

REGISTRATION. 9 0 am. Close 9 30 am.
2 0 pm. Close 2 15 pm.

BRIGADING. For Subjects Of Special Interest Age — Groups Are Amalgamated.

WIRELESS BROADCASTS. Lessons Using Broadcasts Are Marked Thus. *

ORGANISED GAMES.

Classes	4, 3A, 3B,	Monday	3-0 — 4-30
Classes	2A, 2B,	Thursday	11-0 — 12-0
Classes	1A, 1B,	Monday	11-0 — 12-0
Class	2C.	Friday	11-0 — 12-0

SPECIAL NOTE. Each Master Arranges That His Class Gets Some Time Every Week For Writing, Spelling, Tables, and Theory of Music.

VIII. SENIOR BOYS' SCHOOL—SUBURBAN AREA OF CITY

		MORNING								AFTERNOON				
	Class	8·50–9·5	9·5–9·45	9·45–10·25	10·25–10·40	10·40–11·0	11·0–11·20	11·20–12·0		1·45–1·50	1·50–2·30	2·30–3·10	3·10–3·20	3·20–4·0
MONDAY	3A	ASSEMBLY HALL	Scrip.	C R –	RECREATION	A F T			INTERVAL	REGISTRATION	P.T.	Re-Grouping For Clubs	RECREATION	Re-Grouping For Clubs
	3B		P.T.	Sci.		Art	Art / Sci.				Maths.			
	2A		Scrip.	Eng.		Maths.		O.G.			B.Craft.			
	2B		Maths.	P.T.		Eng.		Mus.			Sci. / Art			
	1A		Scrip.	Geo.		P.T.		Eng.			Eng.			
	1B		Scrip.	Maths.		Geo.		Eng.			Hist.			
	1C		B.Craft.	Mus.		Maths.		Geo.			Eng.			
	Prep.		Mus.	Maths.		Hist.		Art			Eng.	Geo.		O.G.
TUESDAY	3A.		Maths.	Geo.		Maths.		Hist.			Mech.Draw.	Eng.		Sci.
	3B.		Scrip.	C R –		A F T					Eng.	Art		O.G.
	2A		P.T.	Maths.		Eng.					Hist.	Geo.		Maths.
	2B		Eng.	Sci.		Sci.		O.G.			Mus.	Maths.		Geo.
	1A		Geo.	Eng.		Art.					Maths.	P.T.		Eng.
	1B		B.Craft.	Mus.		Hist.		Maths.			C R A			F T
	1C		Art			Eng.		Hist.			P.T.	Eng.		Maths.
	Prep.		Mus.	Eng.		Maths.		P.T.			Sci.	C R		A F T
WEDNESDAY	3 A.	REGISTRATION	Scrip.	Maths.		Eng.				SCHOOL	Geo.	Mus.		O.G.
	3 B.		P.T.	Eng.		Maths.		Geo.			Hist.	Mech. Draw.		Mus.
	2A.		Scrip.	Sci.		Art	Art / Sci.				Eng.	Hist.		Sci.
	2B.		Eng.	P.T		Hist.		Geo.			Maths.	Eng.		Geo.
	1A		Scrip.	C R		A F T					Mus.	Sci. / Art		Hist.
	1B		Scrip.	Geo.		Maths.		Hist.			Sci. / Art	Eng.		P.T.
	1C		Scrip.	Mus.		Hist.		Eng.			C R A –			F T
	Prep.		Scrip.	Maths.		Eng.		P.T.			Art			Eng.

Day	Class										
THURSDAY	3A	SCHOOL	Eng.	Mus.	R	Geo.	Hist.	LUNCH	INTO	Maths.	Hist.	R	Eng.
	3B		Geo.	Maths.		Eng.	Geo.			Hist.	Eng.		Sci.
	2A		P.T.	C R–		A F T				Eng.	Art		Mus.
	2B		Scrip.	P.T.		Art				C R A –			F T
	1A		Hist.	Eng.	C	P.T.	Geo.			Sci.		C	Maths.
	1B		P.T.	Eng.		Sci.				Geo.	Eng.		O.G.
	1C		Scrip.	Art / Sci.		Hist.	Eng.			Geo.	Maths.		P.T.
	Prep.	INTO	Eng.	Maths.		Geo.	P.T.			Mus.	Maths.		Hist.
FRIDAY	3A		P.T.	Sci.	E	Art	Art / Sci.		ENTRY	Art	P.T.	E	Eng.
	3B		Scrip.	Eng.		Maths.	Eng.			Mus.	Hist.		P.T.
	2A		Hist.	Geo.		P.T.	Mus.			Geo.	Eng.		Maths.
	2B	ENTRY	Scrip.	Maths.	R	Eng.	Hist.			Eng.	B.Craft.	R	Hist.
	1A		Eng.	Hist.		Maths.	O.G.			Maths.	Mus.		B.Craft.
	1B		Eng.	Art		Art	Maths.			P.T.	Eng.		Mus.
	1C		P.T.	Maths.		Eng.	Geo.			Sci.			O.G.
	Prep.		Scrip.	Craft		Hist.	Eng.			Geo.	Eng.	Eng. Rec.	Eng.

TIME PER WEEK FOR EACH SUBJECT

Class	Eng.	Maths.	P.T.	O.G.	W. work Craft	MechDraw B.Craft.	Sci.	Geo.	Hist.	Mus.	Art	Scrip.	Clubs.	Total
3A–1C	240	160	120	40	120	40	100	120	120	80	100	80	80	1400
Prep.	320	200	120	40	–	120	40	120	120	80	120	120	–	1400

▇ = Broadcast Lessons ◺ = Split Classes

IX. SENIOR BOYS' SCHOOL—COUNTY BOROUGH

		MORNING								AFTERNOON						
	Class	8.55–9.0	9.0–9.30	9.30–10.50		10.50–11.0	11.0–12.0			1.55–2.0	2.0–3.20			3.20–3.30	3.30–4.30	
MONDAY	1A			Maths.	Eng.		A. and C.				Eng.	P.T.	Eng.		Eng.	
	1B			Maths.	Eng.		Eng.	Hist.			Geo.		P.T.		Eng.	
	1C			Maths.	Eng.		P.T.	Eng.			H. Craft.				H. Craft.	
	2A			Maths.	Eng.		Dram. Eng.				Hist.		Arith.		Eng.	
	2B			Maths.	P.T.		Geo.	Eng.	L		A. and C.				Eng.	
	2C			H. Craft.			H. Craft.				Geo.		Eng.		P.T.	Eng.
	3A			Maths.	Eng.		P.T.	Mus.			Dram. Eng.		Eng.		Eng.	
	3B			Maths.	Eng.		Hist.	Mus.	A		Sci.				Eng.	
	3C			Maths.	Eng.		Mus.	P.T.			A. and C.				Eng.	
TUESDAY	1A			Maths.	Eng.		Sci.				Geo.		P.T.		Mus.	Eng.
	1B			Maths.	Eng.		A. and C.		V		H. Craft.				H. Craft.	
	1C			Maths.	Eng.		Hist.	Eng.			Geo.		Eng.		A. and C.	
	2A			Maths.	Eng.		Mus.	Eng.			Eng.				O.G.	
	2B	Y	E	Maths.	Eng.	N	Mus.	Eng.	R	Y	Hist.		Maths.	N	O.G.	
	2C			Maths.	Eng.		Eng.	Mus.			A. and C.				Sci.	
	3A			Maths.	Eng.		Geo.	Eng.			Sci.				O.G.	
	3B	L	R	Maths.	Eng.	O	P.T.	Eng.	E	L	Dram. Eng.		Eng.	O	O.G.	
	3C			H. Craft.			H. Craft.				Hist.		Eng.		O.G.	
WEDNESDAY	1A			Maths.	Eng.		A. and C.				Eng.		P.T.		Mus.	Eng.
	1B	B	U	Maths. (50)	P.T.	I	Sci.		T	B	Eng.			I	Mus.	Eng.
	1C			Maths.	Eng.		Art				P.T.	Eng.			Mus.	Eng.
	2A			H. Craft.			H. Craft.				Geo.		Eng.		Hist.	P.T.
	2B	M	T	Maths.	Eng.	T	Eng.		N	M	Sci.			T	Eng.	Hist.
	2C			Maths.	Eng.		Geo.	Eng.			Hist.		Eng.		P.T.	Eng.
	3A			Maths.	Hist.		P.T.	Mus.			A. and C.				A. and C.	
	3B			Maths.	Geo.		Eng.	Mus.			H. Craft.				H. Craft.	
	3C	E	P	Maths.	Eng.	A	Eng.	Geo.	I	E	Dram. Eng.		P.T.	A	Maths.	Eng.

		A S S	S C R I		R E C R E		L U N C H	A S S		R E C R E	
THURSDAY	1A			Maths. / Eng.		Geo. / Hist.			Dram. Eng. / Eng.		O. G.
	1B			Maths. / Eng.		A. and C.			Hist. / Eng.		O. G.
	1C			Maths. / Eng.		Sci.			Eng.		O. G.
	2A			Maths. / Eng.		P.T. / Eng.			Sci.		Mus. / Eng.
	2B			H. Craft.		H. Craft.			Eng. / P.T.		Mus. / Eng.
	2C			Maths. / Eng.		A. and C.			Eng. / Maths. / Eng.		O. G.
	3A			Maths. / Eng.		Eng.			H. Craft.		H. Craft.
	3B			Maths. / P.T.		Eng.			A. and C.		A. and C.
	3C			Maths. / Eng.		Hist. / P.T.			Geo. / Eng.		A. and C.
FRIDAY	1A			H. Craft.		H. Craft.			Maths. / Eng.		Eng.
	1B			Maths. / Eng.		Sing. / Geo.			Eng.		P.T. / Eng.
	1C			Maths. / Eng.		Eng. / Geo.			Hist. / P.T.		Mus. / Eng.
	2A			Maths. / Eng. (Geo.)		Geo. / P.T.			A. and C.		A. and C.
	2B			Maths. / P.T.		A. and C.			Eng.		Geo. / Eng.
	2C			Maths. / Eng.		Hist. / P.T.			Eng. / Mus.		Eng.
	3A			Maths / Eng.		P.T. / Eng.			Geo / Eng.		Hist. / Eng.
	3B			Maths. / Geo.		Eng.			Hist. / Eng.		P.T. / Eng.
	3C			Maths. / Eng.		Sci.			Eng. / Sci. Notes		Mus. / Eng.

TIME PER WEEK FOR EACH SUBJECT

Class	Scrip.	Recreation	Eng	Arith.	Sci.	Mus.	P.T and O.G.	Geo	Hist	H Craft.	A. and C.	Total
1A	150	100	470	240	60	60	150	80	80	140	120	1650
1B	150	100	480	230	60	60	150	80	80	140	120	1650
1C	150	100	480	230	60	60	150	80	80	140	120	1650
2A	150	100	430	240	80	60	150	80	80	140	140	1650
2B	150	100	430	240	80	60	150	80	80	140	140	1650
2C	150	100	465	265	60	60	150	80	80	140	140	1650
3A	150	100	435	235	80	60	150	80	80	140	140	1650
3B	150	100	450	220	80	60	150	80	80	140	140	1650
3C	150	100	475	195	80	60	150	80	80	140	140	1650

X. SENIOR BOYS' SCHOOL—URBAN AND RURAL AREA

		MORNING									AFTERNOON						
	Class	8·55 9·0	9·0& 9·40	9·0 9·30	9·30–10·15	10·15–11·0	11·0 11·15	11·15–12·0	12·0 12·5		1·40 1·45	1·50	1·45–2·30	2·30–3·15	3·15 3·25	3·25–4·10	4·10 4·15
DAY 1	4th.Yr.	PRAYERS	REGISTERS CLOSED	INSTRUCTION	Hist.	Maths.	ATION	com.subs: H.work.	ISSAL	INTERVAL	EMBLY	CLOSED	Sci.	P.S.	ATION	Eng.	ISSAL
	Up.3				P.T.	Biol^y.		Biol^y.					Eng.	Maths.		Eng.	
	Mid3				P.T.	Hist.		Mus.					Eng.	Maths.		Geo.	
	Low.2				P.T. W.work.	Gardg W.work.		Gardg. W.work.					Mus.	Maths.		Eng.	
	Up.2				Mus.	P.T.		Eng.					Maths.	Sci.		Sci.	
	Mid2				Hist.	Mus.		Eng.					Maths.	Geo.		O.G.	
	Low.2				A.and C.	A. and C.		P.T.					Maths.	Eng.		Biol^y.	
	Up.1				Maths.	Eng.		P.T.					Geo.	A. and C.		A. and C.	
	Mid.1				Maths.	P.T.		Pr. Draw.					W. work.			W. work.	
	Low.1				Maths.	P.T.		A.and C.					A.and C.	Eng.		Mus.	
DAY 2	4th.Yr.				Hist.	Maths.		Eng.					Eng.	Mus.		O.G.	
	Up.3				Maths.	Eng.		Geo.					W. work.			W. work.	
	Mid3.				Maths.	P.T.		Eng.					Hist.	Sci.		Sci.	
	Low3				Maths.	Pr. Draw.		P.T.					Eng.	A.and C.		A.and C.	
	Up.2				P.T.	Biol^y.		Biol^y.					Geo.	Maths.		Eng.	
	Mid.2				A.and C.	P.T.		A.and C.					A.and C.	Maths.		Eng.	
	Low.2				P.T. W. work.	Gardg.		Gardg. W.work.					Sci.	Maths.		Mus.	
	Up.1				Hist.	A. and C.		P.T.					Maths.	Eng.		Eng.	
	Mid.1				P.T.	Eng.		Mus.					Maths.	Eng.		Geo.	
	Low.1				Sci.	Mus.		Eng.					Maths.	Geo.		Biol^y.	
DAY 3	4th.Yr.				Sci.	P.S.		com. subs: H.work.					commer. subs Maths.			Pr. Draw.	
	Up.3				P.T.	A.and C.		A.and C.					Eng.	Maths.		Mus.	
	Mid3				Eng.	P.T.		Pr. Draw.					Eng.	Maths.		Biol^y.	
	Low3				Hist.	Mus.		P.T.					Geo.	Maths.		O.G.	
	Up.2				Maths.	Hist.		Eng.					A. and. C.			Eng.	
	Mid.2				Maths.	P.T.		Eng.					W.work.			W.work.	
	Low.2				Maths.	Pr. Draw.		P.T.					Sci.	Eng.		Geo.	
	Up.1				Eng.	Biol^y.		Biol^y.					Maths.	Sci.		Sci.	
	Mid.1				P.T.	Eng.		Mus.					Maths.	Hist.		O.G.	
	Low.1				P.T.	W.work. Gardg.		W.work. Gardg.					Maths.	Geo.		Eng.	

Assembly and Registration. Religious. Recre. Dism. Lunch. Ass. Registers. Recre. Dism.

Day 4	4th Yr.	Eng.	Maths.	P.T.	Mus.	Hist.	A. and C.
	Up. 3	P.T.	Hist.	Mus.	Geo.	Maths.	Eng.
	Mid. 3	P.T.	Eng.	Geo.	A. and C.	Maths.	Mus.
	Low 3	P.T. W.work.	Gardg.	Gardg. W.work.	Eng.	Maths.	Eng.
	Up. 2	Mus.	P.T.	Pr. Draw.	Maths.	Eng.	O.G.
	Mid. 2	Hist.	Bioly.	Bioly.	Maths.	Eng.	Pr. Draw.
	Low. 2	Eng.	Mus.	Hist.	Maths.	Geo.	Eng.
	Up. 1	Maths.	Pr. Draw.	Eng.	W. work.		W.work.
	Mid. 1	Maths.	P.T.	Eng.	Sci.		Bioly.
	Low. 1	Maths.	Hist.	P.T.	Eng.	A. and C.	O.G.
Day 5	4th Yr.	P.T.	Maths.	Eng.	W.work.		W.work.
	Up. 3	Hist.	Maths.	P.T.	Eng.	Mus.	O.G.
	Mid. 3	Eng.	Maths.	Bioly.	A. and C.	A. and C.	O.G.
	Low 3	Sci.	Maths.	Mus.	Eng.	Geo.	Bioly.
	Up. 2	W.work.		W.work.	Maths.	Eng.	Eng.
	Mid. 2	P.T.	Sci.	Sci.	Maths.	Eng.	Geo.
	Low 2	A. and C.	P.T.	Eng.	Maths.	Gardg. W.work.	Gardg. W.work.
	Up. 1	Mus.	Hist.	P.T.	Mus.	Maths.	Eng.
	Mid. 1	Mus.	A. and C.	A. and C.	Geo.	Maths.	Eng.
	Low. 1	Mus.	Eng.	Eng.	Sci.	Maths.	Hist.
Day 6	4th Yr.	Maths.	P.T.	Bioly.	Mus.	Geo.	Eng.
	Up. 3	Eng.	Maths.	Pr. Draw.	Sci.		A. and C.
	Mid 3	Eng.	Maths.	Mus.	W.work.		W.work.
	Low 3	Hist.	Maths.	Eng.	Eng.	A. and C.	Sci.
	Up. 2	Mus.	P.T.	A. and C.	Maths.	Hist.	Geo.
	Mid. 2	Mus.	Eng.	P.T.	Maths.	Eng.	Mus.
	Low 2	Mus.	Hist.	P.T.	Maths.	Eng.	O.G.
	Up. 1	P.T.	Mus.	Eng.	Geo.	Maths.	O.G.
	Mid. 1	Bioly.	Hist.	Eng.	A. and C.	Maths.	Eng.
	Low. 1	P.T. W.work.	Gardg.	Gardg. W.work.	Eng.	Maths.	Pr. Draw.

HOLIDAYS IN EUROPE

(Continued from Volume VI, page 500.)

A SAMOYEDES' CAMP IN NORTHERN RUSSIA. [*The Photochrom Co.*

POLAND

(For the pronunciation of Polish vowels and consonants, see page 388.)

History.—The traveller who takes an international train eastward from Berlin, or even from Paris, unless he occupy one of the cars of the International Wagons-Lits Company, is likely to find himself in a carriage bearing the initials P.K.P.—Polskie Koleje Panstwowe (Polish State Railways). Thus far has the new state, which came into new life after more than a century of dissolution, progressed, that its railway cars circulate far into the west, incorporated with French and other rolling stock, in trains maintaining communications between western cities and the centres of Polish life and the Russian frontier beyond them.

There is significance in this inter-running of Polish rolling stock with that of western countries in the great west to east and east to west traffic of the Continent, for Poland, although geographically in the east of Europe, has ever been a western land, in marked contradiction to Russia, her neighbour. When in 965 King Micezyslaw I. (962–992) became converted to the Christian faith in its western Roman form, a momentous step was taken, for thereby Poland was set on the road, which she has never abandoned, to a contact with all the civilisation of the west; whereas when Christianity was first accepted in Russia a few years later (988) by Prince Vladímir of Kíev, it was in the Greek Orthodox form. It was natural that the princedom of Kíev should receive its religion in this form, for the missionaries who brought it from Byzantium came up the Dnieper from the Black Sea, whereas the overland trade route from Prague and beyond provided an easier route for those of the Roman faith. As it was in the beginning, so has it continued; throughout the centuries Russia kept her Orthodox religion, and keeps it still in so far as religion persists in the Soviet Union; while Poland, in spite of some indications in the sixteenth century, that she might become a protestant country, has remained faithful to Rome and to-day is one of the most solidly Catholic states of Europe. The tourist interested in such matters will find in Poland, especially in the eastern parts of the country, side by side with the Catholic faith in its rigid form, the Uniat Church, which uses the Eastern Orthodox rite but owes allegiance to Rome. This is not the place to enter into a lengthy explanation of the reasons for this surprising development. Suffice it to say that it became evident in the sixteenth century that great difficulties stood in the way of the absorption of the entire population of Poland's eastern borderlands, which had inevitably been influenced by the prevailing Orthodox religion of Russia, into the Catholic fold, and members of the Society of Jesus evolved this compromise. In the year 1596 at the Synod of Brześć (Brest), the new Church was recognised and it received the sanction of the Holy See.

Although largely sharing in the life of the West through many centuries, Poland presents a unique spectacle in European history—rising to greatness in the Middle Ages, torn asunder into three parts under foreign domination in the eighteenth century, and rising to greatness again in our own day. In the fourteenth century, when England was of little consequence in the comity of nations, Poland was a great state, particularly after the marriage in 1386 of Jadwiga, heiress to the Polish throne, with Prince Jagiello of Lithuania, who was crowned king of Poland, thereby merging the early Piast dynasty of Poland with the Lithuanian House[1] and founding the Jagellonian dynasty which ruled Poland until late in the seventeenth century, when the Polish monarchy became elective in fact as well as in theory. Very serious inner weaknesses, however, were inherent throughout its history in the Polish Republic (Rzeczpospolita Polska),[2] for such was its name although a monarchy. All power was in the hands of the *pans* (great lords) and the *szlachta* (gentry), leaving little for the sovereign unless he were sufficiently strong a personality to impose his will on his lords. Until the end of the fifteenth century, the peasants (*kmetons*) had enjoyed reasonable prosperity and rights, but by enactments of the Diet of Piotrków in 1496 they lost all their rights to the *pans* and thereafter counted for nothing in the state. In addition to other grievous restrictions, the *kmetons* were forbidden to possess land: "Statuimus quod civibus et plebeis undecunque existentibus oppida, villas, prœdia et bona alia juri terreste supposita emere, tenere possidereque perpetuo vel obligatorio modo liceat minime . . . et quod illi qui jam in effectu bona terrestria occuparunt, illa hinc ad decursum temporis quod commode istud facere possent vendere teneantur sub pœnis quas ex illis secus facientibus juxta arbitrium nostrum et Palatinum Terræ, in quo illa consistunt, exacturi sumus irremissibiliter." Such forced sales, with only the *pans* and the *szlachta* as buyers, would undoubtedly depress the price of land and it is probable that the peasants received a mere pittance for their property. The minimising of the power of the king made its appearance as early as 1505, for in that year at the Diet of Radom, King Alexander was forced to enact: "Nihil novi constitui debet per nos et successores nostros sine communi consiliorum et nuntiorum terrestrium concensu." Gradually the practice was introduced of requiring from each king at his accession the so-called *pacta conventa*, limiting his powers and the equally disastrous constitutional right of any member of the diet (*Sejm*) to bring the assembly to a close by

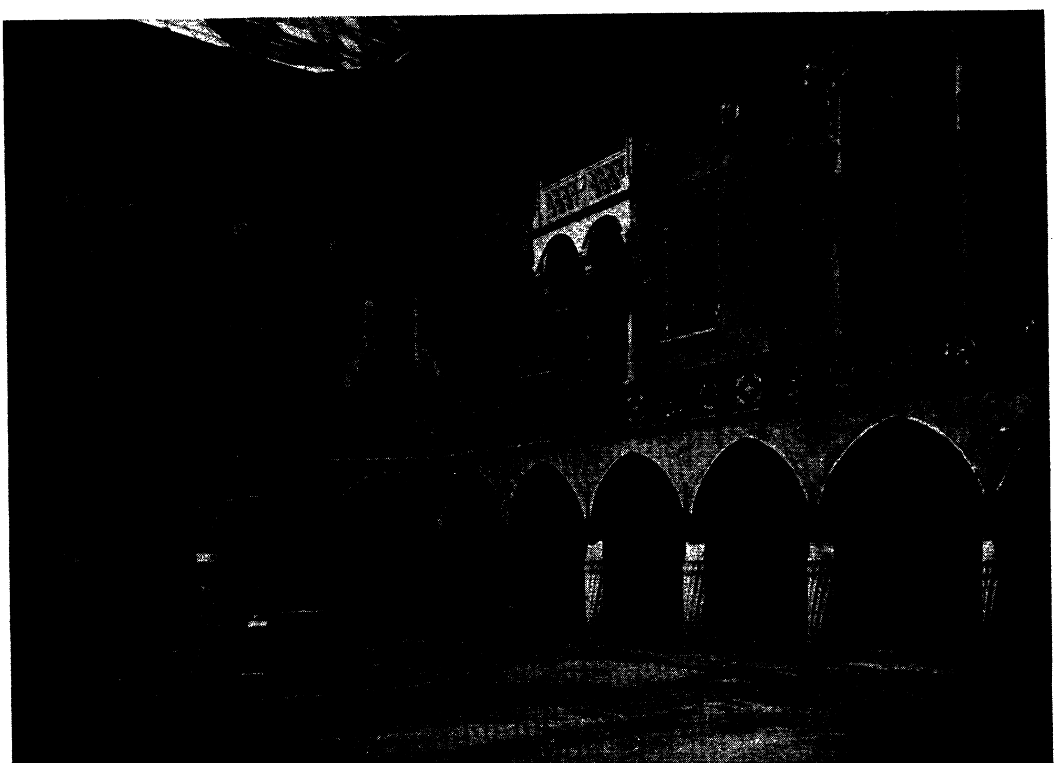
[1] This was a union of the crowns. The complete union of the two states was achieved only in 1569 at the Diet of Lublin. It is interesting to note that, as in the case of England and Scotland some centuries later, an interval elapsed between the union of the crowns and the union of the kingdoms.

[2] This is also the official name of the new Poland whose army was, in October, 1918, recognised by Great Britain and her allies as autonomous, allied and co-belligerent, the first effective act of recognition on the part of other states. The accent on Polish words is usually on the penultimate, but *Rzeczpospolita* is an exception, the accent falling on *pol*.

saying: "*Niepozwalam*" (I forbid), the right known as the *liberum veto*. Strong kings, such as Stephen Batory (1576–1586) and John Sobieski (1674–1696), the valiant conqueror of the Turks outside the walls of Vienna in 1683, were able to maintain the authority of the kingship and even, as in the case of John Sobieski, to achieve European renown; but in the eighteenth century, under a succession of feeble monarchs, the inner weaknesses became manifest and the old Poland went down to the grave dug for her by the sovereigns of neighbouring powers—Russia, Prussia and Austria, in the partitions of 1772, 1793 and 1795.

Then followed a doleful century and more for the Polish people, crushed by the partitioning states. In spite of great but unrealised hopes placed in Napoleon when a noble Polish lady, the Countess Maria Walewska, even gave herself to the Emperor in the hope of thereby purchasing the emancipation of her country, and of bloody insurrections in Russian Poland in 1830 and 1863, no liberation came for the sorely tried country until the downfall of the three partitioning empires in quick succession in 1917–18. Even peace did not come with liberation, and for Poland the Great War lasted seven years instead of four, hostilities continuing with Russia and Germany intermittently until they were finally brought to an end in 1921.

What the new Poland has achieved since 1921 the tourist may see for himself, but, as he may like to form some idea in advance, three works may be mentioned in which the period is fully treated in masterly fashion: *Poland*, by Roman Dyboski, in Ernest Benn's *Modern World Series* (1933); *The*



[*Reproduced by courtesy of Orbis, Ltd.*

Cracow Courtyard of Jagellonian Library with Statue of Copernicus

Poland of Pilsudski, by Robert Machray, Allen & Unwin (1936); and *Dziesięciolecie Polski Odrodzonej* (*Ten Years of the Reborn Poland*), published by the *Ilustrowany Kurjer Codzienny* (*Illustrated Daily Courier*), Cracow. Those interested in the old Poland will find an excellent history in Morfill's *Poland*, published by Fisher Unwin (1893.)[1]

Although Poland has taken the greater part of her civilisation and culture from the West, she has also given liberally. For centuries her sons have been distinguished in science, literature, music and the arts. Space does not permit mention of all those Poles who have achieved not only a national but a world renown, but a few of them shall have notice. Copernicus, the mathematician and astronomer (1473–1543), author of *De Revolutionibus Orbium Cœlestium Libri VI*, in which he confuted the Ptolemaic theory of the universe, was born at Toruń (Thorn). There is a statue of Copernicus by Thorwaldsen in one of the public squares of Warsaw and another statue in the courtyard of the Jagellonian Library at Cracow. Poland's greatest poet, Adam Mickiewicz (1798–1855), himself the greater part of his life an exile, kept alive, in the time of her captivity, aspirations for the rebirth of the Polish State, which he did not live to see. Lelewel (1786–1861), the historian who also, like so many other Poles, passed most of his life in exile, was author not only of *Histoire de Pologne* (Paris, 1844), but also of works of European reputation—*Numismatique du Moyen Age*, 1835; *Géographie du Moyen Age*, 1850–1852, and other works. Henry Sienkiewicz is well known to English readers as the author of *Quo Vadis?* and other novels. In music may be mentioned Chopin and Paderewski, the latter having also become the first prime minister of the new Poland. In our own time, Copernicus has had worthy successors in Olszewski, of Cracow, who discovered a method for the liquefaction of air; and Swiętosławski, of Warsaw, who devised a new standard of thermodynamic measurement. Another Polish scientist of the nineteenth century has a more modest title to fame in having invented the paraffin lamp—Ignatius Łukasiewicz.

Scenery and towns.—Not only is there much out of Poland's past and of the years since she regained her independence to interest the tourist. There are the picturesque peasant costumes of the countryside which may be seen even quite near to Warsaw, and there is great diversity of scenery. On her short sea coast are breezy headlands and pine-crested beaches with a hinterland of lakes and woods; in the south-west the Tatra Mountains, the northern slopes only of which are in Poland, the southern side of the mountains being in Czechoslovakia. Fast-flowing rivers and rocky gorges here delight the eye. Farther east are the more solitary Carpathians and in the north-east are great forests, the like of which are not to be seen elsewhere in Europe, except over the border in Russia. Then there are the towns, mostly situated in the great central plain: Warsaw, the capital since 1610; Cracow, the earlier capital; Lwów (Lemberg) in the far south-east; Wilno in the north-east; Poznań (Posen), the chief town of the former Prussian Poland; Toruń (Thorn) in the north; and the ancient walled towns of Sandomierz and Kazimierz, both situated, as are Warsaw and Cracow, on the Vistula. Łódź is an industrial town and has little of interest for the tourist.

The cities of Poland are very much varied in their appearance and in the features of interest they present for the tourist. Owing to her changing destinies under the three former Russian, German and Austrian Empires, there is little standardisation. Almost all travellers will make their way first to Warsaw (in Polish, Warszawa), although if travelling to Warsaw by train from Berlin they should, if possible, break their journey at Poznań. In addition to ugly buildings constructed in the time of foreign rule, there is one of the oldest cathe-

[1] Second Edition 1923.

[*Reproduced by courtesy of Orbis, Ltd.*

WARSAW

A. ROYAL PALACE AND COLUMN OF KING SIGISMUND III. B. ŁAZIENKI PALACE. C. FUKIER'S WINE SHOP.
D. OPEN-AIR THEATRE OF THE ŁAZIENKI PALACE

drals in Poland, dating from the tenth century and containing the tombs of the first two rulers of Poland, and the old Town Hall with richly decorated rooms. At a distance of thirty-three miles from Poznań is Gniezno (Gnesen), with its cathedral. The Archibishop of Gniezno is, and was throughout the period of Poland's past independence, the Primate of all Poland.

Warsaw.—Warsaw is a well-planned city with long wide streets. The Royal Palace contains a valuable collection of furniture, tapestries and pictures which belonged to the kings of Poland; also the throne. Many of these treasures were removed by the Russians to St. Petersburg after the partitions of the country and after the insurrection of 1830. The Treaty of Riga, concluded between Poland and Soviet Russia in 1921, contained provisions for the restoration of Poland's property, and in the following years many items were recovered, not only for the Royal Palace in Warsaw but also for the Łazienki Palace in the same city and for national collections in Cracow. One wing of the palace is the official residence of the President of the Republic. The Łazienki was built by the last king of Poland, Stanislaus Augustus, at the end of the eighteenth century, and it is for tourists one of the most interesting buildings of Warsaw. In the Wierzbowa stands the house occupied by the Emperor Napoleon during his stay in the city. There are various museums of great interest, including a most interesting Postal Museum in the building of the Administration of Posts, Telegraphs and Telephones. This, in addition to a large collection of stamps, has documents relating to the postal history of Poland, and uniforms and many interesting objects associated with the past and present postal arrangements of Poland and other countries. The museum is officially open on Sundays only, but by a special arrangement permission to see it at any reasonable time on any day of the week will be granted to foreign visitors on application through the intermediary of the Wagons-Lits/Cook Travel Office at 42–44, Krakówskie Przedmiescie. Some of the best restaurants in Europe are to be found in Warsaw and the city has long had a well-deserved reputation for the delicious cakes and pastries of its many tea rooms (*cukiernie*). In the Market Place, in the Old Town, is Fukier's Wine Shop, dating from 1610, which has been kept by the same family from the date of its foundation. There is a beautiful courtyard.

Cracow.—Cracow (in Polish, Kraków) is the most beautiful town in Poland. In the cathedral are the tombs of many of the early kings and a treasury of old monstrances and other objects of ecclesiastical art. Many old churches, the Clothiers' Hall, the Jagellonian University, with its library, and numerous museums offer sufficient to interest the tourist for days in Cracow, the whole surmounted by the royal castle on the Wawel Hill. Cracow has always been the intellectual centre of Poland. Copernicus was a student at the university there and in the forty years before the Great War it was in academic circles in Cracow that aspirations for the deliverance of the country from her bondage were most kept alive and developed. This was possible under the relatively milder rule of Austria as compared with that of Russia and Germany. Excursions should be made from Cracow to Zakopane, Poland's largest summer and winter resort, situated at a distance of ninety miles, with convenient train services; and to the salt mines of Wieliczka, eight miles distant from Cracow. The different levels of the mines are connected by flights of steps and there is a labyrinth of passages. There are ponds with boats upon them in the heart of the mines and several chapels with altars, statues and ornaments hewn out of the rock salt.

Although Warsaw is interesting, two days should be allowed in Cracow for each day spent in Warsaw. Lwów (Lemberg) is so far away that it is likely to be visited by relatively few tourists and it does not offer the same interest as Warsaw and Cracow. It is a meeting place of West and East and contains three cathedrals of different Christian denominations—Catholic, Uniat and Orthodox. Wilno is picturesquely situated on hills and among gardens. There are many styles of architecture—gothic, baroque and rococo. In history, it has seen the Muscovite invasion of 1655, the Russian occupation in 1795, the passage of Napoleon's Grande Armée in 1812, the German occupation of 1915–1919, and its liberation by the Polish troops in the year last mentioned.

detailed and up-to-date information. Internally, the Polish State Railways provide comfortable and convenient services and there are good air services between the chief cities, enabling the tourist with little time to see many parts of the country in a short holiday.

Travellers by steamer to Poland land either at the port of the Free City of Danzig (in Polish, Gdańsk) or at the new Polish port nearby, Gdynia. From either of these, any town in northern Poland may be reached in a few hours by express train, and even the remote parts in twelve hours or so. Two days may very well be spent in Danzig, a beautiful city with many buildings dating from the Middle Ages. As it is not actually part of the Polish Republic, further information is not given here.

[*Reproduced by courtesy of Orbis, Ltd.*

CRACOW INTERIOR AT THE ROYAL CASTLE

The journey.—Warsaw or Cracow are reached by train from London in about thirty-six hours. The return fares at the time of writing (1937) range from about £8 third class to about £18 first class (second class about £12). Sleeping car supplements add £2 or £3 more. There are regular steamer sailings between England and Poland with low fares, and also convenient air communications. Any reliable tourist agency will supply

Hotels.—In all the large cities of Poland, good hotels of various grades are to be found. The *cuisine* is usually excellent and the bedrooms are clean and comfortable in all the larger establishments. Tourists are advised to avoid the smallest and cheapest hotels as they sometimes leave a great deal to be desired in the matter of cleanliness. In the smaller places, unboiled tap water should not be drunk. An excellent natural mineral water from springs near Warsaw, Ostromecko, is obtainable everywhere and is cheap. Those who explore the country districts, especially those in former Russian Poland, must be prepared for primitive hotel conditions. Each year there is an improvement, but it will probably be many years before the hotels in small towns and villages of eastern Poland offer anything like the same conditions of comfort and hygiene as are to be met with in similar places in such countries as Holland and Sweden. In any case, Poland is most decidedly a country where the tourist should make his arrangements through a reliable tourist agency. These agencies by frequent inspection know the hotels suitable for the foreign visitor. Moreover, the number of good hotels available in most towns is not adequate and rooms are often difficult to obtain unless booked beforehand through a tourist agency.

Entry into Poland.—A visa is necessary in order to visit Poland, but this is granted on request and payment of the consular fee. Tourist agencies will attend to this formality on behalf of their clients. On entering the country, travellers must declare all money in their possession, including traveller's cheques, to the frontier officers, and obtain a certificate of the amounts in various currencies. The surrender of this certificate at the frontier on leaving will permit of the same or lower amounts being taken out. It is very important to note that the amount in Polish currency (*złoty*) must not exceed the amount in *złoty* taken in.

Pronunciation and language.—The following rules for the pronunciation of some of the Polish vowels and consonants will be useful:

ą = *on* as in French *bon*.
c = ts
ć = ch
ch = the German guttural *ch* as in *rauchen*.
cz = *ch* in *church*.
ę = *en* as in French *bien*.
g is always hard.
j = y
ł = w. This is not quite the sound; it is as near as it is possible to represent it in English. The foreign traveller who uses this pronunciation will always be understood.
ń = *ni* as in *companion*.
ó = oo
rz = the French j.
sz = sh
w = v
szcz= *shch* as in *Ashchurch*

There is no thoroughly satisfactory manual for the study of the Polish language in English. The best is Ssymank: *Elementary Polish Grammar*; Julius Groos, Heidelberg (London agents—Librairie Hachette, King William Street, Strand, W.C.2). For a deep study is highly to be recommended Soerensen: *Polnische Grammatik in systematischer Darstellung*; Verlag von Haberland, Leipzig. As books of words and phrases, the following may be mentioned:

1. Marlborough's *Polish Self-Taught*;
2. Lyall : *A Guide to Twenty-five Languages of Europe*; Sidgwick & Jackson, Ltd.; an excellent work of its kind.
3. In German, *Metoula Sprachführer* (*Polnisch*). Langenscheidsche Verlagsbuchhandlung, Berlin-Schöneberg.

For a comparative study of Polish, Russian and other Slavonic languages, Hrubý: *Vergleichende Grammatik der Slavischen Sprachen*, A. Hartleben's Verlag, Wien, is useful.

RUSSIA (UNION OF SOVIET SOCIALIST REPUBLICS)

Throughout this chapter the old name *Russia* is employed as being more commonly in use in English speaking countries than *Union of Soviet Socialist Republics*. The appendix treats this question at some length.

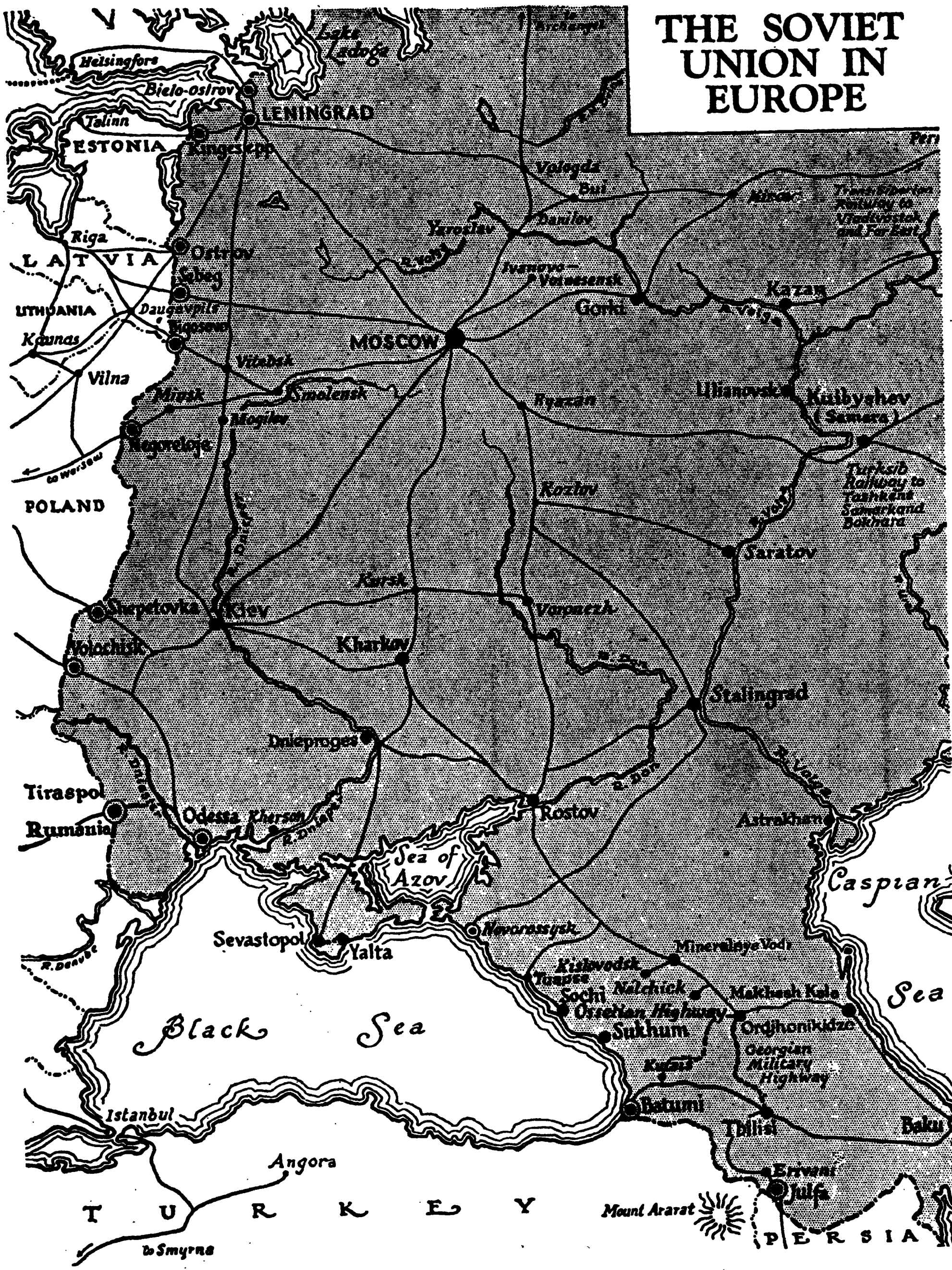
Why go to Russia?—Each reader of this book will have his own reasons for going (or staying away), but the following are some of the reasons which have prompted thousands in the last few years to undertake the adventure, for as such a journey to Russia is usually regarded.

One of the chief reasons is that the country is different, essentially different, from every other country in the world. There, everything is different, from the way of making tea to the width of the railway carriages. It will be interesting to consider for one moment the reasons for the differences between Russia and the West. For centuries Russia was isolated from the West, including Poland, by the Prypeć Marshes. Even in our day, when these marshes have been partly drained, they offer difficulty in places in communications, but in earlier times they were almost impassable, with the consequence that all the countries on this side of the marshes received their culture, law, customs and religion from a western source —from Rome—whereas Russia received hers from the eastern Empire, from Byzantium. Thus, old Russia built up her civilisation on a Byzantine foundation and developed it through centuries almost without influence from western countries, whereas these latter built on Roman foundations and proceeded on quite other lines of thought and action. All the faiths in western countries, even Lutheranism and English Nonconformity, show unmistakable signs of their descent from the great Latin Church, whereas the Russian Church in its architecture and in its ritual has followed the eastern style and rite. As it has been in the religious life, so has it been in secular matters; the Russians followed a path of their own, with results quite different from western modes of thought and life.

Then, there are differences due to the size of the country. Russia occupies one-sixth of the earth's surface and contains 190 different peoples. In this one country may be seen—naturally in different parts—reindeer and camels; mosses and stunted pine trees in the north and palm trees in the south. The distances which may be travelled in a single train are very great: from Negoréloje[1] on the Polish frontier to Manchouli on the Manchoukuo border is 4,720 miles; from Negoréloje to Vladivostóck the distance is even greater—6,348 miles. From Shepetóvka another station on the Polish frontier, to Júlfa, where one may enter Iran, the distance is 2,367 miles as compared with one of the longest distances in Canada—Montreal to Vancouver, 2,885 miles. All the Russian journeys mentioned are covered regularly by trains over the entire distance without change of carriage. In so large an area it will be obvious that there is much to see that is unfamiliar and, therefore, interesting to the visitor from the West.

All these differences and all the interest arising from the size of the country existed before the Russian Revolution of 1917. Now there is the added interest of a great economic and political experiment—gigantic plans for the reorganisation and development of industry in a country which was formerly a land of peasants. There is much to see, much progress to be noted, but it must be remembered how backward the country was before 1917. Many people, having read about it, favourably or otherwise, wish to go to see for themselves. "Ah," you will probably say, "but they are allowed to see only what the Russians want them to

[1] The accentuation of Russian names and words is variable and is very strong on the syllable on which it falls. Although the Russians do not in their printing indicate the stress, the author has done so in this chapter for the guidance of readers. No accent is shown in the case of Moscow, as that is not the Russian name of the city. The Russian form is Moskvá. The accentuation of Polish place names is native to the language and serves a different purpose.



THE SOVIET
UNION IN
EUROPE
Lake Ladoga
Helsingfors
Bielo-ostrov
LENINGRAD
Tallinn
ESTONIA
Kingisepp
Vologda
Bui
Danilov
Yaroslav
Kotelnich
Trans-Siberian Railway to Vladivostok and Far East
Riga
LATVIA
Ostrov
Sebeg
LITHUANIA
Daugavpils
Kaunas
Vilna
Ivanovo-Voznesensk
Gorki
Kazan
R. Volga
MOSCOW
Vitebsk
Smolensk
Minsk
Mogilev
Negoreloje
Ryazan
Ulianovsk
Kuibyshev (Samara)
to Warsaw
POLAND
Rozlov
Turksib Railway to Tashkent Samarkand Bokhara
Saratov
Kursk
Shepetovka
Kiev
Voronezh
Volochisk
Kharkov
Stalingrad
R. Don
Dnieproges
R. Volga
Tiraspol
Rumania
Odessa
Kherson
R. Dnieper
Rostov
Astrakhan
Sea of Azov
Caspian Sea
Novorossiysk
Sevastopol
Yalta
Mineralnye Vody
R. Danube
Kislovodsk
Tuapse
Nalchick
Makhach Kala
Sochi
Ossetian Highway
Ordjhonikidze
Black Sea
Sukhum
Georgian Military Highway
Batumi
Istanbul
Tbilisi
Baku
Erivan
Angora
Julfa
TURKEY
Mount Ararat
PERSIA
to Smyrna

see." This point is dealt with on another page. For the moment, suffice it to say that people of most diverse opinions do find it interesting and useful to go; some because politically they approve of what has been done; others, who disapprove, find it useful all the same to inform themselves accurately on the matter, so that in discussion or when addressing meetings they may be able to meet the arguments of opponents who have been to Russia and who are able to speak with knowledge gained in the country itself.

Scenery and historical interest.[1]—It is an opinion widely held that Russia is uninteresting from the point of view of scenery. It is perfectly true that in the north and the centre there are no mountains, not even any high hills. Those who wish to see high hills in Russia must go to the Crimea and for mountains they must go to the Caucasus, where, however, they will find mountains much higher than any in Switzerland. Nevertheless, much of the scenery in the north is pleasing; something like the Leith Hill country of Surrey with its pines and birch trees. In winter, a very beautiful sight is presented by the forests through which many of the railway lines run, including the principal main line from the Polish border to Moscow. For many, however, the chief interest of the main line from Poland to Moscow will be one of history. In Paris, in the Place de l'Etoile, may be seen the Arc de Triomphe, commemorating the victories of the first Napoleon and his armies: Castiglione, Lodi, Arcole, Marengo, Ulm, Austerlitz, Iéna, Friedland, Wagram and others. It does *not* commemorate Napoleon's campaign of 1812, when the Imperial French Army was defeated, partly by the Russian forces but still more by the terrors of the Russian winter.

Outside the Byélo-Rússkii Station in Moscow, the terminus of the line from Poland, there stood until 1936, when it was pulled down to make more room for street traffic, another triumphal arch which did commemorate the events of that year, 1812. It was seemly, for the railway line in question follows very closely the line of Napoleon's advance and retreat. Some seventy miles west of Moscow, very near to the railway, is the battlefield of Boródino, an indecisive battle, which took place a few days before the Emperor's useless entry into the city of Moscow. On the night before the battle, the priests in the Russian camp were carrying their holy icons in procession and chanting their liturgies. At that moment in the French camp, Napoleon was causing his troops to file past a large painting of his infant son, the King of Rome, just arrived from Paris. Some of his marshals, hearing the sounds from the Russian camp, carried on the breeze, and having all the superstition of unbelievers, came to the Emperor and said, "Would it not be well, Sire, to have prayers in our army too?" According to the statements of some who were present, his reply was, "Moi-même, je suis la prière de mon armée"—"I, myself, am the prayer of my army."

It is not, however, chiefly of Napoleon's advance but of his retreat that we think when travelling on the railway line between Warsaw and Moscow and contemplating those events of a century and a quarter ago. Smolénsk, the River Berézina, and the other stations of that *via dolorosa* of the French Army are all near. The crossing of the Berézina was, perhaps, the most terrible event of the campaign. The French Army with its following women and children—for such was the custom of the time—were crossing the river by a temporary bridge when the Russian artillery fired on the bridge and smashed it, precipitating men, women and children into the icy waters. The story is told in the memoirs of the Comte de Ségur, in the third part of Thomas Hardy's epic drama of the Napoleonic Wars, *The Dynasts*, and in other accounts of the campaign. The two soldiers mentioned by Heinrich Heine in *Die zwei Grenadier* were survivors from the Retreat and the event is commemorated

[1] On Russian History may be recommended *A History of Russia* by Prince D. S. Mirsky; No. 12 in *Benn's Sixpenny Library*. A bibliography is appended to this short but useful work.

in Tchaikovsky's Overture "1812." Six hundred thousand men marched into Russia; more than five hundred thousand perished.

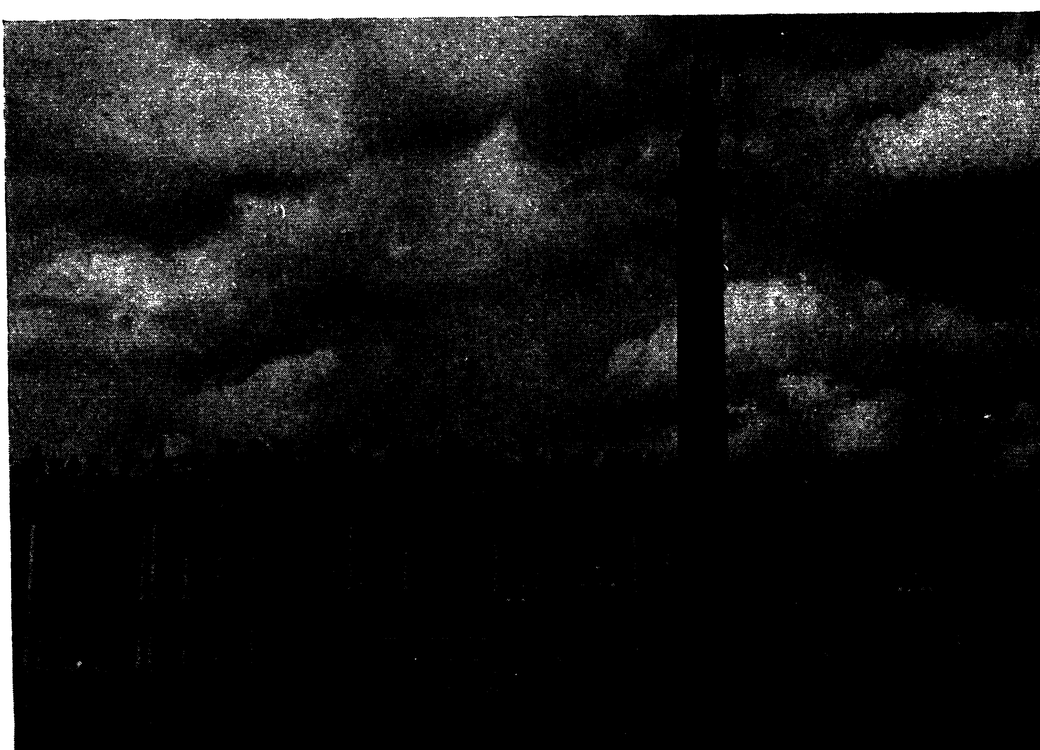
Towns and districts.—But when everything possible has been said of the charms of the Russian forests and fields, it remains true that the chief interest in northern and central Russia lies in the towns: Moscow, Léningrad, Kíev, Khárkov and others. Moscow became an important place about the year 1200, the former centres of Russian life having been Nóvgórod—not Nízhni Nóvgórod, now renamed Gorki; but Nóvgórod, a city in the north-west of Russia—and Kíev. In 1613 a new dynasty, the Románoffs, mounted the Russian throne and in the course of some three generations, threw up a very active and ambitious ruler in the person of Peter the Great, 1689–1725. He was determined to force western modes of life on his unwilling subjects, and, Moscow being isolated from the West by many hundreds of miles and the Prypeć Marshes, already mentioned, he founded in 1703 a new capital, St. Petersburg, in the wastes of the north, an emplacement, however, whence communication with the West was relatively easy. After the October Revolution of 1917, the new Russian authorities transferred the government back to Moscow. After that, St. Petersburg, which had been renamed Pétrograd during the Great War and which, in 1924, was again renamed Léningrad in honour of Lénin, became merely a provincial town although an important one.

Moscow and Léningrad.—Moscow is an old city and typically Russian. It also contains much that is very new in consequence of the development of recent years, many American features and many that are original. Léningrad, on the other hand, gives the impression of a western city, although with some features of its own. It is a city of long vistas and wide open spaces and there is a wonderful congruity in the appearance of the public buildings, nearly all of which were constructed in little over a century. The chief architect of the first period under Peter I (1689–1725) was Tresini, who used the baroque style. From this period date the Fortress of SS. Peter and Paul and the Alexander Nevski Cathedral, both the work of Tresini. In the middle of the eighteenth century Rastrelli followed in a somewhat lighter baroque style. His work may be seen in the Winter Palace and the Smólny. Under Catherine II (1762–1796) two other groups of architects used respectively a transitional and a classical style, among the former de la Mothe, Velton and Rinaldi, and among the latter Guarenghi, Stássov and Bashénov. In the reign of Alexander I (1801–1825) Thomon, Sakhárov, Voroníkhin and Rossi created architectural landscapes, in which the buildings were regarded as parts of a great whole.

The principal sight in Moscow is the Krémlin, a vast enclosure with turreted walls and with massive towers at the corners. It overlooks the River Moskvá and may be likened to the Tower of London, although its style of architecture is, naturally, very different. It contains two cathedrals, one where the Russian emperors were crowned, the other where many of them are buried. Just outside the Krémlin is Lénin's tomb, where his body, embalmed and in appearance just as in life, may be seen. He wears a khaki uniform with the insignia of one order on his breast. Nearby is St. Basil's Cathedral, now a museum. The Trétiakoff Gallery contains modern Russian paintings. The Museum of the Revolution is worthy of a visit by those who are interested in the Russian Revolution of 1917; the abortive Revolution of 1905, in the Dekabrístii Revolt of December, 1825; or in Pugachév's Rebellion of the eighteenth century. There are many other museums with most interesting collections, for no country is so rich in museum exhibits as Russia, all the private collections of pictures and other objects having been nationalised and merged in the public collections. Surprisingly little was damaged or lost during the Revolution. Another sight, of a different kind, is the underground railway, opened only a year or two ago. The technical details, such as signalling and train operation, have been largely copied from the London Underground and the engineers of the London Underground gave their advice in these matters. The finish and decoration of the stations, however, are very different. Instead of white and coloured tiles, we see black and other marbles, granite and valuable stones from various parts of the country. Other features which will strike the tourist are the doors to all the Underground stations, necessary on account of the severe winters, and the buffet at each station, where tea, coffee and light refreshments may be obtained.

In Léningrad, which is magnificently situated on the banks of the Nevá and on islands in the mouth of that river, most visitors will first wend their way to the Hermitage Art Gallery, an enormous collection of objects and pictures, the Spanish School being particularly well represented. Adjoining it is the Winter Palace, the town residence of the former Imperial Family. Very interesting, too, is the Fortress of SS. Peter and Paul, with its clammy dungeons. The Fortress contains not only dungeons, however; it is also the resting place of most of the emperors who are not buried in the Kremlin at Moscow.

Visitors to Léningrad should on no account omit to visit the town of Pushkin, a short distance to the south. Before the Revolution this place was called Tsárskoye Selo. There are two palaces here, both very rich in their collections of articles and pictures, and one of them has a pathetic interest as having been the residence for many years of the last emperor, Nicholas II, and his family. Visitors are shown the emperor's study, the boy's nursery and the empress's bedroom, the walls of which are almost covered with



LENINGRAD—WINTER PALACE AND ALEXANDER COLUMN icons, all exactly as they were during the time they were occupied by the Imperial Family. Other palaces in the neighbourhood are Slutzk (formerly Pavlovsk), Peterhof and Krasnogvardeisk (formerly Gátchina). Peterhof has fountains almost as famous as those of Versailles and Gátchina was long the residence of the Emperor Alexander III.

In early summer the visitor to Léningrad will experience the joy of the light nights, when the buildings, gardens and the Nevá are bathed in the light of the (almost) midnight sun. On June 21 the sun sets at Léningrad at 9.22 p.m. and rises at 2.43 the next morning. Between these times a glorious white light prevails.

Kíev.—After Moscow and Léningrad, Kíev is certainly the most interesting city in Russia. The antiquarian will probably esteem it above either. The city dates from the ninth century and contains many old buildings. The Cathedral of St. Sophia was built by the Grand Prince Yaroslåv in 1037–49. It has fifteen domes. Many priceless mosaics and frescoes cover its walls. The former Kíevo-Pechérskaya Monastery, now a museum, has catacombs and underground vaults. Kíev is now the capital of the Ukráínian Soviet Socialist Republic and it is the centre of Ukráínian culture and art. Khárkov is of little interest from the point of view of history, being a great modern city. It is the industrial centre of the Ukráíne with large factories and industrial buildings. It may well be omitted from the tour of those whose interest is in the past, but the student of the latest developments of the Soviet Government may profitably spend some days here.

At this point the reader should, perhaps, be warned against the famous trip on the Vólga. With remembrance of the *Vólga Boatmen's Song*, this trip exercises a fascination on most travellers who have not undertaken it, but it is likely to prove disappointing. To a native of Moscow or Léningrad who has probably never seen a mountain in his life, the hills along the Vólga doubtless seem very high, but to anyone who has gone down the Rhine or even the Thames or the Seine, there is little of interest except the habits and customs of the local inhabitants, and these, in the opinion of the writer, do not justify the time and expense involved.

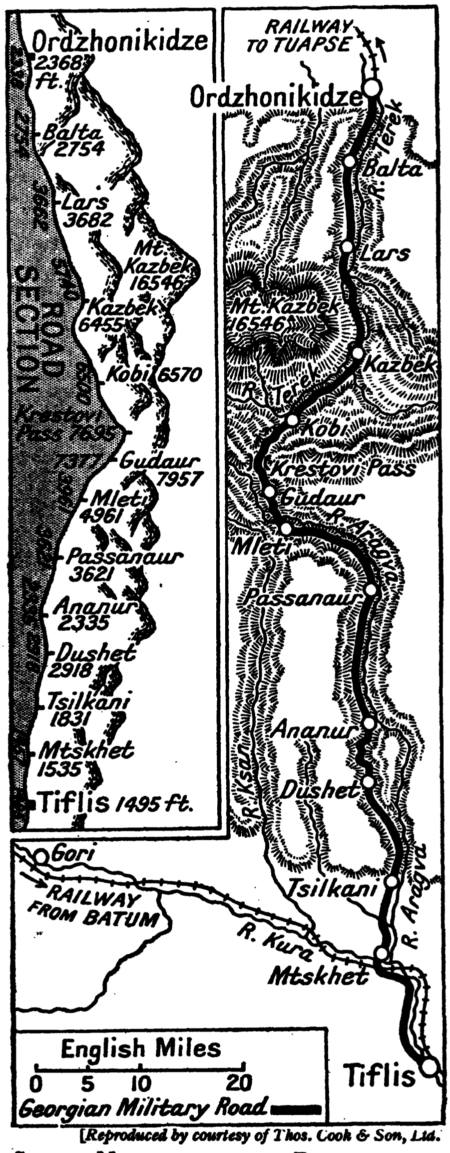
Odéssa.—Much more interesting than the Vólga are the Crimea and the Caucasus, but before passing on to these somewhat distant regions a few words must be said of Odéssa, the chief seaport of the Ukráínian Soviet Socialist Republic. The city is well designed and has a peculiar feature in a great white stone stairway rising from the sea to the upper parts of the town. It possesses medicinal mud baths, much frequented by citizens from all parts of the country, but it is not of great interest and it may in most cases be omitted from the itinerary of the tourist unless his journeyings take him that way; for instance, if he is coming to Russia from Istanbul (Constantinople) or is going to Istanbul on his exit from the country he will most conveniently travel via Odéssa and may then spend one or two days in the city. Russian (Sovtorgflot), French (Messageries Maritimes) and Italian (Lloyd Triestino) steamers connect Odéssa with Istanbul.

The Crimea.—The Crimea has an interest all its own for English tourists on account of its having been the seat of the Crimean War—called by the Russians "The Sevastópol War"—of the fifties of the last century. Near Yálta is the battlefield of Balaklåva, scene of the charge of the Light Brigade, and at Sevastópol (not Sebastopol) is a panorama of the storming of the city by the British and French on June 6, 1855. Those specially interested in the Crimean War will also visit the Malákoff Hill in the neighbourhood of Sevastópol. Its capture decided the fate of the city and thus led to the end of the war. Three miles from the city is Chersonese, founded by Greek colonists in the sixth century B.C. At Bakhchissarái are mosques and other buildings of the Tartar Khans containing old costumes, armour and jewels. Yálta is a well-planned seaside resort and nearby is Livádia, a former palace of the tsars of Russia.

The Caucasus.—The Caucasus Mountains, lying both in Europe and Asia, are unsurpassed anywhere for scenery and contain a great mixture of peoples, languages and customs. The chief towns are Tbilisí (formerly Tiflis), the capital of the Georgian Soviet Socialist Republic; Bakú, of little interest to the tourist; Batúmi, a fine city on the Black Sea; Eriváni, the chief town of Soviet Armenia within sight of Mount Ararat, Sóchi and Ordzhónikídze. The visitor to the Caucasus should on no account omit the journey over the Georgian Military Road from Ordzhónikídze to Tbilisí. This journey is a day's drive in a comfortable car (125 miles) along roaring torrents and past villages perched on the mountain side, through the passes of Terék and Arágva, with views of Mount Kazbék (16,000 ft.). The tourist from Moscow or other northern city visiting both the Caucasus and the Crimea will do well to travel by train to Ordzhónikídze, thence over the Georgian Military Road to Tbilisí, and so to Batúmi, whence steamer may be taken for Yáltá in the Crimea. A side trip from Tbilisí to Eriváni and back may be included by those who wish to see Armenian life. If the traveller is not continuing to the Crimea he may return to Moscow, Khárkov or Kíev by train from Batúmi or Tbilisí, via Bakú. In this way he goes all round the Caucasus Mountains, but there is no railway line through them.

In the Caucasus District—A Garden on the Black Sea Coast

Turkestan.—A land of the future for the ordinary tourist is Turkestan, for the usual Soviet tourist visa is not valid for Turkestan, the authorities considering that this part of the country is not yet sufficiently developed for tourist traffic. In extremely rare cases a special visa for Turkestan is granted on personal application, *after the traveller has arrived in Moscow*. Thus the wonders of Bokhára and Samarkánd cannot at present be explored by the tourist and the author refrains from comment on them.



[*Reproduced by courtesy of Thos. Cook & Son, Ltd.*

SKETCH MAP SHOWING THE ROUTE OF THE GEORGIAN MILITARY ROAD FROM ORDZHONIKIDZE TO TBILISI (TIFLIS)

For those specially interested, the best account the writer knows is that contained in *All the Russias* by Sir Henry Norman, published in 1902.

In all the cities of Russia, but particularly in Moscow and Léningrad, the tourist will find it worth while to visit the theatre. The Russian theatres are world famous and even if he does not understand Russian he will enjoy the wonderful acting and scenery. Specially worthy of note is the annual Soviet Theatre Festival in Moscow in the first half of September. Evening dress is not worn in Russia except at diplomatic receptions.

Journeys across Russia.—This article may be consulted by those travelling through Russia to the Far East or to Iran, and a few words for such transit passengers may not be out of place. The journey from London to the Far East is by any of the usual routes to Berlin, thence via Neu Bentschen/Zbąszyń (German-Polish frontier), Warsaw, Stołpce/Negoréloje (Polish-Soviet frontier), Moscow, Daníłov, Bui, Svérdlovsk, Írkutsk, Manchouli (Soviet-Manchoukuo frontier), Harbin to Mukden. From this point three routes diverge: one via Fusan and Shimonoseki to Japan, another via Dairen and steamer to Shanghai, and a third via Tientsin to Pekin and North China in general. The Polish-Soviet frontier is reached in some forty-eight hours from London, and here a change of trains is made to the Russian broad gauge. Then come eight days in the Russian train and after that changes at Manchouli and Harbin. This point is reached in eleven days from London and two or three more days bring the traveller to his destination. The old route via Vladivostóck is now inconvenient and takes much longer than via Harbin, Mukden. By arrangement beforehand, a break of journey may be made in Moscow. There are two express trains per week over the Trans-Siberian line, and one of these is specially equipped for the non-Russian traveller. Any reputable tourist agency will give further particulars. Passengers bound for Iran follow the same route as far as Warsaw; thence they proceed via Zdołbunów, Mohyłany/Shepetóvka (Polish-Soviet frontier), Kíev, Khárkov, Rostóv-on-Don to Bakú, whence there are steamers twice a week across the Caspian Sea to Pahlevi in Iran, and a day's further journey by road will bring them to Teheran. By this route, Teheran is reached in some eight days from London. A less convenient route is to continue from Bakú, via Tbilisí, to Júlfa, thence by motor car into Iran, but if the destination be Tabriz or anywhere in its neighbourhood, the Júlfa route will bring the traveller more quickly to his journey's end, the train journey from Júlfa to Tabriz taking seven hours.

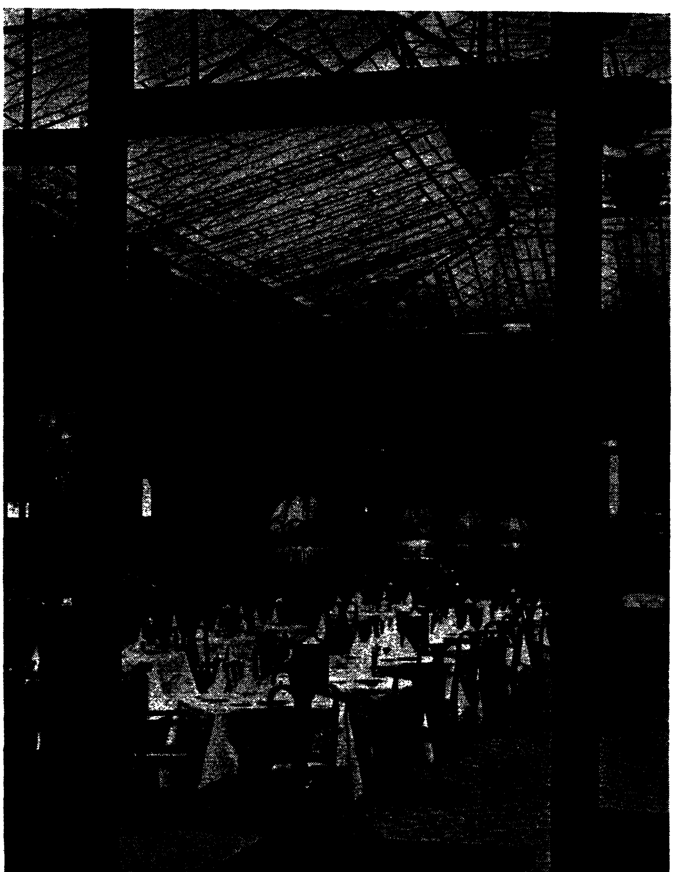
Differences between Russian and western life.—At the beginning of this section it was stated that Russia is essentially different from other countries. Now just one or two of the ways in which life in Russia differs from that of western countries will be mentioned. There are many others and the traveller will find it interesting to note them for himself.

Railways.—First of all, the gauge of the Russian railways is wider than that of most countries, being 5 ft. ½ in. instead of 4 ft. 8½ in. It is true that the railways of Finland and Estonia are of the same gauge as the Russian and that the east to west lines in Latvia are also of the Russian gauge, but with these exceptions Russia has a monopoly of these broad gauge lines in Europe, although at the other end of Europe Spain and Portugal also have a broad gauge, 5½ ft. The extra width of the carriages adds greatly to their comfort, although outwardly they have an ungainly appearance, the windows seeming to be disproportionately small to the size of the carriages. In the winter, as a protection against cold, additional inner windows are fitted to the carriages, as they are to houses, hotels and other buildings.

Another feature of railway travelling which will strike the tourist will be the provision of a boiler for hot water on every station platform, to which, when the train stops, many of the Russian passengers rush with vessels to obtain water for making tea. The tea, needless to say, is not drunk with milk but with a slice of lemon, and it is usually served or taken in glasses, not in cups.

To avoid confusion of mind and intention, it is important that the tourist rightly understand the incidence of classes on the Russian railways, for these also are different from ours. The English newspapers and magazines seem to be under the impression that there are two classes, "soft" and "hard," but the situation is much more complicated; there are four and, moreover, except on short distance trains and certain very slow trains which the foreign traveller is not likely to use, every passenger is provided with a sleeping berth at night, even in the lowest class. The sleeping berth fee is compulsory and the berth must be reserved in advance, otherwise, unless there happen to be berths vacant, which is not likely, the passenger will be excluded from the train. To come now to the classes: they are in diminishing order, from the highest to the lowest—Sleeping Car of Direct Communication 1st Category; Sleeping Car of Direct Communication 2nd Category; Soft Class; Hard Class. Sleeping Cars of Direct Communication 1st Category consist of two-berthed compartments with private toilet, either in the compartment or in an adjoining compartment. Sleeping Cars of Direct Communication 2nd Category are sometimes two-berthed, sometimes four-berthed, with private toilet arrangement. To obtain exclusive use of a compartment, extra payment is necessary. Soft Class compartments are nearly all four-berthed, although a few two-berthed compartments exist. Hard Class compartments on the principal lines are also four-berthed, but on inferior services, not likely to be used by foreign tourists; there may be six or more berths. The berths in the Soft Class compartments are little inferior as regards comfort to the Sleeping Cars of Direct Communication 2nd Category and they are considerably cheaper. The Hard Class is *hard* during the day only, being then similar (wooden seats) to third class on most Continental lines; at night a proper mattress and bed linen are provided. In all classes the carriages are comfortably heated in winter, and summer and winter the bed linen may be counted on to be spotlessly clean. Not all classes run on all trains. On some trains the Sleeping Cars of Direct Communication (both 1st and 2nd Category) are lacking, and on trains in remote parts of the country only Hard Class is provided. The larger tourist agencies have information as to the classes provided on particular trains, full information being shown in the official Russian time-table in the Russian language.

Water taps.—In hotel bedrooms and elsewhere there is frequently no plug for the wash basin and, even if there is, the water taps will be found to be of a different type from those in use at home. The underlying idea is that the person using the wash basin will wash directly under the running water, and with this in view the water supply is placed higher than with us. Furthermore, although there are two taps, hot and cold, the water they control converges into one outlet over the basin, and this exit turns in a vertical plane on a swivel in such a way as to provide either a spray through a rose or a stream of water through a narrow pipe. In addition, the whole arrangement usually moves in a horizontal plane to enable the user to direct the spray or stream of water to any part of the basin, and, when moved to either side, the volume of water delivered is diminished. It follows that, by regulating the taps, the user can obtain either all cold or all hot water, or a mixture of the two; that by the taps he can regulate the volume of water, and by moving the apparatus to one side or the other he can also control the volume of the water and have it at his choice, either in a spray or a steady stream. It sounds very complicated but is quite easy in use.



Leningrad Restaurant of Astoria Hotel

Food and drinks.—Arrived in the dining-room of his hotel, the tourist will find served with the soup—probably a soup the foreign visitor has not tasted before, but very savoury and nourishing—not a piece of bread or a roll, but small meat pies, remarkably good. The rest of the meal will probably not differ greatly from meals obtainable in hotels anywhere in the world, except that the fish and the game, if served, are likely to be of types not familiar. Russian cooking is usually good and the food well served, although, as mentioned later, the service is slow. Drinks obtainable are beer of a light variety, Russian wines of most of the types familiar in western Europe, and Russian natural mineral waters. Of the latter, the best is Narzán. It is prudent to avoid unboiled tap water. Coffee usually leaves something to be desired, for Russia is a tea-drinking country. One soon gets used to lemon in place of milk or cream with the tea. Vódka should be taken in moderation, if at all, and only at the same time as food. It is served in small glasses and the proper way is to toss it down the throat at one gulp. The pleasure of vódka drinking is alleged to be in the sensation it produces; there is certainly no pleasure to be derived from its taste, hence the reason for tossing it down the throat. It is doubtful whether non-Russians ever really enjoy it.

Forms of address.—The Russian alphabet is very different from ours, being derived from the Greek, as are the Bulgarian and Serbian alphabets. The Russians have no words corresponding to Mr., Mrs. and Miss, the words formerly used in this connection having completely passed into disuse. To one another, Russians say "Továrishtch"—"Comrade." For strangers, the words are theoretically "Grazdanín" (to a man), "Grazhdánka" (to a woman), but they are little used in practice. Both words mean "Citizen," and recall the usage of French Revolutionary times. In intimacy, however, Russians say, for example, "Martín Ivánovitch"—Martin son of John, or "Ólga Ivánova"—Olga daughter of John. Another peculiarity for which the traveller and the reader of Russian literature must be prepared is that the surname changes slightly according to sex; thus, we will suppose that the surname of Martín Ivánovitch is Stolýpin, and that he has a wife, Lydia, whose father's Christian name was Alexander, and a son Michaíl and a daughter Ólga. The full names will then be as follows:—*Husband*: Martín Ivánovitch Stolýpin; *wife*: Lýdia Alexándrovna Stolýpina (note the feminine termination "a"); *son*: Michaíl Martínovitch Stolýpin; *daughter*: Ólga Martínovna Stolýpina (again the feminine termination). The modern Russians have not introduced these habits; they existed in the old Russia—except that in the former time there were words for Mr., Mrs. and Miss.

Arranging a tour.—After what has been said, it will not surprise the reader to learn that the method of planning and booking a tour in Russia is different in important particulars from arranging one elsewhere, but it should be emphasised that it is only different, not more difficult. In fact, there is no country where the tourist may travel with less difficulty for himself than Russia. It is very important, however, that the intending visitor place himself in the hands of a reliable tourist agency, for not otherwise will he enter the land of the Soviets.

Visa.—There are two essential conditions to fulfil. An inclusive tour, that is, including hotel accommodation and sightseeing, must be booked for the whole period of the stay in Russia, and a tourist visa must be applied for, the latter not being granted except to persons booking for, or undertaking to book for, an inclusive tour. It is not necessary to decide on the itinerary or length of the tour at the time of application for the visa; this can be settled later, but the visa, even if authorised, will not be stamped in the passport unless an inclusive tour be booked. Visa application forms are obtainable from tourist agencies and the visa application should be submitted to the tourist agency chosen at the earliest possible moment, as from twenty to thirty days' notice is necessary, the application having to be sent by the tourist agency to Moscow for approval. With the forms, photographs must be supplied. The writer refrains from mentioning any number, as this varies from time to time, as does the number of forms to be filled up. The tourist agency will advise on this point. However, in addition to the number of photographs submitted with the application, the traveller should provide himself with three photographs for registration purposes while in Russia. If he fails to do this the consequences will not be serious but he will have the inconvenience and expense of having further photographs taken while on his tour. When the visa is authorised, the tourist agency will be advised by the authorities in Moscow by telegram at their expense. The visa may then be obtained from the Soviet Consulate-General and there will be no obstacle to the issue of tickets for the tour; the traveller may depart the same day for Russia, subject to train or steamer accommodation being obtainable. Once more, the traveller should be advised to apply early for the visa, as otherwise when his tour is planned and he is ready to start he will be waiting for his visa.

Choosing the tour.—Either before or after the visa is authorised, the tourist must decide on the tour he will make, the routes by which he will travel to and from Russia, and the class of travel and grade of hotel accommodation. In an earlier part of this section the four classes of rail travel have been described, and the reader should now be informed that, as a tourist, he will not in ordinary circumstances be able to travel in Sleeping Cars of Direct Communication 2nd Category. It is only passengers travelling on business (see Appendix) and those making transit journeys through Russia to or from the Far East or Iran who have the option of choosing this class of travel. Three classes are available for the tourist in Russia; first class, tourist class and third class, the respective arrangements being as follows:

1. *First class.*—Railway travel is in Sleeping Cars of Direct Communication 1st Category except on some of the less important lines where these cars are not run, and it is then in Soft Class. Hotel accommodation is in the best available rooms with private bathrooms wherever possible. Sightseeing is carried out in modern open or closed motor-cars.

2. *Tourist class.*—Railway travel is in Soft Class. Good hotels are used. Sightseeing is in saloon motor-buses. Tourist class is a thoroughly satisfactory combination of comfort with economy.

3. *Third class.*—Railway travel is in Hard Class. The hotels are thoroughly clean and comfortable. The meals are simple but ample and well varied. Sightseeing is in saloon motor-buses.

Now, with regard to the cost, the tour must be so arranged as to start at one of the large cities as, for example, Léningrad or Moscow, and to terminate at the same city or another one, for example, Khárkov or Kíev. Your tourist agency will provide you with coupons from the chosen starting point to the chosen finishing point covering travel for the route specified in the itinerary with reserved sleeping-berths for all night journeys and the necessary meals *en route*—in restaurant-cars where running, otherwise packed and supplied at the hotel on departure; hotel accommodation and meals at each place visited, three meals daily in the tourist and third classes, four meals daily (including afternoon tea) in the first class; conveyance between stations or steamers and hotels and *vice versa* on arrival and departure at each place visited; conveyance, including porterage of baggage up to 32 kilograms per person; and one sightseeing excursion, about three hours—each morning in each place visited, including conveyance, services of guide-interpreters and admission fees to places visited.

Fares and routes.—The fares for these arrangements from April 16th to October 15th are approximately £3 per day first class, £1 15*s.* 0*d.* per day tourist class, and £1 per day third class. During the winter months the fares are reduced by 20 per cent.

In addition to coupons for the actual tour, you will require tickets and, probably, sleeping car tickets for the journeys from

England to the starting point of the tour and from the terminating point back to London. The following tables give the approximate fares in force from and to London at the time of writing (1937), and it should be noted that the fares in the first column include the compulsory sleeping berth supplements on the Russian Railways.

FARES (SINGLE)

	1st Class (a) £	s.	d.	2nd Class (b) £	s.	d.	3rd Class (c) £	s.	d.
London— Moscow via Dover–Calais	13	10	0	9	15	0	6	15	0[1]
Moscow via Dover–Ostend	12	15	0	9	5	0	6	5	0
Moscow via Harwich–Hook of Holland	13	5	0	9	15	0	7	10	0[1]
Léningrad via Dover–Ostend	10	10	0	8	0	0	5	10	0[2]
Léningrad via Harwich–Hook of Holland	11	0	0[1],	8	15	0	6	15	0[2]
Kíev via Dover–Calais	11	15	0[2]	8	5	0	5	15	0
Kíev via Harwich–Flushing	11	5	0	8	5	0	5	10	0

(*a*) Sleeping Car of Direct Communication 1st Category on Russian Railways.
(*b*) Soft Class on Russian Railways.
(*c*) Hard Class on Russian Railways.

SLEEPING-CAR SUPPLEMENTS

(Sleeping-car accommodation is not available in 3rd class.)

	1st Class £	s.	d.	2nd Class £	s.	d.
Calais—Berlin	4	16	0	3	12	0
Warsaw	6	16	0	5	6	0
Negoréloje	8	6	0	6	14	0
Flushing—Berlin	2	5	0	1	6	0
Berlin—Warsaw	2	14	0	1	19	0
Negoréloje	4	4	0	3	7	0
Tilsit (for Riga)	2	12	0	1	3	0
Riga—Ostrov (Ritupe)	—				3	6
Warsaw—Zdołbunów (for Shepetóvka)	2	7	0	1	7	0

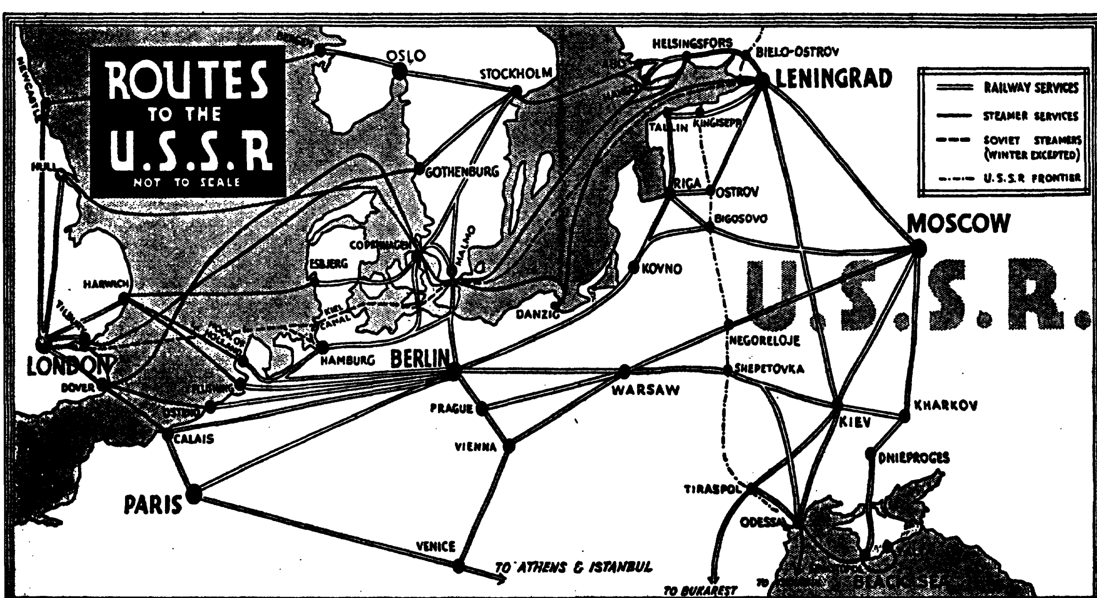
Fares by other routes, as, for example, through Denmark, Sweden and Finland, will be quoted by any tourist agency, as will fares by air lines. These are not given here as they vary considerably from year to year.

From London to Léningrad the most convenient route is via Berlin, Tilsit, Riga, Ritupe/Óstrov (Latvian-Soviet frontier). To Moscow, the most direct route is Berlin, Warsaw, Stołpce/Negoréloje (Polish-Soviet frontier), Smolénsk. To Kíev, the route is Berlin, Warsaw, Zdołbunów, Mohyłany/Shepetóvka (Polish-Soviet frontier). The time necessary to reach any one of these cities is approximately two and a half days, but in the case of Moscow this may be somewhat reduced by taking the luxurious Nord Express via Dover, Calais, Brussels, Cologne, Berlin, Warsaw, Stołpce/Negoréloje. This is, naturally, more expensive than the other routes. In consequence of the different gauge on Russian railways, already mentioned, a change of train has to be made at the Russian frontier, except in the case of the Riga route, on which the change of gauge and of train is made at Riga itself.

[1] 2nd class London—Hook of Holland, and Dover, Calais.
[2] 2nd class Riga—Leningrad (no 1st on train).

During the summer, air travel is usually available from London to Moscow. During the summer of 1937 the most convenient air route was via Stockholm, and it is expected that similar arrangements will be in force in 1938 and later years. Passengers left London at 7.30 and arrived at Stockholm at 15.30. After spending the night there, they departed at 9.00 the following morning and arrived at Moscow at 18.00. In the reverse direction, passengers left Moscow at 7.00 and, after a change in Stockholm, arrived in London at 21.55 the same night. There was no through air connection to or from Léningrad; passengers could fly from London via Stockholm to Helsingfors, but from that point had to travel by train via Rajajoki/Biélo-Óstrov (Finnish-Soviet frontier) to Léningrad. Between London and Kíev it was possible to travel in the course of one day via Prague, with a change of 'plane in that city.

There is one other way of travelling to and from Russia; by steamer. From April to November, or as long as the port of Léningrad is free from ice, steamers of the Russian Sovtorgflot Line leave London, usually on Saturdays, and sometimes additionally on Wednesdays, via the Kiel Canal, for Léningrad, where they arrive five days later. This way of travelling has the advantage, for those who desire it, that the passenger is in a Russian atmosphere from the moment of stepping on board and thus has a short period of initiation into the ways of Russian life. The master, crew and stewards are all Russians, and the food is Russian and is served in the Russian way. The steamers are very comfortable and are of approximately 4,000 tons. Three classes are provided, corresponding to the Russian tour classes; namely: first, tourist and third. Information regarding other steamer services between England and Russia arranged from time to time can be obtained from the principal tourist agencies. Convenient homeward sailings are also provided. For tourists taking the steamer route, inclusive fares from London back to London are in operation, and these range from approximately £38 first class, £27 tourist class, £16 third class, for a two weeks' tour giving three or four days in Léningrad to approximately £129 first class, £81 tourist class, £48 third class,



for a six weeks' tour (from London back to London) covering Léningrad, Moscow, Rostóv, Ordzhónikídze, the Georgian Military Road, Tbilisí, Eriváni, Batúmi, the Black Sea Coast, Yálta, Sevastópol, Khárkov, Kíev. Many variations of the internal routes in Russia are possible between these prices. Moreover, with adjustments in the fares, the tourist may travel first class on the ships and tourist class in Russia, or third class on the ships and tourist class in Russia. Furthermore, with adjustment of fare, travel outward by sea, homeward overland or *vice versa* may be arranged. Any large tourist agency will quote fares.

Arrival.—On arriving in Russia, by railway, air or sea, the tourist will be met by a representative of the Russian State Tourist Company Intourist, for this company is the agent of all reputable tourist agencies outside Russia, as they are of it in non-Russian lands. From that moment until he leaves the country, his every reasonable want will be attended to by Intourist. As we have already seen, travel and practically everything else is included in the fare the tourist will have paid to his agency, and that agency will have advised Intourist of his requirements so that he will find everything already prepared, including sightseeing of some three hours each day. Visits to schools and factories may be included in the three hours' sightseeing by arrangement with Intourist. If the tourist requires further sightseeing he may arrange this on extra payment at the local Intourist office. Thus, the traveller will have daily some twenty-one hours out of the twenty-four at his own disposal in which, if he is so minded, he may go to see all those things which, it is alleged, the Russians do not want him to see. Provided he does not stray into military or naval establishments, enter factories without permission, or invade the homes of private citizens, he will not, judging by the experience of the writer, come to any harm thereby. It should be obvious to anyone that it is not possible to camouflage the daily life of great cities such as Léningrad and Moscow before the eyes of thousands of tourists, and it is surprising that such a silly *canard* should ever have gained credence.

Hotels and meals.—One piece of advice is, perhaps, desirable. Except in remote parts of the country, the traveller is not likely to find the comforts or amenities of life inferior to those of western Europe, but in one respect the Russian hotels leave something to be desired. As already mentioned, the service is slow, and a tourist taking breakfast with sightseeing to follow will be well advised to allow twice as long for his eating as he would in any other country, as otherwise he will probably have to cut his meal short in order to join the sightseeing drive. The three principal meals are called respectively breakfast, dinner (midday) and supper. Breakfast may be taken until about 10 a.m., and is quite substantial; not quite as heavy as the traditional English breakfast but much more of a meal than the Continental *café complet.* The midday dinner is usually taken rather late, at about 2 p.m., after the sightseeing. It is a most ample meal, more generous than the *table d'hôte* lunch at an average tourist hotel outside Russia. Tourists usually quickly fall into the Russian habit of taking supper late. It is available from about 8 p.m. until the early hours of the morning, and a very pleasant way of spending the evening is first to visit the opera or theatre and to take supper afterwards. The restaurants of the large hotels are at their liveliest about midnight. First class tourists are also served with afternoon tea without extra charge, and tourist and third class may have it on extra payment in the hotel, restaurant or café. Gratuities are forbidden, but nevertheless are customary on a modest scale.

Money.—As the writer has already stated, all the normal requirements of the tourist will have been covered by the fare he has paid to his tourist agency. Nevertheless, he will need some money for buying souvenirs, postcards, postage stamps, wines and spirits, mineral waters, theatre tickets or, perhaps, additional sightseeing. These needs will depend on his inclinations and the size of his purse. He must, on no account, buy Russian currency—roubles—until after his arrival in the country, as the import and export of Russian currency is illegal and, if found on a traveller at the frontier, it is confiscated on entry or placed to his credit in a Russian bank if he tries to take it out. At every entry point from abroad, stations, airports and steamer quays; also in hotels and Intourist offices, money-changing counters are provided and it is at these places that the tourist should exchange his foreign money for Russian. Only sufficient for day to day requirements should be changed on each occasion, as once converted into roubles the money cannot be changed back into foreign currency. Traveller's cheques are convenient for those carrying large amounts; they are readily accepted at all Intourist offices. On entering the country, the traveller must declare all the money he possesses, in whatever currency, also traveller's cheques and valuable articles such as watches, cameras, opera glasses, typewriters and jewellery to the frontier officers. He will receive a certificate and, on presenting this on his exit from Russia, he will be permitted to take the same articles out as well as the money and traveller's cheques, or any lesser amount remaining over from his expenditure in the country.

Clothing.—An important question is that of clothing. For the traveller to Russia in the summer, clothes similar to those he would wear in England at the same season are suitable. It must be mentioned, however, that the climate of Léningrad is treacherous. It is often raw, damp and very unsettled. Snow often falls as late as May, and even the second half of August may be raw and inclement. Curiously, in September and early October it is often warmer and more settled than in late August. At any time, however, a cold wind may suddenly spring up and the tourist should provide himself with an overcoat or wrap for protection against these changes in climate. It is only in Leningrad and its neighbourhood that such provision is necessary in summer. In the extreme south, except on the mountains, the weather is mild even in the winter. The traveller to northern or central Russia in the winter will probably decide to go to the outfitter and buy the thickest underclothing he can find. He should do no such thing. In winter, all the hotels, shops, theatres, offices and other interiors are provided with double windows and doors, and with efficient heating apparatus. A tourist with warm underclothing will be very uncomfortable. On the other hand, very warm *outer* clothing, overcoats or wraps, should be taken to put on when going from the warm interiors into the cold air outside. The hands must be covered by warm gloves, and some means should be taken to cover the ears against frostbite. Another necessity in winter is a pair of goloshes. These should be purchased on arrival in Russia, or in some neighbouring country such as Poland or Latvia, as a special kind of goloshes is manufactured in eastern Europe, with thick sides. After a little practice, it is easy to step in and out of these goloshes without touching them with the hands, and thus they have a great advantage over the kind sold in England. On entering a shop, theatre or other building, one kicks off the goloshes; a porter places them in a kind of long rack and hands them back when one leaves.

In conclusion, it may perhaps be said that the personal safety of the tourist is as well assured in Russia as in any other country.

APPENDIX

The U.S.S.R.—The following information is largely taken from the new (1937) *Constitution of the U.S.S.R.* This Constitution has been published in English by the Co-operative Publishing Society of Foreign Workers in the U.S.S.R., Ulitsa 25 Oktyábrya 7, Moscow.

As stated at the head of this chapter, the old name *Russia* has been used throughout. Nevertheless, the official and correct name of the country is, and has been since 1923, Union of Soviet Socialist Republics. The word *soviet* means council, and is taken from the councils governing the country, ranging from the small village councils dealing with rural affairs to the great councils of the nation.

The Union of Soviet Socialist Republics is a federated state, formed on the basis of the voluntary association of the following Republics possessing equal rights:

The Russian Soviet Federative Socialist Republic
The Ukrainian Soviet Socialist Republic
The Byelorussian Soviet Socialist Republic
The Azerbaidjan Soviet Socialist Republic
The Georgian Soviet Socialist Republic
The Armenian Soviet Socialist Republic
The Turkmen Soviet Socialist Republic
The Uzbek Soviet Socialist Republic
The Tadjik Soviet Socialist Republic
The Kazakh Soviet Socialist Republic
The Kirghiz Soviet Socialist Republic.

The Russian Soviet Federative Socialist Republic is the largest constituent republic, extending from Smolensk, across the central and northern parts of European and Asiatic Russia, to the Manchoukuo border and Vladivostóck.

The Ukrainian Soviet Socialist Republic occupies the south from Chernígov and Khárkov southward, except the Crimean Peninsula which, however, is federated with it.

The Byelorussian Soviet Socialist Republic is situated between the Polish frontier and the Russian Soviet Federative Socialist Republic.

The Azerbaidjan Soviet Socialist Republic is a small republic on the western shore of the Caspian Sea.

The Georgian Soviet Socialist Republic is in the Caucasus, on the south-east coast of the Black Sea.

The Armenian Soviet Socialist Republic is a small republic on the Turkish border between the Black and the Caspian Seas.

The Turkmen Soviet Socialist Republic extends along the Afghan and Iranian frontiers from a line somewhat to the westward of Bokhara and Termez to the Caspian Sea.

The Uzbek Soviet Socialist Republic is on the eastern border of the Turkmen Soviet Socialist Republic.

The Tadjik Soviet Socialist Republic is a small republic in Central Asia.

The Kazakh Soviet Socialist Republic is a very large republic, extending from the north-eastern shore of the Caspian Sea across Siberia as far as Mongolia, which lies to the south-east of it.

The Kirghiz Soviet Socialist Republic is a small republic south of the Kazakh Soviet Socialist Republic.

Within these republics are included various autonomous regions and small republics.

The capital of the Union, as also of the Russian Soviet Federative Socialist Republic, is Moscow. The highest state authority is the Supreme Soviet of the U.S.S.R. This consists of two chambers: the Soviet of the Union and the Soviet of Nationalities. The Supreme Soviet at a joint sitting of both chambers elects its Presidium, consisting of a Chairman, eleven Vice-Chairmen, a Secretary, and twenty-four members. The Presidium is accountable to the Supreme Soviet for all its activities. The highest EXECUTIVE and ADMINISTRATIVE state authority is the Council of People's Commissars. The Council of People's Commissars is responsible to the Supreme Soviet and is accountable to it; in the intervals between sessions of the Supreme Soviet it is responsible and accountable to the Presidium of the Supreme Soviet.

The departments of the government are not called ministries, but commissariats, and the full titles are People's Commissariat for Home Affairs, People's Commissariat for Foreign Affairs, etc. The head of each department is called People's Commissar for . . . The office which corresponds most closely to that of President of the United States or the President of the French Republic (in so far as it is possible to find an equivalent) is the Chairman of the Presidium of the

Supreme Soviet. The state emblem consists of a sickle and hammer against a globe depicted in the rays of the sun and surrounded by ears of wheat with the inscription in the languages of the Union Republics: "Workers of the World, Unite!" Above the emblem is a five-pointed star. The state flag is of red cloth with the sickle and hammer depicted in gold in the upper corner near the staff and above them a five-pointed red star bordered in gold. The relation of the width to the length is 1:2.

Travel on business.—In this chapter on *Russia*, the reader who wishes to go to the U.S.S.R. for purposes of business will have found no guidance. It may be convenient here to offer this: his procedure as regards the visa will be quite different from that of the tourist bent on pleasure or study. In the first place, he must enter into negotiation with the competent State Commissariat or Trust in the U.S.S.R. (for all trade is in the hands of Government Departments or Trusts—there is no such thing as internal private manufacture or trading) or with the Russian State trading organisation in London —Trade Delegation of the U.S.S.R., 51, Hatton Garden, London, E.C.1. If the Soviet Government wishes to transact business with the applicant, either the State Department or Trust within the U.S.S.R., or the Trade Delegation in London will so inform the Russian Foreign Office (People's Commissariat for Foreign Affairs) in Moscow, and that department will then instruct the Soviet Consul General in London to grant a visa. The applicant will be advised when this has happened by the State Department with which he is in correspondence or contact. He should then decide on his date of departure and route, have the visa stamped in his passport, and go to a tourist agency, inform them of the circumstances and that his visa is authorised for trade purposes, and purchase from the tourist agency inclusive arrangement coupons (as well as the necessary travel and sleeping car tickets to and from the U.S.S.R.) for the *maximum* period he is likely to be in the U.S.S.R. The reasons for this procedure are that, notwithstanding his probably not requiring the sightseeing to which his coupons entitle him, he will find it much cheaper to provide for his hotel accommodation in this way rather than paying locally in the hotels. The *maximum* period should be covered because once in the U.S.S.R. he cannot purchase further inclusive coupons at the same relatively low rates as outside. If he does not use all the coupons he must obtain a certificate to this effect from an Intourist office in the U.S.S.R.—a special form for this purpose is included in the booklet—and, on his arrival back in England, his tourist agency will refund to him in full the value of all completely unused days of service. Portions of days are not refunded.

The Russian language.—For the study of the Russian language, the following books may be recommended:

Forbes: *First, Second, Third* and *Fourth Russian Books;* Clarendon Press, Oxford.

These books by the late Nevill Forbes, one of the greatest authorities on the Slavonic languages we have had in England, treat the subject in an unusual but effective manner.

Forbes: *Russian Grammar;* Clarendon Press, Oxford. This is a more formal and orthodox work by the same author.

Garbell and others: *Das russische Zeitwort;* Langenscheidtsche Verlagsbuchhandlung, Berlin-Schöneberg.

This is a most useful work on the Russian verb, with tables showing the imperfective aspects of the verbs in alphabetical order, with the perfective aspects under them, and full conjugations of both aspects. The aspects of the verb are one of the difficulties of the Russian language and this book will be found useful even by students with no knowledge of German.

The following are useful word and phrase books:

Marlborough's *Russian Self-Taught;*

Lyall: *A Guide to Twenty-five Languages of Europe;* Sidgwick & Jackson, Ltd.

JOHN WARD HARMSHAW.

ELECTRICITY IN THE HOME

THE ELECTRIC LIGHT

As a convenient, clean, healthy and adaptable means of illuminating a home, electric light has no equal. The ease with which lamps may be turned on or off, and the possibilities of modern two-way and three-way switches in halls, stairways and bedrooms make an electric installation particularly attractive. As the luminous material in a lamp is completely enclosed, it does not affect the nature of the atmosphere nor does it emit smoke or fumes. Through the exercise of careful choice it is possible to build up a system of lighting which will blend artistically with the scheme of interior decoration adopted for its surroundings, for much of the modern equipment now available is both effective in use and also pleasing in design. In many homes it may be claimed with justification that the electric lighting appliances are integral parts of the scheme of furnishing.

Every household system is based on the use of the *filament lamp*, as this is the only one of several methods of producing light electrically which has proved really practical for domestic purposes. The scientific aspect of electric lighting is concerned chiefly with the construction, function and characteristics of the *bulb*, as this device is the actual source of illumination. The means of operating a bulb through the agency of insulated cables, switches and holders is a subject common to all domestic appliances which are worked by electric power from the mains and has, therefore, no peculiar interest in connection with electric lighting.

The filament lamp.—In principle the electric light bulb is very simple. An extremely thin wire or *filament* made of metal which can withstand high temperatures is supported on little hooks within a glass bulb which has been evacuated or which contains an atmosphere of inert glass. A current of electricity passes through the filament and heats it so that it becomes incandescent. As there is no free oxygen in a properly made bulb, the filament does not suffer oxidation even at the high temperature which it attains during normal working, whilst the well chosen composition of the filament material and the presence of inactive gas in the bulb keep the evaporation of

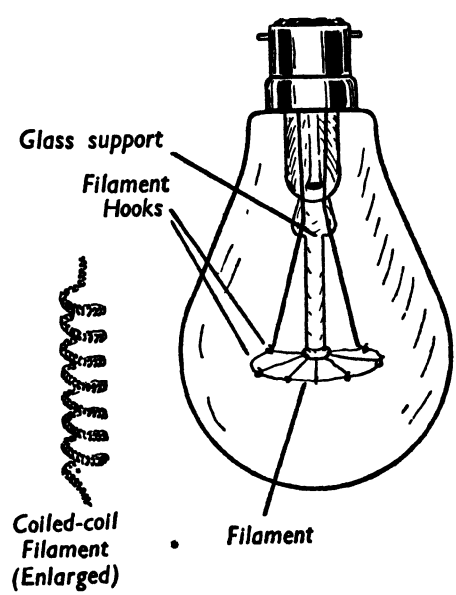
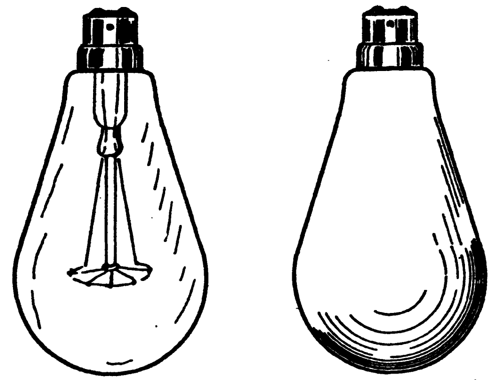


FIG. 1

metal from the hot surface down to negligible proportions. By coiling the filament wire into a close spiral, or by double coiling, the radiation of its heat is reduced to a minimum, and so the highest degree of incandescence for a given consumption of electric power is attained. Judged by other artificial means of lighting, the filament lamp is an economical and efficient device, although actually it only succeeds in transforming rather less than two per cent of its input into light, the rest being wasted as heat.

Selecting a bulb.—As many different kinds of filament bulb are now manufactured, the factors which determine the type which should be selected for a particular room need to be understood. The voltage of the bulb is decided by the electricity supply and can be found by inspecting the Electric Power Company's charts or the entries on the electricity meter information plates. In homes supplied with power from the National Grid, the voltage is standardised at 230 volts.

The power of the bulb is a matter on which to compromise. A light should be bright enough to permit working without eye strain and yet should not be so bright as to irritate by glare. The dimensions of a room, the kind of work to be carried on in it, the scheme of decoration, the type of lampshade in use and the quality of the proposed lamp all have an important bearing on the choice. As a rule, lamps with a consumption of 100 watts should be considered to be the largest size suitable for domestic purposes. A room which is so long and narrow that a single lamp of this power is ineffective, really requires *two* lower powered bulbs in separate lighting points. Reading, writing, sewing or other close work demands a good clear light with a simple white shade or else an auxiliary lamp which can be turned on and off independently of the main source. Dark decorations absorb much of the light which falls upon them—to avoid dinginess therefore, a more powerful lamp than usual is used. Deep, coloured shades and those of the bowl type give a soft, pleasing and well-distributed illumination but they waste more light than the simpler kinds. This waste implies the need for extra power at the source. A cheap lamp of a particular rating will not give so good a light as a similar one of better quality.



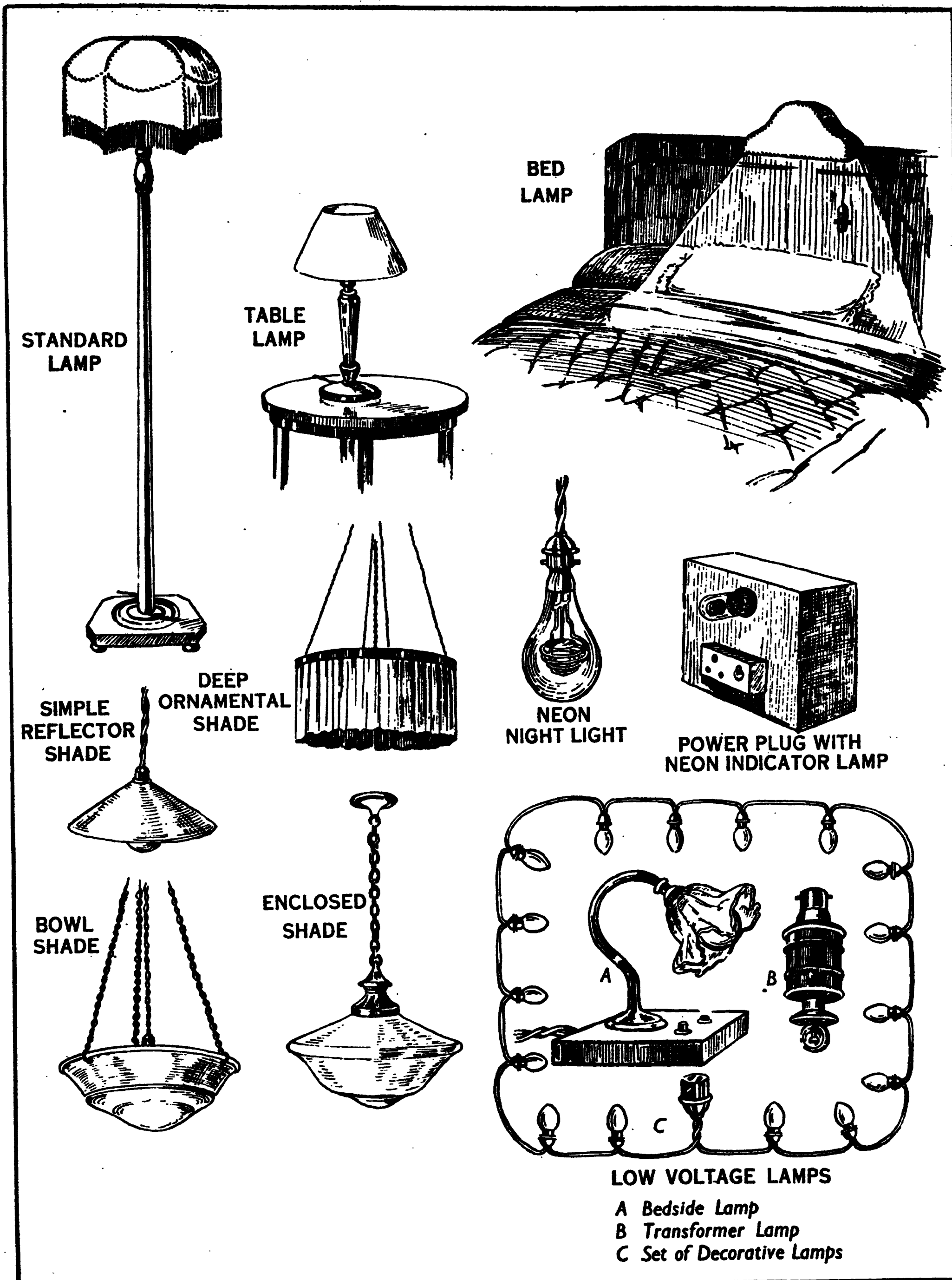
A FIG. 2 B

A. CLEAR LAMP. B. PEARL LAMP.

In rooms where the electric light is used a lot, it pays to fit a high grade bulb as the additional original cost is more than counterbalanced in the long run by the saving in power consumed. In other parts of the home where the light is used very little, a cheap bulb may be a reasonable purchase.

Electric light bulbs are made with clear or with pearl glass. Considered purely in terms of illuminating power, the clear glass bulb is the more efficient and this type should always be installed in lamps which do not shine directly into any person's eyes. For instance, clear bulbs should always be used with bowl shades. Though it absorbs some of the light which a clear glass would transmit, a pearl bulb diffuses the rays and thus mitigates to some extent the glare which is so painfully obvious with plain bulbs. It is well worth while to sacrifice a little power for the sake of eye comfort, and so in exposed lamp holders it is recommended that pearl bulbs be used.

Although some people like the yellow light characteristic of the vacuum filament lamp, the gas-filled bulb is generally preferred as it gives illumination which approximates more closely to daylight.



THE ELECTRIC LIGHT

THE ELECTRIC BELL

Power supply for bells.—A transformer, operated from the mains, is the most convenient means of working a bell system as it requires no attention whatever when once it has been properly fixed. Bell transformer

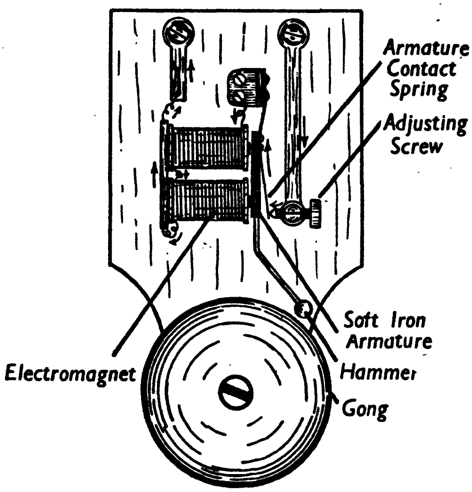


FIG. 3

running costs are negligible. Accumulators with thick plates can give very good results if charged regularly a few times each year. They need to have distilled water added occasionally to make up for loss by evaporation. In circuits which are in constant use, accumulators are more reliable than primary cells. Wet Leclanché cells are popular for bell systems because worn-out parts can be replaced independently of each other. The zinc rods in the cells are consumed, and the solution and pot units become exhausted after long use. Dry cells are often installed in a house because they are so convenient, being easy to fit, neat in appearance, quickly replaceable when run down and clean to handle. They usually prove rather more expensive to maintain than the wet cells.

How the bell works.—The common electric bell consists of an electromagnet, a spring-mounted soft iron armature, a circuit interrupter and a gong. When the switch in the bell circuit is pressed, a current passes through the electromagnet and magnetises its core. In consequence, the soft iron armature is pulled forward. This movement makes the bell hammer strike the gong, but it also causes a break in the circuit at the point where the adjusting screw bears on the armature contact spring. When the circuit is broken, the electromagnet ceases to attract the armature, so this moves back to its normal position. Contact between the screw and the armature spring immediately re-establishes the circuit, and so the armature moves forward to make a second stroke. This cycle of events repeats rapidly.

Indicators.—In a circuit with swinging indicators, for every press switch there is a simple straight electromagnet and a freely mounted pendulum to which an indicating plate is fixed. Near one pole of the electromagnet at a point on the pendulum rod a

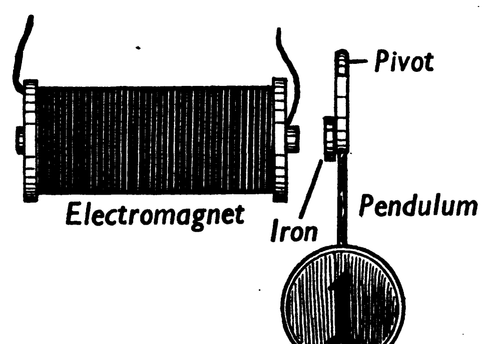
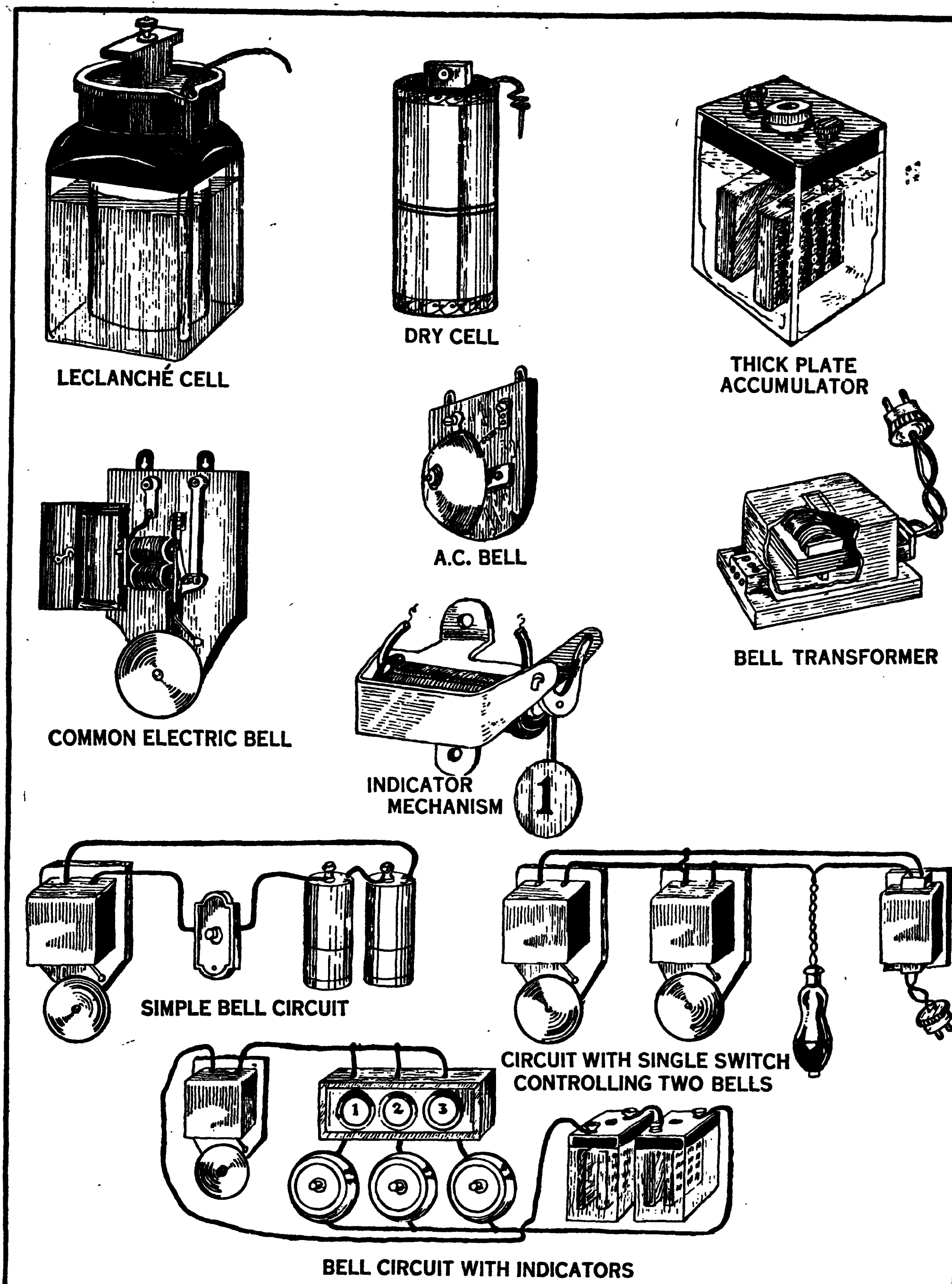


FIG. 4

small piece of iron is attached so that the energised magnet may be able to pull the pendulum to one side. When the current is cut off, the pendulum falls away from the magnet core and swings freely for quite a long time. An observer near the indicator box can judge from which press switch the bell has been rung by noticing which indicator is swinging from side to side behind its window.



THE ELECTRIC BELL

DOMESTIC ELECTRIC HEATERS

As an electric current heats every piece of material through which it flows, each wire and connecting link in an electrical appliance becomes warmer when in use. As this heating effect is uneconomical and inconvenient in many kinds of electrical apparatus, steps are taken to keep it down to a minimum by wise design and careful choice of components. Cables or links which are intended merely to convey the current with the smallest possible loss of energy are usually made of copper, as this metal offers little *resistance* to the passage of the current. The use of copper wire is not a complete safeguard against unwanted heating effects however, for a heavy current passing through a fine strand of this metal will cause it to become incandescent and then to melt. The thickness of conductors is chosen to suit the load which has to be carried. For instance, an electric fire is always wired with stouter flex than an ordinary filament lamp.

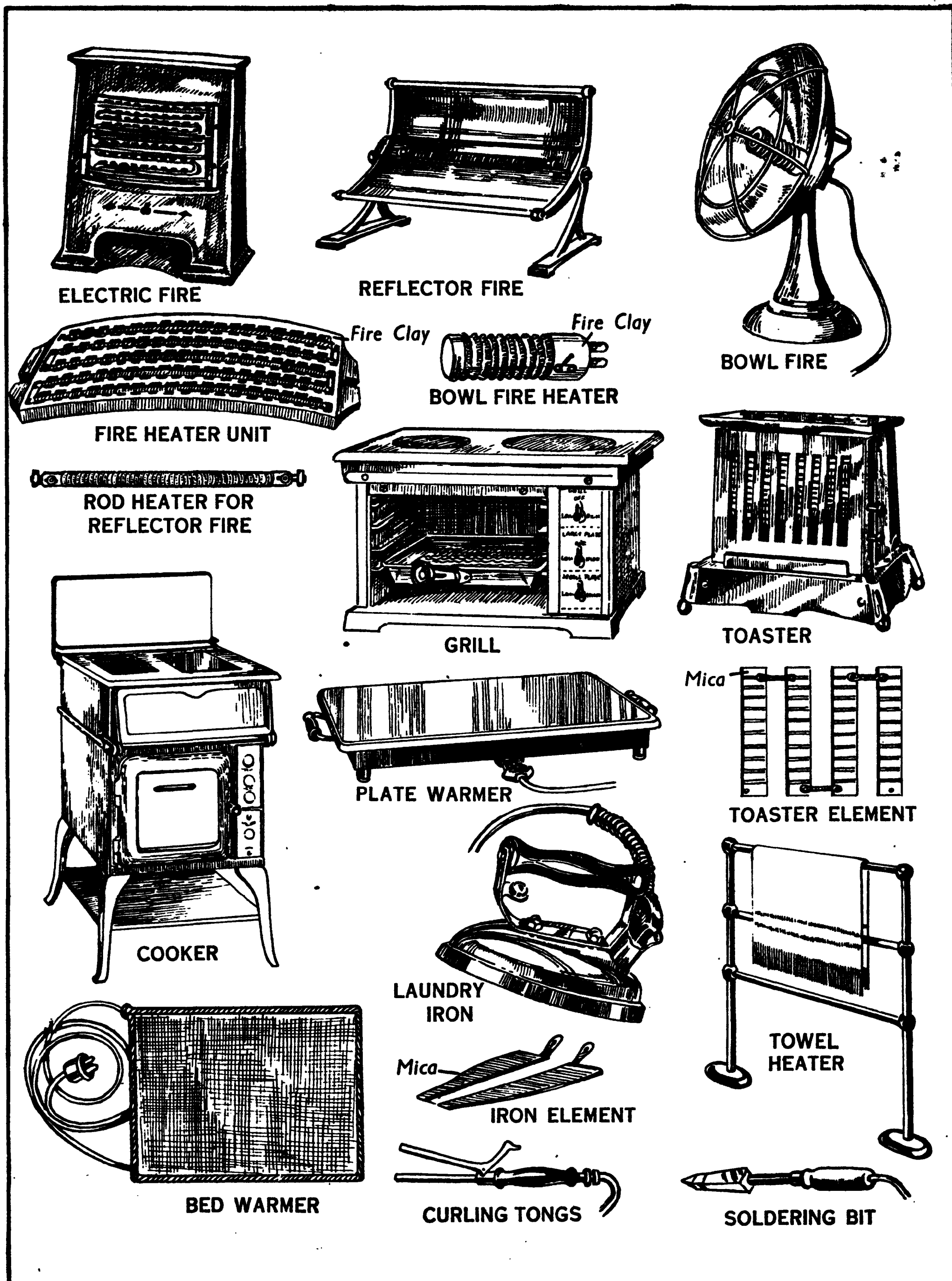
Heating elements.—Most common metals melt or oxidise when kept for long periods at the normal working temperature of an ordinary electric fire, but it has been found that an alloy of nickel and chromium can withstand a stress of this kind very well indeed. Moreover, the alloy offers greater resistance to the passage of electricity than does copper or brass, and so there is no need to make heating coils from fragile wire of very thin gauge. The shape and arrangement of nickel-chromium heating elements vary according to the design and purpose of the apparatus, but their function in every case is to become hot under the influence of the electric current flowing through them.

Insulation.—It is obvious that such common insulating materials as rubber, cotton, wax, silk and paper cannot be used as covering for nickel-chromium heating wire because they are all combustible. For the same reason, these substances are unsuitable for heater cores and for insulating the wires and cables from the case of a hot appliance. Most electric heaters are insulated with either fire clay or mica, as these materials are unaffected by moderate heat. Mica is a transparent mineral, somewhat similar to celluloid in appearance, but having a tendency to split into thin sheets after the manner of slate. It is tough, flexible and remarkably resistant to heat, whilst its insulating properties are of a high order. Mica is used for supporting terminals and heaters and for making insulating shields of all kinds. Fire clay, unlike mica, is brittle and cannot withstand mechanical stress. It is widely used in slab or rod form as foundations for heating coils, and in bead form for insulating wires.

Open heaters.—In electric fires and in many makes of hot plate, grill and cooker, nickel-chromium wire is coiled in a close spiral and supported on a fire clay block or rod so that the adjacent turns do not touch. In many toasters flat strip wire is wrapped on a plate of mica which is supported in a vertical position in a suitable framework. Guard rails or wires are fitted in order to minimise the risk of touching the hot bare wires.

Enclosed heaters. — The laundry iron may be considered as a typical example taken from the class of appliances in which electric current is required to heat a metal surface.

Nickel-chromium wire wound on flat strips of mica is sandwiched between two sheets of the same material and clamped to the metal baseplate by means of bolts and an iron block. Metal strips from the heater element make connections with plugs in the case, the plugs being insulated by mica discs. Heat generated in the nickel-chromium element is transmitted to the iron base and to the clamping block by conduction, and so a uniformly heated metal surface backed by a reserve of heat in the form of a hot iron block is available for laundry work.



ELECTRIC HEATERS

ELECTRIC WATER HEATERS

Dampness and electricity together usually spell danger, because water can act as a conductor of electricity and may permit a current to pass along an undesirable path. For this reason electric water heaters are made with particularly reliable insulation between the wet surfaces and the current bearing cables and elements. In addition, this insulation is carefully shielded so that there is little chance of splashing or accident causing it to become damp. As an extra precaution, the metallic parts of the appliance which are in direct contact with the water are often connected to earth by a wire which is entirely separate from the electrical circuit, so that in the unlikely event of a defect in insulation arising, any leakage of current to earth will take place through the wire and not through a person handling the apparatus. The result of all this care in design is that, although the electrical working parts and the water container are in very intimate contact, there is practically no chance of interaction between them, other than the simple transference of heat.

Heating elements.—The elements used in water heaters, though similar in design, are usually not so robust in construction as those of similar rating intended for action in the open air, because the presence of water near the heater has the useful effect of keeping the working temperature down to a comparatively low level. The heat generated is constantly passing away from the elements by conduction through the intervening wall between heater and liquid and by convection in the water itself. Water heating elements are constructed to suit the stresses to which they are normally subjected and an electric water heater should never be worked in a dry condition, as in such circumstances disastrous overheating will quickly occur.

In some appliances the complete insulated unit is fixed by means of clamps to the outside surface of the water container base, but in others the unit is enclosed in a suitable case and immersed directly in the water which is to be heated, Fig. 6. Both arrangements are satisfactory and both enjoy considerable popularity. The cases or metallic walls which separate the heaters

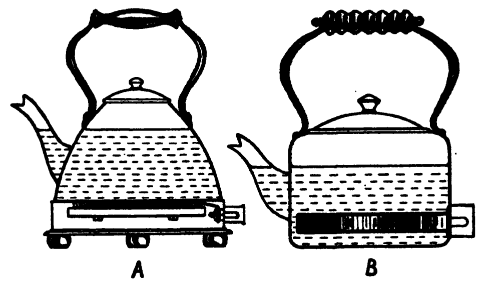
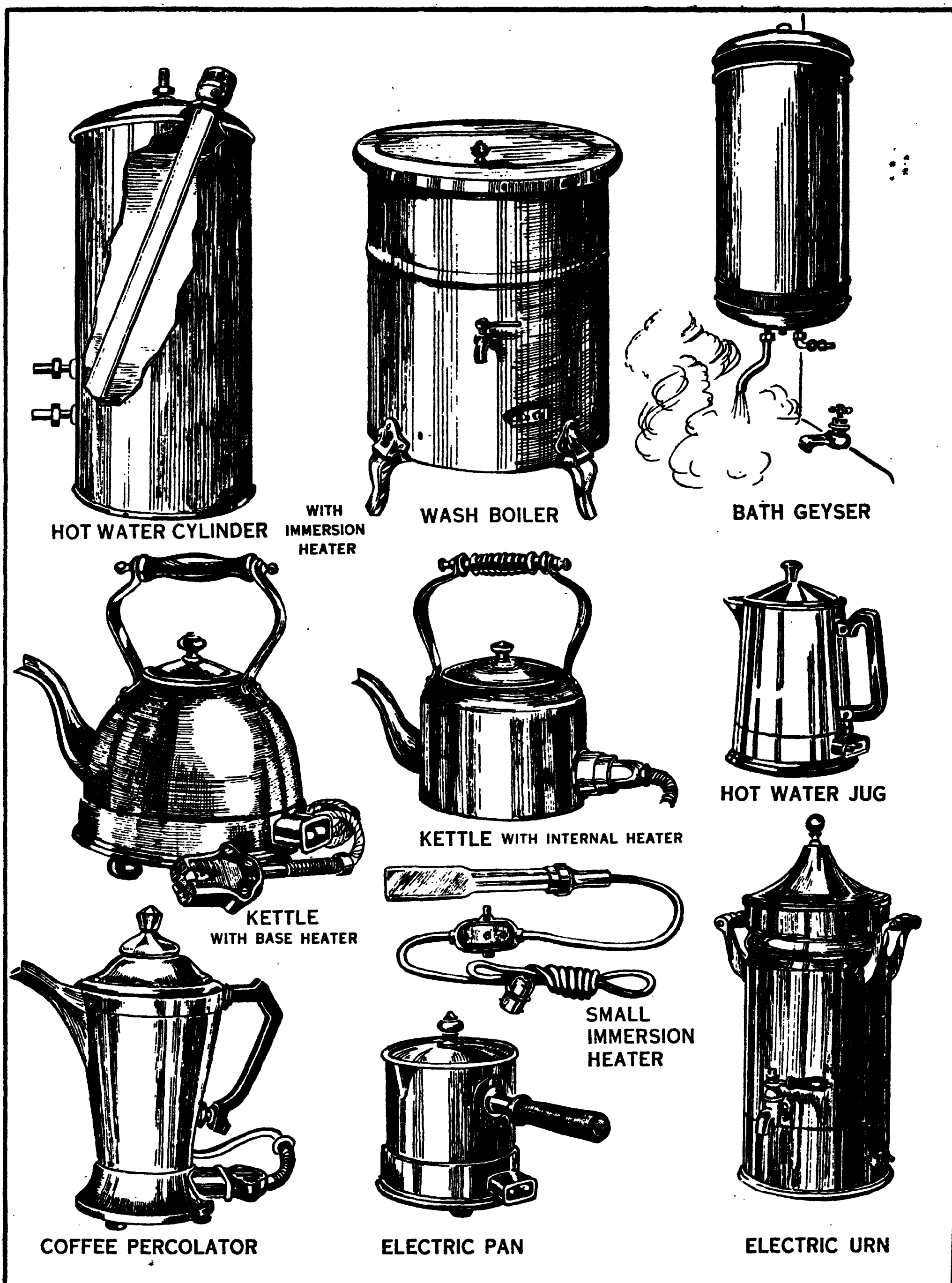


FIG. 5
A. Kettle with external base heater.
B. Kettle with internal heater.

from the liquid are often made of copper, as this substance has a high thermal conductivity and so promotes the passage of heat. Copper would oxidise in air at the temperature which it would attain under the influence of the heater, but in the cool water appliances trouble of this kind does not arise.

Switches.—The kind of switch used to control a water heater depends on the purpose which the apparatus is to serve. A hot water system supplying domestic taps usually has an automatic thermostatic switch which turns the heating current on when the temperature of the water in the storage cylinder falls below a predetermined level and turns it off when the supply is sufficiently hot. Wash boilers usually have two switches which give three heating rates. Kettles and other small heaters generally have a simple control switch, but some contain special fuses which melt if the appliance overheats and thereby cut off the heating current and prevent serious damage. Such fuses are fitted in addition to the normal control switch.



ELECTRIC WATER HEATERS

MOTOR DRIVEN ELECTRICAL APPLIANCES

Many electrically operated devices in the home are intended to produce mechanical movement of some kind, and to achieve this end are fitted with electric motors. Electric motors are machines which change energy supplied in the form of electric current into movement, and they do this through the agency of magnetism. There are many different kinds of motor and several of these find a place in the home. Electric clocks, meters, refrigerators and washers have their own special types to suit the particular class of work which is to be done, but most of the other popular motor driven contrivances make use of one common design.

What the motor does.—In every case, the electric motor used for domestic purposes produces rotary motion of a shaft or spindle, but this motion is not always applied in the same way. On the motor shaft in a vacuum cleaner, ventilating fan or hair drier there is a set of blades which agitate the air directly and thereby cause suction or a draught. Clock and gramophone motors are simply geared to give the required steady rotation, but washers, sewing machines, whisks and the like incorporate mechanisms which suitably modify the original rotation of the motor shaft.

The structure of the motor.—Electric motors of the type most commonly used for domestic purposes consist of the following parts:—

1. An *armature.* This is a slotted iron core made up of many thin plates insulated from each other by a layer of shellac varnish. Coils of insulated wire fit snugly in the slots. The whole armature is fixed firmly in position on the motor shaft.

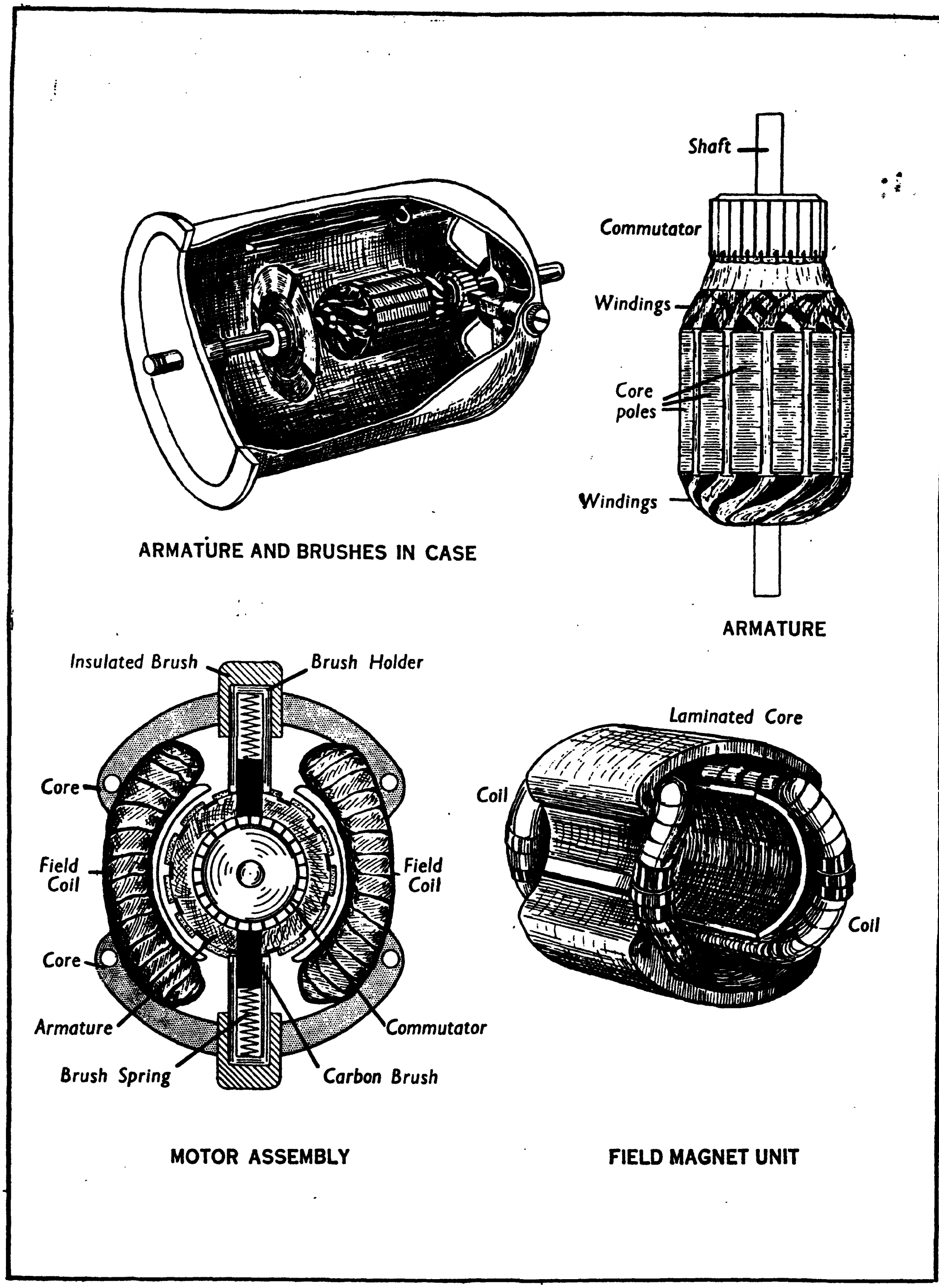
2. A *commutator.* This is a group of small copper bars arranged in cylindrical form by the side of the armature near one end of the shaft. The bars, or *segments,* are mounted in mica so that whilst closely packed together they are insulated from the shaft and also from each other. The whole commutator forms a strong fixed rigid unit. All the ends of the armature coils are soldered to the commutator segments according to a definite wiring scheme.

3. A set of *field magnets.* This is a hollow iron unit, built up like the armature from flat laminations, but having internal projections which carry coils. The hole, or *tunnel,* through the field magnets allows comfortable clearance for the armature.

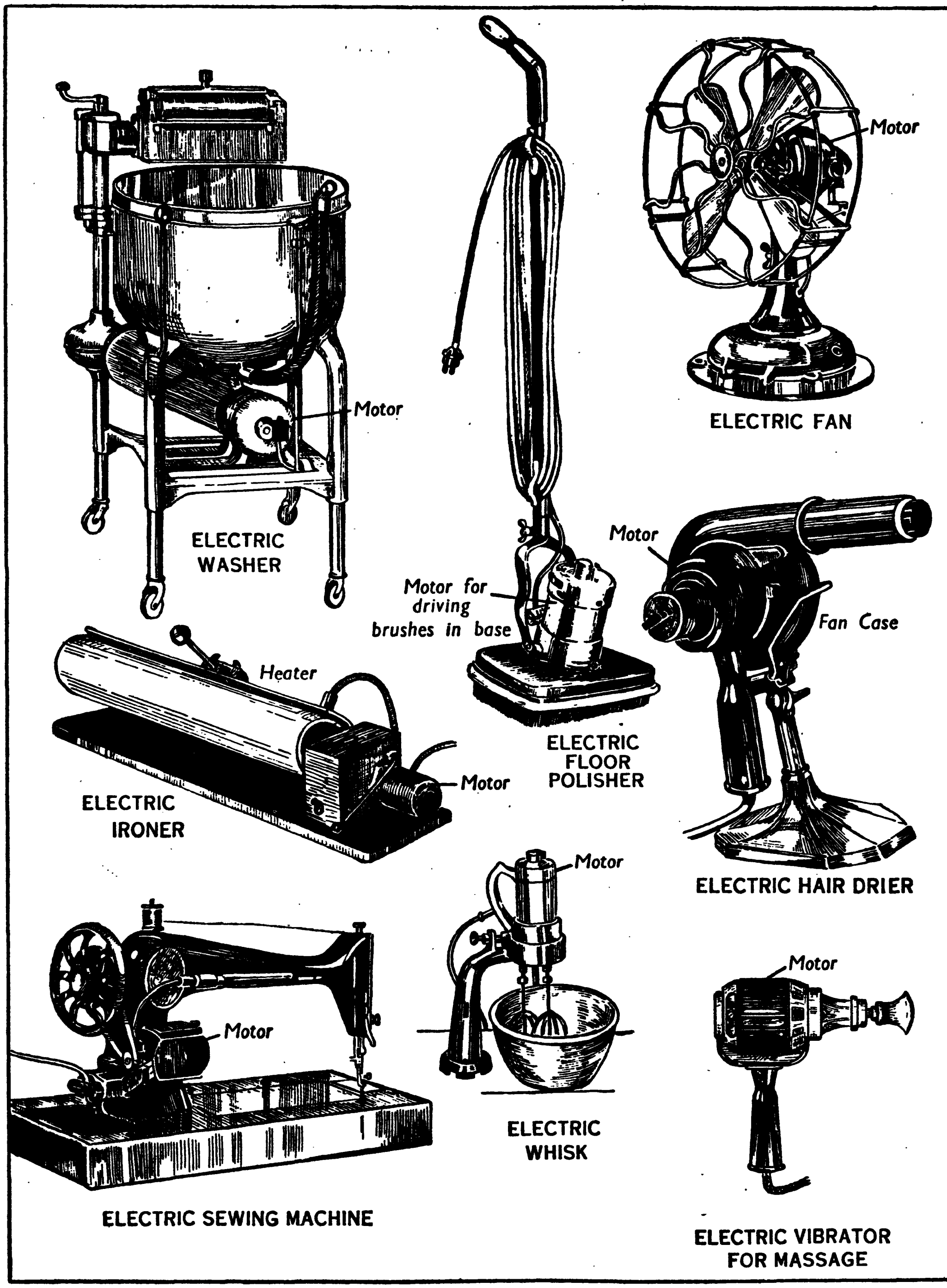
4. Two *brushes.* These are blocks of hard carbon mounted in insulated sockets and backed by light springs. In a properly assembled motor the brushes bear lightly but firmly on the commutator at two points diametrically opposite to each other.

Action of the motor.—The current from the mains goes through the windings on the field magnets and also through the coils on the armature via the brushes and commutator segments. Under the influence of this current, each projection on the field magnet unit becomes an electromagnet, and so does each projecting piece of core on the slotted armature. These magnetised projections are called *poles.* There are two kinds of poles, one being the result of a current traversing the magnetising coil in one direction and the other the consequence of a current flowing in the opposite sense. Moreover, similar poles repel each other and unlike poles attract. Owing to the design of the windings, each field magnet pole is similar in polarity to one section of the armature and opposite to the other. It consequently repels one part and attracts the other, thereby setting up rotation.

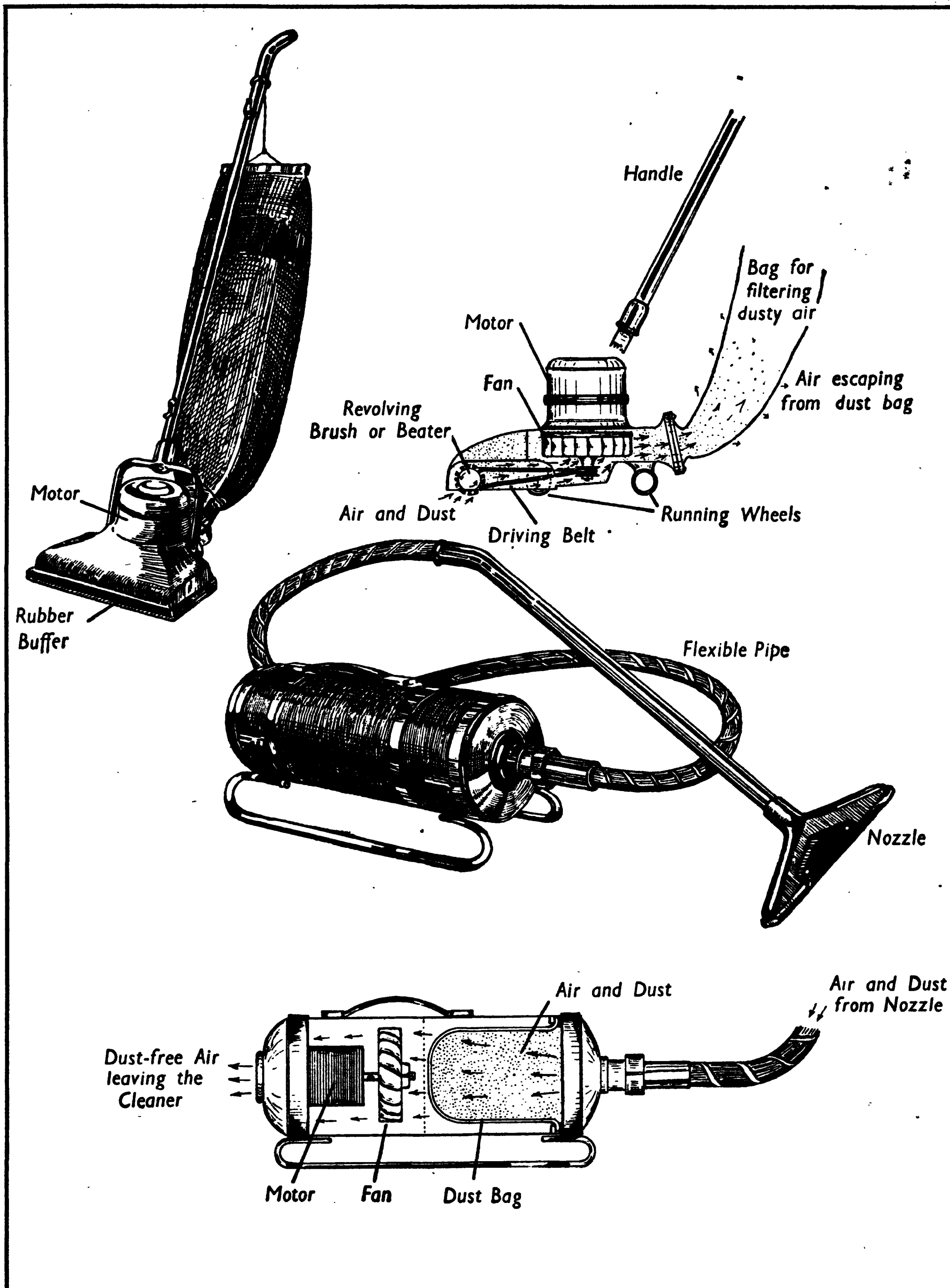
If the polarity of the armature and field did not alter, the armature would merely swing round until a field magnet pole and the dissimilar poles on the armature were near together. The actual state of affairs, however, is that the polarity of the armature sections changes as the brushes move from one pair of commutator segments to another. Moreover, the brushes are set so that as each armature pole reaches a field magnet pole under the influence of attraction, its polarity reverses and so it continues to turn, moving away under the influence of repulsion. This cyclic repulsion and attraction keeps the armature of the motor in motion.



The Electric Motor



MOTOR DRIVEN ELECTRICAL APPLIANCES



ELECTRIC VACUUM CLEANERS

THE ELECTRIC REFRIGERATOR

The machine to be described is a refrigerator of the motor-operated mechanical type. A certain quantity of gas contained in the refrigerator is made to pass through a series of changes in such a way that at one stage intense cooling occurs. Sulphur dioxide is a gas commonly used, but others such as ammonia or carbon dioxide are able to give satisfactory results. The gas which works the refrigerator is completely enclosed in three main pieces of apparatus which are mounted unobtrusively in convenient parts of the cabinet.

The compressor.—The electric motor of the refrigerator is coupled to a simple *compressing pump* which consists of a cylinder, two valves and a piston. As the motor revolves, the pump takes in gas at low pressure from the *evaporator* or cooling section through one of the valves. After being compressed, the gas is allowed to pass through the second valve into the *condenser.* The work done by the compressor is therefore two-fold:—Firstly, it creates a state of low pressure in the evaporator or cooler from which it draws a supply of gas, and secondly it creates a state of high pressure in the condenser by pumping compressed gas into it.

The condenser.—This is a long finned metal tube which is kept cool by a draught of air blown across it by a fan on the motor shaft. The action which takes place in the condenser depends on two simple scientific facts which need to be clearly understood:—

1. When a gas is compressed it becomes warm. (This phenomenon is well-known in connection with the inflation of pneumatic tyres.) The application of the fact to the present case is clear: the high pressure gas entering the condenser from the compressor is comparatively warm.

2. Gases such as the sulphur dioxide used in a refrigerator can be liquefied at ordinary temperatures by subjecting them to more than normal pressure. Sulphur dioxide is usually sold in the liquid form, contained at high pressure in a glass siphon of the kind used for the sale of mineral waters.

What happens in the condenser of the refrigerator can now be realised. The compressed gas entering the air-cooled tube is warmer than its surroundings, but it soon loses heat which is carried away by the external air draught. Being still under the influence of high pressure, the cooled gas *liquefies.* The cool, but not especially cold, liquid passes through a regulator valve at the end of the condenser into the evaporator, or cooling section of the machine.

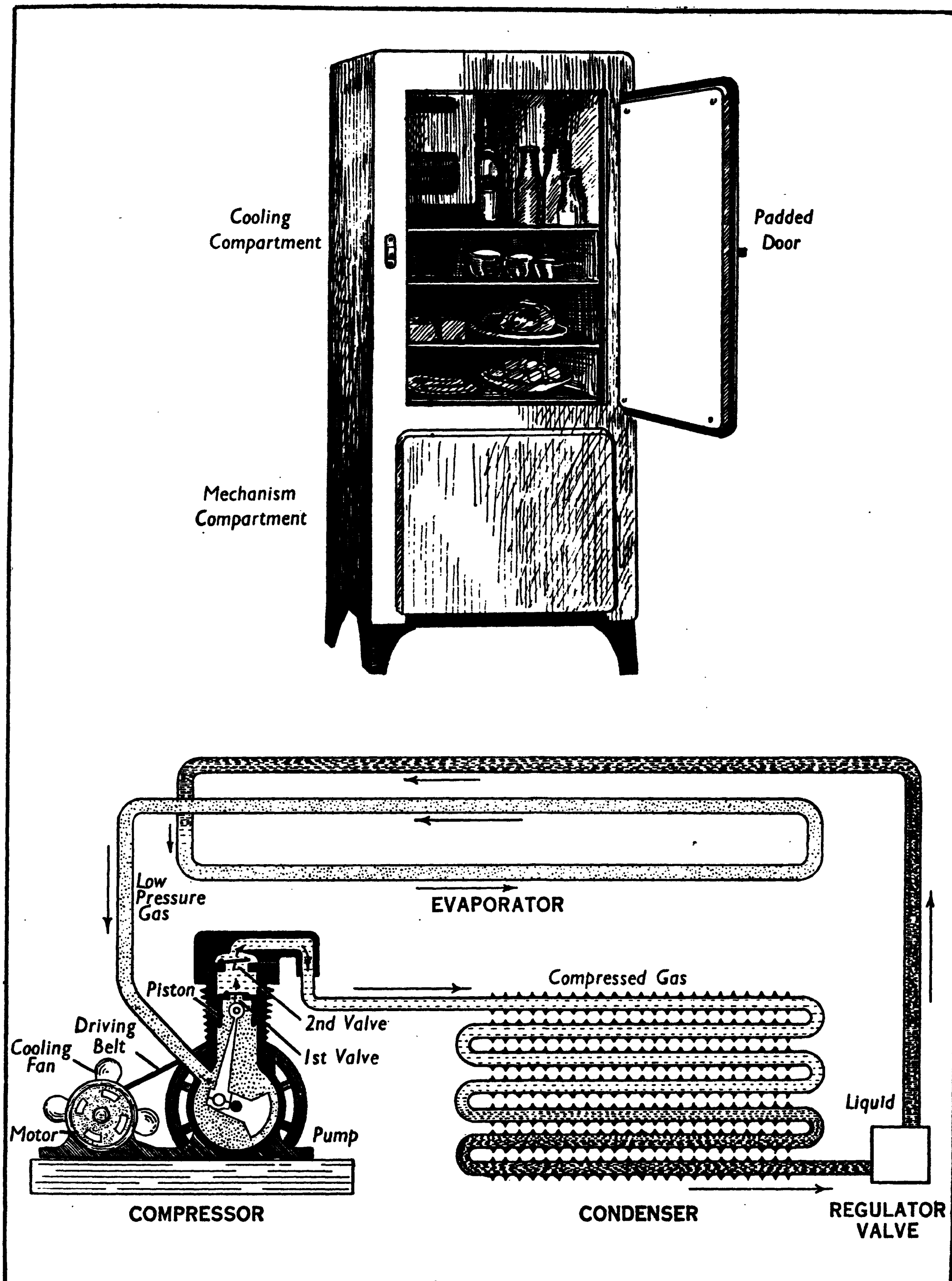
The evaporator.—As the compressor is constantly drawing gas from the evaporator, it is clear that the pressure in this part of the apparatus must be low. The liquid from the condenser is therefore entering a chamber in which it is fairly free from pressure. Two more scientific facts bear on the action in these circumstances:—

1. A liquid boils or evaporates much more quickly when subjected to low pressure than when highly compressed.

2. All liquids absorb much heat from their surroundings as they evaporate.

The action of the evaporator can now be worked out. The liquid passing out of the condenser through the regulator valve is relieved from pressure and so it evaporates quickly, absorbing heat from the evaporator tube walls. In consequence, these walls become very cold and tend to absorb heat from outside objects which are near. The evaporator is situated in the refrigerator cupboard close to the foodstuffs which are being preserved. The temperature of the cupboard contents is therefore reduced as the evaporator absorbs heat to enable the liquid inside it to evaporate.

Continuous action in the refrigerator is possible because the working gas goes through a complete cycle of changes, during which heat is absorbed in the evaporator and given out in the condenser. No external supply of gas is needed and the appliance requires little attention.



THE ELECTRIC REFRIGERATOR

THE ELECTRIC CLOCK

Common clocks and watches use springs or weights and balance wheels or pendulums as driving and control agents, but the popular electric clock is driven by a very small controlled electric motor.

Synchronous motors.—Some electric motors revolve at a rate which varies with the amount of work which is being required of them, but others run at a definite speed which is determined by the structure of the motor and the characteristics of the supply current. Machines which run at one speed only are called synchronous motors. The synchronous motors in electric clocks can be operated only on mains which supply *alternating current* at an *accurately controlled frequency.* In order to understand these terms it is necessary to know that alternating current changes its direction of flow many times per second, and that these changes may be accurately timed or may vary in an irregular uncertain manner according to the circumstances ruling at the generating station. A mains supply which is suitable for running electric clocks always varies its flow at an accurately timed rate or frequency. All mains connected in National Grid circuits have the one definite frequency of 50 cycles per second, and as these circuits are rapidly extending their service areas electric clocks are becoming very popular. All National Grid generators are controlled by frequency regulators which keep Greenwich time.

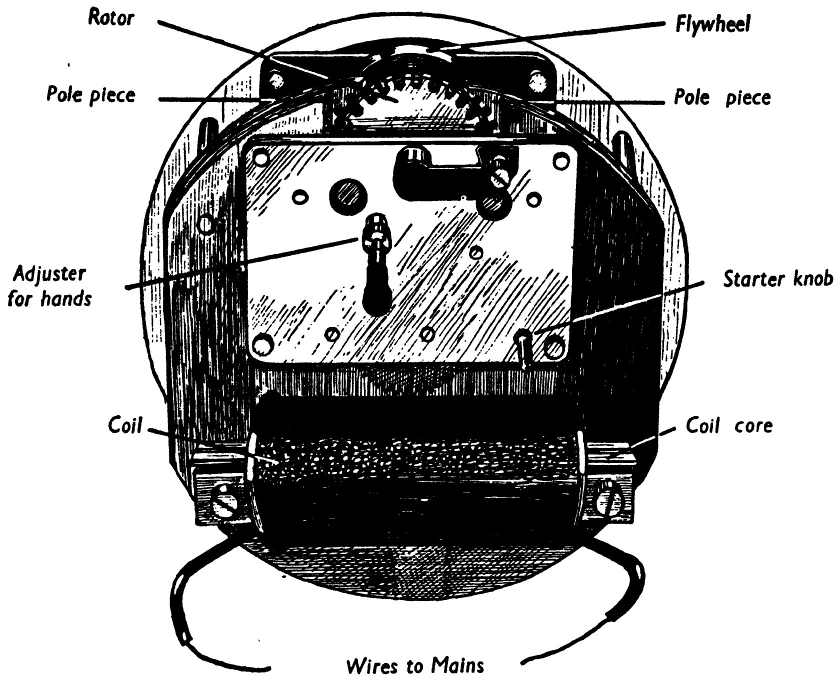
An electric clock contains no controlling mechanism comparable with the balance wheel or pendulum of an ordinary clock, because its speed is determined by the regulator at the generating station through the medium of the current frequency and not by any self-contained device. Clocks which are timed by a distant mechanism of this sort are called *slave clocks,* and are really nothing more than remote dials of the central timing apparatus. An electric clock has no adjusting device fitted to it because there is no speed controller to adjust. So long as the current alternates at the specified frequency the clock keeps perfect time.

Construction of the electric clock.—An electric clock driving motor is in two parts —a *field magnet* and an *armature* or *rotor.* The rotor is mounted on a spindle along with a flywheel which steadies the movement of the revolving mechanism. The rotor spindle is connected by gear wheels to the second, minute and hour hands. A setting knob is attached to the gear train so that the clock hands may be turned independently of the motor, and a second knob is included for the purpose of giving the motor a start.

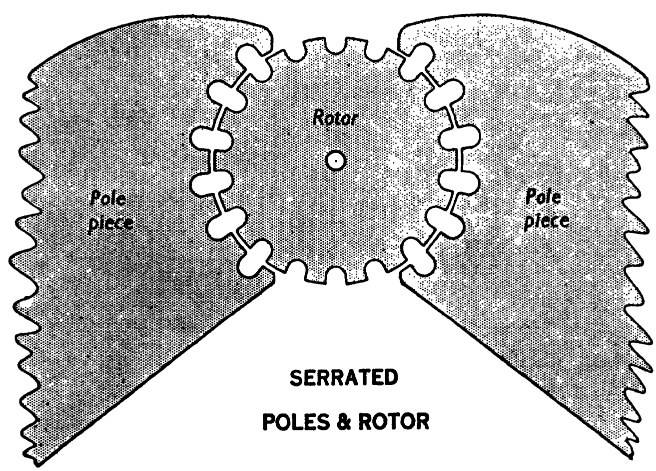
The field magnet consists of a few thin iron plates which form a core in a bobbin, a coil of many turns of fine wire wound upon the bobbin and a pair of serrated pole pieces which are curved to match the rotor and which are bolted to the bobbin core ends. The mains current passes through the coil and energises the magnet.

The rotor is a simple toothed iron wheel, mounted so that it may rotate between the field magnet poles. The square teeth and the intervening spaces of the rotor are of equal width, and they correspond with the similar serrations of the field magnet poles.

How the clock motor works.—The field magnet poles change their polarity each time the A.C. changes its direction. These changing field magnet poles induce poles in the rotor, but the changes in the latter lag behind the field to a slight extent. At the normal running speed the rotor teeth move from positions in which they are opposite pole piece *spaces* to where they are opposite *teeth,* being under the influence of attraction exerted on them by the pole piece teeth which are building up one polarity. Then the field polarity changes and so the rotor teeth are repelled to a position where they are opposite the next spaces in the pole pieces. By the time they reach the space position the polarity has again changed and they move on towards the teeth.



ELECTRIC CLOCK MECHANISM



SERRATED
POLES & ROTOR

THE ELECTRIC CLOCK

THE ELECTRICITY METER

Three items enter into an electrical measurement:—

1. The current actually flowing through the apparatus which is using the electricity.

2. The pressure which is being required to force that current through the circuit.

3. The length of time during which the current is flowing.

Electrical pressure is measured in *volts*; current is measured in *amperes*; and power, obtained by multiplying together the volts and amperes, is measured in *watts*. The amount of energy which has been expended in running an electrical appliance is decided by multiplying the watts being used by the length of time during which the power has been on. A thousand watts form a unit of power called a *kilowatt*, and a kilowatt expended for an hour constitutes a unit of energy called a *kilowatt hour*. The kilowatt hour is the unit of electrical energy used for measuring the consumption of domestic installations. The words kilowatt hour are often shortened to K.W.H.

As the electricity meter in a house is required to measure K.W.H. units, it contains apparatus which registers the three factors—time, pressure and current. The instrument is actually a special kind of electric motor coupled to a set of dials through a clockwork type of gearbox. The speed of the motor is influenced by the voltage of the supply mains and the current flowing to meet the requirements of the household appliances in use. The length of time during which power is being used has its due influence on the meter record as the dials change continuously and register every movement. The mechanism of the electricity meter is geared so that the indicators register kilowatt hours directly.

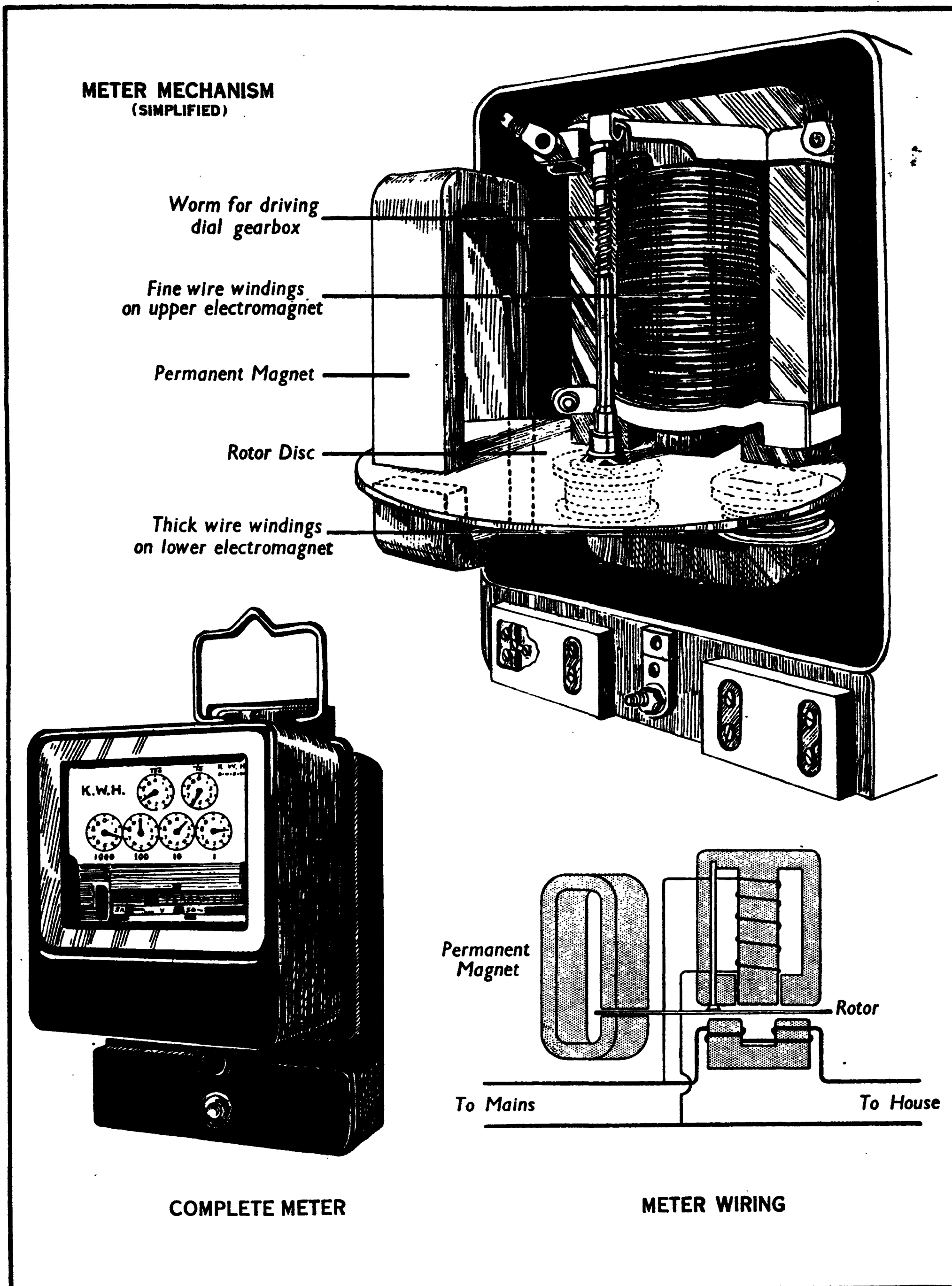
Construction of the meter.—There are five main parts in an ordinary electricity meter —two *electromagnets*, a disc *rotor*, a *permanent magnet* and a *dial gearbox*.

The electromagnet above the rotor is wound with many turns of very fine wire and is connected directly across the mains. It is quite independent of the house wiring and its purpose is to introduce into the meter the influence of the mains pressure. The second electromagnet is opposite to the first and is below the rotor. Its winding consists of a few turns only of very thick wire through which passes the current flowing in the house circuits. When no electrical appliances in the house are in use, this electromagnet is not energised at all.

The rotor of the meter is a simple metal plate mounted on a long spindle which rests in bearings at its upper and lower ends. The rotor is free to turn between the poles of the permanent meter magnet and between the two electromagnets. Its movement is transmitted to the dial gear-box through a worm gear cut on the rotor spindle. The electricity meter has six dials which register thousands, hundreds, tens, units, tenths and hundredths of kilowatt hours respectively.

How the meter works.—When no current is flowing through the meter to serve the house, the rotor is under the influence of the upper electromagnet and the permanent magnet only. Under these conditions no rotor movement occurs. When a current does flow, the lower electromagnet comes into action and the two electromagnets together exert a magnetic influence which generates currents in the disc itself and which consequently set the rotor in motion. The magnitude of this magnetic interaction determines the speed of rotation of the rotor, and it depends on the voltage of the supply, operating through the upper electromagnet, and the current flowing in the house circuits, operating through the lower one. Therefore the speed of the disc is proportional to the watts.

The permanent meter magnet acts as a brake on the rotating disc by inducing in it currents which oppose the motion. The presence of the permanent magnet ensures that the rotor disc revolves steadily at one particular speed for each wattage.



THE ELECTRICITY METER

THE TELEPHONE

The fundamental instruments in a telephone system are quite easy to understand, for most of the equipment of a modern telephone centre is concerned with ease of control, clarity of speech, effective long distance work, rapid interconnection of subscribers and the like, and not with the simple problem of electrical transmission of speech.

A complete telephone circuit consists of two similar stations linked by a pair of landlines through one or more exchanges. Each station contains a *transmitter*, a *receiver*, a *bell* and some kind of *switch*. The person using the telephone speaks into the transmitter, listens to the receiver, is attracted to the instrument to receive a call by the bell, and calls the attention of the exchange operator by means of the switch when he desires to communicate with some other person. In the case of an automatic telephone, the switch is of a special rotary type which is coupled to a selecting mechanism at the exchange. Operating the switch in accordance with the official instructions effects connection with the desired distant station without the intervention of an operator.

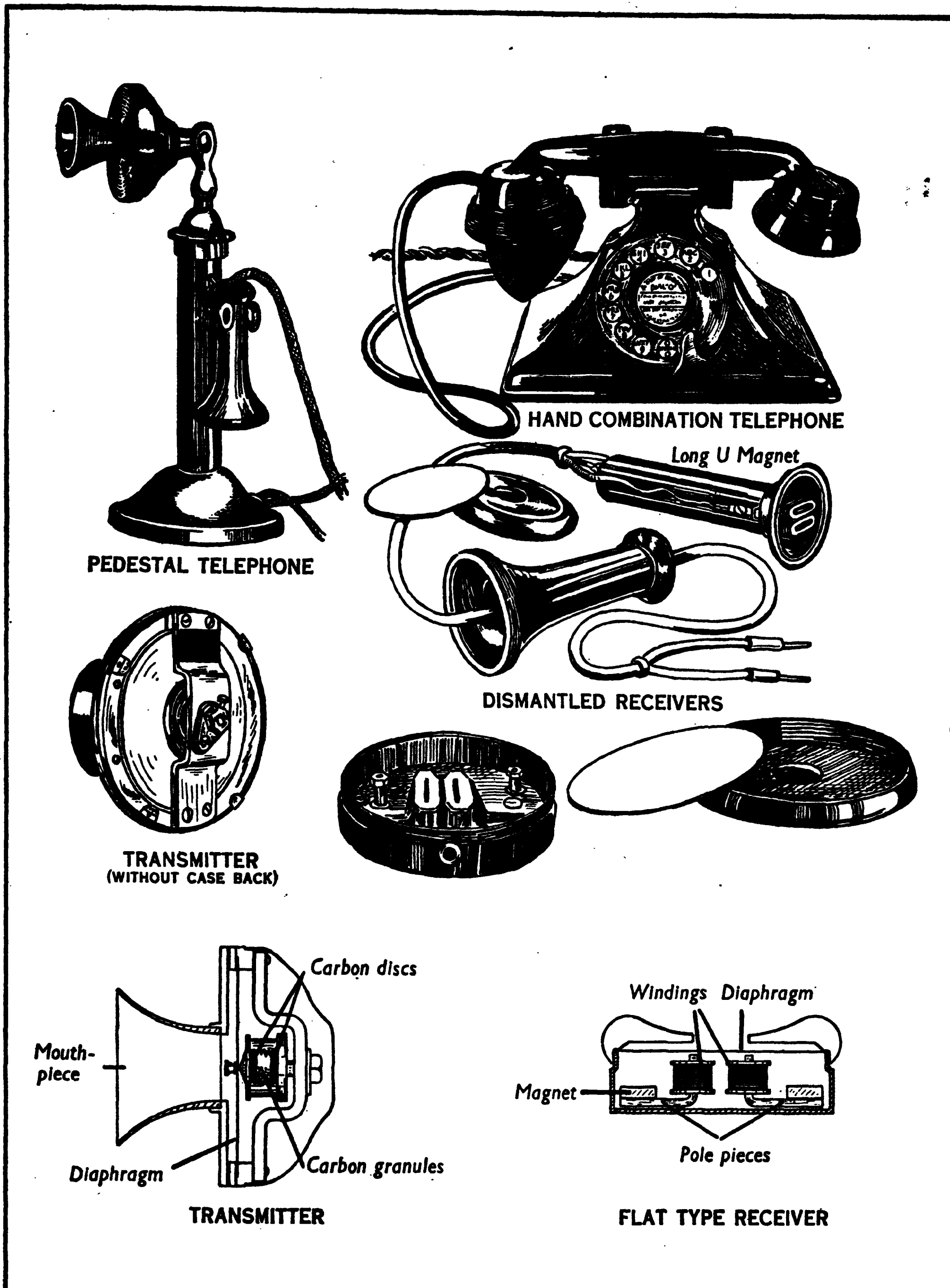
Bells, switches and landlines are used in many electrical contrivances, but transmitters and receivers are characteristic features of telephonic apparatus.

The telephone transmitter.—In its popular form, this instrument consists of a case containing a light metal diaphragm and a box fitted with two little discs of carbon and partly filled with carbon granules. One carbon disc is in the base of the granule box and the other is mounted freely above it so that the two are connected electrically through the carbon granules which rest between them. The movable carbon disc is attached to the metal diaphragm. The possible movement of the combination is strictly limited as the diaphragm is supported by the case round its edge.

The air movements produced by the voice of a person who speaks near the transmitter disturb the diaphragm, thereby compressing or releasing the granules between the carbon discs. An electric current from a battery flows through the transmitter granules from one carbon disc to the other when the telephone is in use, and this current is affected by the diaphragm movements. When the carbon granules are compressed by a sound wave impinging on the diaphragm the current flowing through the transmitter is momentarily increased because the resistance to the passage of the current is lowered by the intimate contact between the granules. In this way, each characteristic of the spoken words impresses itself upon the current flowing through the transmitter.

The telephone receiver.—This instrument makes use of the current which has been modulated by the transmitter and produces sounds which are similar to those which originally influenced the transmitter diaphragm. There are three main parts in the receiver. A permanent magnet fixed in a suitable case carries two small bobbins wound with many turns of very fine wire. The magnet poles are close to a thin iron diaphragm which is clamped firmly at its periphery. The receiver is wired in circuit so that the transmitter current passes through both the coils on the magnet.

When the receiver is not in use, the permanent magnet exerts a steady pull on the iron diaphragm which is close to it. A current passing through the magnet coils influences the strength of the magnet and thus increases or decreases the pull. Therefore, on putting the receiver into service, the fluctuating transmitter current causes the receiver magnet to vary its pull on the iron diaphragm in a manner which corresponds exactly to the impressions made by the speaker's voice on the transmitter diaphragm. The iron diaphragm therefore moves backwards and forwards under the influence of the varying pull of the magnet and sets up air movements near it, exactly like those which operated the transmitter. In this way the original sound is reproduced.



THE TELEPHONE

THE ELECTRIC GRAMOPHONE

Construction of the electric gramophone.—As one group of expensive components is common to both the radio set and the electric gramophone, it is economical to build the two instruments into one cabinet or else to adapt the amplifying portion of the radio for gramophone purposes by means of a change-over switch. The combination of the two instruments is not in any way essential and an electric gramophone may have its own amplifier and speaker and thereby be complete in itself.

An electric gramophone consists of an electric motor, a record-carrying turntable, a pick-up unit, an amplifier and a loud speaker. The mechanical parts of the instrument, which include the motor, turntable and pick-up, are built up on a baseboard, but the amplifier and speaker are often housed quite separately.

Some gramophone motors are of the synchronous type, as used in electric clocks, but others are capable of operating at various speeds. The first kind has the advantage of being perfectly timed, but the second is adaptable to mains which supply alternating or direct current, and to controlled or uncontrolled frequency. Non-synchronous motors are adjusted to the correct number of revolutions per minute by means of a mechanical governor of the usual gramophone type.

The pick-up unit is mounted on a swivelling arm so that its needle can traverse the spiral groove of a record on the turntable.

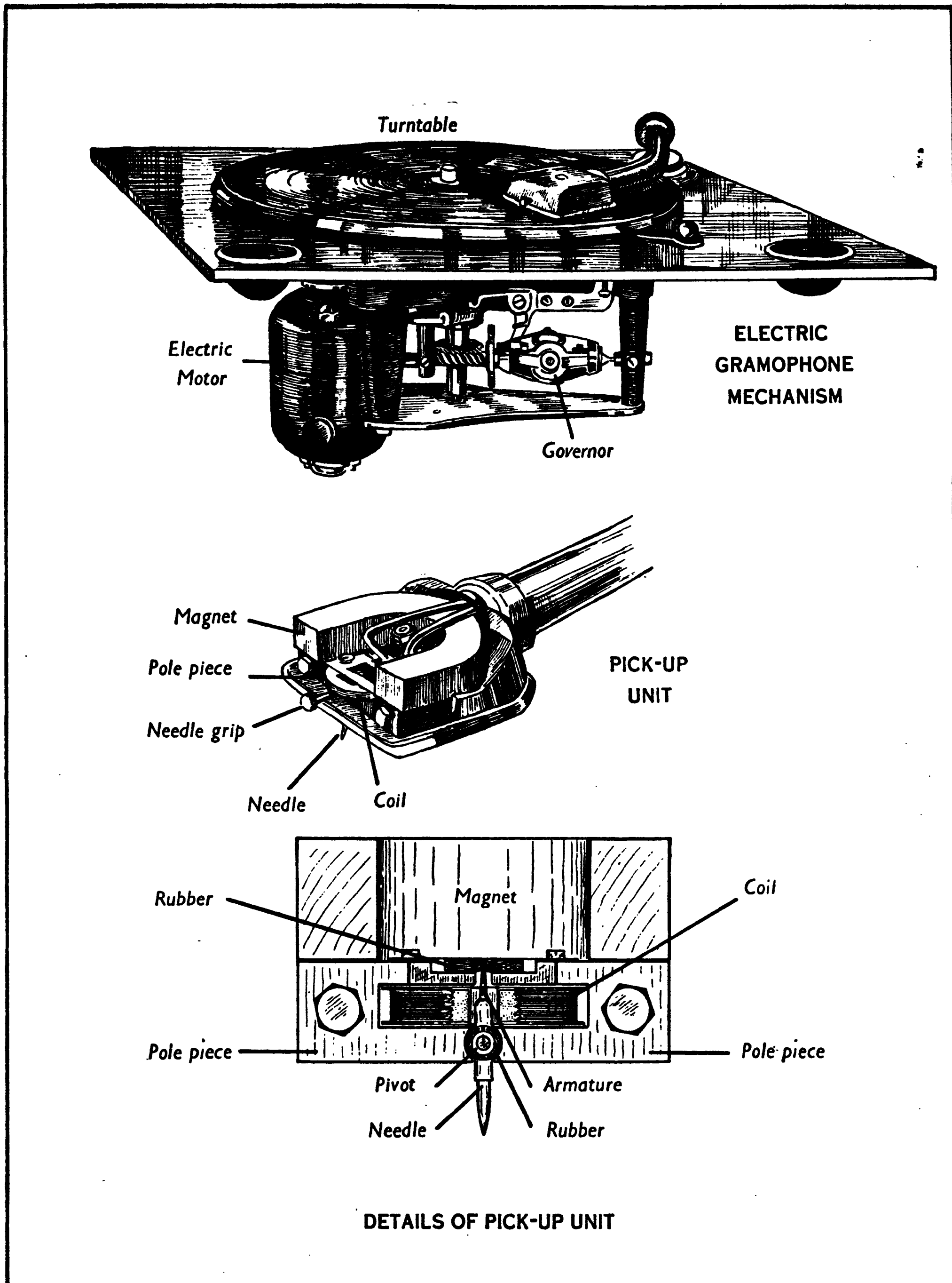
How the electric gramophone works.—The groove on a gramophone record has a remarkable wave form, like a miniature road with many abrupt and irregular bends. The irregularities on the original record were cut by a fine tool which was actuated by the sound waves in the recording studio. Each characteristic of the series of sounds has therefore a mechanical counterpart in the record groove.

As the pick-up needle makes its way along the tortuous track it wags from side to side, this movement being permitted by a rubber-bushed pivot in the needle mounting. The peculiar oscillations of the needle are transmitted directly to a small iron armature which is situated between the poles of a permanent magnet inside the pick-up case.

The pick-up contains a coil of fine wire, placed so that it comes under the influence of the permanent magnet. In the drawing the coil is shown between the magnet poles, encircling the vibrating armature. Normally the magnetic field in the neighbourhood of the coil is steady and the windings are unaffected by it. Movements of the armature cause variations in the magnetic field and these induce an undulating current in the coil. Thus through a mechanical and magnetic link, the distinctive qualities of the record groove are reproduced in an electric current generated in the pick-up coil. This current is carried to the amplifier of the gramophone by twin flex.

Through the agency of special electric relays called thermionic valves which are operating in the amplifier, the pick-up current is used to release a similar but much stronger current from the power supplying apparatus. This strong current passes on to the loud speaker where the final transformation takes place.

The loud speaker consists of a powerful magnet placed so that it may influence effectively a coil of wire attached to the apex of a parchment cone. The coil and its conical diaphragm are mounted so that they may vibrate freely. The current from the amplifier passes through the coil windings. The magnet attracts the coil irregularly in accordance with the varying current passing through it, and so a vibration is set up, each characteristic of the current making its own contribution to the movement. The diaphragm transmits the disturbances to the air, and so the sounds which originally occurred in the recording studio are reproduced.



THE ELECTRIC GRAMOPHONE

RADIO

Any kind of electromagnetic radiation can travel through space from one point to another without the aid of material links of any kind. Radio broadcasting is a system whereby messages of general interest are transmitted from one point to several others through the agency of wireless waves. In many ways the wireless is similar to the ordinary telephone, for both make use of transmitting and receiving stations and obtain from an external source the energy necessary for carrying on their work.

The radio transmitting station.—The wireless waves radiated from a broadcasting station are the resultant of two factors, comparable in character to a letter and to the messenger who delivers it. The message element in the radiation is provided through the action of a transmitter or microphone, but the waves which carry the message are established by powerful electric currents from the station's generators.

The microphone in the radio studio interprets sound in terms of a varying electric current, just as a telephone transmitter does. This electrical equivalent of the sound, as the microphone current may be called, is amplified by apparatus in the studio control rooms and passed on to the transmitter by telephone lines. The studio buildings and the transmitter may be many miles apart, but the distance causes no inconvenience as effective telephonic communication is established between the two departments.

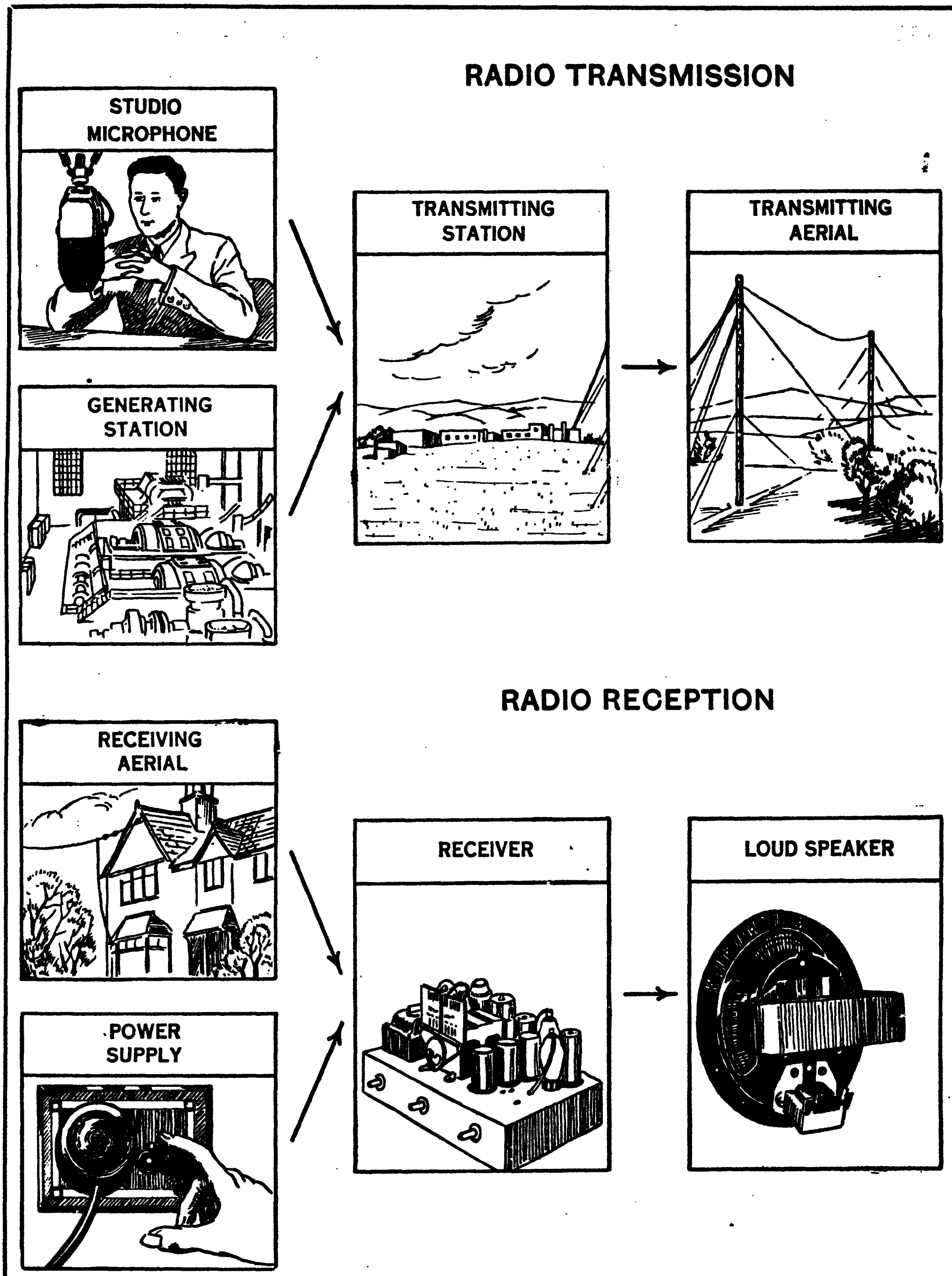
The apparatus at the transmitting station is used to generate a powerful alternating current of high frequency in a circuit which includes an aerial. As a result of this current a constant succession of wireless waves is broadcast in all directions from the aerial, just as light is radiated in all directions from the hot filament of an electric lamp. The transmitting current acts on the aerial even when the studio is silent, but the broadcast in those circumstances consists of a steady series of uniform waves only, and so a receiving set in the neighbourhood produces no sounds as a result. This regular silent emission is called the *carrier wave*, and its function is that of messenger boy.

Each radio station has a particular wavelength, to which its carrier is made to conform by means of tuning apparatus. Sending out wireless waves which are tuned to a particular wavelength is similar to shining a light of a particular colour.

When a programme is to be broadcast, the microphone current from the studio is applied to the steady high frequency current in the transmitter's aerial circuit in such a way that it modulates it. As the character of the carrier wave is determined by the aerial current, the modulation of the one is passed on to the other. The carrier wave thus becomes a sort of radio equivalent of the original studio sounds. It is this modulated carrier which takes the message to its destinations.

The radio receiving station.—The receiving aerial traps the energy of the wireless waves which reach it and leads it down to the set in the form of a weak high frequency alternating current. Tuning apparatus in the receiver selects the current of a particular transmitter and directs it to the amplifying section of the instrument.

The weak current from the receiving aerial bears the high frequency which originated in the transmitting apparatus and the modulations which were established by the microphone. The influence of the microphone is carefully preserved throughout the series of changes which take place in the set, but the high frequency element is suppressed at a suitable stage. In some of the simpler receivers this suppression or *rectification* is undertaken by the first section of the circuit and is followed by an amplifying process which leads on to the loud speaker. More elaborate sets have amplifying stages both before and after rectification, whilst the most expensive commercial instruments incorporate many refinements which contribute to ease of control and purity of reproduction.


RADIO TRANSMISSION
STUDIO MICROPHONE
GENERATING STATION
TRANSMITTING STATION
TRANSMITTING AERIAL
RADIO RECEPTION
RECEIVING AERIAL
POWER SUPPLY
RECEIVER
LOUD SPEAKER

Radio

TELEVISION

The television transmitter.—When being transmitted, a picture or scene is not treated as a whole but is scanned by a ray which covers only a very small area of the subject at any particular time. This ray, which acts as a kind of message collector, moves across the picture or an image of the scene which is being televised, and it sets up in an external circuit a current which varies with the light and shade of the spots on the picture which come under the influence of the ray. After having travelled right across the picture the ray swings back very quickly and starts another line just a little below the first. When it has scanned the whole picture by moving in lines in this way, the ray returns to the starting point and the process recommences. The speed at which the scanning ray works is amazing, for it takes two hundred or more lines to make a picture and yet the ray does twenty or more pictures per *second!*

The wireless waves carrying television are modulated by the current from the scanner, so that the broadcast variations are equivalent to the light and shade in the original picture. Besides the modulation, two other sets of impulses are impressed on the television carrier wave. One of these indicates the time of starting a new line in the transmission and the other marks each beginning of a picture.

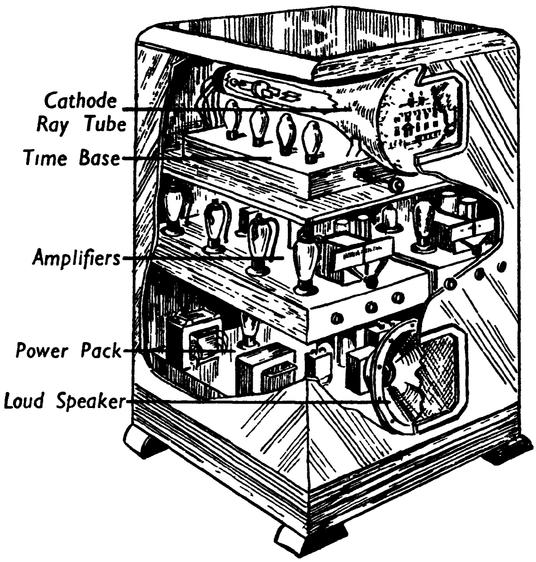
The television receiver.—The apparatus used to interpret television signals is built up in a number of separate units. First there is the *power pack* which takes electric power from the mains and prepares it for the use of the other parts of the receiver. The portion of the set which deals with sound consists of the *sound amplifier* and the *loud speaker*. The *vision amplifier* sends modulated current to both the *cathode ray tube* and the *double time base*. The vision amplifier makes use of the incoming signals from the aerial, the cathode ray tube produces the pictures and the double time base prepares the new line and new picture impulses in the transmission for application to the picture-forming equipment in the tube.

The cathode ray tube.—This appliance is a large cone-shaped tube of glass with a long neck at the apex. The flattened end of the cone is covered on the inside with a thin coating of specially selected chemicals which fluoresce when the tube is in action. The tube is supported in the receiver cabinet so that the chemical screen can be viewed either directly or through a mirror, for it is upon this screen that the televised images are formed.

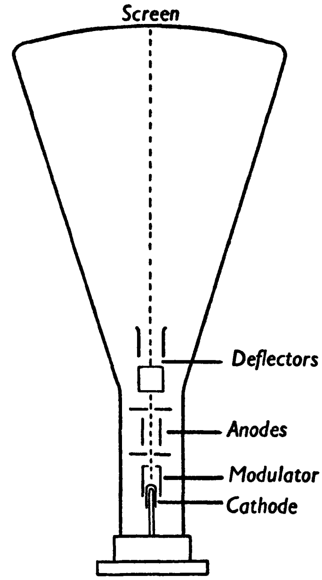
A ray emitter, or *cathode*, is fixed in the neck of the tube and is energised by an electrically heated filament. The cathode rays are shot forward and concentrated on to a very small spot on the screen by several electrical devices fitted near the cathode itself. The spot on the screen shines brightly.

The three elements in the television broadcast are applied to this ray in the tube. The modulation of the transmission, which represents the light and shade of the original picture, acts through a small metallic electrode called the modulator, fixed near the cathode. Its effect is to vary the intensity of the ray exactly in accordance with the changes in the incoming signals.

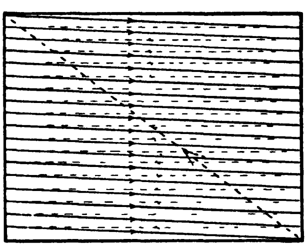
The modulator makes the brightness of the spot on the screen vary, but it does not distribute the influence of the spot over the whole screen and thus create a replica of the original scene. This distribution is undertaken by two sets of deflector plates in the tube neck which apply influences prepared in the double time base and synchronised by the timing signals incorporated in the transmission. One pair of plates pulls the ray steadily across the screen and then lets it swing back quickly, whilst the other pair moves it down steadily and then permits a quick return. As this distribution is exactly similar to the original scanning, the cathode ray builds up the impulses of light and shade in correct order on the screen and thereby reproduces the original picture.



TELEVISION RECEIVER



CATHODE RAY TUBE

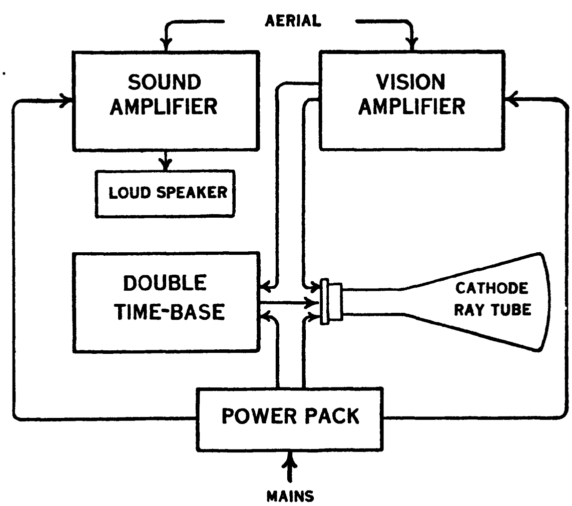


A SIMPLIFIED FORM OF SCANNING

Arrow heads indicate the continuous path of the ray

Complete strokes represent the picture-forming lines

Broken lines show the quick return movements



STRUCTURE OF A RECEIVER

The lines and arrowheads show the links and directions of transfer between the components

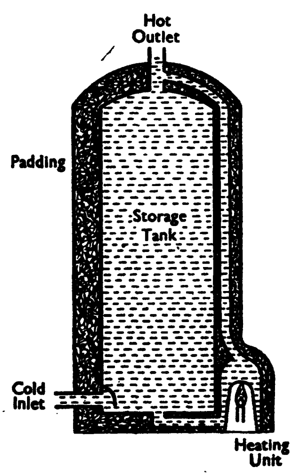
TELEVISION

HOW IT WORKS

THE GAS WATER HEATER

As a means of heating water for domestic purposes gas has proved itself to be excellent in every way. Modern water heating appliances are of a high standard of efficiency, they are easy to operate, economical in service and perfectly safe. Chief amongst the advantages offered is speed—it is claimed that a steady flow of boiling water can be established from cold in forty seconds by means of a suitable up-to-date gas appliance.

There are two main classes of water heater. Equipment of the first kind incorporates a storage tank for hot water and is operated by a low consumption burner. Heating is carried out in a small chamber which is linked to the storage tank by short pipes after the manner of the common household hot water system. Hot water accumulates as an upper stratum in the tank and is drawn off for use as required.



Arrangement of Storage Type Gas Water Heater

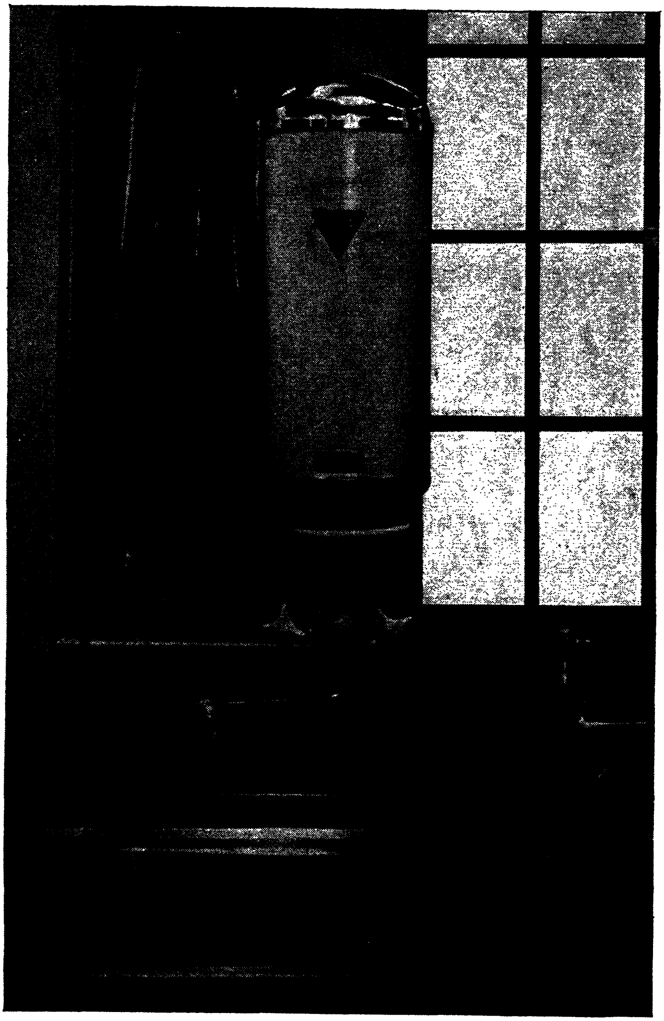
For most household purposes the second type of water heater is to be preferred. This class of apparatus draws water directly from the cold supply and heats it to the required temperature in the course of its passage to the outlet nozzle. To achieve this result of course a high consumption burner has to be used, but this does not imply extravagance as the gas is automatically turned on only during the period that the water is flowing. In a well-designed appliance a high percentage of the heat evolved is imparted to the water. Such instantaneous heaters, as they are called, are obtainable in various sizes to supply one or more outlet spouts.

Construction of the instantaneous water heater.—The appliance illustrated is entirely self-contained. It draws its supplies directly from the gas and cold water mains and delivers a steady flow at any desired temperature ranging from cold to boiling.

A water heating chamber, surrounded by a sectionalised finned type heat exchanger, is mounted centrally in the head of a cylindrical combustion chamber which contains a multi-jet burner near its base. These components are enclosed within a vitreous enamelled shell. The top cover of the appliance deflects the combustion products as they escape from the cylinder so that discolouration of walls and ceiling may not occur.

There are two gas cocks on the water heater and these are interlocked so that the smaller tap controlling the pilot flame must be turned on before the larger one connected to the main burner is free to move. An additional control in the form of an automatic gas valve is provided so that the main supply of gas cannot pass to the burners until an adequate flow of water through the appliance has been established.

The water section of the apparatus consists of two main taps of the usual design, a water volume governor, a gas valve



[*Reproduced by courtesy of Messrs. Ascot Gas Water Heaters, Ltd.*

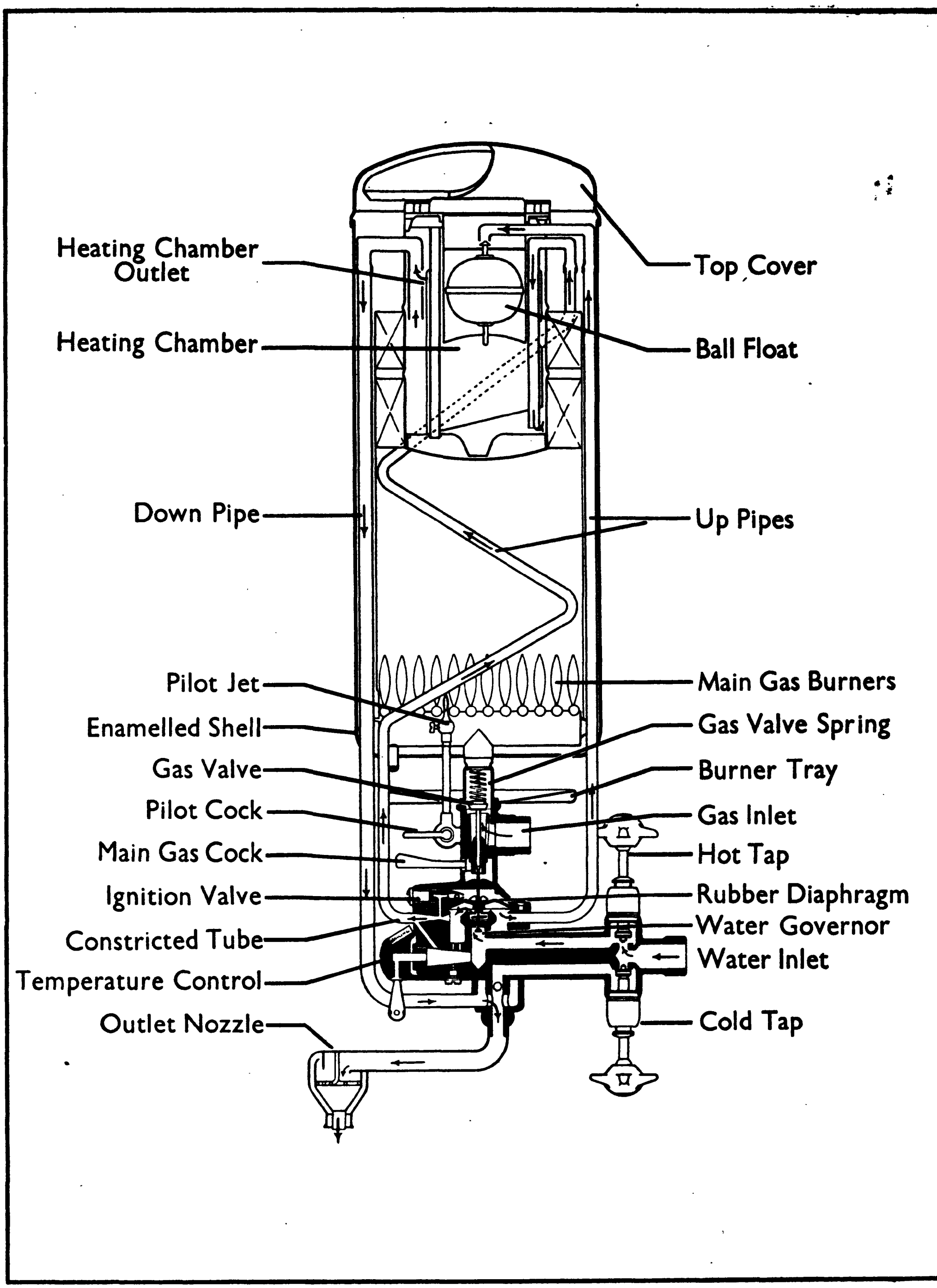
THE INSTANTANEOUS GAS WATER HEATER

diaphragm and a temperature selector. These components form a group below the main gas inlet. Two up pipes carry the flow from the mechanism in the base to the heating chamber in the cylinder head and a single down pipe guides the output to the spout or nozzle. In order that the cylindrical combustion chamber might be kept at an even temperature the waterways are coiled around it.

How the heater works.—When the appliance is ready for service but is not actually working, both water taps are closed, both gas taps are open and the pilot jet is alight. Under these circumstances, however, no gas can flow to the main burner as the passage is closed by the spring-loaded gas valve. On the hot tap being turned the valve opens gradually and admits gas to the main burner where it ignites owing to the presence of the pilot jet. Water passes through the channels of the lower section and thence to the heating chamber from which it issues as a hot stream at the spout.

The diagram represents the apparatus with the temperature selector set in the position *Boiling*. Thus regulated, the cold stream from the inlet passes through the water volume governor and then divides into two. The main portion goes through the pipe shown on the right to the top of the heating chamber where its entry is controlled by a ball float valve, housed in the inner chamber of the container. The smaller stream which passes through the alternative pipe line represented on the left is made to operate the gas valve. When the water in the heating chamber boils, it is raised by steam pressure to the level of the side outlet through which it flows to the down pipe and spout. As the level in the heating chamber lowers, the ball float drops and allows fresh water to enter and replace that which has been drawn off. In this way a continuous, unlimited supply of heated water is provided, boiling point being attained without regulating the gas supply or the inlet temperature of the water.

The temperature selector fitted to the appliance has three positions—*Boiling, Hot*



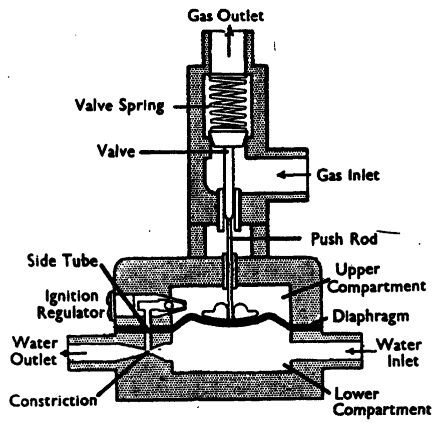
Internal Arrangement of Instantaneous Gas Water Heater and *Warm*. When the control is at *Boiling*, the water has only two passages open to it after passing the water governor, but at *Hot* an additional one is opened. At *Warm* another is brought into play and as this one by-passes the water governor, the temperature of the output in this setting of the selector can be controlled directly by the hot tap.

The automatic gas valve and the water volume governor.—The first of these interesting features of the heater enables the water tap to control both gas and water supplies and the second overcomes difficulties due to varying water pressures. A rubber diaphragm in the water section of the appliance operates both these devices.

An increase in pressure at the water inlet causes the diaphragm to rise and to lift the water valve in the governor slightly. This reduces the size of the passage and thus counterbalances the effect of the extra pressure. In a similar way a drop in pressure is accompanied by a small increase in the water valve opening.

The arrangement of the automatic gas valve is shown separately in the diagram. A spring-loaded valve controlling the gas inlet is linked to a flexible diaphragm by a short push rod. Inlet and outlet water pipes open into the compartment below the diaphragm. A small side tube connects the throat of a constriction in the outlet pipe to the upper diaphragm chamber through an adjustable valve which serves as ignition regulator.

When water flows through the apparatus a difference in pressure is established between the two diaphragm compartments because the pressure at the throat of a constricted pipe where the velocity of the water stream



Arrangement of Simple Automatic Gas Valve

is greatest is considerably lower than that at a point immediately before the constriction. In this way, when the flow is sufficient, the pressure difference between the two sides of the diaphragm is able to raise the rubber, overcoming the force exerted by the spring-loaded gas valve. As soon as the hot tap is closed and the flow of water ceases, the pressures in the two diaphragm compartments equalise. Consequently the spring pushes the gas valve on to its seating again.

GAS LIGHT

For many years now the use of gas for domestic lighting purposes has been adversely affected by the widespread adoption of electricity, but the gas industry has faced the competition bravely and has improved its lighting technique in so many ways that its shortcomings in comparison with its rival have been greatly curtailed. Modern lighting by gas is much more convenient and effective than that offered some years ago.

The only system of gas lighting now recommended for domestic purposes makes use of the inverted incandescent mantle in conjunction with a specially designed bunsen burner. Two or three standard sizes of mantle and burner are in common use, these having been chosen to meet normal requirements. Higher power lights than those standardised are obtained by using mantles in sets of two or more. Remote controls for gas lights, offering the convenience characteristic of the electric switch, are now available and can be fitted quite easily to an existing installation if necessary.

Mantles.—The luminous material of a gas light is a mantle which consists of certain selected chemicals on the skeleton of a knitted stocking of silk or ramie grass fibre. The actual silk or fibre built into the mantle in the course of manufacture is burned away at one stage so that only a delicate shell remains to bind together the chemicals with which the knitted stocking had been impregnated. The first mantles were supported in an upright position by means of a small asbestos loop, but modern mantles are inverted and hang from a three-legged clay ring. The amount of light obtained from a gas point depends on the temperature attained by the mantle, and as a slight increase in this temperature produces quite a big improvement in the illumination it is important to use burners which promote the highest possible mantle temperatures.

Gas lighting burners.—Following the normal plan of a bunsen, a lighting burner has a small hole which serves as gas injector and a larger air inlet which is controlled by an adjustable ring. In some makes, the gas is injected through a group of small holes instead of through a single one, the idea being to reduce noise. In actual practice, however, neither type of injector appears to have any marked advantage compared with the other. The really important thing about the gas inlet is the accuracy with which the hole has been drilled. Ragged edges or unsuitable sizes of inlets reduce efficiency very considerably. The flame from a good burner plays on the mantle in such a way that its hottest part is acting directly on the luminous surface. A flame which is too big or too small for its mantle will fail to achieve this.

The mantle ring is held on the burner by a suitably shaped support of fire clay or porcelain, materials chosen for this purpose not merely because they can withstand the heat but also because they are of low thermal conductivity. Metal supports cause loss of light by carrying away heat which should be fostering high mantle temperature.

Above the mantle support is a gallery which serves several purposes, although only the obvious one of holding a shade or globe seems to be generally recognised. The gallery top is cut away so that the burner may be adequately ventilated, but the openings are shaded by projections which divert the stream of hot air which rises from the region of the mantle. In this way the gallery prevents the fittings on the upper part of the burner from being overheated, it keeps the products of combustion away from the air inlet of the burner and it spreads the convection currents of hot air so that the tendency to discolour the ceiling is reduced.

Remote control.—The usual kind of "gas switch" is a mechanical contrivance whereby the control tap on the supply pipe near the burner is linked to a lever or turn button near the door. A length of nickel-silver wire is enclosed in a spiral spring casing and is connected at its ends to the hand lever or button and to the gas control, after the style of a cable-operated bicycle brake. The pull or push action of the wire as the hand control is worked moves the gas tap lever.

A means of igniting the gas must be available near the mantle when using a switch. As a rule, a very small by-pass flame which is independent of the switch is left burning, although flint igniters, chemical heaters and battery operated filament lighters have been used with some success.

THE GAS FAN

In order to produce movement by means of gas, it is usual to employ an internal combustion engine, but as such machines are quite unsuitable for work in a house, the gas industry has not developed domestic appliances which involve rotating mechanism. Thus, for instance, there are no gas operated clothes wringers, vacuum cleaners or sewing machines. But there is one notable exception to this rule, for gas ventilating and cooling fans have been designed and are manufactured as a commercial proposition.

Construction of the gas fan.—The machine is planned on the same lines as the common electric fan, a four-bladed agitator of large diameter being used. A wire guard is fixed round the rotating mechanism and the whole thing is supported on a substantial base. The fan itself is mounted directly on the end of the crankshaft of the driving engine. The two cylinders are both below the level of the crankshaft, and immediately underneath one of them is the small gas burner which provides the motive power.

Each cylinder has its own piston and connecting rod, but both rods work on the same shaft. The two cranks in this are not in the same plane but are at right angles to each other. The first piston, called the *displacer*, is very slack in its cylinder so that gas may pass quite freely round it from side to side, but the second, which is the *power piston*, is a reasonably good fit. Extreme accuracy in this matter is not very important in an engine of the fan type as the working pressures are low.

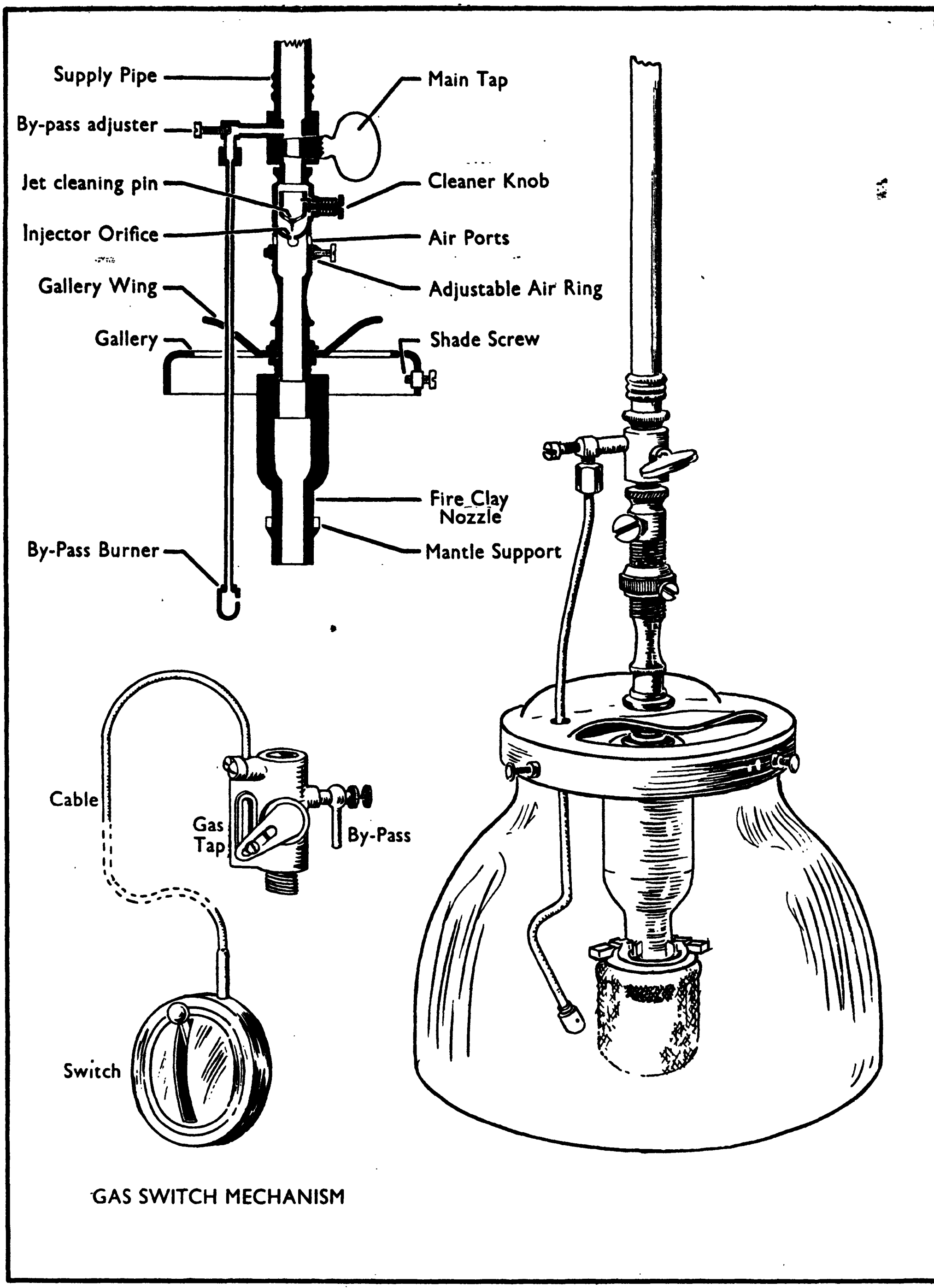
The power cylinder is open above the piston, but the displacer cylinder is closed at both ends. This arrangement gives the engine three chambers—the power cylinder and the two ends of the displacer cylinder. All three are in communication with each other as a pipe or duct links the two cylinders.

The lower part of the displacer cylinder is just above the burner and thus forms the heating chamber. The upper section is fitted with radiating fins of the kind used on motor cycle engine cylinders, so that it may be cooled effectively by the atmosphere. The draught created by the fan helps to cool this upper chamber.

How the fan engine works.—A fixed quantity of air enclosed within the two cylinders of the engine constitutes the working substance of the machine. When air is heated it tends to expand and when cooled it tends to contract; these tendencies are applied in the present case to the practical job of driving an engine.

Starting a survey of the cycle of operations at a time when the displacer piston is at its highest position, it is found that the power piston is half way up its stroke. At this particular point in the cycle the power impulse is at a maximum as the cold part of the displacer cylinder is practically free of air, and the hot part is full of air which is expanding and forcing the power piston upwards. Fig. 1.

As the crankshaft turns under the influence of the ascending power piston, the displacer moves towards the hot compartment so that by the time the power stroke is finished, and the power piston is at its highest position, the displacer is midway between the hot and cold ends. The change in the location of the displacer causes the air in the cylinder to occupy part of the cold end. Therefore the air considered as a whole begins to contract, a process which is accompanied by a downward movement of the power piston. Fig. 2.



THE GAS LIGHTING BURNER

The contraction is at a maximum when the displacer is at the bottom of its stroke as practically all the air has moved round the periphery of the piston into the cold compartment. At this stage the power piston is halfway down its stroke. Fig. 3.

As the power piston approaches its lowest position, the crankshaft begins to lift the displacer upwards so that the air may re-enter the heated section of the cylinder. The transfer to the hot compartment is halfway towards completion by the time the power piston has finished its downward stroke. Expansion is once more commencing and so the power piston is ready for a new upward stroke. Fig. 4.

The power piston movements induced in this way by the cyclic expansion and contraction are made to rotate the fan shaft in the usual way by crank and connecting rod action. The displacer is of course a driven unit and makes no contribution to the power of the engine. The air which works the machine does not escape, so there is no exhaust noise, and with the exception of oiling occasionally the device requires no attention.

THE GAS REFRIGERATOR

The state of affairs to be observed in a gas refrigerator seems paradoxical, for in this machine a cooling effect is caused by a gas flame. To establish refrigeration by applying heat appears at first glance to be an impossibility, but the following analysis of what occurs in the tubes and chambers which comprise the cooling apparatus shows how it is accomplished.

Construction of the refrigerator.—The working part of the refrigerator consists of three containers, an air-cooled duct, a warming jacket and a series of pipes linked together to form a completely enclosed system, as represented in the diagram. This hermetically sealed apparatus contains a certain quantity of pure water, ammonia and hydrogen. An external gas burner is installed so that its flame may heat simultaneously two tubes, one of which is coiled round the other.

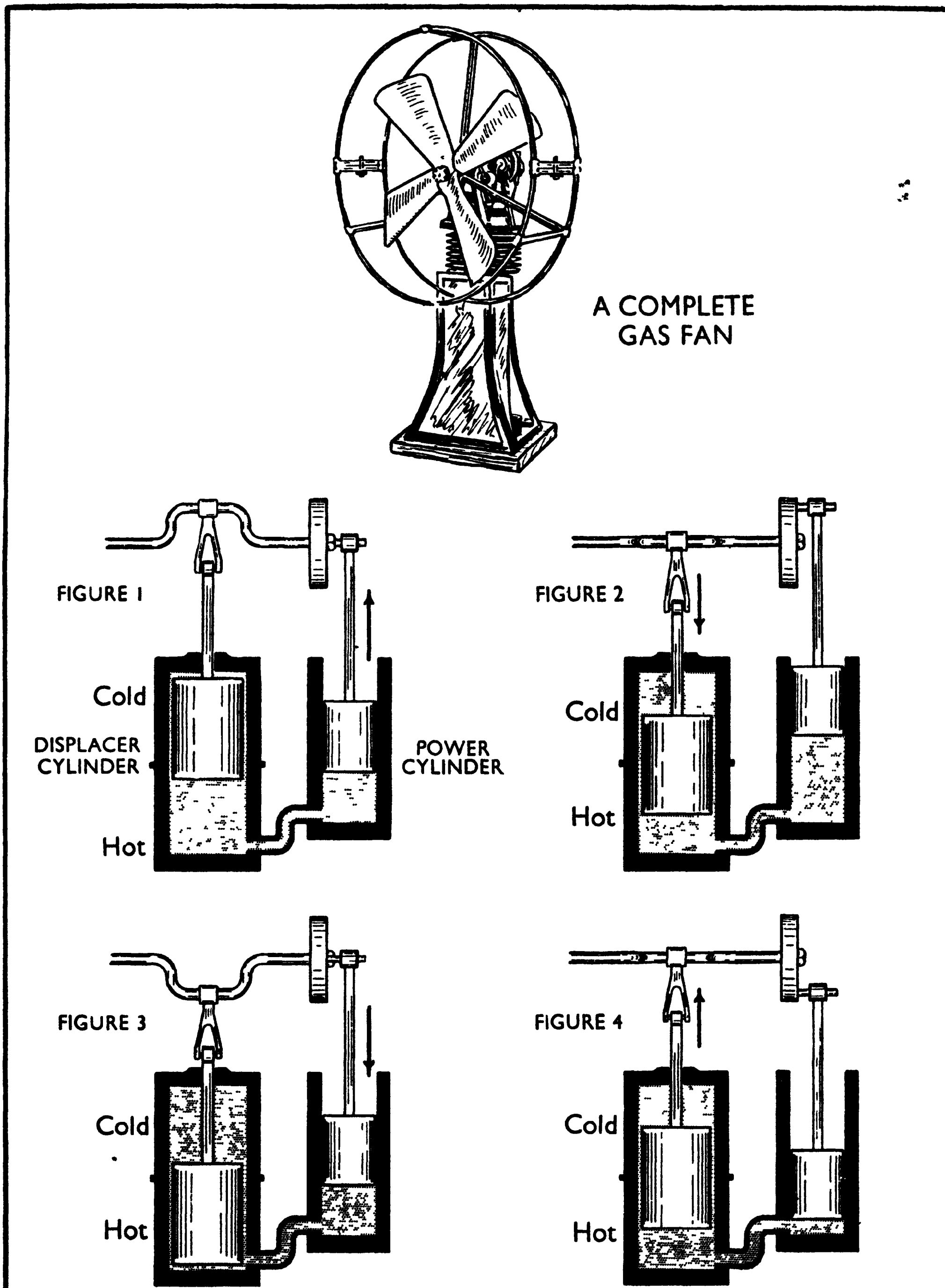
The first container, called the *generator*, is nearly full of strong ammonia solution. Heat from the gas burner is applied to this generator when the refrigerator is in action. The second container is the *evaporator*. This is fitted with shelves or trays which facilitate evaporation of liquid entering at the top by splitting it into numerous small drops as it drips to the bottom. The evaporator is housed in the storage cupboard of the refrigerator cabinet as it is the chamber which actually produces the cooling effect. The third container is the *absorber*. Liquid entering this at the top drips over trays and absorbs gas rising from the bottom.

How the refrigerator works.—The action of the gas operated refrigerator is based on the following scientific facts:—

1. When a solution of ammonia gas in water is heated, the ammonia is liberated.
2. Ammonia gas liquefies when subjected to high pressure at ordinary room temperatures.
3. Liquids evaporate easily when broken up into small drops.
4. Liquids absorb heat as they evaporate.

Starting now at the generator the cycle of changes can be traced out. Ammonia gas is liberated in the generator as the gas burner warms the solution. This gas passes through the air-cooled duct, losing heat to the atmosphere outside on its way. The space in the pipes and containers not occupied by water or ammonia is filled with hydrogen, a light gas which has no chemical effect on the other contents of the apparatus. This hydrogen applies high pressure to the ammonia gas which has been liberated in the generator and therefore causes it to liquefy when it has cooled sufficiently in the duct. Notice that liquid ammonia is not the same thing as ammonia solution.

The liquid ammonia trickles over the trays in the evaporator, vaporizes and absorbs heat from its surroundings. From the bottom of the evaporator a mixture of ammonia gas and hydrogen passes through an



THE GAS FAN ENGINE (DIAGRAMMATIC)

outlet pipe to the base of the absorber. Here the gases meet a stream of water which is trickling down over the trays. The ammonia is therefore absorbed as it is very soluble in water, but the hydrogen passes on unaffected. A return path to the evaporator for hydrogen is provided at the top of the absorber.

The liquid at the bottom of the absorber is strong ammonia solution. This passes along a pipe to the generator where it recommences the cycle of operations.

So far as refrigeration is concerned, the above description is complete, but the water circulation which makes the system entirely self-contained has so far been taken for granted. It will be noticed that in order to make the machine continuous in action, the generator must be constantly supplied with fresh ammonia to make up for that which is passing out and the absorber must be provided with a steady trickle of water containing practically no ammonia, so that the gas may be collected after serving as refrigerant.

The circulation of ammonia solution and water is established and maintained by the hot coiled tube which serves as a simple kind of lift pump. Normally the liquid in the generator is on a level with the top of the pipe which pours water into the absorber. Similarly the levels in the absorber and in the generator feed pipe are the same. But this state of balance is disturbed when the gas burner is working because bubbles of ammonia are released in the coiled tube. These bubbles rise in the feed pipe and carry ammonia solution over into the generator. As the bottom of the generator is linked by pipe and warming jacket to the absorber, a rise in the level in one chamber causes an overflow into the other. Thus water from the generator passes into the absorber by the action of gravity whilst solution from the absorber is forced back again into the generator by the hot coiled tube.

The contribution made by the warming jacket is a mutually advantageous interchange of heat. In this apparatus, the strong solution is warmed prior to passing into the hot coiled tube whilst the weak liquid is cooled so that it may be ready to dissolve ammonia when it reaches the absorber.

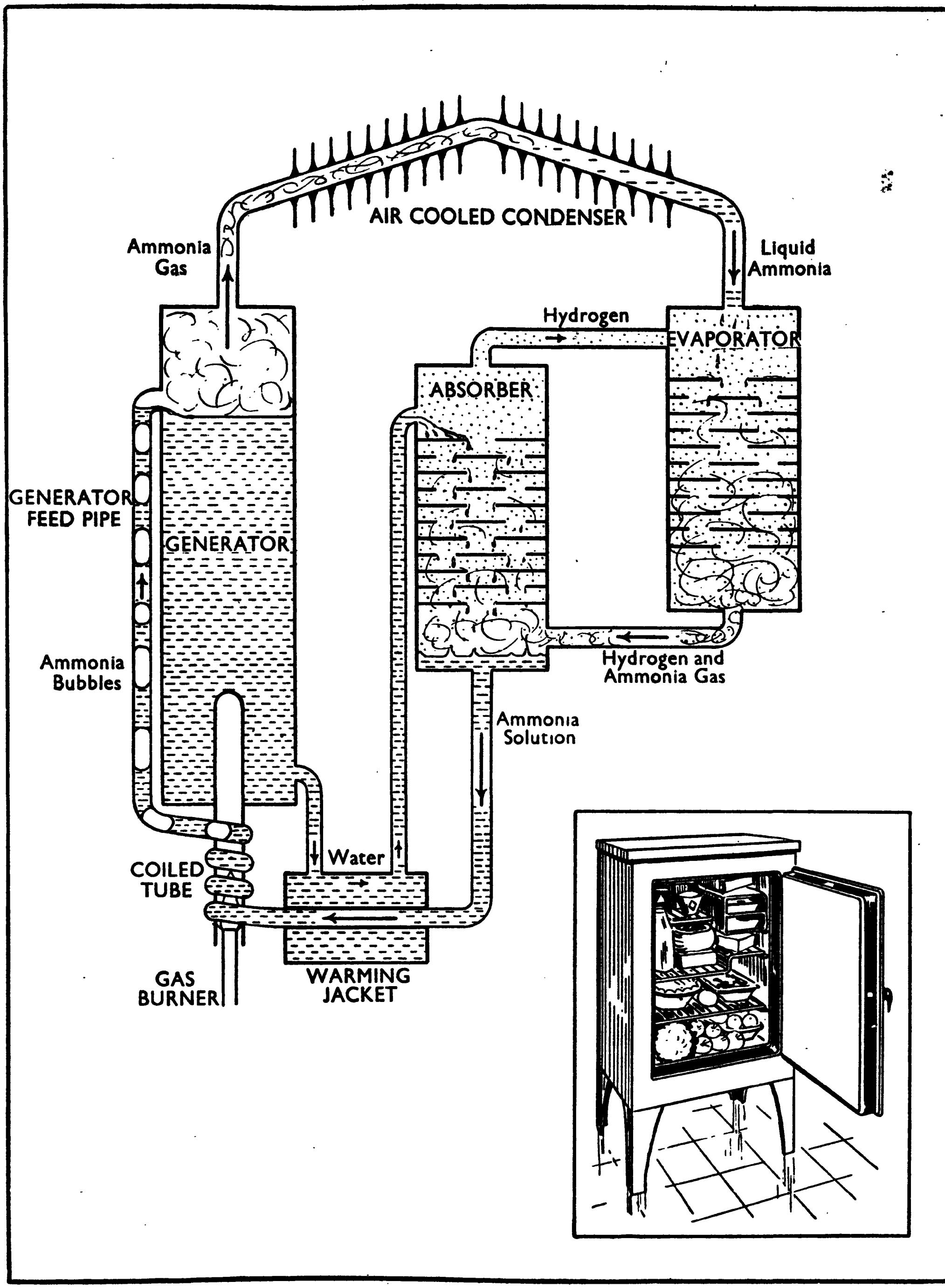
THE GAS METER

The most straightforward and direct way of measuring the volume of a quantity of liquid or gas is to observe how many times the fluid will fill a vessel of known capacity. The method is regularly applied in garages, dairies, etc., for the purpose of measuring such liquids as milk or oil. Gases are not so easily handled as liquids and their containers have to be completely enclosed to prevent escape, but the same system of measuring can be adapted to suit them. The common gas meter is nothing more than a set of measuring vessels with automatic mechanism which records each filling.

Construction of the gas meter.—The case of the gas meter is divided internally into two main sections by a permanent horizontal partition. The lower compartment, which is much larger than the other, is subdivided into four measuring chambers whilst the upper one contains recording mechanism and a gas reservoir.

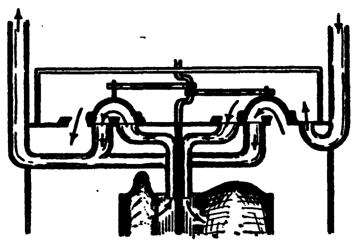
A rigid vertical wall is fixed centrally in the lower section of the meter, and on each side of it is attached a flexible sheepskin diaphragm or bellows. In this way, four gas compartments are formed, two being within and two being outside the flexible bellows. Four gas passages lead from the chambers to the control mechanism above. The circular end discs of the bellows are linked by a system of rods and levers to the main shaft of the recording mechanism in the upper compartment so that diaphragm movements may be registered.

The main gas supply pipe which feeds the meter opens into a small compartment in the top part of the instrument. This chamber serves simply as a reservoir from which gas passes when required into the measuring compartments below. The four outlet pas-



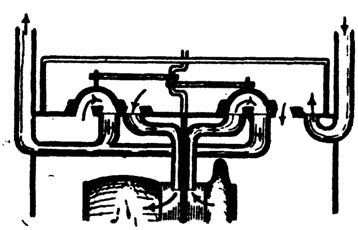
INTERNAL ARRANGEMENT OF GAS REFRIGERATOR (DIAGRAMMATIC) sages from the reservoir are controlled by simple slide valves which operate from a crank on the main shaft of the meter mechanism. There is a slide valve for each half of the lower compartment. The middle opening or *port* of each valve is connected to the pipe which leads to the house.

How the meter works.—The slide valves of the meter are arranged so that gas is free to enter the *outer* measuring chamber in one half of the meter and the *inner* or bellows chamber of the other half at the same time. Whilst these two gas ways are open, the other two chambers are in communication with the house pipe through the middle ports of the valves. Thus gas



Meter with Gas entering the Bellows on the Right and the Outer Chamber on the Left

enters the outer chamber in one half and pushes the contents of the adjacent bellows into the house pipe by pressing on the circular end disc. In other words, as gas enters the outer chamber the bellows collapse. Whilst this is occurring, gas is entering the bellows in the other half of the meter. As



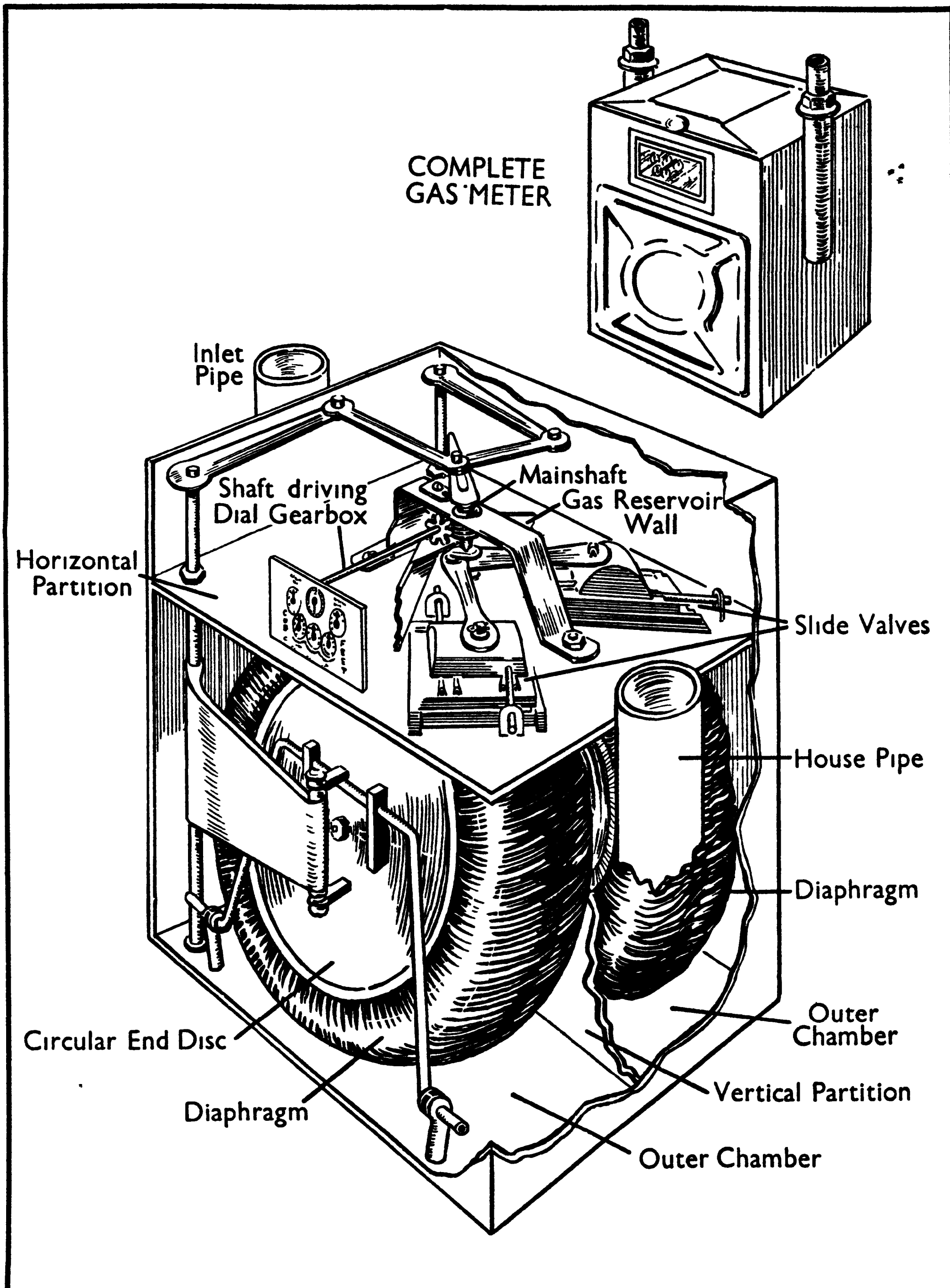
Meter with Gas entering the Bellows on the Left and the Outer Chamber on the Right

inflation occurs here, gas is forced out of the corresponding outer chamber into the house pipe. The two diaphragm movements together turn the main shaft of the meter mechanism and through the clockwork gearbox make an appropriate record on the dials. The diaphragm lever system is adjusted so that the volume of gas swept out of the two chambers is equivalent to the registration.

By the time the diaphragm movements are complete, the main shaft has moved the slide valves over to their alternative positions. The chambers which have just been filled are now opened into the house pipe through the valves and are cut off from the supply in the reservoir. The outer chamber and the bellows which have been discharging are put into communication with the main supply. Consequently, a second simultaneous filling and emptying process occurs.

Each discharge from the outer chamber of one half of the meter and the inner chamber of the other half makes its record on the dials. Every time the diaphragms reach the limit of their movement, the slide valves reverse and so a new stroke commences. Throughout the cycle of operations, gas is available for use in the house as there is always a pair of chambers which are ready to be emptied.

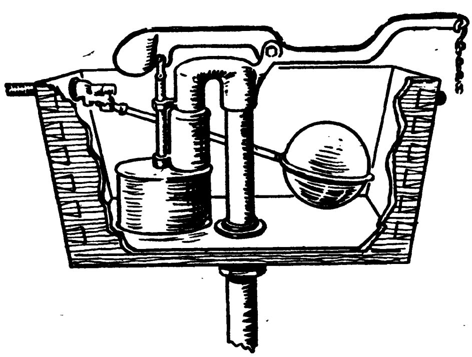
The gas meter is entirely self controlled. Diaphragm movement begins as soon as a gas tap in the house is opened and ceases when the flow is cut off. The speed at which the meter works varies automatically according to the demands made by the apparatus in use and may rise to the rate of 1,000 revolutions per hour when the instrument is operating at its maximum. As a meter is really a kind of gas engine, the energy necessary to work the dials and valves is withdrawn from the gas. Consequently, the introduction of a meter into a pipe line involves a slight loss of pressure, but in practice this loss is so small as to be negligible. Accuracy of workmanship and care in the choice and preparation of the raw materials used in manufacture have made the modern gas meter capable of long service with remarkable reliability.



INTERNAL ARRANGEMENT OF THE GAS METER

THE FLUSHING CISTERN

Construction of the flushing cistern.—The cistern case, which is made of wood with a metal lining, fireclay or some other strong impermeable material, is fitted with a ball tap, a flushing unit and an overflow pipe. The ball tap is connected directly to the main water supply in the usual way and the overflow leads through the wall to a suitable place outside the building. When the ball tap develops a fault and fails to shut off properly, the overflow pipe carries away the excess water and prevents flooding.

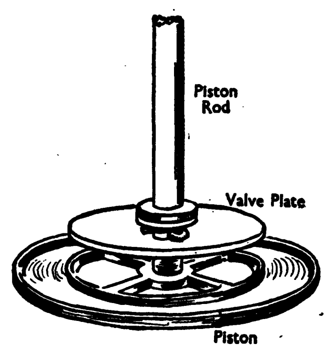


ARRANGEMENT OF FLUSHING CISTERN MECHANISM

The flushing unit is built on a pipe of large bore shaped like an inverted J. The long arm of the J passes through the base of the cistern and leads down to the basin which is to be flushed. The top of the inverted J projects above the cistern and the short arm opens into a wide cylinder whose mouth is near the tank bottom. A piston, with a movable valve plate on its upper surface, is mounted in the cylinder and the piston rod extends through a hole in the cylinder top to a coupling on the cistern operating lever.

How the cistern works.—Prior to flushing, water is settled at a common level in the cistern itself and in the short arm of the J. As this level falls short of the top of the pipe, no water can pass down the long arm into the basin.

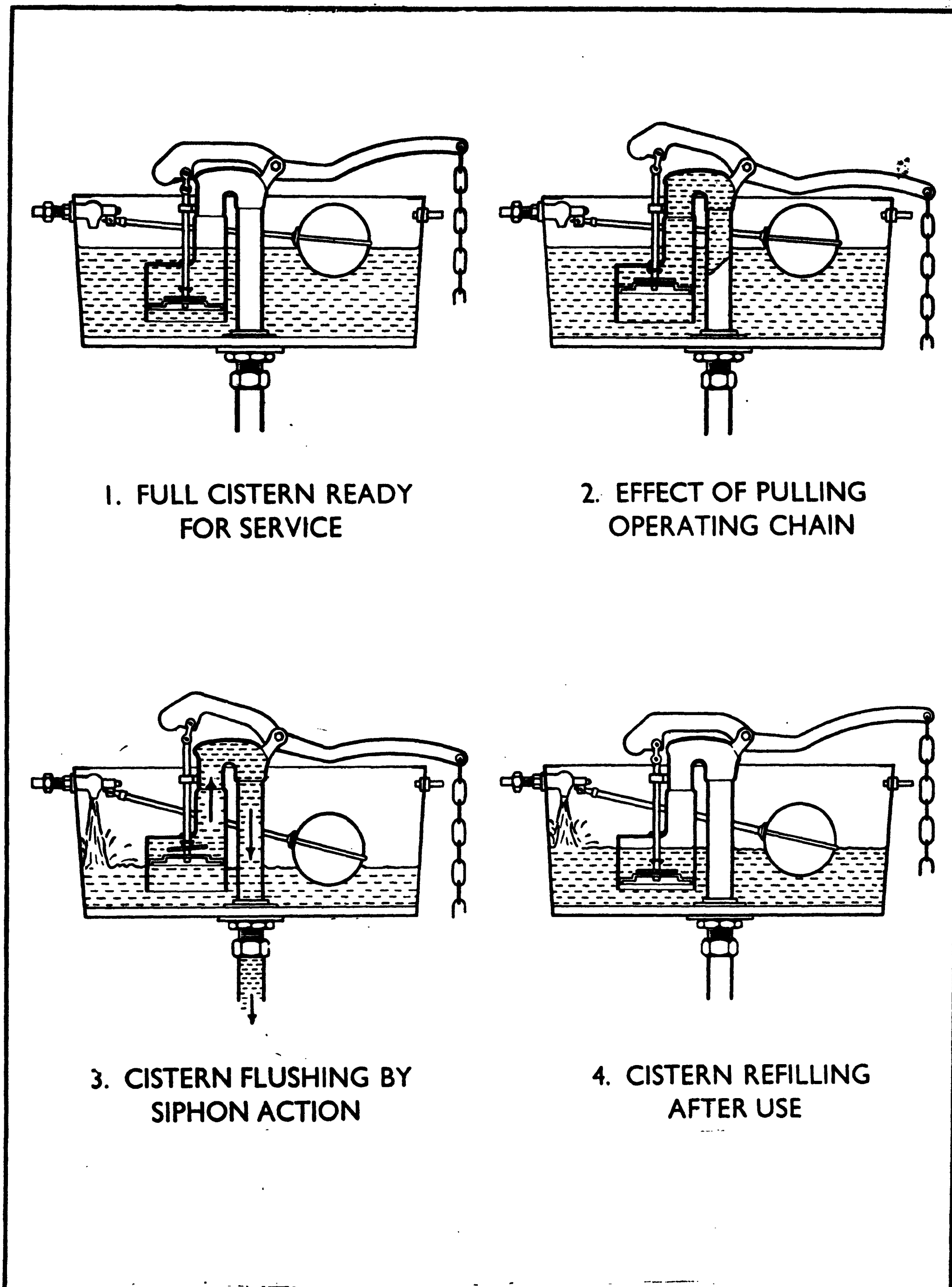
When the operating chain or lever is pulled, the piston slides smartly upwards



THE PISTON AND VALVE UNIT

carrying with it the water which is in the short arm and in the upper portion of the cylinder. Water from the cistern follows the piston, thus occupying the space vacated by the rising column in the cylinder. The flushing unit is designed so that the piston lifts more than enough water to fill the short arm and top curve of the J. Towards the end of the movement therefore, water begins to run down the long arm. This establishes siphon action as the long descending column in the down pipe cannot be balanced by the short liquid column in the tank.

Water rushes up the short arm and down into the basin, overcoming the opposition offered by the piston by lifting the valve plate up from the perforations. When the cistern level falls below the mouth of the cylinder, the flow stops, both pipes drain, the piston and lever mechanism drops down to its original position and the tank begins to fill again as water runs into it from the ball tap orifice. When the normal water level is restored, the tap float and lever shut off the supply and the cistern is ready for use again.



ACTION OF THE FLUSHING CISTERN

THE WATER SOFTENER

Construction of the water softener.—The contrivance consists essentially of a cylindrical container filled with a special kind of sand and fitted with inlet and outlet pipes. In order that the necessary routine attention may be given with the minimum of trouble, some of the larger household water softeners are supplied with additional valves, taps and controls, but these are in no way vital to the working of the appliance.

As water softeners require to be treated with common salt periodically in order to restore efficiency, arrangements are usually made for the convenient introduction of this material. Some models have detachable lids in the cylinder heads. The salt or brine is poured into the depression which surrounds the lid and soaks into the active material below. More elaborate water softener designs include a separate brine cylinder which stands by the side of the sand container. Sufficient salt for several treatments is stored in this way and a number of regenerations may be carried out without recharging the apparatus.

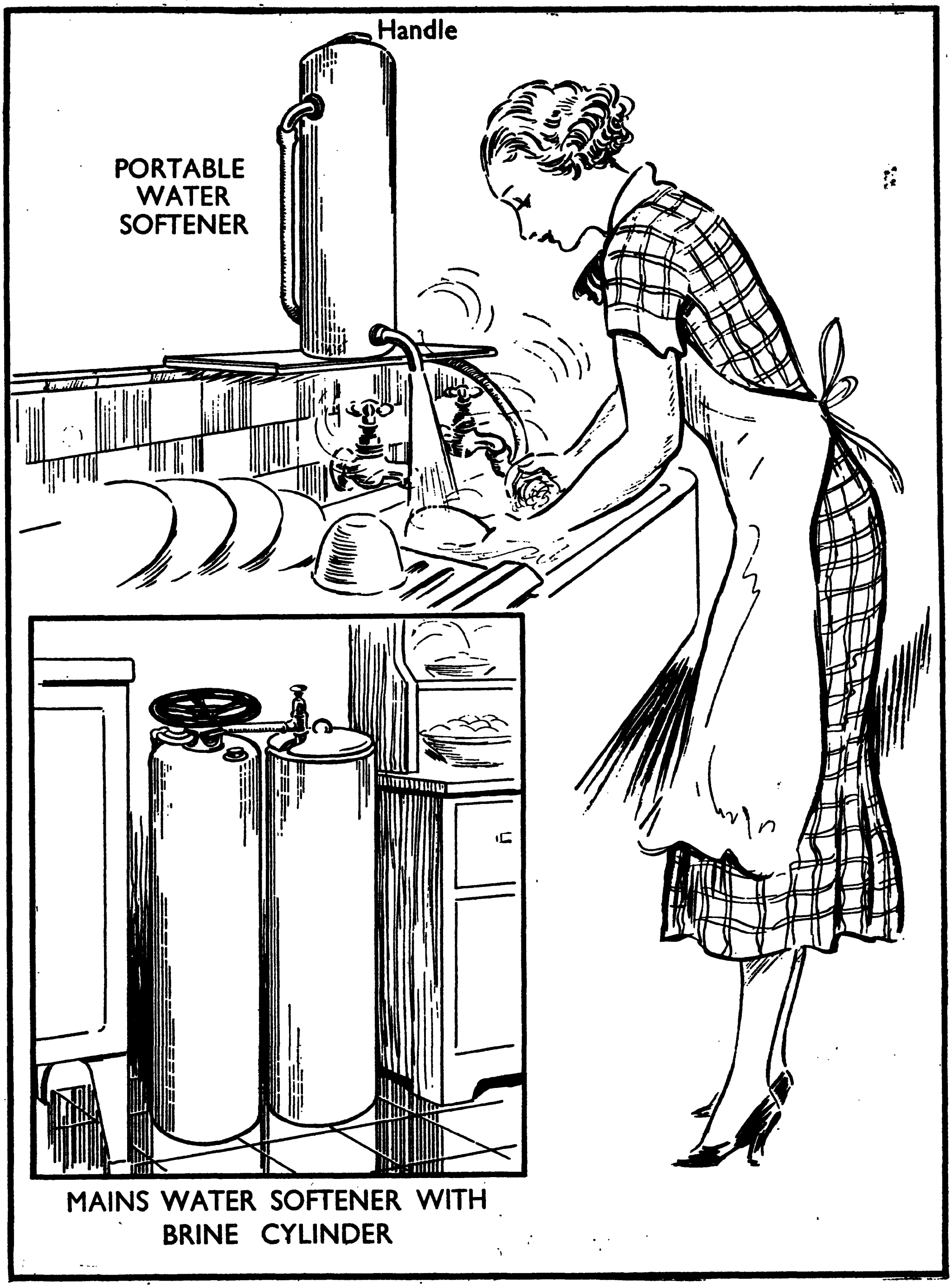
How the water softener works.—In order to soften a quantity of water the calcium and magnesium which it contains have to be extracted. In hard water these two elements do not occur alone but are found in a state of combination with several other elements. The resulting chemical compounds are known as *salts*. The salts which commonly cause hardness in water are: Calcium carbonate; Calcium sulphate; Calcium chloride; Magnesium carbonate; Magnesium sulphate; Magnesium chloride.

As it is only the calcium or magnesium in a salt which causes hardness, it is unnecessary to remove from the water the whole of the offending compound. This complete elimination indeed would be difficult. In practice, therefore, the unwanted calcium and magnesium are made to change places with another element called *sodium* which is contained in the softening agent. The sodium becomes part of the salt content of the water, transforming this into sodium carbonate, sodium sulphate or sodium chloride. As none of these sodium salts causes hardness or is objectionable when present in small quantities in a domestic supply, the exchange is an excellent system of water softening.

The sand used in a water softener belongs to the group of chemicals known as zeolites. The zeolite contains sodium in its composition and it has the power to exchange its sodium for any calcium or magnesium which may be present in water percolating through it. Upon this action is based the water softening process. As hard water passes through the cylinder it exchanges its magnesium and calcium for sodium, the magnesium and calcium are retained by the zeolite whilst the water flows out of the apparatus with nothing but sodium salts in solution. As these salts produce no hardening effect, the output of the appliance is perfectly soft.

When all the sodium in the sand has been replaced by either calcium or magnesium, no further softening can take place. At this stage the softener requires *regenerating*, a process which consists of running common salt solution through the sand bed until the escaping liquid tastes strongly of salt.

During regeneration an exchange occurs which is exactly opposite to that which produces softening. Common salt is *sodium chloride*. As this substance passes through the exhausted sand it exchanges its sodium for the calcium and magnesium contained in the zeolite. Calcium chloride and magnesium chloride are formed as a result of this, and these salts, being soluble in water, pass out of the appliance in the waste stream. The sodium from the salt is retained by the sand which is thus restored to its normal composition. A rinse with fresh water clears the cylinder of any brine which remains unused and the water softener is capable of rendering further service.



Household Water Softeners

THE FIRE EXTINGUISHER

A fire may be subdued either by cooling the burning material or by excluding air from it. The first method is being used when water is squirted on to a fire and the second when a rug or similar object is applied to smother the flames. Although the first system of fire fighting is thoroughly effective, it usually requires the application of a considerable quantity of the extinguishing substance in order to achieve its purpose completely, and for that reason it cannot be adapted very well to the limitations imposed by handy portable extinguishers. The second system is not so easy to put into practice as the first but it certainly has the advantage of needing only a limited quantity of extinguisher. Simply because of its modest requirements, the latter method is applied when using emergency apparatus.

Special extinguishers are provided in buildings where inflammable liquids are stored and these emit foam, solution or vapour which can form a blanket *above* blazing stock. A petrol or oil fire would be aggravated rather than suppressed if an extinguisher with an aqueous content were used upon it, as such blazing fluids can float and spread on water. Similar precautions are taken in places where the extinguishing jet may play on live electrical cables, as water, being a conductor in its normal state, may cause short circuits and thus encourage subsidiary outbreaks.

The extinguisher to be described is of a type recommended for most general purposes and is known as the "Soda Acid" pattern.

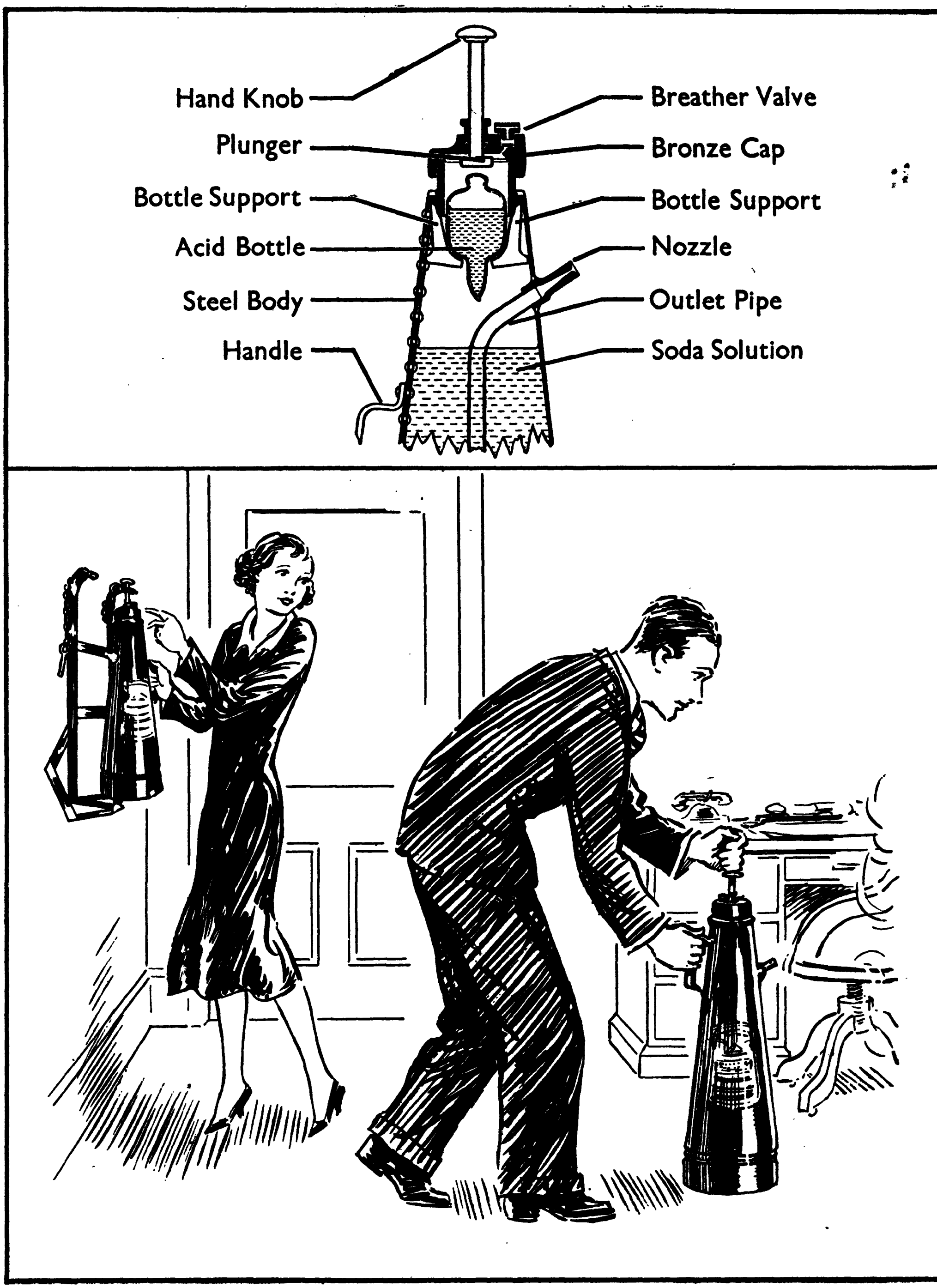
Construction of the fire extinguisher.—A conical body of steel, suitably coated with resistant metal to avoid corrosion, forms a container for the extinguishing liquids. Its stout build enables it to withstand high internal pressures. A nozzle projecting from the side extends internally to the bottom and a handle opposite provides a grip for the operator. A screw-down bronze cap fitted with hand knob and breather valve closes the top of the machine. Immediately below the hand knob plunger, supported firmly in clips, is a sealed glass bottle containing strong sulphuric acid. A solution of common soda in water fills the body of the extinguisher.

How the extinguisher works.—When the hand knob is struck a sharp blow, the plunger breaks the bottle and allows the acid to fall into the solution below. A vigorous reaction takes place and a great quantity of carbon dioxide is generated. As the space within the extinguisher is very limited, this gas creates a high pressure and consequently the liquid mixture is forced out of the machine through the outlet pipe and side nozzle. Carbon dioxide is very soluble in water when subjected to high pressure and so most of the gas liberated in the chemical reaction is carried away in solution in the jet of liquid.

An ordinary extinguisher can throw its contents a distance of thirty feet or more, so the operator can direct the stream on to the base of the fire whilst standing in a safe position. By the action of the machine therefore, a strong solution of carbon dioxide in water is poured directly on to the flames.

In the open air the extinguishing liquid is not under pressure comparable with that exerted within the appliance. Its carbon dioxide content therefore comes out of solution and takes on its normal gaseous form. The heat from the fire helps this evaporation process. Being much heavier than air, the carbon dioxide forms an invisible cloud over the flames, and as the gas cannot support combustion the cloud has a strong smothering effect.

The water which has acted as carrier for the carbon dioxide and the sodium sulphate which is a by-product of the soda-acid reaction make a secondary contribution to the extinguishing action by exerting a cooling influence on the burning material.



THE FIRE EXTINGUISHER

THE ALARM CLOCK

In an ordinary alarm clock there are two distinct mechanisms driven from two entirely separate mainsprings. One of the units operates continuously in order to drive the hands, but the other comes into play only when the alarm is to be sounded. The two parts of the clock are interconnected so that the alarm may be controlled by the time keeping section.

Construction of the clock.—The time keeping mechanism of the clock is built round a powerful spring which drives a large gear wheel as it uncoils. This wheel meshes with a pinion fixed on the long shaft which carries the minute hand. Power is transmitted to two separate trains of gears from this shaft by means of two gear wheels. The first train, mounted just behind the dial, reduces speed and drives the short tubular spindle which carries the hour hand. The other gear train increases the speed and drives a small wheel which meshes with a two-pronged fork. A balance wheel connected to the pivoted fork oscillates steadily so that the last wheel of the gear train is released at a uniform rate, one tooth at a time. The hairspring on the balance wheel is adjusted so that the oscillating system allows the main shaft of the clock to rotate once per hour.

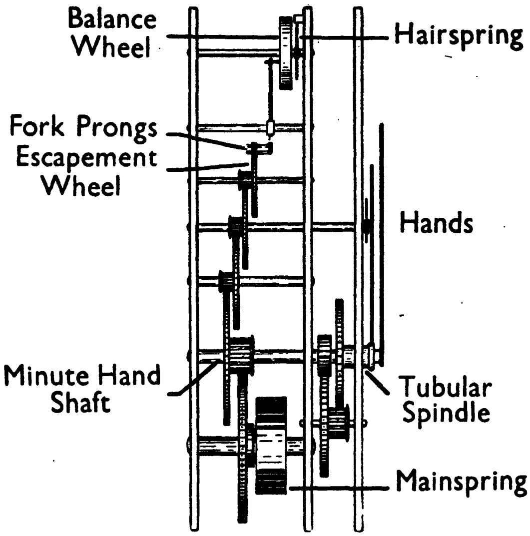
The alarm mechanism may be considered in two parts—the time control and the driving gear. The time control consists of an ordinary toothed wheel driven from the hour hand pinion so that it revolves once in twelve hours. The wheel is free to turn independently of its spindle and is pressed forward by a long springy strip mounted behind it. A pin in the spindle governs the position of the wheel on the shaft. At one point on the wheel boss a slot is cut. This slot is big enough to take the pin so that when the two coincide the whole wheel is free to slide forward. One side of the slot is sloped so that the pin can easily slide up to the boss top again after it has been in the notch. The springy strip behind the control wheel is bent over at the top to form a brake arm and this projects into the alarm driving mechanism.

This driving mechanism is straightforward clockwork. A coiled mainspring coupled to a large gear wheel drives a pinion. On the pinion spindle there is a toothed wheel which engages with a two-pronged fork. The fork is pivoted and as it turns it moves the gong hammer and brake engagement rod which are built in a unit with it.

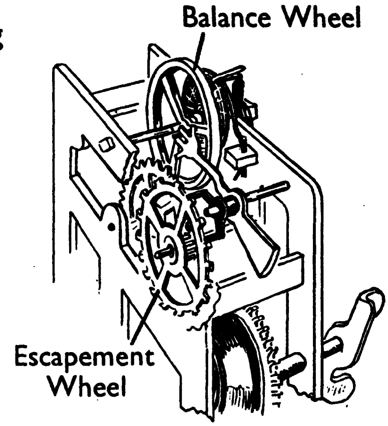
How the alarm works.—To set the alarm, the shaft upon which the time control wheel rotates is turned by means of its hand knob until its pin is in a position which corresponds with the desired time. As time elapses, the control wheel moves round in the ordinary way, but the shaft and pin remain stationary. At the specified moment the wheel slot and the pin coincide, the wheel slides forward until the slot bottom touches the pin, the springy strip follows the wheel and in doing so draws its brake arm clear of the hammer mechanism.

The wheel which is in engagement with the hammer fork begins to rotate, power being transmitted from the spring through the gear and pinion. The fork prongs trip over the teeth of the rotating wheel and set up a to and fro movement of the gong hammer. This striking action directed on to the gong itself produces the required noise.

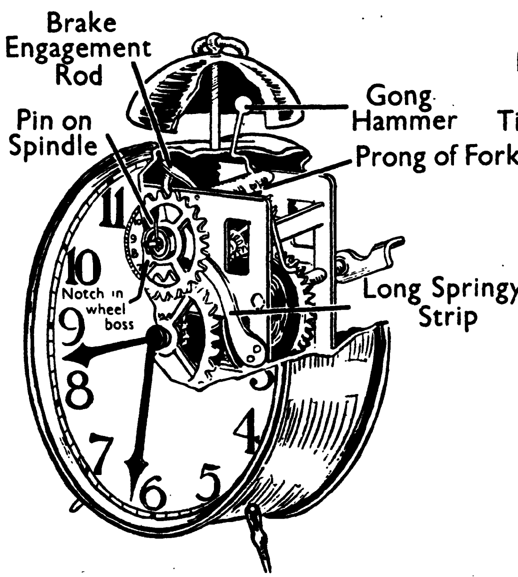
If the clock is not disturbed, the alarm will continue to sound until the spring has run down, but an additional catch is usually fitted so that the noise may be checked from an external trigger. The time keeping section of the instrument is not affected by the alarm action as the two mechanisms are entirely separate when the brake arm has been withdrawn. During the hour following the alarm, the time control wheel slowly slides backwards along its shaft as the pin mounts the sloping side of the slot. This movement resets the brake arm in preparation for the next occasion.



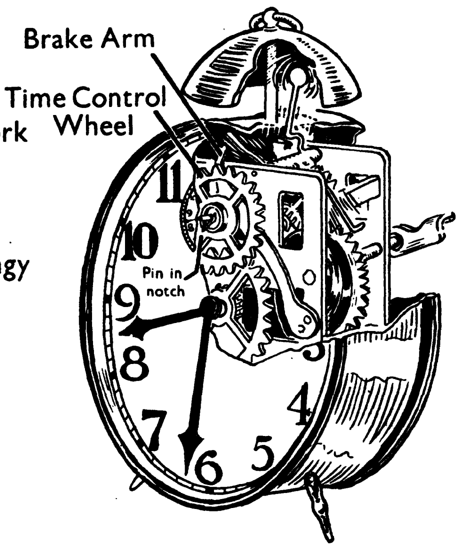
CLOCK TIME-KEEPING MECHANISM



DETAILS OF BALANCE WHEEL AND ESCAPEMENT MECHANISM



ALARM MECHANISM LOCKED



ALARM IN ACTION

THE ALARM CLOCK

THE SEWING MACHINE

Construction of the sewing machine.—A mainshaft is supported in a horizontal position within the hollow frame of the machine and is connected to an open flywheel at the right hand end. Reciprocating motion is imparted to two rods housed in the upright part of the frame by cranks on the mainshaft. Long bars underneath the bed plate transmit the movements to mechanism just below the sewing plate.

A crank and double lever system attached to the free end of the mainshaft communicates with the needle holder and the thread take-up lever. These two components perform a series of up and down movements when the mainshaft rotates. A needle with an eye in the point is gripped in a clamp just above the sewing plate and a spring-loaded presser foot is fixed immediately behind it.

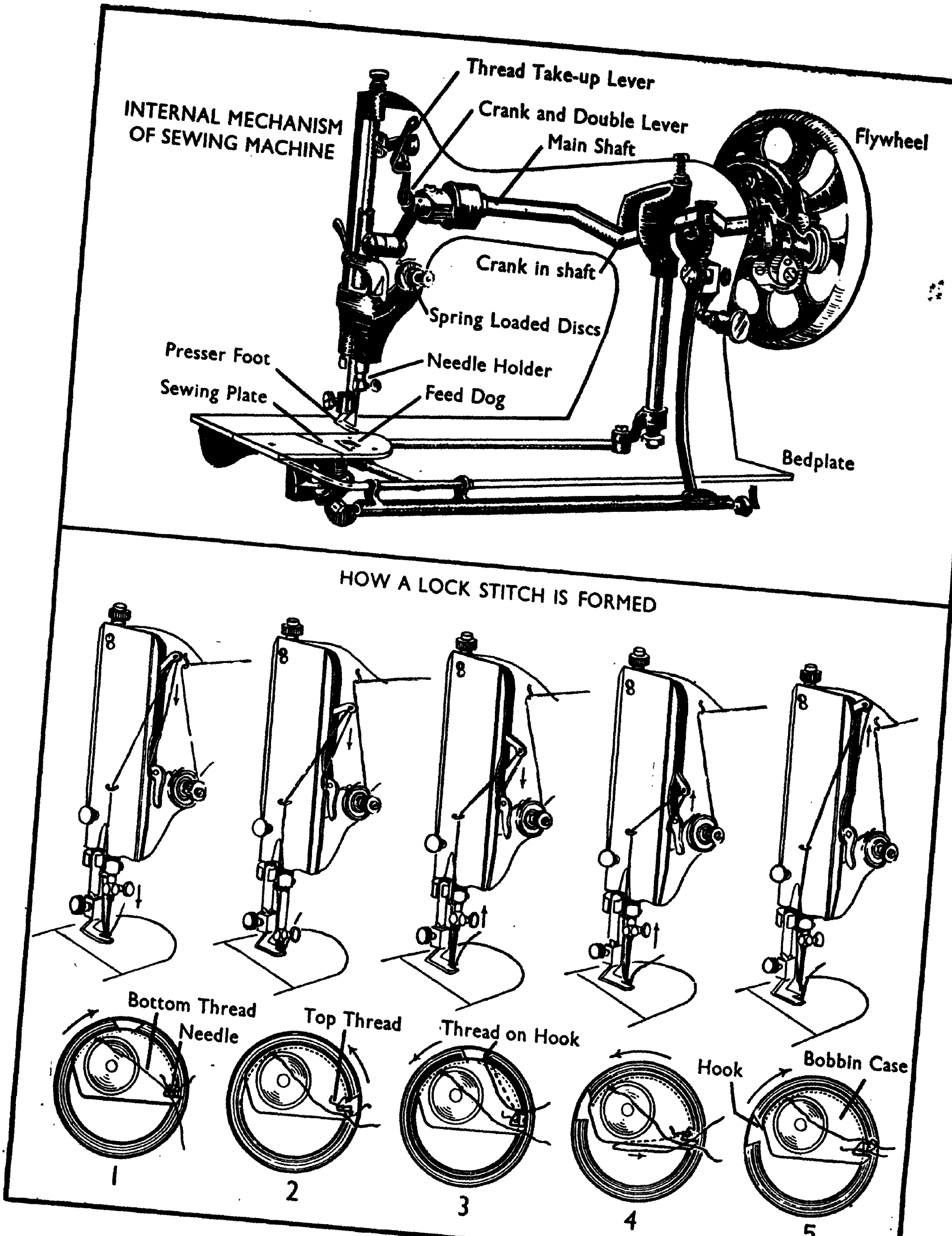
Below the sewing plate there are three very important parts of the machine—the oscillating hook, the bobbin case and the feed dog. The hook is cut in the edge of a circular steel plate which is mounted on a central vertical axis. The bobbin case contains the lower thread supply and is fixed in one half of the circle formed by the hook plate. The hook is capable of turning backwards and forwards, but the case always remains stationary. The feed dog consists of steel serrations arranged so as to correspond with small slots in the sewing plate. At appropriate stages in the cycle of operations, the dog rises and projects slightly above the level of the plate, it moves backwards, then downwards and finally forwards to the starting position.

How the sewing machine works.—Thread from a reel on top of the machine passes over a hook, between a pair of spring-loaded discs, under an inverted hook, through the take-up lever and down a pair of guides to the eye of the needle. A second thread from the bobbin below the sewing plate passes through a slot in the case, under a spring clip and through the hole below the needle. The cloth which is being sewn is held between the sewing plate and the presser foot.

The needle is pushed through the material as the mainshaft turns and a loop of thread is therefore carried downwards, the loose end being left behind on the surface. There is no strain on the thread as it goes down because the take-up lever descends and gives the necessary slackness. When the needle is in its lowest position the hook below the sewing plate catches in the loop of thread and the circular plate in which the hook is cut then turns half a revolution, carrying the thread with it. The extra length of thread necessary for this is allowed by the take-up lever which moves downwards quickly whilst the hook is turning.

The thread slips off the hook just as this reaches the limit of its turn and whilst the circular plate swings back to its starting place, the thread is pulled along a slot which follows a diameter of the plate circle. Superfluous length released during this return is absorbed by the take-up lever which travels upwards very rapidly. As the bottom bobbin is mounted within the half circle round which the upper thread is carried, the result of the hook action is that the upper thread is looped round the lower one. When near the top of its stroke, the take-up lever pulls the loop into the fabric which is being sewn and also tightens the stitch. This completes the act of sewing.

In order that the stitches may be spread evenly along the material, the feed dog comes into play after each penetration. During the time that the needle is clear of the cloth, the dog rises, grips, pushes backwards and sinks again. As the cloth is held down firmly by the spring-loaded presser foot, the dog serrations are able to carry it a short distance away from the operator every time they move.



THE SEWING MACHINE

1. Top thread being carried down by needle.
2. Top thread loop ready for catching on hook.
3. Thread being taken round bottom bobbin.
4. Thread loop slipping across to starting point.
5. Tightening the lock stitch.

The bottom set of drawings shows the hook mechanism in plan.

THE PRODUCTION OF SCHOOL MAGAZINES

Introduction.—The following extract from "The Headmaster's Page" of a senior school's second magazine will offer some indication of the spirit in which magazine production should be approached:—

"The first number of our school magazine received very favourable comment from parents and other friends of the school. The fact that it was so obviously a boys' magazine—written by boys, for boys, about boys and duplicated and bound by boys—seems to have been an attractive feature. Therefore it is without apology for visible crudities that this second number is published. It is a schoolboy magazine which presents to the boys accounts of their own activities during the past year, and offers them encouragement for the future. The detailed substance of such a boyish magazine as this cannot be of particular interest to adults, but it is hoped that parents and all others interested in X . . . School will derive from its pages some indication of the lively atmosphere of co-operation and interest which is so vital a part of school life."

The value of a school magazine.—The production of a magazine can become one of the most useful and pleasant activities of a school. In its finished form it is a fine example of very valuable co-operation between the children and the teachers, and in itself it is an attractive and popular record of that co-operation.

The actual making of the magazine is an adventure which demands smooth organisation, willing effort and the best which the school can produce in written English, art and bookcraft. In its pages the varied interests and achievements of the scholars and teachers are sublimated and co-ordinated in a form more comprehensive and compact than any other record of school life. The decision to have a magazine opens up new and unexpected avenues of endeavour, interest and even excitement.

All who have had experience of work connected with the production of school magazines will know the pride of the appointed officials, the call for articles and the fun of preparing them. If the call sometimes becomes a pleading and the fun of preparation sometimes changes to painful labour, no one really minds as long as the magazine is growing apace and there is an ever increasing pile of articles and sketches awaiting acceptance or rejection.

The magazine makes a proud record of the work of the school for the term or the year. It contains all kinds of interesting articles on such topics as school organisation, staff changes, work, games, sports' successes, house notes, societies' notes, school journeys, etc. It may contain a few poems of outstanding merit, and be enlivened by sketches or full page illustrations. Whatever its contents, it offers to parents the one really detailed insight that they will ever get into the life of the school. The best type of magazine also offers to parents and administrators a desirable insight into the spirit and atmosphere permeating the school's activities. Suggestions on how to obtain this reflection of school spirit appear in a later section.

A magazine develops a community feeling among the children. It is a communal project and a symbol that they are not isolated units, but members of a corporate body with corporate life and activities worthy of being permanently recorded. Pride in the magazine develops a wider pride in the school and urges keener effort toward the common good.

To the youthful authors themselves it brings personal satisfaction and self-confidence, as it does to an author of any age who finds his work accepted and bound in a book. To the child whose work, often the fruits of hours of labour, is refused, it offers a standard of attainment towards which he can work in the future. Methods of approach to disappointed children are discussed later. To those who have written nothing for the magazine, it is still a matter for personal pleasure if their names can be printed in its pages for some achievement in school life. To everyone in the school, whether they have any personal connection with the magazine or not, it is a keenly appreciated record of their school's accomplishments, and as such is a constant source of pride. In after years, a glance through its pages will be a happy reminder of youthful endeavours, of forgotten incidents and of former triumphs.

Appointment of officials.—The following notes are not categorical. They are suggestions which will naturally be modified by circumstances such as school organisation, the abilities and aptitudes of staff and children, and by the facilities available. It will be found in practice, however, that if the general principles indicated in these notes are followed, the magazine produced should be a success at the first attempt.

As this is above everything else a school's effort, the initiative must be taken by the head teacher, who should very carefully choose the officials nominated below. Selection should be governed by an estimate of their abilities to undertake the responsibilities noted.

It is desirable that an English specialist, or a keen volunteer from among the staff, should be the *General Editor*, and a teacher of art and bookcraft might be appointed *Production Manager*. Choose two intelligent children whose written English is of good quality for the position of *Literary Editors*. In a mixed school there might be a boy and a girl. A child with artistic interests should be selected as *Art Editor*. It should be pointed out to all these officials that their names will appear on the title page of the magazine and that they are responsible for its success.

Duties of the officials.—The business of the General Editor is to co-ordinate the work of all branches of the magazine organisation. His will be the final decision if any differences of opinion arise. He should be prepared for arguments likely to arise, and indeed should welcome them, for argument is a sign of interest. He will be chairman of the small informal meetings of officials when the arrangement of pages, illustrations, articles and advertisements is decided. And, maybe, he will be called upon to encourage puzzled editors and to stimulate despondent contributors.

The task of the Literary Editors, under the watchful eye of the General Editor, will be to collect material from all available sources, a matter which will be discussed later. They are concerned only with literary articles. They have no interest in the drawing of illustrations or the accumulating of advertisements. These editors, having been selected because of their comparative skill in written English, will have sufficient powers of judgment to accept good material and to discard that which is obviously bad. Whenever they are not sure of the value of an offering they should consult the General Editor and abide by his decision for or against acceptance. Some guidance on the important matter of selection follows in a later paragraph.

There will also be discussed the selection of art material, which will be the chief concern of the Art Editor, who performs the same functions as the other two child editors, but on the illustrative side. On difficult points he will seek the advice of the Production Manager, who has the responsible job of supervising illustrations and the magazine cover, the paging and the binding, when this latter section of the work is performed in school. The provision of appropriate illustrations for selected articles and poems, etc., will be a matter for consultation between the two teacher officials. Some guidance on the work of the Production Manager appears later in this article.

There is the complete executive. There are sufficient members to prevent any one of them from being overworked, and not so many as would cause wasteful dissipation of effort. It must be taken for granted that all the officials will receive from other members of the staff and from selected children all the help they require, for this is a school effort. If it were to become the work of a toiling few it would fail to achieve its most valuable purpose.

Literary style.—If the magazine is to become a record of all the school's activities, children and teachers must co-operate in writing up accounts of the work of all branches. Topics for articles can be suggested to the children, and in addition they should be encouraged to use their initiative and produce their own ideas on various school interests. It is usually necessary to impress the need for a cheerful and pleasant style, and to avoid a dull and stereotyped catalogue of facts. In some schools the would-be contributors are given carefully selected short paragraphs from newspapers to study. The following exercise forms a useful introduction to the production of a school magazine.

The children are given two paragraphs for comparison. One paragraph contains the facts of an incident as telephoned to his newspaper by a reporter. The other shows the style in which these facts are reproduced in the next edition of the paper:

1. "Smith the pilot, 'Sparks' the wireless operator and I flew with many other passengers from Liverpool to Belfast yesterday. The name of the aeroplane was *Skyflier*. The passengers were anxious because there was a stormy sky and some mist. They need not have been disturbed, because we maintained contact by wireless with a Manchester airport all the time. When we were near the Isle of Man we saw a snowstorm in the distance. It looked like a long white curtain. When we flew into it the snow-flakes rushed past us very quickly. Although we could not see ahead, the officers were not worried."

2. "Yesterday, *Skyflier* was faced with bad weather conditions for the flight from Liverpool to Belfast. Let us picture her, complete with a load of passengers a little doubtful of the business, especially when we started off above the River Mersey, and sky and water merged into one horizon, the dockyards and buildings of Liverpool a smoky smudge. If these anxious passengers had been taken into the confidence of Smith and 'Sparks', they would have felt, I am sure, much happier. With radio contact with Manchester, these two knew our exact position. Manchester also knew where we were, for 'Sparks' told them, at intervals. We encountered, near the Isle of Man, a white curtain of snow. We appeared to be running into an impenetrable white cloud extending down to the turbulent sea. A few seconds later, millions of snow-flakes flashed by as though shot from a gun. Though nothing else could be seen, 'Sparks' smiled and so did the pilot. They were enjoying themselves."

Each sentence in paragraph 1 is taken separately, and the children seek out the corresponding sentences in paragraph 2; they study the lively phrasing that has put vigour into simple facts. If this is done with several pairs of paragraphs the children begin to feel their way more confidently toward a style, which, however far it may be removed from true literature, will nevertheless give life and sparkle to magazine articles.

Following this general impression, the children might be given practice in actual examples such as will be desired from them for the magazine. Write on the blackboard the following sentences, and similar ones such as may occur in connection with any of the school's activities:—

1. Our school football team (hockey team, etc.), playing in a snowstorm, won a match 4–2.
   The school cheered when the result was announced.
2. The Reds were glad when they won the House Championship.
   The Blues were disappointed, but they cheered heartily.
3. The girls of Form 3a were proud of Mary Smith when she gave a good lecture on the subject of birds' eggs.
   She showed the girls some eggs. Two fell to the floor and were broken, but Mary did not mind.
4. At our school concert in the Parish Hall the room was full of parents.
   They liked our singing better than our dancing.

Invite the children to write sentences in a cheery and interesting style about the facts mentioned. Then allow selected children to read aloud their own interpretation of the recorded incidents and invite criticisms and suggestions from the others. This method will make quite clear to the children the general idea of the required style, especially if they are warned against undue verbosity.

Articles.—Make a list of all the activities which are to be recorded. Here is a list taken from the magazine of a senior boys' school:—

First Year Notes; Second Year Notes; Third Year Notes; House Notes of—The Blues, The Greens, The Reds and The Yellows; The School Concert; The Football Season; The Football Team; Senior and Junior Art Club Notes; The Craft Guild; The Historical Society; The Geographical Society; The Scientific Society; The Literary Society; The Musical Society; The Gym. Club; The Swimming Club; School Journeys; School Savings Association; Our Armistice Day Service; The Stamp Club; The Prize Poem; Old Boys' Letters; The School Officials.

To these are added the Editorial Page, the Headmaster's Page and a series of advertisements. The size of this magazine is about forty pages, each 8 in. by 6½ in.

The following list of articles is taken from the magazine of a small country school:—

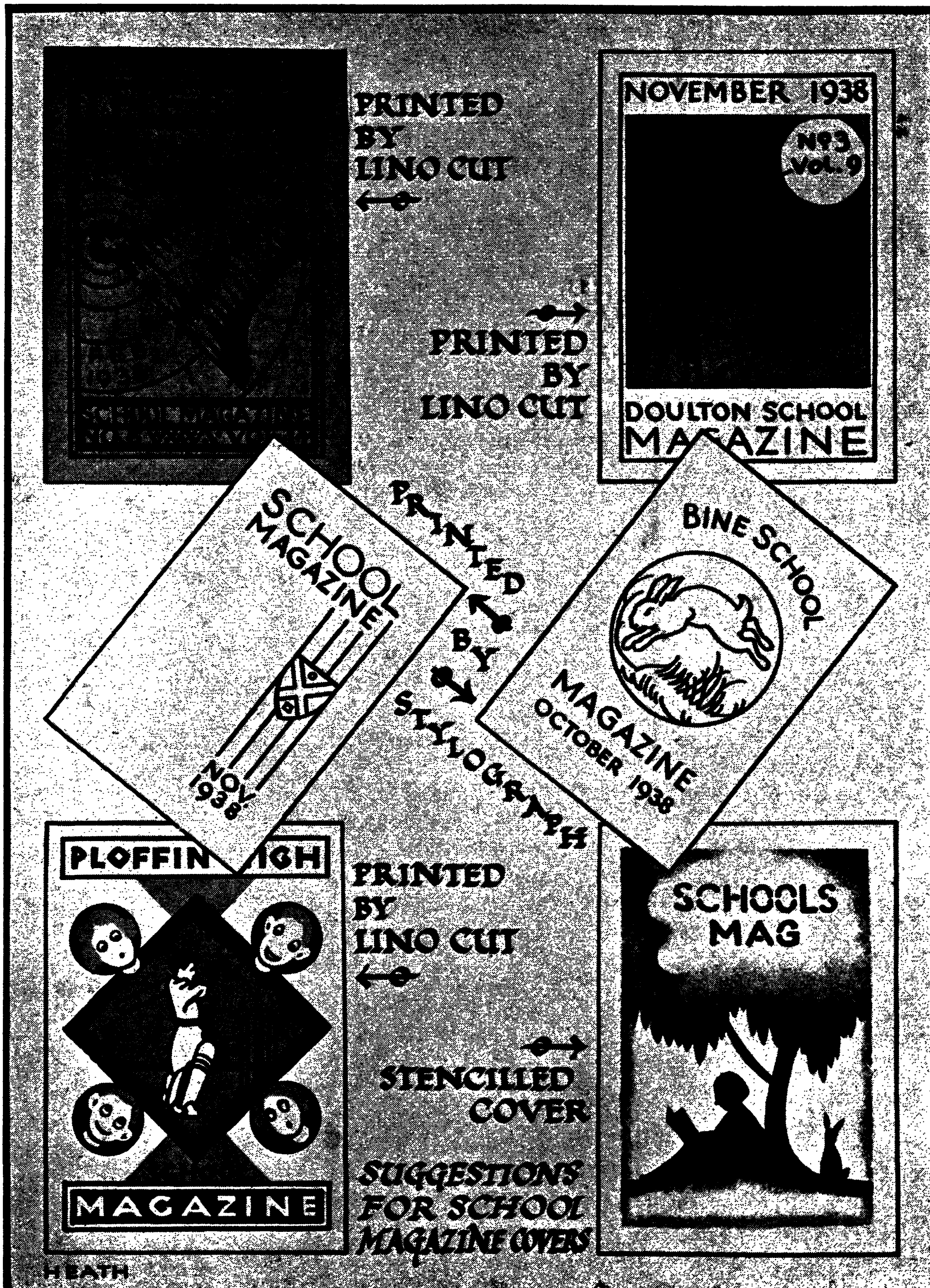
Headmaster's Letter; School Notes; Cricket, Football and Netball News; Wireless Notes; School Music; Prize Story; Gardening Notes; Weaving and Rug-making —Past, Present and Future; Jokes, Howlers and Conundrums; Competitions.

Except for the last two articles this small magazine follows the same principle as the larger one.

There are two distinct types of school magazines. In one case, very little appears except records of school activities. Examples of this type are the two quoted above. In the other case, a large proportion of the magazine is made up of children's stories, poems and essays on various topics. The contents page of a magazine of this second type reads as follows:—

Editor's Notes; House Notes; School Games; British Birds; Poem—*The Moon;* Our Drawing Club; A Visit to the Docks; Architecture of a Norman Church; My Home; Why I like my School; School Wireless; Poem—*On Leaving School;* How Whales are Hunted; School and Class Captains.

This type of magazine, as well as the other, makes interesting reading. The answer to the question of whether the magazine is to be purely a record of activities, or is also to contain general articles, is a matter for individual inclination, but it is advisable to adopt a definite policy from the start, and to draw up a basic list of titles for suggested articles. Methods of obtaining material vary a great deal. In some schools the child secretaries of each society or activity are commissioned to write a descriptive account of the work. In others, each member of the society writes an article and the best is selected. Alternatively, a composite article can be built up from all these efforts. In



PRINTED BY LINO CUT
NOVEMBER 1938
No. 3 Vol. 9
PRINTED BY LINO CUT
DOULTON SCHOOL MAGAZINE
SCHOOL MAGAZINE
NOV 1938
PRINTED BY STYLOGRAPH
BINE SCHOOL
MAGAZINE OCTOBER 1938
PLOFFIN IGH
MAGAZINE
PRINTED BY LINO CUT
SCHOOLS MAG
STENCILLED COVER
SUGGESTIONS FOR SCHOOL MAGAZINE COVERS
H BATH

some circumstances this is an effective method of obtaining a very lively account.

Children are sometimes hesitant when asked to write articles, but if it is found that the flow of inspiration is sluggish, the normal composition lesson can usually become a source of supply.

All spontaneous efforts sent in might be rewarded by the award of house-points, but for reasons to be discussed later it is inadvisable to reward separately the children whose articles are accepted. Acceptance is its own reward.

Selection of material.—As has previously been stated, the selection of material becomes a matter for consultation between the Literary Editor and the General Editor. There are several factors which should be taken into account. Is the content of the article suitable? Is the style pleasant and attractive? Could it be made interesting by a little alteration? Would it require too much alteration? Is the factual information accurate and complete? Is the quantity of material offered proportionate to the importance of the topic? For example, are we offered five hundred words on one football match and only fifty words on the whole football season? Sometimes it is found that one boy or girl has a particularly fluent style in written English and is also keenly interested in many school activities, in which case a large number of articles may all have the same signature. It is necessary to overcome the temptation to include all these efforts, for the magazine should be representative of the children as well as of the school life. An article by each of twelve children is preferable to twice the number of articles written by two or three scholars.

The final factor governing selection of material is that of space. In some schools the number of pages in the magazine is limited. Thus, it may be decided that forty pages will be a convenient size for the purpose, in which case sufficient material for that limit is accepted and all else is rejected. In other schools the size of the magazine is limited only by the quantity and quality of the proffered articles.

Types of material.—A discussion on the contents of many of the articles which might appear in a magazine is beyond the scope of this article, but a comment on certain types of "Notes" may be of interest. Year Notes offer a place in the magazine to the youngest children as well as to the oldest. The First Year Notes might contain a reference to the adventure of being in a new school and to the determination to add to its reputation and successes. Second Year Notes might contain a comment to the effect that the children are very proud of their year, and are looking forward to becoming members of the third year. The atmosphere of Third Year Notes is sometimes one of facing the future with happy memories of school life. All Year Notes might be given a personal touch in references, by name, to individuals who have achieved special fame, and they should be composed and signed by one member in each class of the Year concerned.

The House Notes comment on positions in recent championships and successes in work and games with references, by name, to members of teams, leaders, captains, etc. Here is a typical opening paragraph to the Notes of one House, taken from a recent issue of a school magazine:—"There has been much activity in the camp of the Blues this year, but most of it has been of that steady kind which usually lacks high spots. The House has done well in work as in games, and for two successive terms was Champion House of the school. This great success was followed last term by fortune of the opposite kind, for then we were at the bottom of the list. If we are to become known as a 'House of Extremes,' it is to be hoped that all Blues will see that at the end of this term we finish at the top once more." (A.H. age 14 years, Captain.)

Notes on Sports might contain an account of the season's play, with league tables and a single sentence comment on the abilities

Suggestions for School magazine covers.

of each player in the school teams. Such Notes should be composed and signed by the captains of all the teams concerned. Notes of school societies should be written and signed by the respective secretaries and might contain lively accounts of the chief activities in their sphere. If there is sufficient space and there are not too many members, a neatly arranged list of their names adds interest. In any case, it is sound policy to introduce, on some pretext, into all sections of the magazine the names of as many scholars as possible. Such a procedure adds greatly to the interest and appreciation of the magazine and the school by the children and their parents.

Where it is appropriate, Notes should end in an atmosphere of hopefulness for the future as well as pride in the past. The following pleasant comment is taken from the fortieth magazine of a small village school:—

"The reader will see from these Rambling Club Notes that we can walk as far and study as hard as those one-time members who left our school years ago, yet we are sure that in the months to come our happy walks and talks will be more bright and useful than they have ever been before." (J. G. Secretary, age 12 years).

Rejection of material.—If great enthusiasm has been aroused the quantity of material submitted will doubtless exceed the limits imposed on magazine space. A number of articles will be rejected because of this fact or because they are not suitable, as being inappropriate or crude. It is quite probable that these rejected articles have been the subject of as much thoughtful work as any of those accepted, and care must be taken to ensure that children whose work finds no place in the magazine shall not be discouraged from making further attempts. Otherwise, a possible source of material for future magazines will disappear. The following method of approach to this problem adopted in several schools can confidently be recommended:—

The editor gives a list of the names of all authors of rejected material to the head teacher, who then interviews the children concerned, telling them that it is regretted that there is not enough space in the magazine for their efforts, and that if they write for the next issue their work will be given every consideration, and if at all possible it will be given a place. As a final compensation in the magazine, this appears:—

"The Editors regret that it is has been impossible through lack of space to insert interesting articles received from the following:— "

Then follows the complete list of names. It has before been mentioned that every child submitting efforts might be rewarded with house points or in other ways, whether their contribution can be accepted or not.

Production.—No two school magazines are alike in their contents or in the way they are built up. Some magazines are professionally printed, some are printed in the school, others are produced in cyclostyled typewriting or in cyclostyled handwriting. The style of production and the method of binding depend on the facilities available and on individual taste, and in this article it is possible to indicate only a few general principles and to give warning of certain pitfalls.

First there is the problem of illustration. It is a sound policy to have a few good drawings. Many an otherwise attractive school magazine has been ruined by the introduction of superfluous illustrations. There should be definite aim and purpose behind the reproduction of every sketch and picture. Not all the drawings need be on serious topics, but their quality should be good, and, above all, the method of placing them should be a matter for careful thought. The various plates which illustrate an article should look as if they had been built into the page arrangement and not placed haphazardly without thought.

Ambitious work such as coloured sketches, lino-prints, coloured prints or multi-colour stencils should not be attempted for magazine production unless it is certain that the quality of the finished illustrations is equal to the quality of the letterpress. There is, too, the fact that many illustrations when drawn in pencil, pen and ink, or colour, look suitable and attractive, but are difficult for amateur reproduction on stencil plates. It may be disappointing to have to reject them, but that is much better than to find them in one's magazine spoiling the whole appearance of a page. In the majority of cases art subjects, which will allow of being cut in firm, clean and simple line on a stencil plate, are the most satisfactory.

For purposes of brightening the appearance of pages with illustration, House Notes might be headed with the house badge. Society Notes might have some distinctive sketch appropriate to the subject, for example, an effective heading to notes on a craft-guild would be a work bench on which lie a hammer, chisel, plane etc. Several excellent school magazines have full page prints of stencil and multi-colour lino blocks which are definitely the work of an art teacher, and are signed as such. Although from an educational point of view their only value is in showing the children what can be done with such materials, they hold the attention and certainly help to make the magazine interesting. The decision as to whether articles and illustrations which are purely teachers' work shall be introduced in the magazine is a matter for the exercise of individual discretion. It is, naturally, a matter of common honesty that such work should be signed by the teacher concerned, just as all ordinary magazine work is signed by the children who contribute.

Unless the magazine is to be produced on a printing press, it should be written or typed out in full before reproduction starts. This may seem to entail a great deal of extra labour, but it is usually worth the trouble, for then it is possible to re-arrange matter in a way that is not possible when one is working straight on to a stencil. This method simplifies the task of catering for illustration. The illustration can be fitted into a page and the letterpress arranged round it.

Hectographed magazines.—Although the hectographed magazine is losing popularity, as other forms of duplicating become available to schools, it still has many advantages. It is very cheap, and it gives satisfactory reproduction. In addition, variety of colour can be introduced without any additional labour or equipment, and red, green and blue hectograph inks can give to the pages of the magazine an interesting and attractive appearance in a form which the cyclostyle cannot provide.

When a hectograph apparatus is used for magazine work, the original positive sheet can be used on several jellies, so that the printing can be done more quickly, and clearer prints will be obtained, for it is then easier to avoid the common fault of expecting too many clear prints from one negative. The general principles of lay-out apply equally to hectographed magazine pages. There should be generous margins, especially on the binding side; the writing should be uniform and legible, and the text should be well spaced and in no way crowded.

The great disadvantage of this type of magazine is that only a moderate number of copies can be made, and the work of reproduction is slow. However, if there are plenty of willing helpers and a large number of copies is not required, the hectograph method is very successful.

The use of the duplicator.—The stylograph and the rotary duplicator require a stencil made by writing or typing on a wax sheet. Type-written stencils are more readable and are usually neater in appearance than hand-written stencils; one does not require more than average typing ability to produce attractively arranged lay-outs, and if each page is produced beforehand on ordinary paper, by writing or typing, as suggested elsewhere in this article, space can be left on the stencil sheet for hand-drawn illustrations. When the stencilled text is complete, the drawings can be made with the stylographic pen by tracing over an original. It should be noted that sketches for type-stencilled pages should be very light in character, to correspond with the light and open print of typed stencils.

The cutting of the stencil should be so arranged that allowance is made for extra space on the binding side. It is on this side that the pages are fastened together, and unless ample room is left, some of the matter will be hidden, with disastrous results to the appearance and value of the magazine. The amount of space to be left clear on the binding side depends on the size of the page and on the ultimate thickness of the magazine, but if the page size is, for example, 8 in. by 6½ in., a 1 in. margin is sufficient. On the other side of each page there should be a clear ½ in., to give a well-framed appearance to the text. Such small but important matters are worthy of attention and of experiment, if the magazine is to approximate in any way to the excellent arrangement of the majority of modern journals. It should be noted that the binding side, requiring the wider of the two margins, is on the left-hand side of one page, and on the right-hand side of it's obverse.

The printed magazine.—Printing, as a craft, is receiving increased attention in schools, and the selection of suitable types and studies of lay-out are becoming a valued addition to the art work of many schools. It is increasingly recognised that children should develop some critical appreciation of the art and craft of printing, so that there shall be secured in the future a continued improvement in the appearance of newspapers, posters, books and leaflets, the style and design of all of which have made a great advance during recent years. In view of the extensive influence of the printed word in modern life it seems desirable that the schools should help to cultivate a sound public taste in this matter.

Apart from the cultural value of printing in schools, the press has a utilitarian value. The printing of programmes, cards and tickets will soon save the original cost of the machine, and a printed magazine offers still further scope for experimenting with the craft.

It is not necessary to indicate in this article the uses of the many and varied tools and pieces of apparatus used in printing, and the reader should consult some of the many available craft books which deal with the methods and problems of printing.

Small, automatic, self-inking presses, suitable for the printing of cards, tickets, programmes, etc., can be obtained for a few pounds; but for school magazine purposes the best type is the hand machine, which can be screwed down to a bench. It is operated by a hand-lever, and has automatic inking rollers which move from the inking plate over the type. These machines cost between £8 and £12, and they are reliable and substantial. They will give a fairly large type area, with clear, even printing, so that they can be used with great success in the production of school magazines. Such machines can frequently be obtained secondhand, in good condition, from specialising firms.

Paging.—Proceeding to the point where the pages have been printed, we are confronted with colossal piles of papers, and the problem is how to arrange them in magazine form. Methods vary a great deal and it is possible here only to indicate one method that is commonly used. Let us imagine that there are thirty pages in the magazine and that one hundred copies are to be made. Therefore there are thirty piles, each of one hundred sheets. These piles are laid in order around two tables which have been put together. They are in the order in which the articles appear on the original list of contents. Selected children now form a line, and walk round the tables, picking one sheet from each pile and collecting them in the hand, making sure that all are the right way up. Having been round the table, each child now has thirty different pages, which are placed inside prepared covers or in some other way are kept separate. This is a simple and rapid method of arranging three thousand sheets of paper to make one hundred magazines.

The magazine cover.—The production of a distinctive school cover is a most interesting process, and one which calls for imagination and skill. Some schools have been fortunate enough to invent so characteristic a cover design that it has not been changed for many years. Other schools, with equally good covers, change the design regularly. The cover design is seen more frequently than the contents and is certainly remembered long after the contents have been forgotten. Mention the name of any well-known magazine, weekly or monthly, and immediately one has a mental picture of the cover design—not of some article or story in the latest issue. Therefore our school magazine cover design must be satisfying and worthy of the school. The first design may disappoint, and so may the second, but it is worth while to experiment and invent until the school can say that its magazine has a cover which everyone admires. When that design is discovered, use it for every issue, for it becomes a very personal and characteristic feature of the school, and one which will be remembered by the scholars long after they have left.

One method of finding a suitable basis for a design is to offer a small prize to the children for the best design sent in. Children are always enthusiastic when they learn that their work may have a practical application, and particularly so when there is a possibility that it may be accepted for so important a purpose as the magazine cover. It is not suggested that a child will be able to design a cover that can be accepted without alteration, unless there is a particularly gifted scholar, but the method ensures a very wide variety of designs from which a suitable one may be selected. If no such design appears, the co-operation of an artist among the staff or other interested adults should be invited. The essentials are the same as those suggested for illustrations, i.e., simplicity, clean-cut line and attractiveness.

There are several matters connected with cover design which must be decided; e.g., whether the Contents List shall be external or internal; whether the names of officials shall appear on the cover or inside; the position of the date and number of the magazine, etc.

The cover should extend a little, not more than ¼ in. beyond the limits of the pages as a safeguard, and it should be in stronger material than the paper of the internal work. Strawboard is excellent for the purpose, and the covering of it forms an excellent exercise in bookcraft, especially as it is for so practical a purpose. Manilla is a tough paper with a smooth surface and makes a good cover. As a general standard, one can say that the cover should be at least as strong as that of an ordinary exercise book, and stronger if possible. Fawn, light brown, light red, are cover colours that would form a contrasting background to most types of cover designs, and as the necessity for a bright and cheerful cover must ever be borne in mind, it is probably desirable to avoid covers of dark green or of other shades which may tend to deaden the general effect.

A final comment on covers is that in some schools where the magazine is cyclostyled, the cover only is printed professionally. If the design is simple, this is not an expensive matter, and it is a method of ensuring a cover with an appearance of good quality and attractive finish.

Methods of binding.—The method of binding comes within the province of bookcraft, suggestions for which appear elsewhere. Where facilities for bookcraft are not available, or if the form of the magazine is not suitable for sewing or stitching, stapling is a useful method of binding. There are several types of inexpensive stapling machines on the market, and in use they are economical of time and energy. Alternatively, in most towns there are printing firms who would willingly offer an estimate for stapling school magazines on their own machines, and sometimes these firms will also cut the edges of the magazine square. One school's method of binding is described in the next section.

A boy's description of magazine production.—The following extract is taken verbatim from a school magazine, and was written by a thirteen-year-old editor:

"I wish to tell you how our magazine was produced, to show you that though the work is hard it is also interesting. First of all, we asked for articles, stories, verse, anything, and a number of boys did work at home or in their spare time at school. When these came in, they were read and except for three or four articles were returned with regrets. Then, some more were done during English lessons at school, and after a fortnight we had about two thousand pages.

"This was a good response so far as it went, but now we came to read them. On the whole it was disappointing. Only one twentieth was any good. That is to say, nineteen out of every twenty pages had to be returned, again with regrets to the authors. However we managed at last to get sufficient, including work from outside contributors, chief of whom was the Minister of Transport. Having decided on the articles which were any good, our chief editor, Mr. X, typed them out on plain paper, leaving a margin of 2 in. all round. Then I had the job of counting the lines on each page to make sure that there were just forty-six lines to a page, with not more than fifty-six letters to a line. The articles were then put in their proper order—work by outside contributors, staff, school events, house events, stories, general articles and then verse and this conclusion.

"When we were sure that each page had about the same number of words, stencils were cut on the typewriter—sixty-four in all—and these were rolled off on the rotary duplicator. The pages were then put together by a row of boys and were fastened with staples in four sections per magazine. Each section was given three staples, making twelve in all. Then the sections were sent to the bookcraft room for binding.

"Here, the four sections were glued together and the white end-papers stuck on. The work was then pressed. After this the back of each one was well glued to harden and to act as a backbone to the section. When nearly dry they were separated so that they would not stick. Now the cases or book covers were made. The strawboard, or cardboard as some people call it, was stuck on to the cloth and the borders turned over. This was then rubbed and pressed so that a lump of glue would not form an unsightly bulge on the surface. This was allowed to dry and then the back of the sections were pasted on to the inside front and back end-papers, and we had our magazines in the form of a library book, giving us a magnificent journal of seventy-four pages.

"To print and publish our magazine has taken from ten to twelve weeks of solid work. If it had been about thirty pages we could have finished it in about one month. But now that it is finished, the magazine is something worth looking at. All those who have bought a copy at 3d. each have got full value for their money. And I myself am ready anytime to start another edition."

There is the opinion of at least one youthful editor. It will be noticed that he mentions outside contributors. It is quite a sound idea to ask well-known local or national persons to write a paragraph for the magazine. It is a procedure which adds interest and variety to the matter. If it happens that well-known local persons are patrons of the houses in the school's house system, all four might be invited to contribute a comment which would form a striking introduction to the house notes.

THE HOUSE AND TEAM SYSTEM

Introduction.—A successful house system is a helpful factor in the development of a lively school atmosphere, and when the system is based on sound principles the keen, friendly rivalry between houses gives to the children an added urge and interest which is beneficial both to them and to the school. If we regard the development of character as one of the fundamental tasks of education, then every method of encouraging self-support, independence, a sense of responsibility, self-government and submission to a just authority must be adopted. For this purpose the house system has long been used in the growth of a sound social consciousness. It is highly beneficial if its shortcomings and defects are kept in mind and counterbalanced by other measures.

It is a common opinion that the greatest service education can render to any human being is to lead him to the discovery of his own powers. To accomplish this it is necessary to liberate his energies, of which an immense reservoir is hidden in every human being. One of these unsuspected energies is the community spirit we seek to control and use to the best advantage in general school life, and Professor L. P. Jacks, in a comment on communal activities, offers a sound justification of the principles upon which the house system is built.

He says, "Man is naturally co-operative—a born co-operator, a fact often overlooked, though needing to be greatly stressed whenever education, either of children or adults, is in question. Whether you study the constitution of his mind or his body, you find at every point that the activity his structure demands, and is fitted for, is not isolated activity, but concerted activity. The man is made to co-operate with the woman, and vice versa; the parent with the child; the old with the young; the individual with his neighbour—why else is he endowed with the faculty of speech? He works best when he is working with others, plays best when he plays against another player, and should be thought of as playing with him, since without an antagonist there is no game at all. Man needs an antagonist both for work and for play; and his antagonist is often his best friend."

House names.—These are usually decided upon beforehand and the selection of suitable names is a matter best left to the choice of the individual school. There are, however, several points worthy of consideration before the house names are selected. They should be of genuine interest to the children, and it is generally desirable that local atmosphere be taken into account. One should not select, for example, the names of four Greek philosophers, or four names from mythology, or four planets, or from a list of towns or public schools, etc. Such house names have no intensity of meaning in the mind of the ordinary child.

The following actual cases will give some indication of the method of approach to the problem. A school in the heart of a district where there were several ducal estates invited four of the landowners to become patrons. Permission was readily granted for the names to be used, and sports' trophies were presented to each house by these local patrons. In the Shakespeare country, in a school where his plays are taken in more than usual detail, the children found by voting the four most popular characters for use as house names. In the west country, the names of four of our greatest sailors are much used for the purpose. An example of interesting house names occurs in a ship-building area. Most of the male parents are employed in the yards, and the house names are selected from those of some of the more famous ships built by these parents. The intensity of friendly competition in this school is such that it extends to the homes of the children and parents take a keen interest in the struggle for house-points. In another area, one school uses the names of four historic local families, and their heraldic designs have become the shields of the houses. One district has produced four cricketers of international fame. The children are greatly interested in their careers, and several schools have adopted them as patrons. In view of the intensity of local interest, this is quite a good idea. Its weakness lies in the transitory nature of sporting fame. In all the above cases and in most others of their type the children are familiar with the history of their patrons and are proud of their house name.

A pretentious and artificial atmosphere surrounding a house name serves no useful purpose. The children will merely disregard it and whenever possible will refer to their house only by its colour name. In fact, in many schools, where the house system is a strong and vitalising force, there are no house patrons at all. The four houses are Blues, Greens, Reds and Yellows, and the children are as proud of their colour as they would be of any other house name. The house system is but a means to an end, and simplicity in this, as in most things, is a virtue which usually leads to sincerity. In the remainder of this article it will be assumed that the problem of house names will be settled by the reader, and reference will be made only to house colours.

Preliminary work.—The first move in the building up of a house system is to divide each class into four teams, and then to give each team a colour. Those in general use are blue, green, red and yellow. The children of each team colour from every class have a meeting. The four gatherings thus held form the four houses. There is the skeleton round which we build.

Each team in every class now holds a meeting and elects a leader, and a "second man" who will take charge when the leader is absent. For the first term the four leaders should draw lots to find a class captain. In future terms, the method to be recommended later will provide an automatic election for class captaincy. At the first house meeting, all the members vote in the choice of a house captain from among the class leaders, and they also select a vice-captain and a secretary who might keep in minute-book style short records of the transactions of the house at each meeting.

Members of the school staff are divided among the houses. In a staff of twelve, three teachers are allotted to each house, as housemasters. One of them should be regarded as senior housemaster, and it is he who will consult with the head teacher on matters affecting his house. As in all aspects of school life, the more willing and energetic the co-operation of the teachers, the more pleasing will be the results.

The first house meeting.—The first house meeting is an important occasion. It will give the initial impetus to the system, and the urge to the members to work in co-operation for the good of the house should be conveyed as enthusiastically and convincingly as possible. After the election of the officials previously referred to, each housemaster should take it in turn to express an opinion on the possibility of the newly-formed house becoming the finest house in the school, and winning the championship in the very first term. A lively house spirit cannot be built up at once, but the housemasters should take advantage of the new enthusiasm that will appear, to comment on this first occasion on the duty each member will have towards the house, and on the loyalty and keen endeavour that will be expected. For the benefit of retarded pupils it should be pointed out that fine classroom work in "subjects" is not by any means the only way in which the house can be helped. It will be possible to obtain house-points for conduct, manners, good appearance, steady loyalty, good performance in school games and on the sports field, etc. It can be summed up in the fact that anything a boy or girl does which shows they are keen, willing, loyal and working members of the class or the school will benefit their house and bring credit to themselves and to their school. A cheer for the housemasters, captains and the house is a fitting finale to this preliminary building up of enthusiasm.

Every member of the house should, if possible, wear either a "button" in the house colour or a ribbon. The buttons can be obtained cheaply from several firms, and any small piece of ribbon can be obtained from home. Buttons with such titles as "captain," "vice-captain," "house secretary," can also be obtained in distinctive colours. They add to the children's sense of importance and dignity of their office. The fact that such buttons or ribbons are to be made available should be mentioned at the meeting.

Next comes the election of the house committee. The members will be the house officials together with the class team leaders or other elected children. It will be explained to the general body of members that the purpose of this committee is to look after the general affairs of the house and to decide what matters shall be brought before the whole house. Such procedure gives the children an incidental insight into the meaning and purpose of the term "executive committee."

If the children leave this first meeting with the feeling that their house is a separate community within the school community, that they are going to be proud of it and that it is going to beat all the other houses in whatever is undertaken, then the teacher in charge of the meeting has been successful in giving his house a sound impetus towards a realistic career.

Duties of officials.—

1. Team leaders are responsible for their class teams, and in some forms of class team work they take charge; for example, in physical training and in certain types of class dramatic work. They must encourage the team and warn any member who shows apathy that he is liable to be reported at the next house meeting. Care must be taken that team leaders, in excessive zeal, do not try to stamp out individuality. As in the life of the adult citizen, the interests of the community take precedence, but personal freedom must be safeguarded as well. Incidentally, if a boy shows deliberate antipathy to his team, colour or house, the leader should be instructed to inform a housemaster, who should then seek the reason. It may be something that can be put right easily. For instance, Blue's sister may be a Green, and Blue will not be happy until he is a Green, too. Every case of antipathy to the house should be investigated and the matter rectified if at all possible. Otherwise the rebel may nurture a sense of injustice, and no artificially imposed method such as a house system, however justifiable in its general effects, should make any child into an enemy of his community. The suggestion may cause an adult to smile, but to a child his house and the opinion of his fellows is a very serious matter, and one of the defects of the house system is that unless it is well organised and carried out with enthusiasm tempered by discretion, it will lead to disillusion and even subversive action on the part of a sensitive child.

2. The class captain should be able to take control during the absence of the teacher and should be given the right to supervise impartially every other team in the class, as well as his own. Class affairs as well as his team affairs are his concern. He should be captain of any class sports team.

3. The house captain should hold regular meetings of his few team leaders and ensure that house affairs are running smoothly in every class. He is responsible to the housemasters for the welfare of the members, and, possessing as he does the boyish point of view, might well be encouraged to speak his mind to his housemaster with complete frankness. From a wise and confident

captain housemasters can learn many things regarding the children's point of view in house affairs.

4. Housemasters or housemistresses are responsible to the head teacher for the conduct of house events and for maintaining enthusiasm by every means possible. They keep a watchful eye on all the matters retailed in this article.

5. The house committee is a very important body, and one which can relieve the housemasters of much work. It will choose teams for inter-house competitions, build up an agenda for a house meeting, interview and congratulate individual members for some noteworthy performance, and devise ways and means of stimulating a sound house spirit. Members of this committee should be encouraged to adopt a correct committee attitude of freedom of expression of opinion, controlled by accepted committee procedure. In a certain school, housemasters invite their committees to tea once a week and in the informal atmosphere of buns and hot drinks the work of the house is happily discussed.

6. A house meeting should be held at least once a month. When the system is flourishing in a school, the vigorous spirit of a house meeting is a delight to the members and to the onlooker. There is a thrill of pride in the unconscious thought of the children, "Here we are, all our house, together in one room—and how sorry we are for those outside!" Nowhere in life does a child hold on to a more compact and pleasant community feeling than in a well conducted meeting of his house. That is why once a month is better than once a term for these meetings, even if the actual business transacted is insignificant. It is a good idea to have an elected doorkeeper, preferably with a high-sounding official title, whose one duty is to stand at the door to prevent the ingress of "strangers." Sometimes the term includes the head teacher, who might request permission to enter the private domain of the house.

7. The work of all the houses is co-ordinated for school purposes by the head teacher, who should always observe a spirit of strict impartiality as between house and house. It is a delight to the children if on sports days, the head teacher signifies that impartiality by wearing a rosette made up of the four colours.

House-points.—No two schools have the same method of awarding points. So much depends on the atmosphere of the school, the intensity of the house spirit, the ability and keenness of the staff, and the method of recording, that no authoritative method can be offered. Therefore, the method adopted in one school where the house system has maintained its freshness and vigour for many years is indicated. In schools where the system is being newly introduced, it is suggested that this method be used as a groundwork and that such alterations as personal preference or experience suggest be introduced gradually.

Because the ability of individual teachers on a large staff to estimate the value of work which should be rewarded with one or more house-points varies very widely, each teacher is limited to a maximum of ten points per house per week, for school record purposes, from ordinary class work. Some teachers are reluctant to award more than one point at a time, or to strike off more than one point. Others enthusiastically reward a child with five points for one piece of work and with equal vigour will take off four or five points for a particularly heinous offence. Therefore, by the end of the week the points totalled by one teacher may be Blues, 8; Greens, 10; Reds, 3; and Yellows, 5; and by someone else, Blues, 40; Greens, 19; Reds, 38 and Yellows, 21. It would obviously be unjust to the houses for these points to be regarded as of equal value. Therefore the second teacher's points are scaled down to:—Blues, 10; Greens, 5; Reds, 9 and Yellows, 5—thus arriving at a value approximately equal to those of the first teacher, while maintaining the proportion between the houses. This method reduces the award of the parsimonious and

HOUSE CHAMPIONSHIP
EXAMINATION RESULTS
JULY 19......

Form	Position	Name	B.	G.	R.	Y.
3A	1		10			
	2				5	
	3			3		
3B	1					10
	2			5		
	3				3	
3C	1		10			
	2				5	
	3		3			
2A	1			10		
	2					5
	3					3
2B	1			10		
	2		5			
	3				3	
2C	1					10
	2				5	
	3			3		
1A	1				10	
	2		5			
	3		3			
1B	1			10		
	2				5	
	3					3
1C	1				10	
	2					5
	3				3	
		TOTAL	36	41	49	36

Fig. 1

Method of Recording Examination and Competition Points Totals the extravagant teacher to a common level, and the desire for just dealing is satisfied. The school captain goes round with a form each Friday afternoon, and on it the teachers write the total number of points they have awarded during the week, the captain making sure that the maximum given to him for any one house is ten. These points are then totalled by the captain and given to the head teacher. The captain does not communicate the results to anyone else. If there are sports points or examination points or those from any other source, the head teacher adds these to the classwork points, thus arriving at the grand total for the week. Methods of informing the school of the total are suggested in a later section.

Extra points.—In the school whose method is under review, inter-house competitions are arranged in football, cricket, running, swimming, draughts, dominoes, chess and table-tennis. In each competition the teams are chosen by the house committees, and the indoor games are supervised by the house captains; for example, when a member of the Blue team is playing a Red, the Green and Yellow captains act as referees, and their final duty is to indicate the winning team upon the competition record sheet. This sheet should, in any inter-house competition, be a very large one—at least 30 in. by 20 in.—and be exhibited in a prominent position where all children can watch the progress of the tournament. At the end of the competition, the winnng house receives ten points, the second five points and the third three points.

After the term examinations, the top boy or girl of each class receives ten points, and the second and third five and three points respectively. Fig. 1 is an illustration of a convenient sheet on which examination points are collected and then exhibited on the notice board. At the annual school sports the first, second and third in each event receive three, two and one points respectively, whatever the length, difficulty or quality of the event. This simplifies the recording of results and points, and also makes the young child who has won merely a thirty-yard obstacle race feel that he is just as useful to his house as the winner of the quarter-mile championship. However, as a consolation and reward for individual effort, the *Victor Ludorum* receives a bonus of ten points, and the boy or girl taking second and third places in the results of all individual efforts receive five and three points. In any swimming events and championships the same system obtains, and the recording system shown in Fig. 1 is used.

Recording of points.—The school captain has a record book in which he keeps account of all these "extra" points, as apart from classroom awards. In the classroom one of two systems is used. Either the teacher keeps a record of all points allotted, or else the class captain keeps a book of records, which is then regularly inspected by the teacher. In physical training the system is quite different, for this is a subject where a visible record of points will lead to greatly increased effort and enthusiasm. In the school hall or gymnasium there is a board on which wide tapes of the colours are wound around four cotton reels fixed fairly tightly on an axle. Vertical markings of points from 0 to 50 are arranged on the board, and at the end of each P.T. lesson the instructor asks each team leader how many points have been won. It is then a simple matter to raise the brightly coloured tapes according to the number awarded. The tapes are pointed, and are held in position by drawing pins. One has but to watch the keen glances at this P.T. board to realise the value of this simple arrangement. It is one which might also be used in the classroom.

Informing the school.—As has been previously explained, the head teacher holds each Friday afternoon a list of the total points won by each house during the week. Fixed in a prominent position in the school hall there is a board (Fig. 2). On the board are

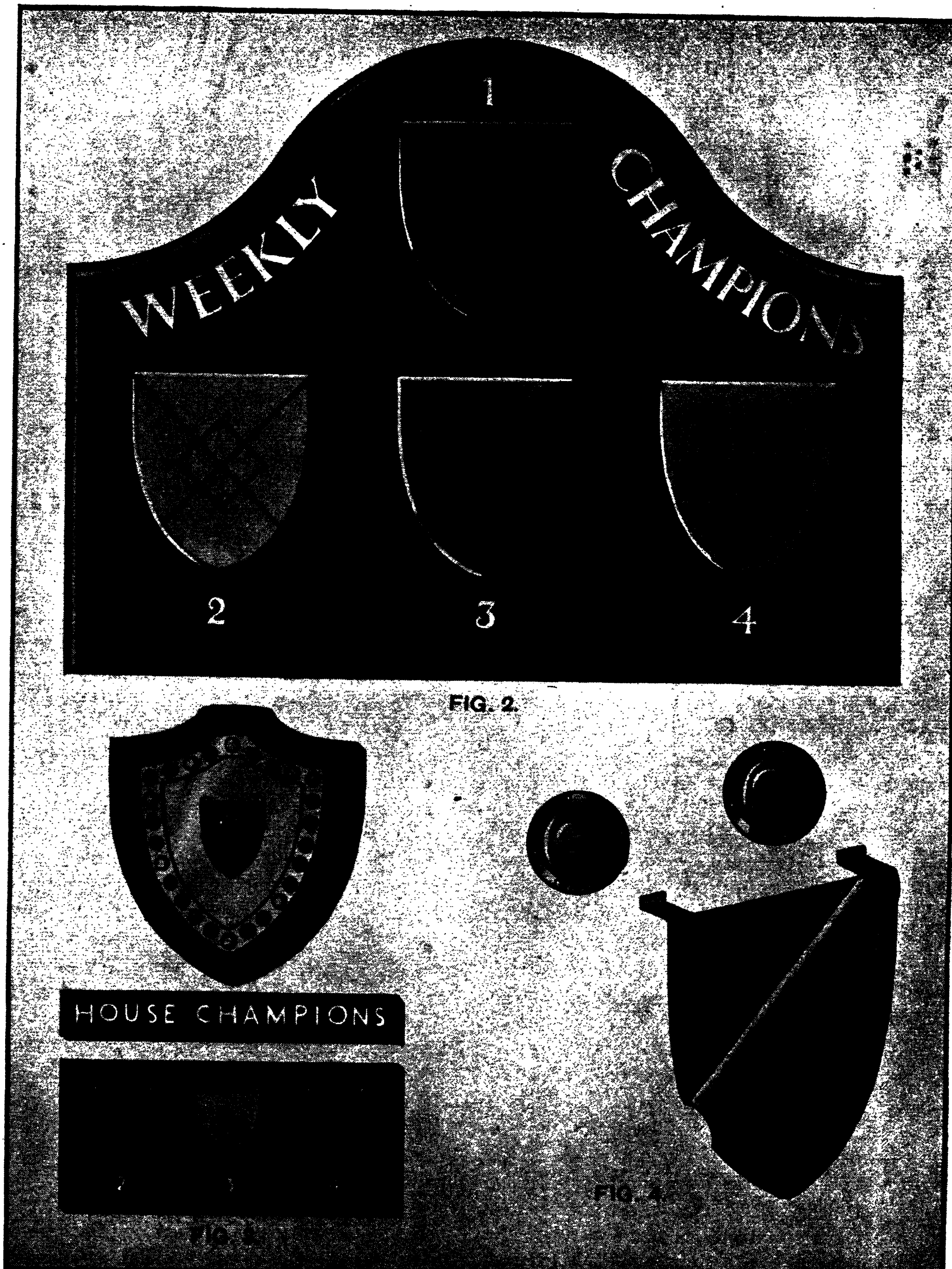


FIG. 2: WEEKLY CHAMPIONSHIP BOARD
FIG. 3: ARRANGEMENT OF TROPHY FOR MONTHLY OR TERMINAL CHAMPIONSHIP
FIG. 4: ONE OF FOUR HOUSE SHIELDS FOR CHAMPIONSHIP TROPHY

printed the words "Weekly Champion," and there are spaces for all four house shields, which are painted plywood, about 8 in. square. Each shield is held in place by four thin nails which form grooves into which the shields slide easily. When the announcement of each house's total is to be made in assembly, the shields are taken off the board, and lie beside it. The head teacher then says something like this, "Blues, 43 points," and places the Blues shield in the lowest position. "Greens, 47 points," and their shield goes to third place. "Of the next two houses, one has 52 points and the winner has 56 points." Then the head teacher, after a moment's hesitation, during which excitement becomes intense, places the two remaining shields in their correct position. There is, inevitably, a spontaneous outburst of clapping or cheering from the winning house. This somewhat dramatic method of informing the school of the week's results is very useful in maintaining the children's interest in the house system, and also gives them a clear indication that their head teacher is interested, too, a pleasant result that is not always obtained by a casual reading from a list. Then, the head teacher tells the school the total points obtained by each house during that portion of the term, always in order, mentioning the top house last. This method ensures that every boy knows at any time exactly how his house is progressing, for there is, too, a board like the P.T. board previously mentioned, but larger and more elaborate, on which the progressive totals are recorded.

At the end of each month or term, according to the length of time it is decided each championship race shall last, the procedure for announcing weekly totals is closely copied. The only difference is that the permanent "Championship Board" is called into use (Fig. 3). This board has been made in the woodwork room, and in metalwork the boys have made four shields. Fig. 4 shows how these shields fit into slits in small metal cups fixed on the board. This method of fixing is very convenient, for the shields are firmly held during the term, and yet can be slipped in and out quite easily at the time for the declaration of the champions.

The shield of the champion house remains in the place of honour during the next month or term, and in each class the team leader of the winning colour automatically becomes class captain. All retiring class captains hand over their badge of office at a whole school assembly, with due ceremonial. This not only settles the vexed question of which team leader shall become class captain, but also gives the winning house in every class in the school a tangible result of their efforts, and one which will affect them during the next championship race. Finally, by special dispensation, the champion house is given extra play, and the house which came second receives just half as much.

General comment.—The house system just outlined has worked very successfully in a large senior school for several years. It has its faults, and there is no doubt that most other systems of awarding points and of keeping the school informed of progress are equally successful. The chief merits claimed for the above system are simplicity and vigour. Simplicity is maintained because all members of the staff realise that the house system is but a means to an end, and vigour is built up by constant references to the system, by regular house meetings, by elaborate means of recording results in graphic form, and by the fact that short term championship races, as opposed to an annual championship, maintain genuine freshness of interest among the children.

Details of illustrations.—Fig. 1 shows a method of recording examination and competition point totals. A convenient size for the sheet is 11 in. by 7 in.

Fig. 2 illustrates a "Weekly Championship" board. It is about 30 in. long, and is made of plywood, painted black, with white lettering and figures. The house shields are also of painted plywood, about 8 in. square, and are designed in simple form to give each house a distinctive badge in appropriate colours. Number 1 is in pale red, with a dark red stripe. Number 2 is yellow or gold with black lines. Number 3 is pale blue, with a dark blue stripe, and Number 4 is in green, with a cross outlined in black. Each is held by thin nails forming grooves into which the shield slides.

Fig. 3 shows the arrangement of the trophy for the monthly or terminal championship. The metal shield forms a useful project for the metalwork room. It might be in brass, copper, aluminium or tinplate, and is fixed on a polished wood base with small screws. Discs are raised all round, and as each championship is won, a disc is painted in the colour of the winning house, thus providing a permanent record by which each house can see at a glance how many times the championship has been won. In the centre of the shield are two raised slots into which the champion house shield is fitted (see Fig. 4). On the title board below the shield each letter is cut from metal plate, is about 2 in. long and is fastened with panel pins to a polished wood base. The other three house shields are hung on a polished wood base in the order in which they appear in the championship. The method of constructing the four house shields for the trophy and a suggested method of hanging them are described below. The figures 2, 3 and 4 for this board are cut from metal and also fastened with panel pins. Each of these figures is 1½ in. long, and their wood base is 21 in. by 10 in.

Fig. 4 shows one of the four house shields for the championship trophy. It is about 4½ in. wide, and is constructed in thin metal. The design is embossed, and makes a useful exercise in beaten metalwork. The shield is painted in the exact colours of the weekly championship shield. When the shield is first cut out, two flanges are left at the top, each about ½ in. square. These flanges are bent as shown and fit into slots in a round metal disc. The diameter of the disc is about 1¾ in. For the three shields six discs are required and each is fixed to the wood base with rivets or screws. The purpose of this method of affixing the shields has been explained in the text of the article.

In schools that have no metalwork centre, or where there is already some form of house championship trophy, such as a cup or special shield, etc., four shields in plywood or cardboard might be fixed in a prominent position by the same method as shown for the weekly championships. In some girls' schools a very attractive trophy is a white silk flag, across which a silk ribbon of the colour of the winning house is lightly stitched. It is suggested, however, that whatever form the trophy takes, the other three houses should also be represented by some method such as that shown above, so that every child shall know exactly where his house stands, and shall have a constant reminder of the possibility of improving its position.

MISCELLANEOUS CLASS PICTURES

TREES—I

(Class Picture No. 17 in the Portfolio.)

1. Oak.
   a. Winter.
   b. Summer.
   c. Buds.
   d. Leaf.
   e. Fruits.

2. Ash.
   a. Winter.
   b. Summer.
   c. Buds.
   d. Leaf.
   e. Fruits.

3. Black Italian Poplar.
   a. Winter.
   b. Summer.
   c. Buds.
   d. Leaf.
   e. Leaf of Black Poplar.

4. Sycamore.
   a. Winter.
   b. Summer.
   c. Buds.
   d. Leaf.
   e. Fruits.

TREES—2

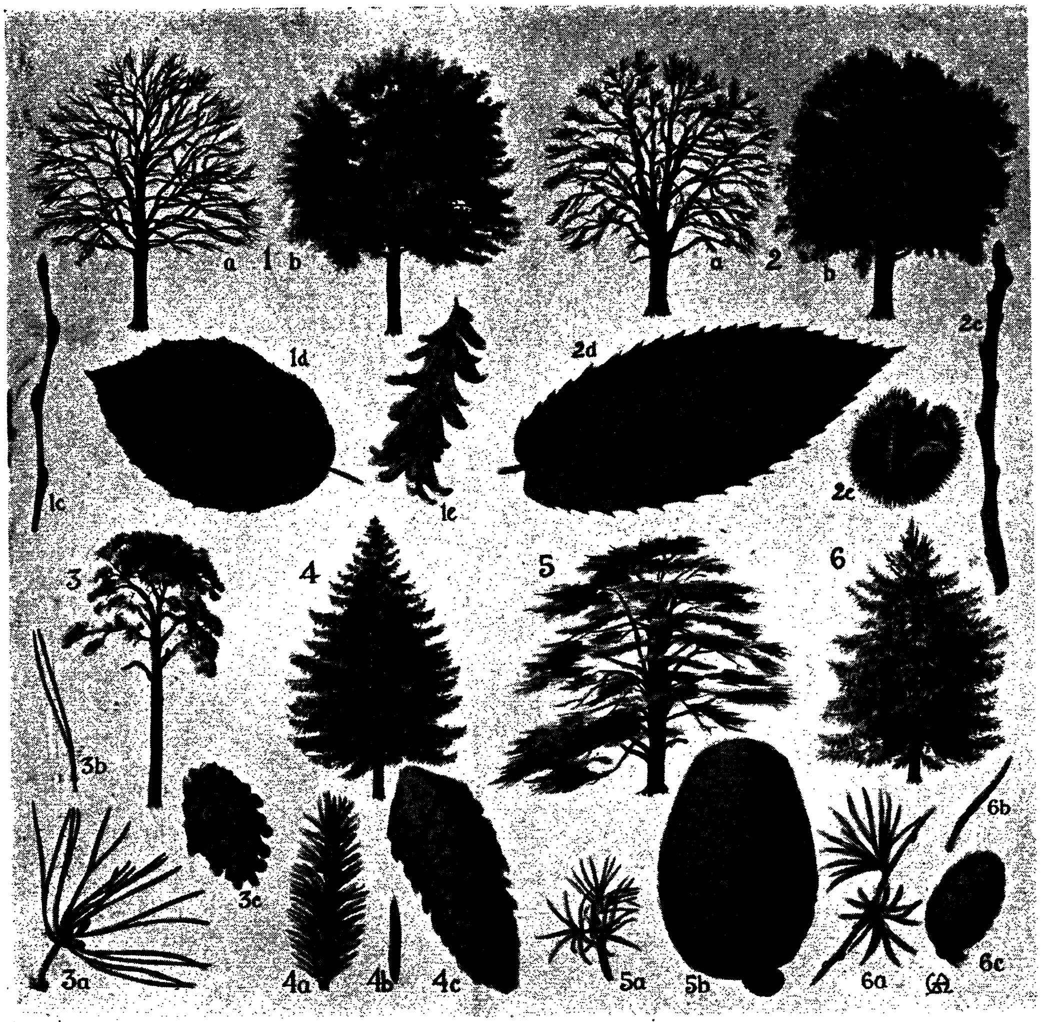
(Class Picture No. 18 in the Portfolio.)

1. Common Elm.
   a. Winter.
   b. Summer.
   c. Buds.
   d. Leaf.
   e. Fruits.

2. Wych Elm.
   a. Winter.
   b. Summer.
   c. Buds.
   d. Leaf.
   e. Fruits.

3. Lime.
   a. Winter.
   b. Summer.
   c. Buds.
   d. Leaf.
   e. Fruits.

4. Alder.
   a. Winter.
   b. Summer.
   c. Buds and Fruits.
   d. Leaf.
   e. Fruit.



TREES—3

(Class Picture No. 19 in the Portfolio.)

1. Hornbeam. *a*. Winter. *b*. Summer. *c*. Buds. *d*. Leaf. *e*. Fruits.
2. Sweet Chestnut. *a*. Winter. *b*. Summer. *c*. Buds. *d*. Leaf. *e*. Fruit.
3. Scots Pine. *a*. Shoot. *b*. Needles. *c*. Cone.
4. Spruce Fir. *a*. Shoot. *b*. Needle. *c*. Cone.
5. Cedar of Lebanon. *a*. Shoot. *b*. Cone.
6. Larch. *a*. Shoots. *b*. Needle. *c*. Cone.

Poisonous Plants

(Class Picture No. 25 in the Portfolio.)

1. Yew.
2. Wild Arum.
3. Corn Cockle.
4. Monkshood.
5. Meadow Buttercup.
6. Marsh Marigold.
7. Box.
8. Hemlock.
9. Water Hemlock.
10. Laburnum.
11. Bittersweet.
12. Belladonna.
13. Black Nightshade.
14. Foxglove.
15. White Bryony.
16. Cherry Laurel.

WATER AND MARSH BIRDS

(Class Picture No. 33 in the Portfolio.)

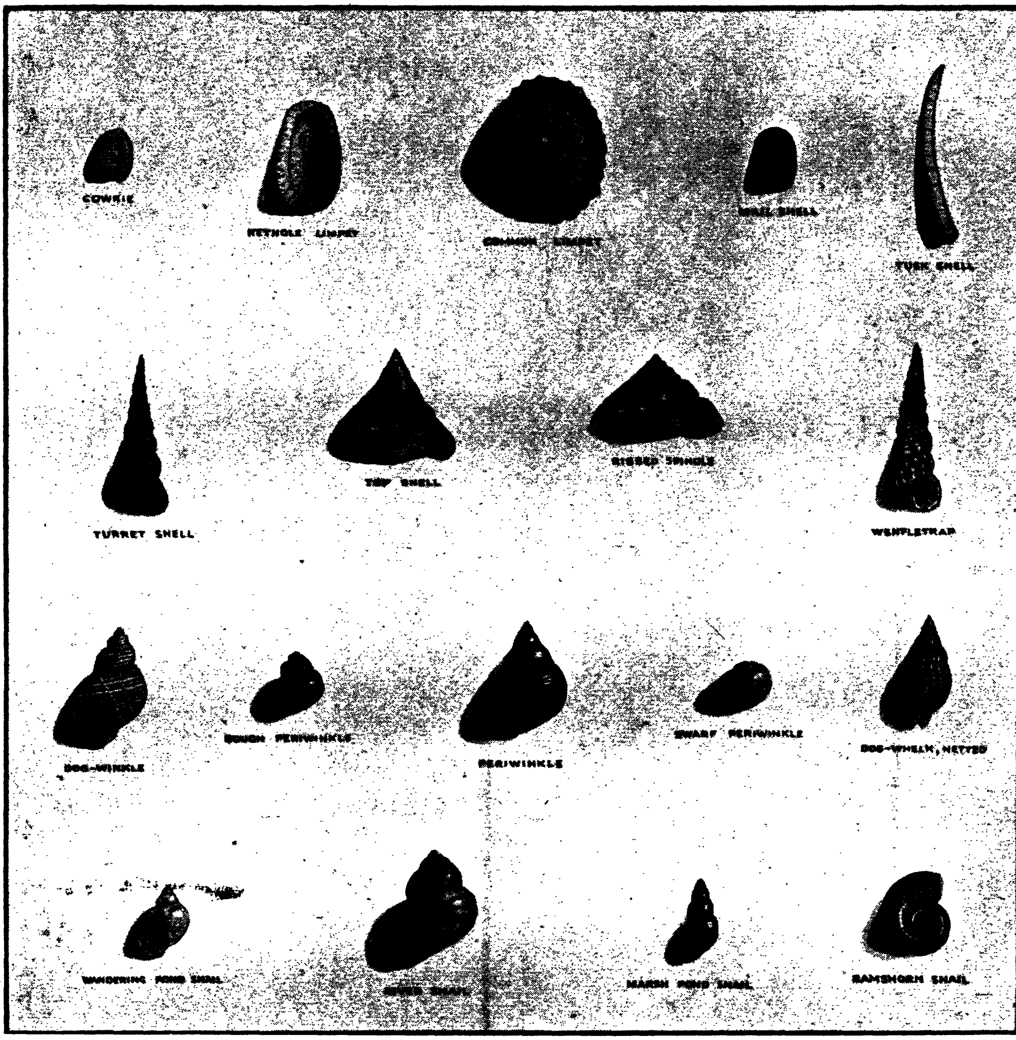
1. Puffin, 12 in.
2. Cormorant, 36 in.
3. Gannet, 34 in.
4. Herring Gull, 23–24 in.
5. Black-headed Gull, 16 in.
6. Coot, 18 in.
7. Dabchick, 9½ in.
8. Moorhen, 13 in.
9. Common Sandpiper, 8 in.
10. Snipe, 10½ in.
11. Tufted Duck, 17 in.
12. Oyster Catcher, 16 in.
13. Golden Eye, 19 in.
14. Pintail, 28 in.
15. Widgeon, 18 in.
16. Mallard, 23–24 in.

All measurements are from tip of beak to tip of tail.

SEAWEEDS

(Class Picture No. 35 in the Portfolio.)

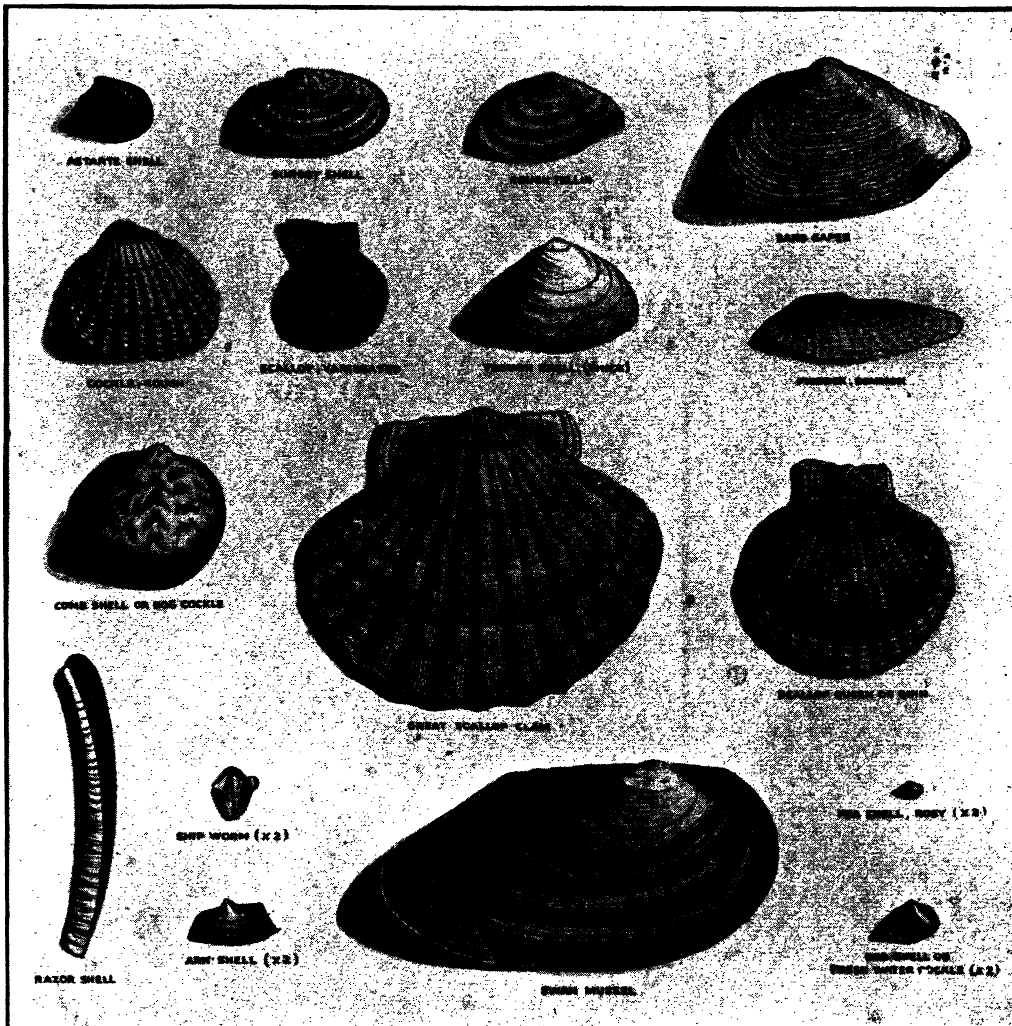
1. Fucus Vesiculosus (Common Bladderwrack).
2. F. Serratus (Serrated Wrack).
3. F. Nodosus (Knotted Wrack).
4. Laminaria Digitata (Ribbonweed or Tangle).
5. Chorda Filum (Cordweed).
6. Ulva Latissima (Sea Lettuce).
7. Enteromorpha Compressa (Sea Grass).
8. Corallina (Coralline).
9. Rhodymenia Palmata (Dulse).
10. Chylocladia Articulata.
11. Ectocarpus Siliculosis.
12. Carrageen Moss or Irish Moss.
13. Rhodymenia Bifida.
14. Polysiphonia Urceolata.
15. Plocamium Coccineum.
16. Cladophora Rupestris.



Univalve Shells

(Class Picture No. 36 in the Portfolio.)

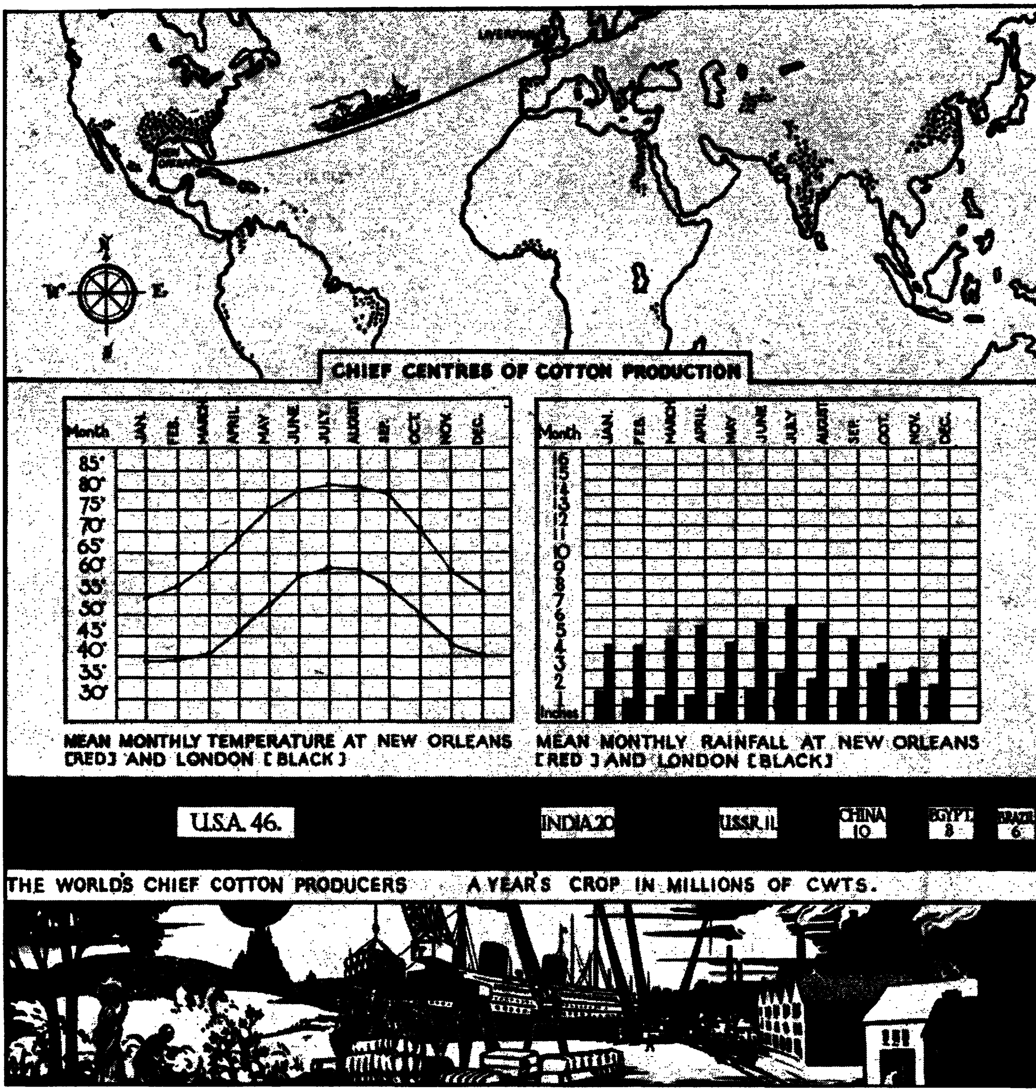
1st line: Cowrie. Keyhole Limpet. Common Limpet. Mail Shell. Tusk Shell.
2nd line: Turret Shell. Top Shell. Ribbed Spindle. Wentletrap.
3rd line: Dog-winkle. Rough Periwinkle. Periwinkle. Dwarf Periwinkle. Dog-whelk, netted.
4th line: Wandering Pond Snail. River Snail. Marsh Pond Snail. Ramshorn Snail.



BIVALVE SHELLS

(Class Picture No. 37 in the Portfolio.)

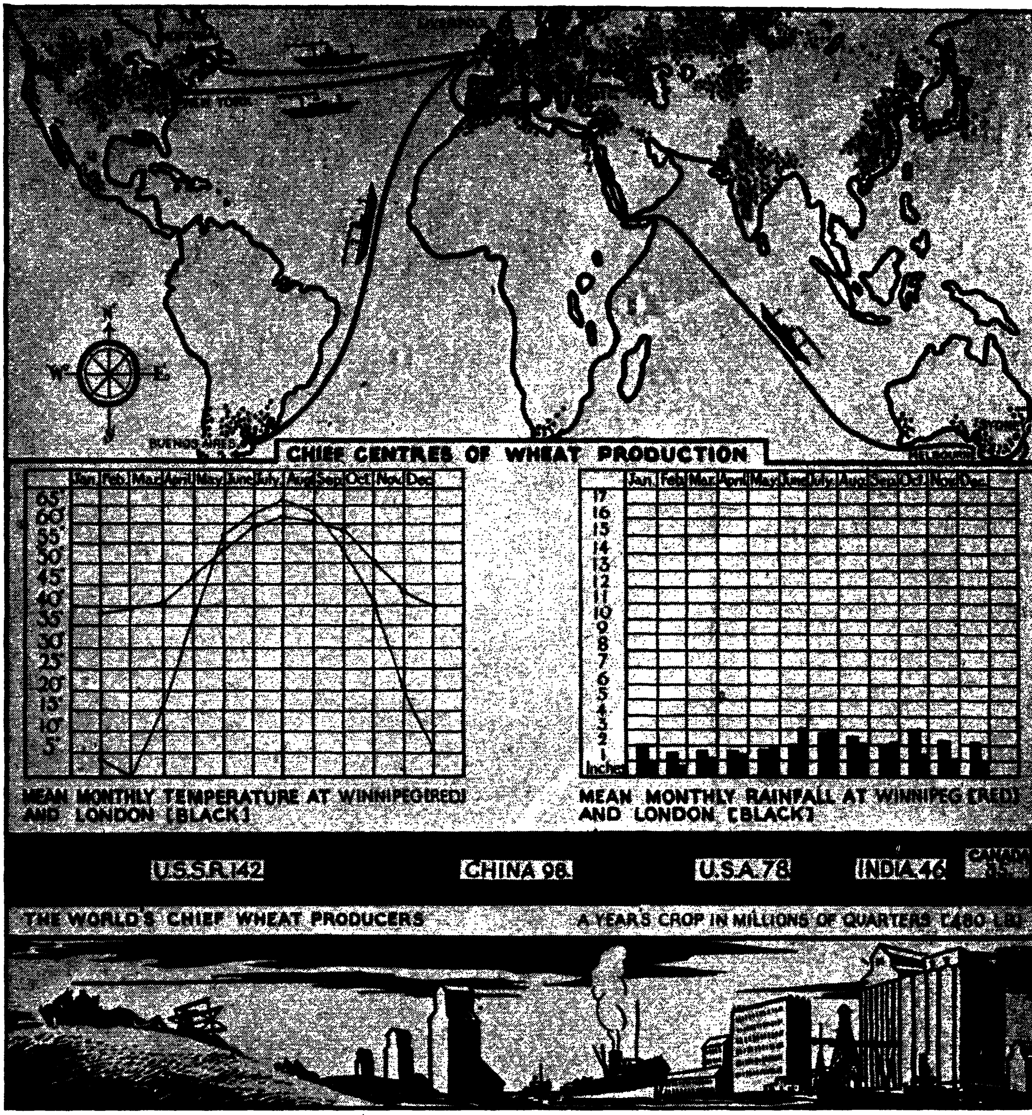
1st line : Astarte Shell. Sunset Shell. Rough Tellin. Sand Gaper.
2nd line : Cockle, Rough. Scallop, Variegated. Trough Shell, Thick. Piddock, Common.
3rd line : Comb Shell or Dog Cockle. Great Scallop Clam. Scallop Queen or Quin.
4th line : Razon Shell. Ship Worm. Ark Shell. Swan Mussel. Pea Shell, Rosy. Orb Shell or Fresh Water Cockle.



Geographical Chart—Cotton Production

(Class Picture No. 89 in the Portfolio.)

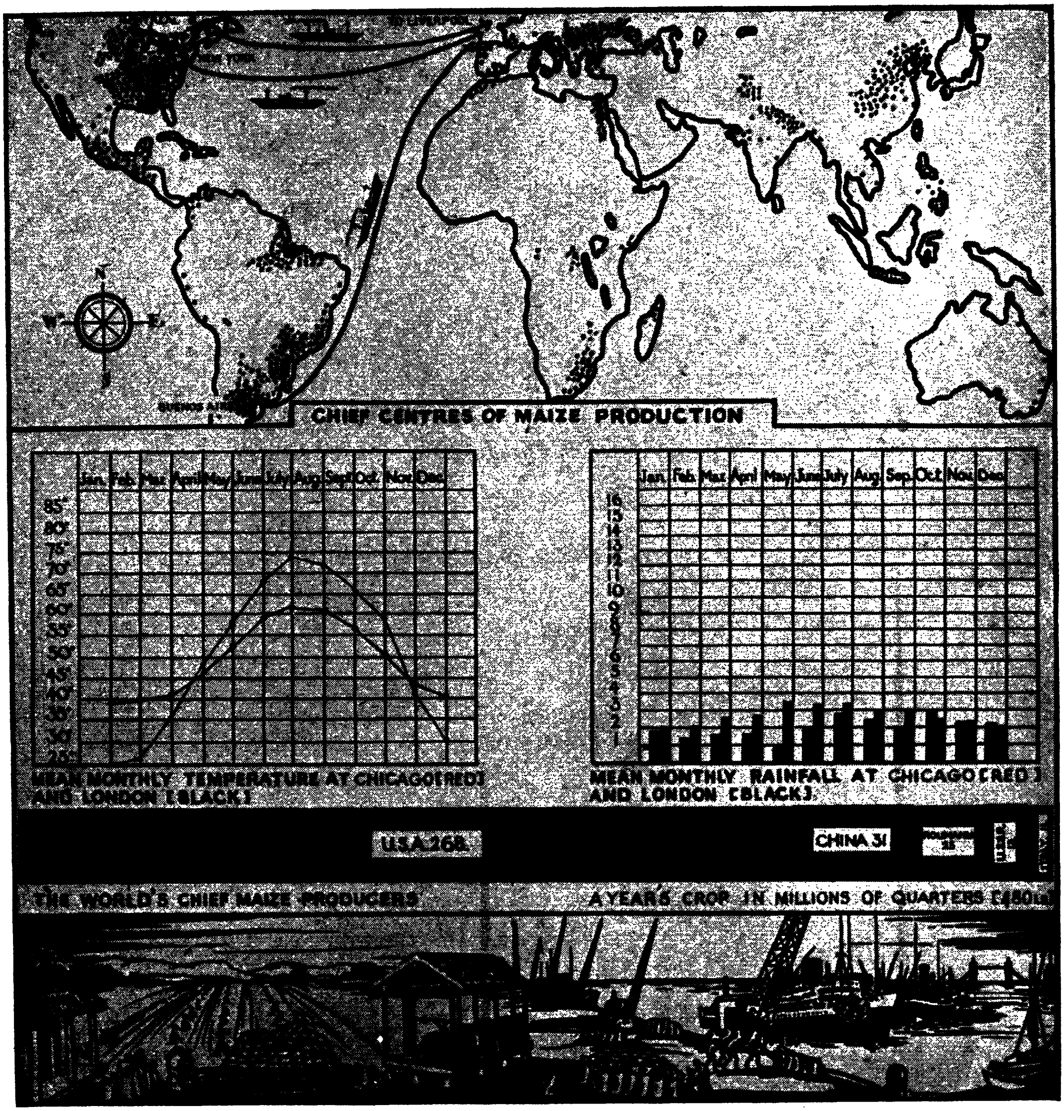
This chart shows the sub-tropical conditions of heat and the heavy rainfall necessary for the growth of the chief vegetable textile, cotton. The comparative scantiness of distribution indicates also the need for rich soil and irrigation in many areas, such as the Nile region. The main route to the United Kingdom only is given as an indication of the long stapled cotton required for the best quality materials compared with the short stapled types, common as in India. Note also a summary of the stages in production from plantation to the mill. On the chart in the Portfolio all items can be clearly distinguished by the colouring in black and red.



Geographical Chart—Wheat Production

(Class Picture No. 90 in the Portfolio).

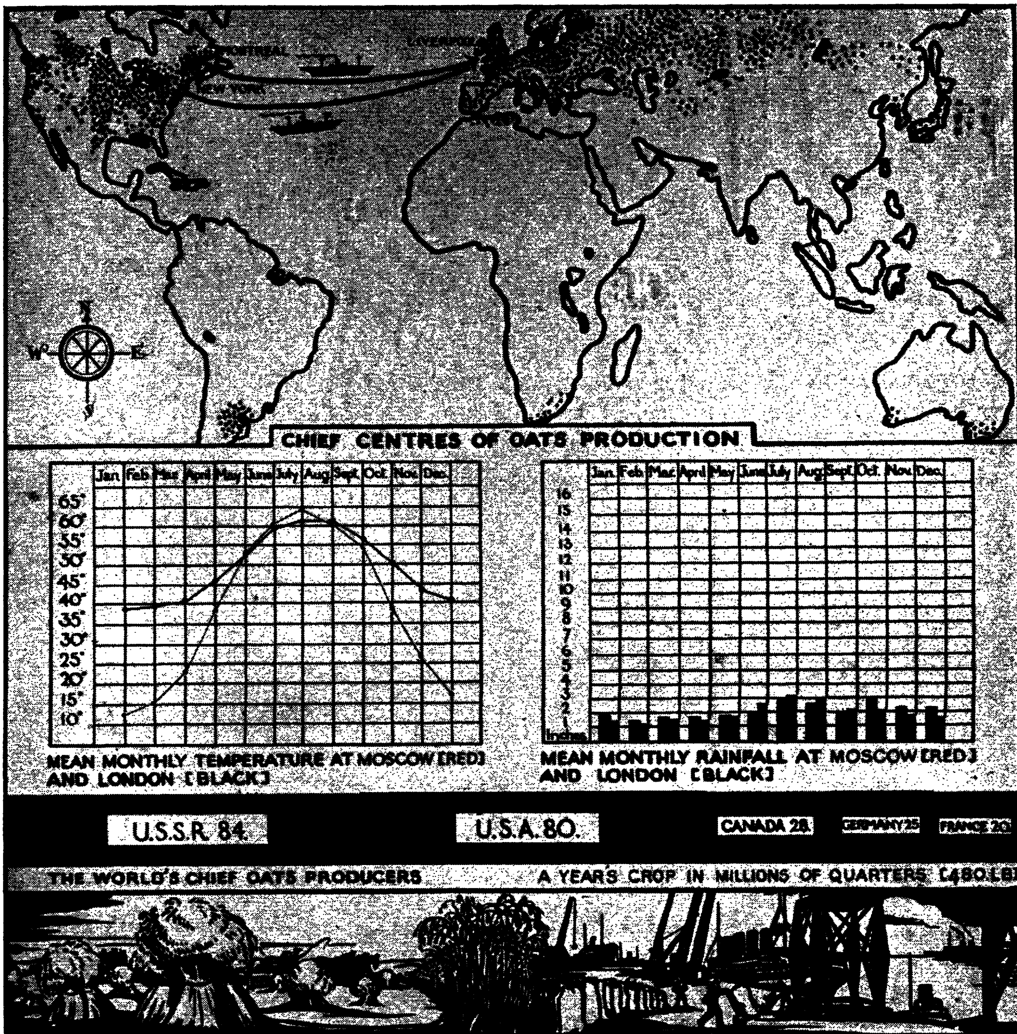
This chart is self-explanatory regarding the main facts of production in this cereal. The items noted are: 1. World distribution and the supply routes to the United Kingdom; 2. the conditions of temperature and rainfall necessary for autumn (England) and spring (Canada) sown wheat; 3. the amounts in proportion of the main producers, shown diagrammatically; 4. the mechanism employed in distributing the crop. In the Portfolio points of comparison are immediately distinguishable by colouring in red and black.



Geographical Chart—Maize Production

(Class Picture No. 91 in the Portfolio.)

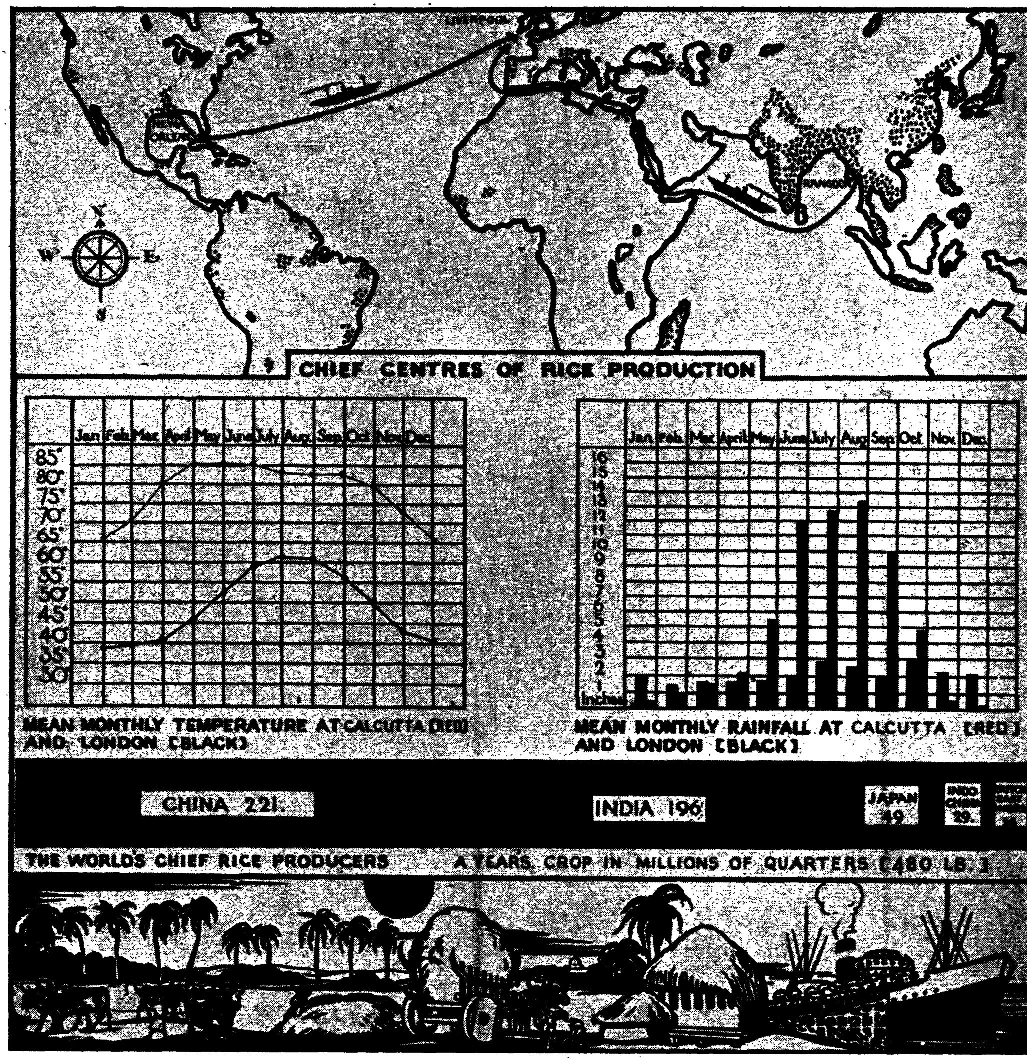
This chart, besides giving details of the distribution and the proportionate amounts harvested by the chief producers, affords details of the conditions necessary for the growth and harvesting of the crop. A comparison of the temperature and rainfall graphs of London with those of Chicago shows the need in general for sub-tropical conditions. Other items to note are the employment of negro labour; the necessity for covering the crop in harvest time from sudden and violent rains; the sacking of the grain for transportation. In the Portfolio the chart is coloured clearly in red and black.



GEOGRAPHICAL CHART—OATS PRODUCTION

(Class Picture No. 92 in the Portfolio.)

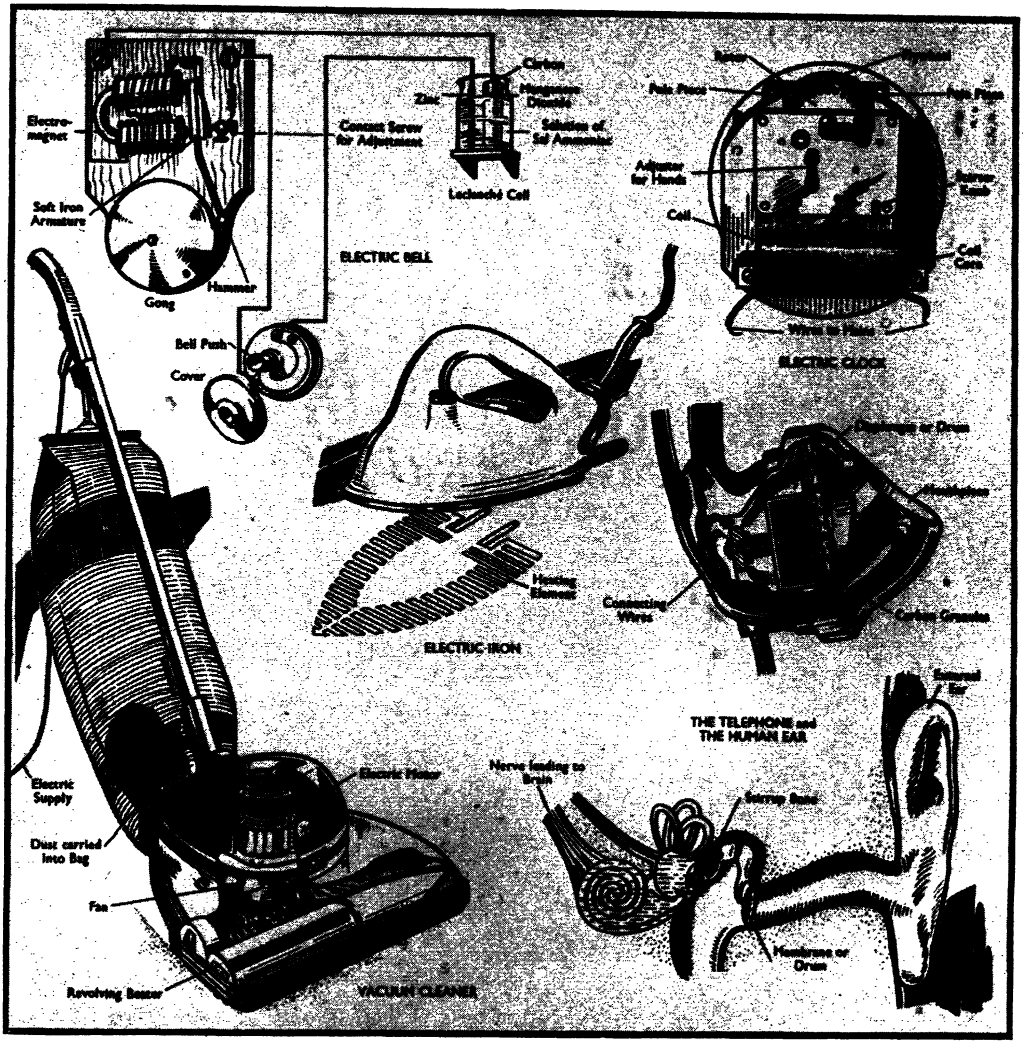
This self-explanatory chart shows the extraordinary importance of the grain in the north temperate zone, and the amounts harvested should be compared with those of wheat. The temperature and rainfall graphs of Moscow and London indicate the adaptability of the cereal to bleak and wet regions unsuited for the cultivation of wheat or maize, although about 70° N. Lat. the temperature is too low. Note the cranes on the quayside for sack transportation. Milling is usually performed at the port of landing. In the Portfolio the chart is coloured clearly in red and black.



Geographical Chart—Rice Production

(Class Picture No. 93 in the Portfolio.)

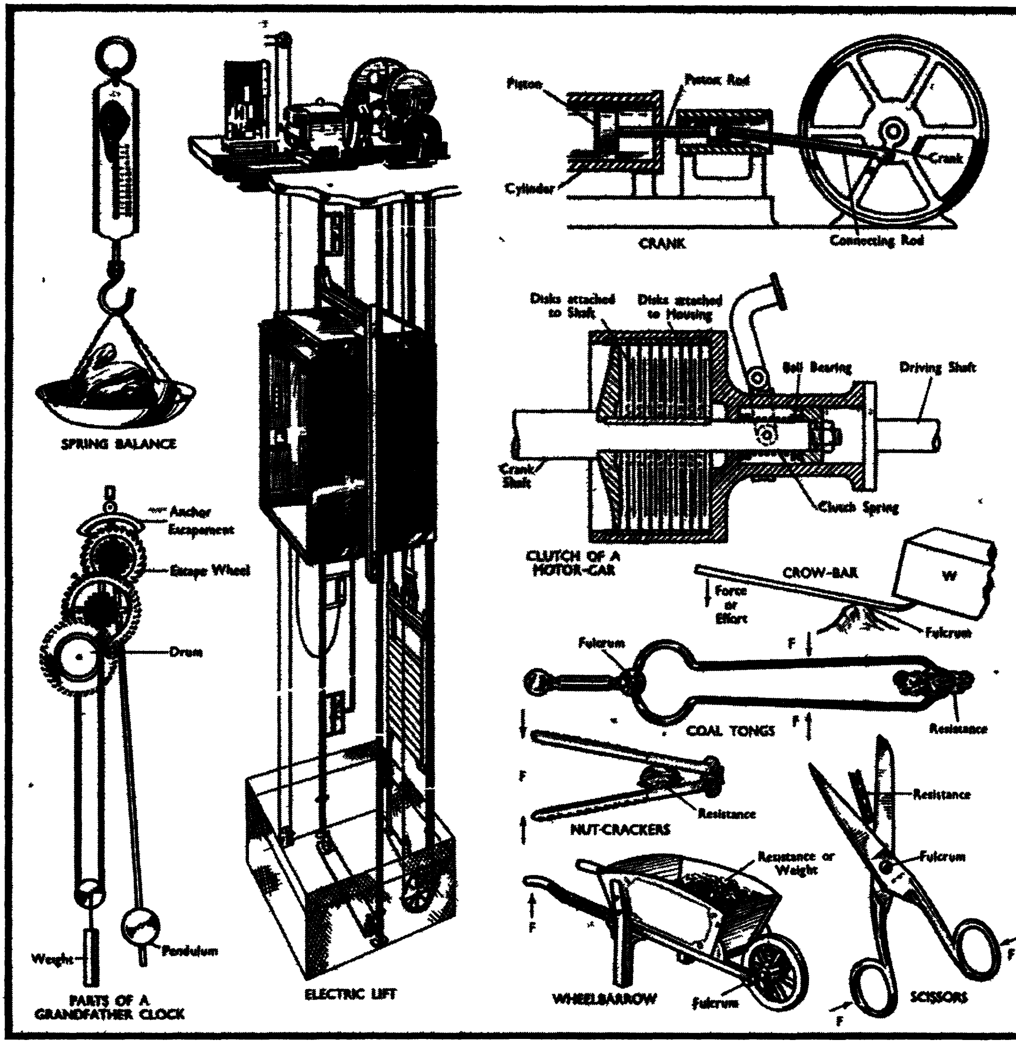
This chart shows very clearly the suitability of the grain for the swamp conditions experienced particularly under the monsoon climate in India and China. Items to note are the abundance of the crop in tropical and sub-tropical regions and the need for irrigation in Mediterranean districts. The enormous amounts harvested should also be noted and compared with other cereals. Note, too, the primitive methods of the native Indian farmer and the human porterage at the quayside. The red and black colouring of the chart in the Portfolio is specially useful in comparing the climatic conditions of London and Calcutta.



SCIENCE—I

(Class Picture No. 141 in the Portfolio.)

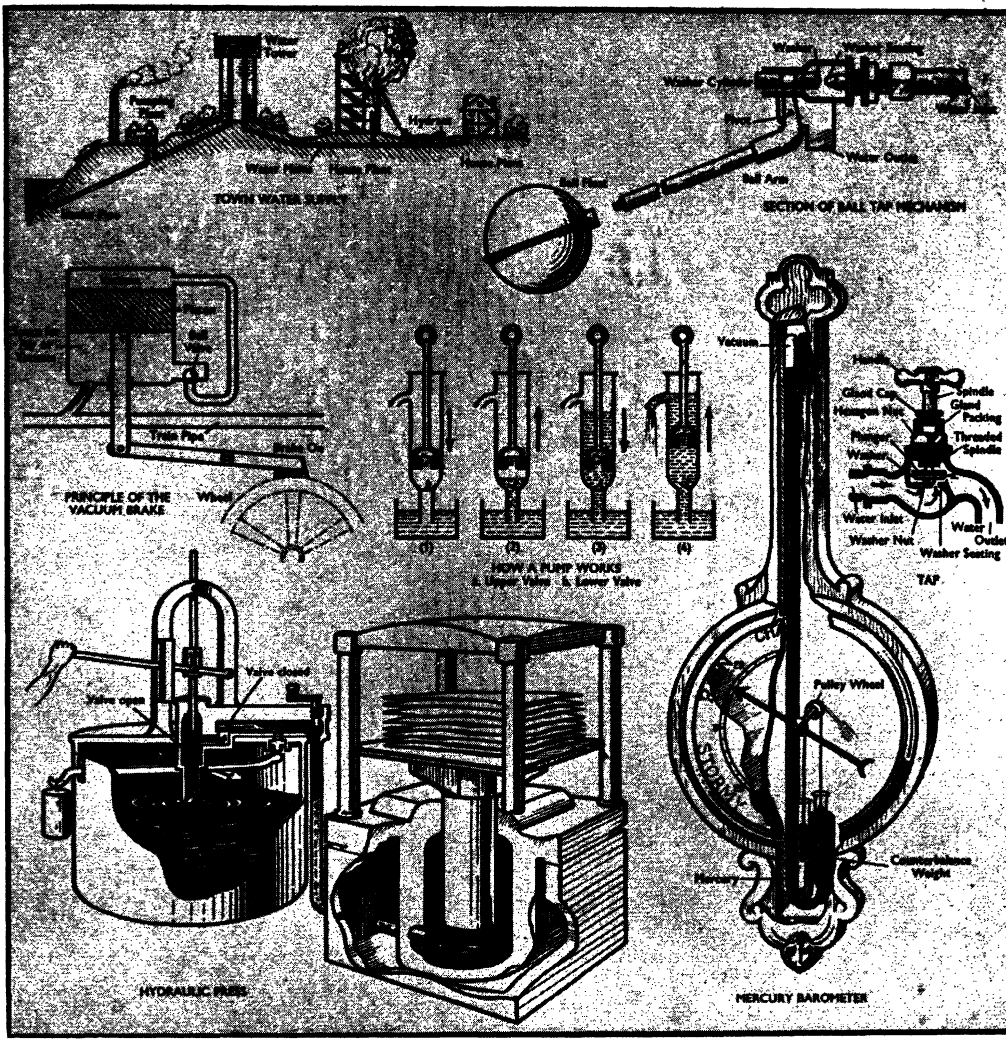
The illustrations on this Class Picture show the workings of an Electric Bell; a Vacuum Cleaner; an Electric Iron; an Electric Clock; and a Telephone, which is compared with the Human Ear.



SCIENCE—2

(Class Picture No. 142 in the Portfolio.)

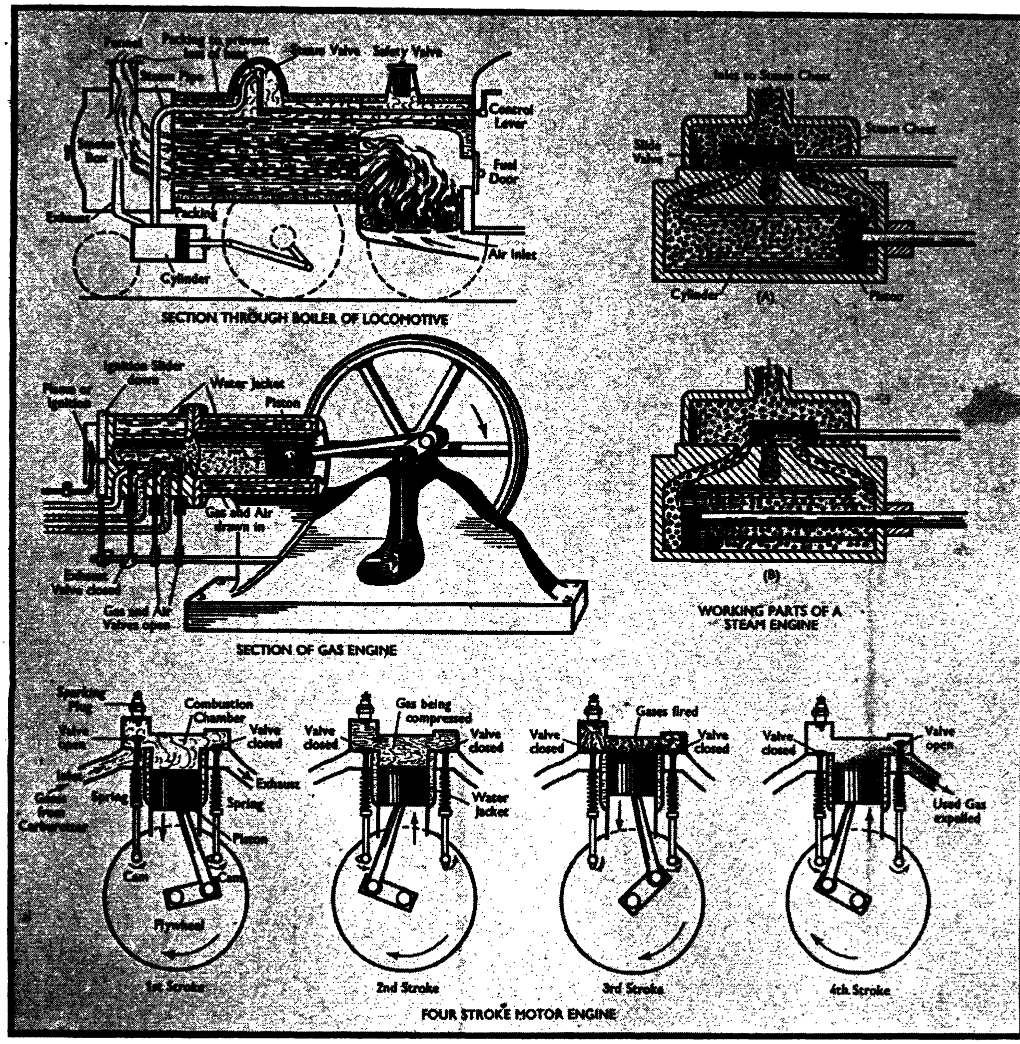
The illustrations in this Class Picture show a Spring Balance; the parts of a Grandfather Clock; the works of an Electric Lift; a piston coupled to a Crank through a crosshead and connecting rod; a Motor-car Clutch, a Crow-bar (simple lever); Coal Tongs (double lever); Nut-crackers (double lever); a Wheelbarrow (double lever), and a pair of Scissors (double lever).



SCIENCE—3

(Class Picture No. 143 in the Portfolio.)

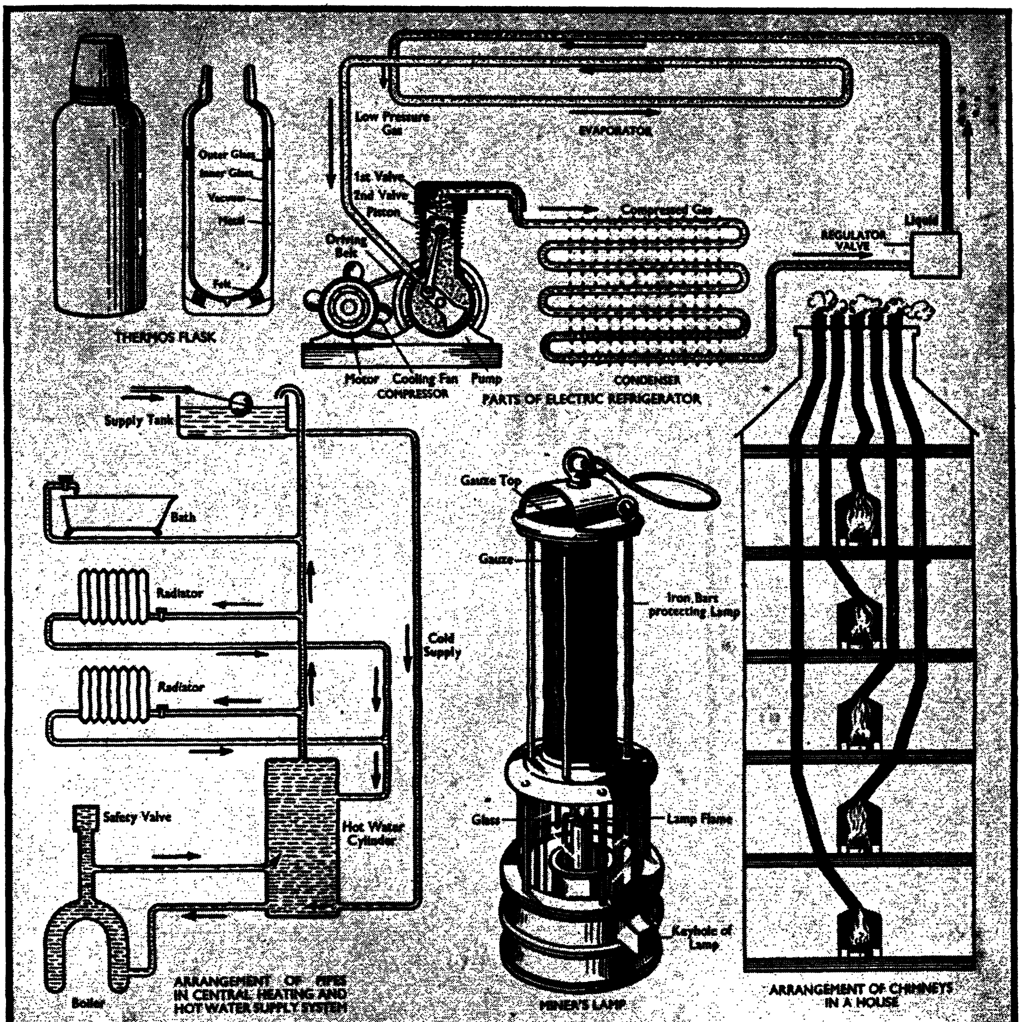
In this Class Picture a diagram shows how water in a low lying reservoir can be supplied at adequate pressure to Town Water Mains. The apparatus is shown of a Ball Tap, which is installed in tanks and cisterns in which a constant water level is to be maintained automatically. The Vacuum Brake, fitted to railway trains, offers a reliable means of applying simultaneously the brakes on the wheels of every coach. The workings of a Pump, a Water Tap, a Hydraulic Press and a Mercury Barometer are also shown.



SCIENCE—4

(Class Picture No. 144 in the Portfolio.)

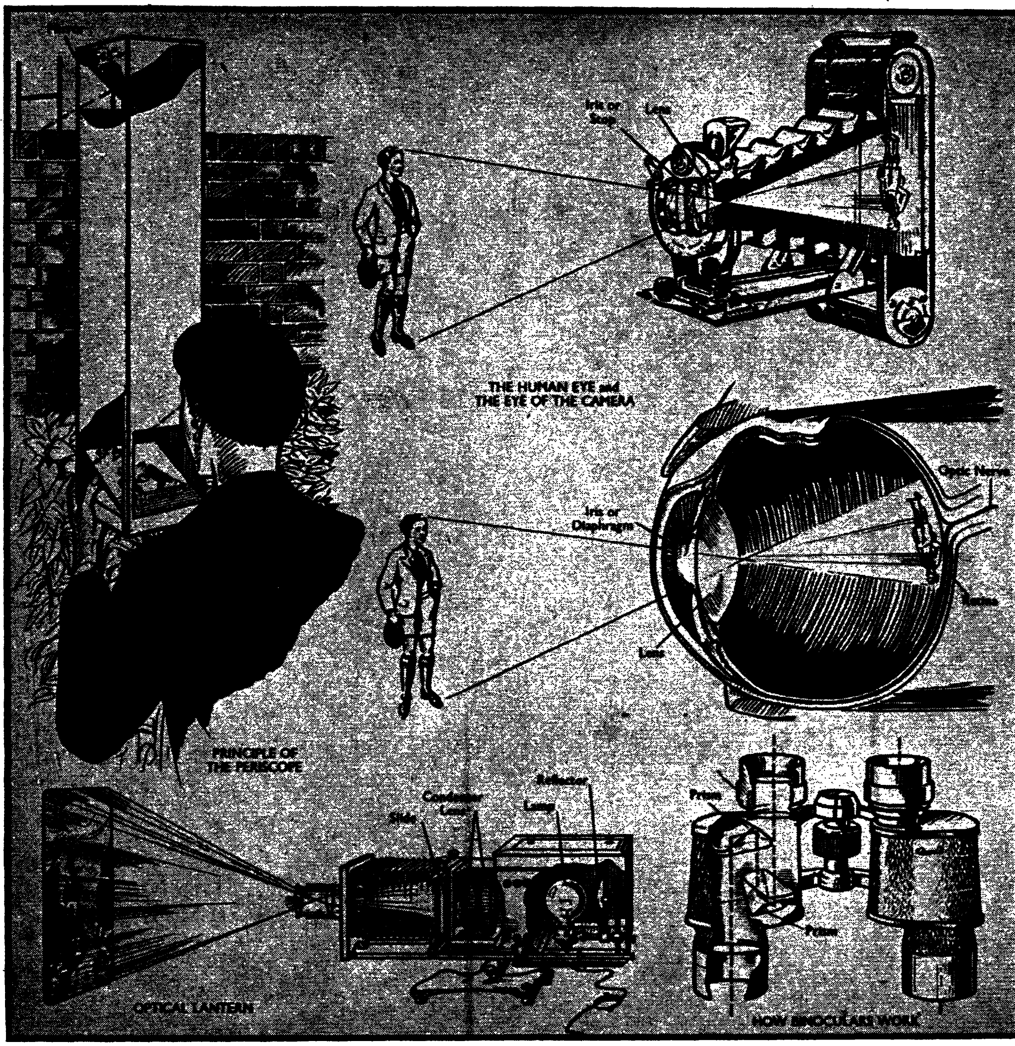
This Class Picture shows a section through the Boiler of a Locomotive, the working parts of a Steam Engine, a section of a Gas Engine, and a Four Stroke Motor Engine.



SCIENCE—5

(Class Picture No. 145 in the Portfolio.)

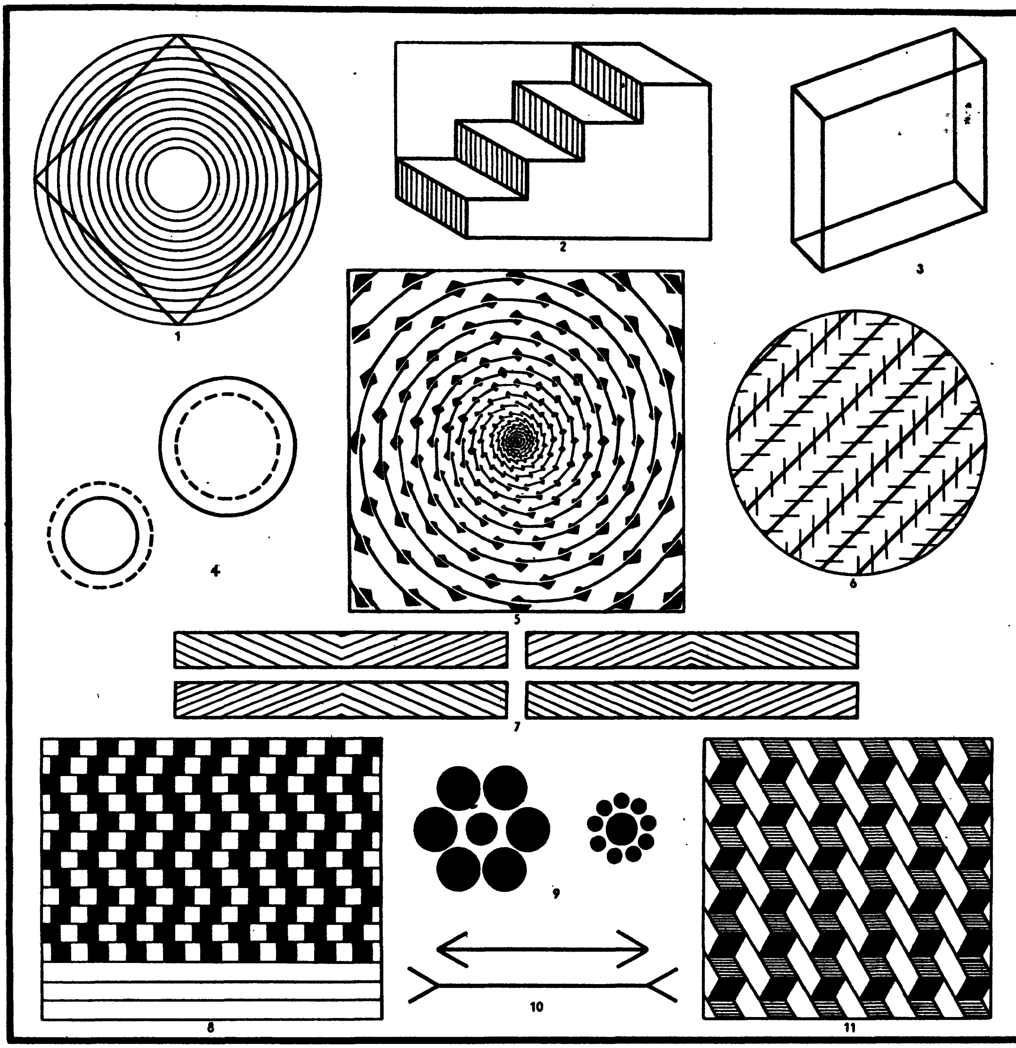
This Class Picture shows the parts of a Thermos Flask, the parts of an Electric Refrigerator, the arrangement of Pipes in a Central Heating and Hot Water Supply System, a Miner's Safety Lamp, and the arrangement of Chimneys in a House.



SCIENCE—6

(Class Picture No. 146 in the Portfolio.)

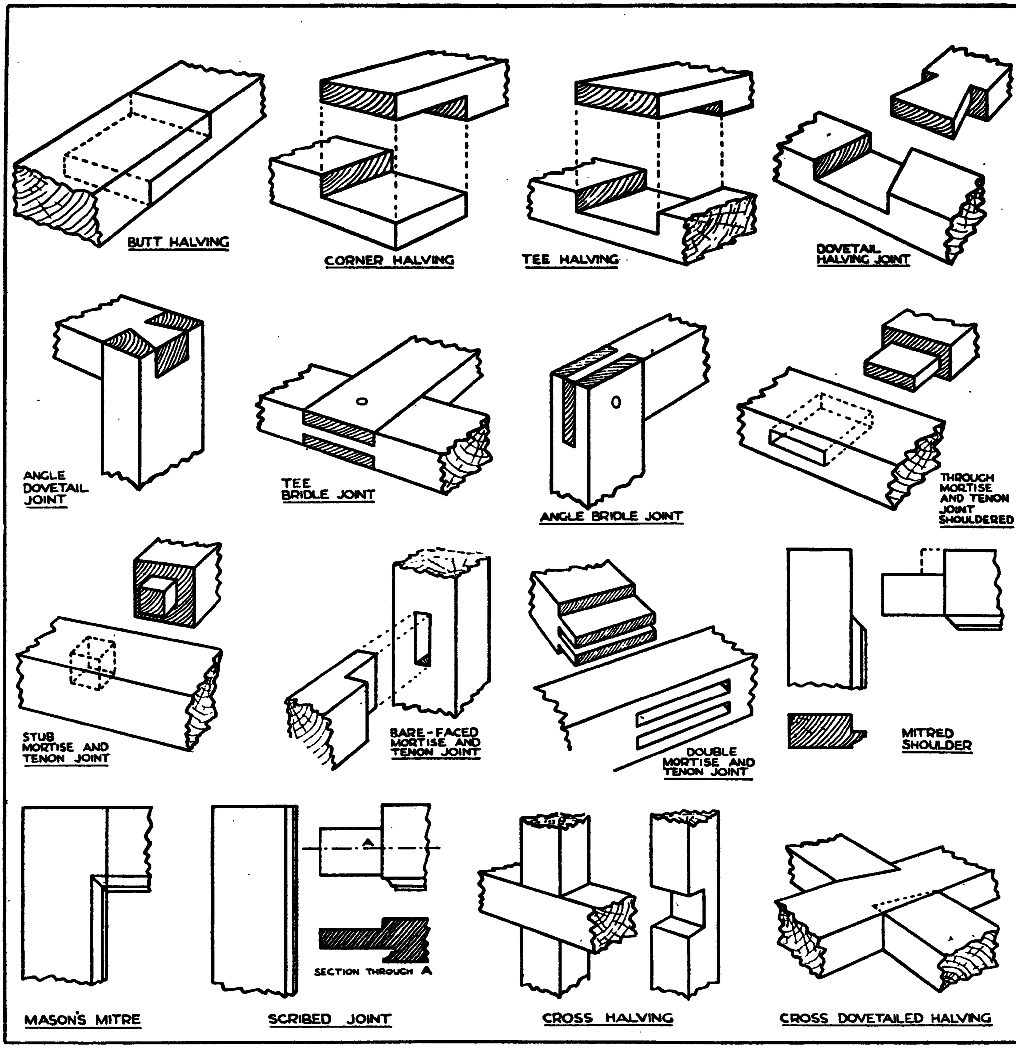
This Class Picture shows the principle of the Periscope; compares the Human Eye with a Camera; and shows the workings of an Optical Lantern and a pair of Binoculars.



SCIENCE—7. OPTICAL ILLUSIONS

(Class Picture No. 147 in the Portfolio.)

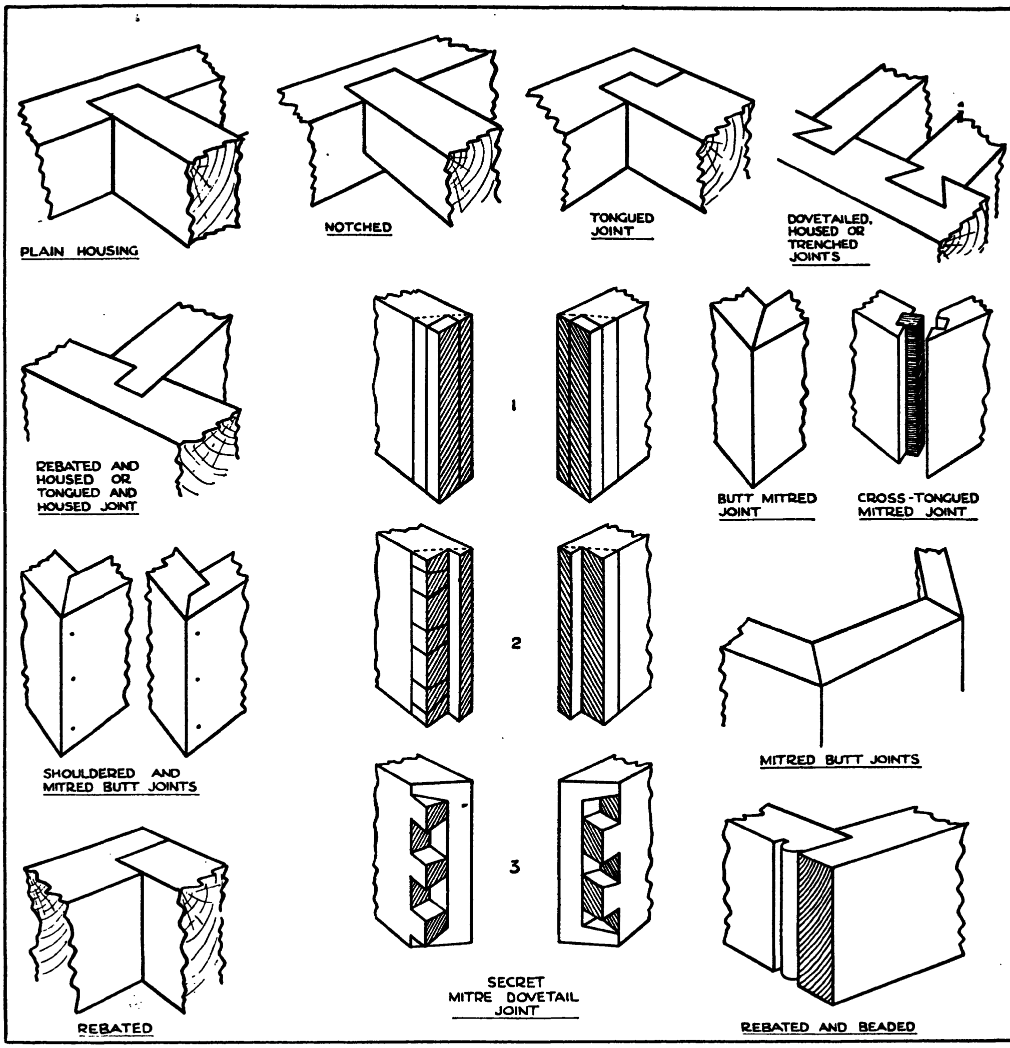
1. The sides of the square are perfectly straight although they appear to curve inwards.
2. At first the observer recognises the drawing as a view of some steps taken from above. Then it changes and appears as a view from underneath.
3. This appears at first to be a view looking down on an oblong box but this also changes to an upward view.
4. The two dotted circles are exactly the same size although the others near them make the same sizes appear different.
5. The curved markings do not form a continuous spiral as might be supposed. By following them round it will be seen that they form circles.
6. The bold lines running across the circle are all parallel although they appear to converge in pairs.
7. The long sides of the four rectangles are all perfectly straight and parallel.
8. The horizontal lines between the rows of blocks are all parallel although they seem to be twisted to peculiar shapes.
9. The two central circles are equal in size but the one on the right appears to be much larger than the other.
10. The two horizontal lines are the same length but the arrangement of arrow heads makes them appear different.
11. The blocks in this pattern appear at one time to be pointing downwards and at another, upwards.



WOODWORK JOINTS—I

(Class Picture No. 148 in the Portfolio.)

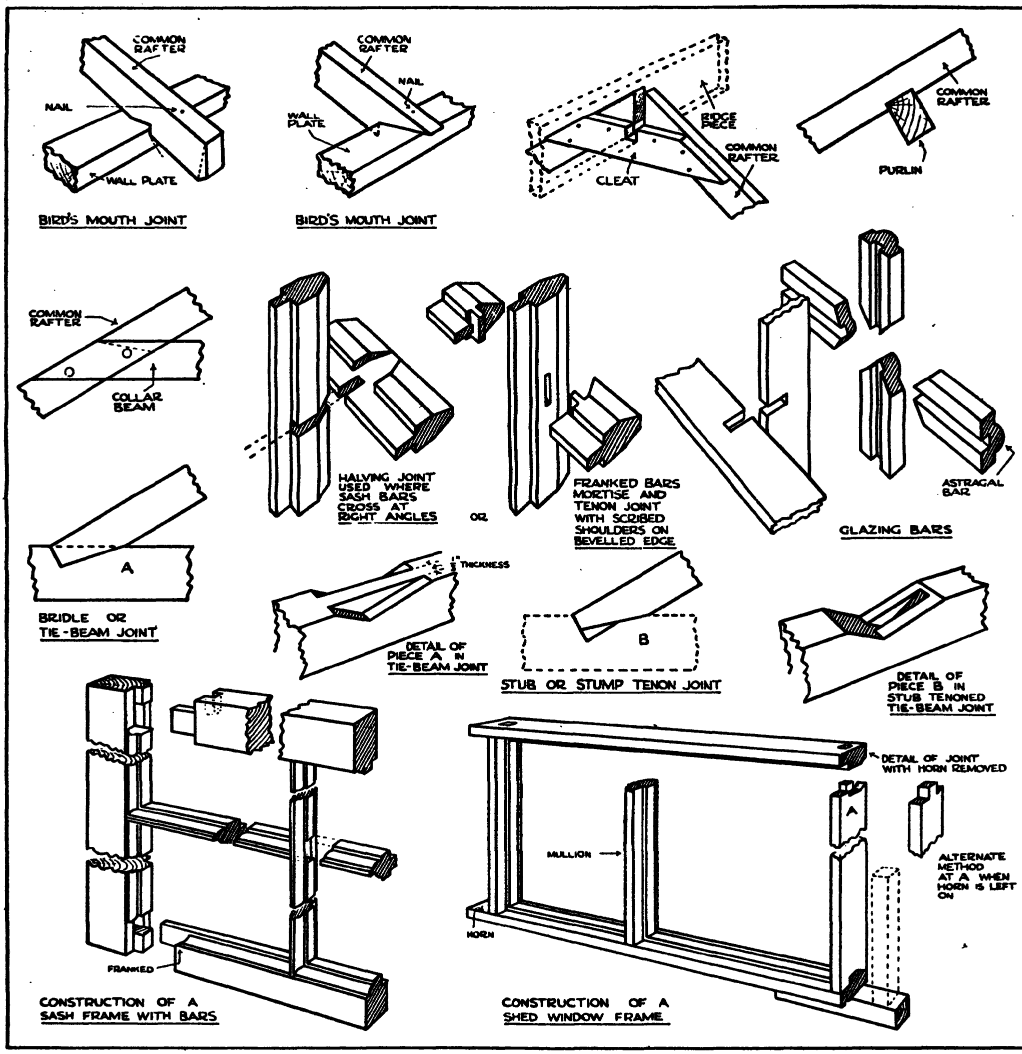
The woodwork joints illustrated in this Class Picture include:—Butt Halving; Corner Halving; Tee Halving; Dovetail Halving; Angle Dovetail Joint; Tee Bridle Joint; Angle Bridle Joint; Through Mortise and Tenon Joint Shouldered; Stub Mortise and Tenon Joint; Bare-faced Mortise and Tenon Joint; Double Mortise and Tenon Joint; Mitred Shoulder; Mason's Mitre; Scribed Joint; Cross Halving, and Cross Dovetailed Halving.



WOODWORK JOINTS—2

(Class Picture No. 149 in the Portfolio.)

The woodwork joints illustrated in this Class Picture include:—Plain Housing; Notched; Tongued Joint; Dovetailed, Housed or Trenched Joints; Rebated and Housed or Tongued and Housed Joint; Secret Mitre Dovetail Joint; Butt Mitred Joint; Cross-tongued Mitred Joint; Shouldered and Mitred Butt Joints; Mitred Butt Joints; Rebated, and Rebated and Beaded.



WOODWORK JOINTS—4

(Class Picture No. 150 in the Portfolio.)

The construction of a Sash Frame with Bars and of a Shed Window Frame are shown in this Class Picture. The joints illustrated include:—Bird's Mouth Joint; Halving Joint used where sash bars cross at right angles; Franked Bars Mortise and Tenon Joint with scribed shoulders on bevelled edge; Bridle or Tie-beam Joint, and Stub or Stump Tenon Joint.

THE CARE OF PETS

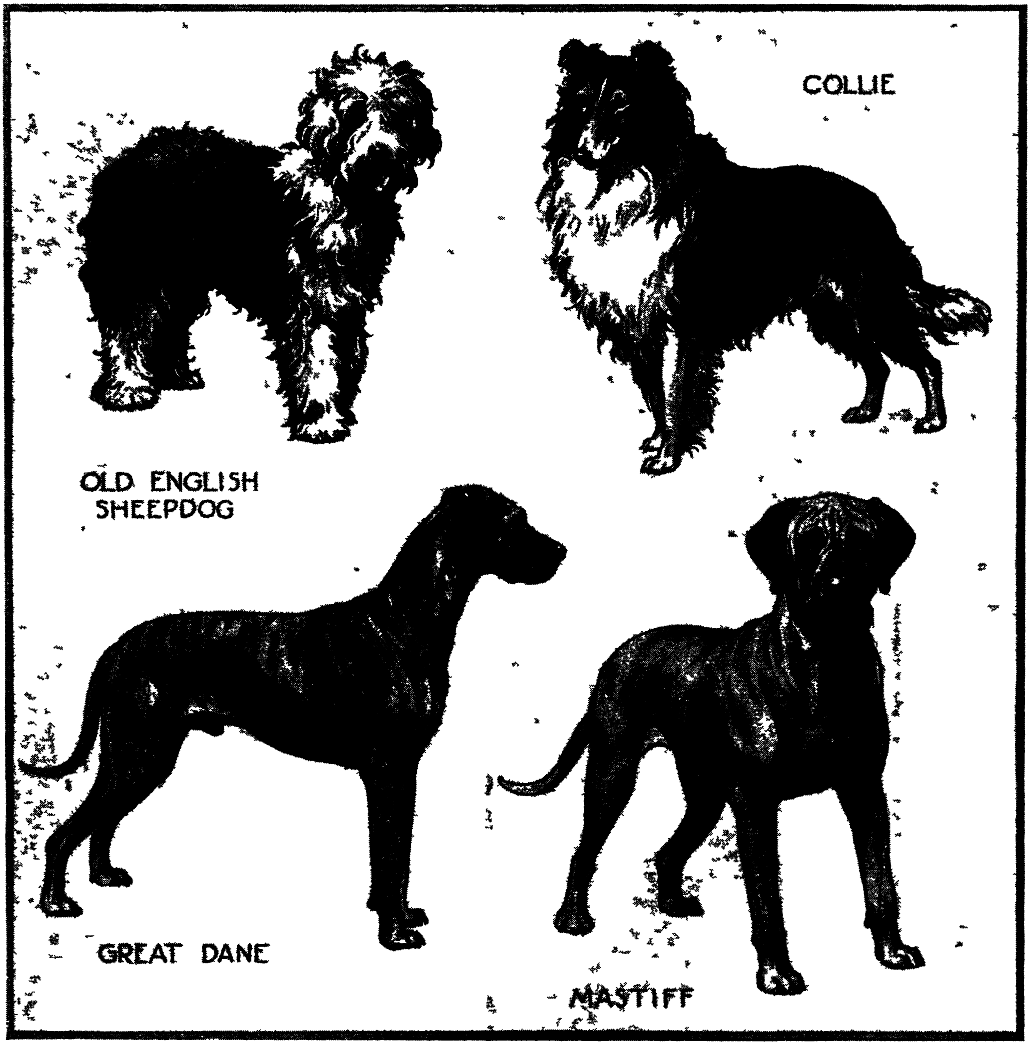
DOGS

Introduction.—It is extraordinary how "Man's first friend" has enshrined himself in the hearts of the human being ever since those dim days when his wild ancestor first crept nervously from the shadows to bask in the warmth of a prehistoric fireside. Beyond his utility in the hunt or in his defence of the home there is something about a dog, be he an unkempt nondescript vagabond or be he the dignified son of a long line of canine aristocrats, that makes no proper man begrudge a kindly word or a spare biscuit.

He is without doubt the world's great companion, in fair weather or in foul, and to his master and his master's friends and possessions he will give faithful service that no change in fortune will corrupt. In recent times the recognition of the dog as one of the strongest links binding family life has developed so remarkably, that to-day, in order to cater for the particular needs of the thousands of dog lovers in the country, upwards of one hundred separate breeds are to be found in the register of the Kennel Club.

Buying a dog.—We are not concerned here with dog breeding as a hobby but with the care and maintenance of the ordinary family dog, so firstly, before buying, let us dispose of the breed question. Shall he be a mongrel or a thoroughbred? Both types fully grown, at their worst, betray characteristics that are unwelcome, and both at their best possess all the attributes of the true companion. But the real thing that matters is, that after the attractive, woolly stage is past, what will your dog grow up to be? With a thoroughbred you know where you are; you have bought him knowing the special appearance, traits and habits that have marked his species for generations, whereas with the mongrel you can only hope that he will turn out well. Then, again, if you take a material point of view, whatever you buy—clothes, furniture, or garden plants—if you are not content with a shoddy article, isn't it more important to have first-rate quality in a living creature that will be with you for many hours and in many places?

The next step is to decide whether to buy a puppy or a grown dog and which is the most suitable breed. It is often thought that the dreaded disease of distemper is caught only in the puppy stage and that it is better, therefore, to buy a dog that has passed that period. Dogs can suffer from this complaint on several occasions and there is no reason why a puppy properly kept should not be free from any ailments. At the same time, a grown animal has adopted definite habits that may be unsuitable, whereas a puppy is very adaptable, and his training into correct habits creates, moreover, a great deal of interest and causes comparatively little trouble. With regard to choosing the breed, no decision should be made without considering firstly what type is suited best for the conditions under which you live and also your own reactions towards dogs. It is quite foolish and unfair to the dog to keep such a big breed as an Alsatian, a Dalmatian, an Airedale, or any of the essentially field dogs, enclosed within the confines of the

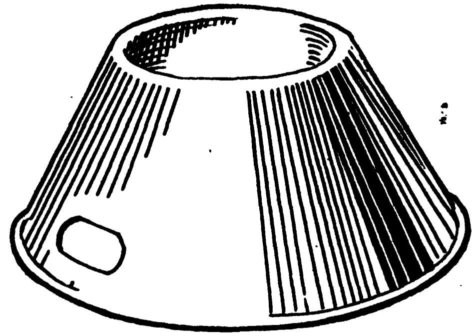


DOGS—1
(Class Picture No 28 in the Portfolio)

ordinary town house unless there is ample provision at hand for long walks and free running. A large dog may command a certain amount of admiration from neighbours, but unless you have the natural trick of control, he will lose his respect for you, and a sulky animal kept in subjection with a whip is no longer a friend but a dangerous servant. Consequently, for the average town dweller with a small garden, a Wire or Smooth-haired Terrier, a Sealyham, a Cairn or a Scottie will be found to be advisable; or if your inclinations run in the direction of lapdogs, a Pekingese, a Pomeranian, a Griffon or a Schipperke are just a few of the many types available. Having decided upon the breed, advertisements in the local newspaper or in any of the weekly periodicals devoted to the interests of doggy people, will put you in touch with kennels or breeders supplying puppies. A visit beforehand to a dog show or two would give an opportunity of discovering what points to look for when buying; but if that is not possible, choose a pup that stands boldly and firmly. Make sure that his eyes are bright, his skin flexible, his coat clean and in good condition, and that his gums and tongue are bright with teeth sound and milk white in colour. There is no need to buy from the first litter you see; do not allow sympathy to overcome your judgment, but insist on a good sound animal, then no trouble should ensue. With regard to the price to be paid, if you are dealing with the right people, do not attempt to argue. The price is fixed, and if it so happens, tell the breeder frankly that it is beyond your purse and he will always do his best to find another less expensive. The price of a good dog may seem very high, but when it is considered that under ordinary conditions he will be with you from ten to fourteen years, the cost is not really abnormal.

Having acquired a dog you must be alive to your responsibility. At first it will whine for apparently no reason; it will not be clean in the house; it will do a dozen little things that may be annoying, but shortly there will be ample compensation for all these petty troubles, and in the meantime a system of training must be evolved in which reason, gentleness, patience and insistence must all play their parts.

First of all, a dog is naturally a hardy, healthy animal and will undergo hardship far beyond the powers of the human being. However, under the varying climatic conditions of this country it is not surprising that he is often affected by sudden changes in the weather and becomes weak and loses his stamina with the resultant liability to illness. Correct feeding and proper hygienic measures are of major importance in obviating this source of trouble and so let us begin by paying attention to these.



Feeding Trough for Long-eared Breeds

Feeding.—Before leaving the breeder with your puppy, be sure to inquire what food he has been accustomed to and for a time keep strictly to it, as sudden changes in diet are very likely to cause digestive trouble. Small puppies should have four meals a day consisting, generally speaking, of prepared milk food and puppy meal, a little raw or cooked meat, and green vegetables. White bread, sweet biscuits and cake on no account should be given. It is a good plan to begin the day and end it with a milk food and meal, providing meat and meal for the two intervening periods. There are at least a dozen firms specialising in the manufacture of dog foods containing the correct blend of dog meat and cereals. Such foods form an excellent basis for a feeding system, but a little meat, fish, warm soup, gravy or milk with an occasional portion of lean, raw meat will be necessary for a complete diet. At this point it may be worthy of note that it is a fallacy to feed strictly according to the book. Each owner must be alive to his dog's particular tastes and requirements and should change the diet accordingly.

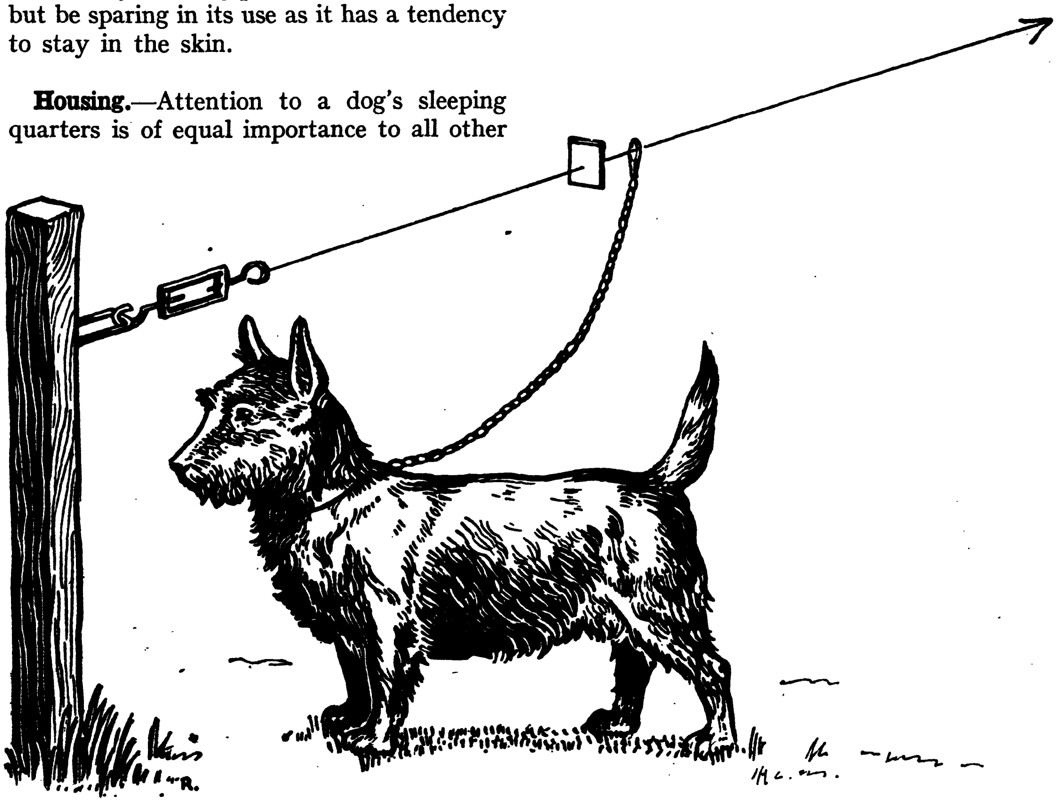
With regard to the quantity of food to be given at each meal, no definite rule can be laid down. Watch your puppy at feeding times for a few days; if he leaves any food on the plate, reduce the quantity; if he does not appear to be satisfied, give him a little more. Some dogs will over-eat if given a chance, but gluttony soon shows its effects and a wise owner will not encourage the habit. A little and often is a golden rule when feeding young puppies and old dogs, but for others, two meals a day are ample. All adult dogs are better for having something hard to eat, as it assists digestion and helps to keep the teeth in order. It is a good plan to keep a large unsplinterable bone from which, for a house dog, all the meat has been removed. Let him have this to gnaw after every meal as an aid to the flow of saliva. Whilst on the subject of grown dogs, the amount of food required to keep them in condition can be estimated roughly by allowing three quarters of an ounce of food per day for every pound they weigh. This does not include gravy, which, though of course of no great consequence, they are better without, but it must be emphasised again that amounts given must vary according to the dogs. Heavy and slow going dogs naturally require less food than those that are very active and well exercised.

Once the meals of your dog in particular have been established, be sure to give them at the same time each day, as this will help digestion and encourage regular habits. Do not make a custom of giving snacks between meals or tit-bits from the table. They will not only ruin eventually his digestion and thus make his life a misery, but also will cause him to be a nuisance when visitors come to the house. It is very difficult to resist the pleading eyes of a pet—but be firm; give him his meal before you have had yours and then make him lie down.

Hygiene.—*Grooming and washing.*—A dog as a family pet is leading an unnatural life to a very great extent and it is essential for his well-being that his toilet receives daily attention. Ten minutes or so only are necessary, but the time spent will prevent many minor ailments and also give the opportunity of checking any serious trouble at the beginning. Puppies' coats are not a difficult matter—a damp sponge here and there and a brisk rub being all that are necessary. For dogs, a hair glove will keep the smooth-coated varieties in excellent condition and a fairly stiff bristle brush for the long-coated ones, with the frequent use of a wire brush for those with a heavy undercoat. May is usually the month when the greatest care is necessary. At this time adult dogs usually shed their coats and in order to save constant scratching, a fine-toothed metal comb is advised for helping the animal to get rid of its old hair. Scratching does not necessarily mean the presence of insects or a skin disease; the irritation caused is often nature's way of getting the dog to help himself. Lastly, the coats of some of the long-haired varieties are greatly improved by stripping. This operation should be performed by an experienced person but the beneficial effect is well worth the expense.

The constant washing of dogs is a debatable point. It is argued, and quite rightly, that the hair is robbed of its natural oils and that the coat, in consequence, becomes soft and brittle. On the other hand, a dog is better for washing; it keeps his coat and skin clean and free from the doggy smell that is often offensive in a home. The natural way of the dog affords perhaps the best solution; he delights in a quick plunge into a pond or in a long quest through dew-soaked grass, followed by a hard shake and a series of quick drying sprints. That is his own method; are the methods employed at home similar? Where does the use of soap come into the operation? This, it seems, is the crux of the argument. Soap is necessary without a doubt; the conditions of living require it, but be careful in its use. Stand the dog in a bath of *lukewarm* water, wet him thoroughly and then rub in a shampoo or a hard soap *specially prepared for dogs.* It is the ordinary household soap that is often the cause of trouble. Start at his ruff (the place where insects take to for shelter) and work in a special lather; then journey to the hindquarters paying extra attention to the armpits and knee joints. Always leave the head until the last and then be careful not to cause discomfort by allowing soap to enter the eyes. The ears too are very delicate subjects and inflammation may be set up by soap and water causing irritation. After washing, rinse him well in clean water with a little disinfectant added, and after he has had a vigorous shake, give him a hard rub down with two or three towels and take him out for a sharp walk until dry, or in winter let him lie down in front of a fire. A bath such as this, once every fortnight or so in summer and once every two months in the colder periods can do nothing but good to a dog excepting, of course, if he is old or delicate. Puppies can have their first bath as soon as possible after they are six weeks old, but the operation must be performed quickly, and drying should be thorough and carried out in a warm place. A dirty coat can always be kept clean in between baths by brushing in one of the several dry-cleaning powders on the market, but be sparing in its use as it has a tendency to stay in the skin.

Housing.—Attention to a dog's sleeping quarters is of equal importance to all other matters relating to canine hygiene. A dog is entitled to proper comfort and will repay you by creating no disturbance at night. If he is to sleep in the house, see that he has a basket or bed raised from the floor and placed in one particular corner that is free from draught. He likes his own special blanket or cushion—a sack stuffed with wheaten straw is advisable—but make sure that it is always clean. If you insist that he has no right to trespass on chairs or couches, he will soon learn to use his own resting place, and once that is established leave him in peace to go there whenever he wishes. A large dog should, of course, sleep out of doors where a proper building should be set apart for him. Now he does not require a palatial construction of several rooms or does he deserve the indignity and danger

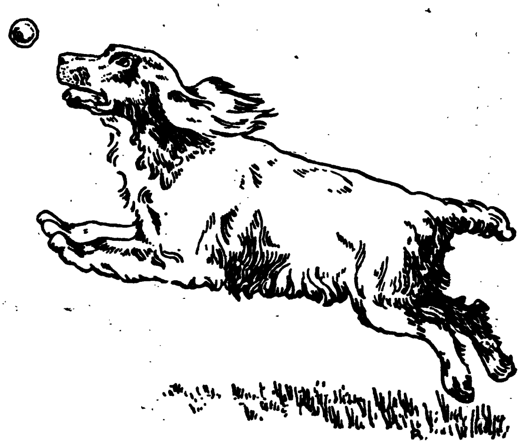


Attach end of Wire to Kennel

of an old box that happens to be handy. No, all that he needs is a decent wooden structure set apart from cold winds, free from dampness and lined with matchboarding for protection from the draughts and intense cold of winter nights. Stand it on some bricks so that there is free ventilation under the floor and if possible make it movable so that the earth beneath can be forked over now and again. It is better for the opening to be at the end of a side rather than in one of the ends so that the dog can curl up away from a direct rush of wind and also there should always be an easy means of getting into the kennel for cleaning purposes. For flooring, wood, asphalt or bricks are all quite suitable, but do not use cement as it is too cold and becomes wet through condensation. Whatever flooring is chosen, cover it freely with pine sawdust in order to absorb any moisture and to keep the kennel free from any doggy smell. It is a good plan to fix a low bench to the floor for the bed but it is not necessary, and your dog will be very happy on his bedding of wheaten straw or pine shavings. The kennel must be kept scrupulously clean. Shake up the bed every morning removing all soiled parts, and as often as possible sluice the floor with water to which a little disinfectant has been added, drying off with a sprinkling of sawdust and renewing it when the moisture has been absorbed. These precautions, the addition of a weekly spray of disinfectant over all woodwork, will remove the possibility of skin troubles and prevent the harbouring of insect pests. There is another point to remember. Will circumstances compel your dog to spend some hours on a chain? The perpetual chain is an infliction of the greatest cruelty that none but ignorant or callous people would insist upon but a certain measure of control is often necessary. In this case the running chain is a humane method of serving the purpose. Stretch a wire, collar high from the kennel to a convenient post or fence and as far away as possible and supply the chain or leash with a metal ring that will run freely. If you use a post, place a stop on the wire a little more than chain distance from it and then the dog will not cause trouble by entangling himself as he runs round. When he wants a rest, a slatted frame placed outside the kennel and raised a little from the ground will save him from the mud and dampness of wet days.

Whilst attending to the sleeping arrangements do not forget the feeding utensils. They should be enamelled or of glazed earthenware and must be washed immediately after use. A supply of clean, cold water should also be available always, so that your dog can drink when he wishes and will not have to depend on occasional long draughts.

Exercise.—Regular exercise is yet another essential duty if you wish to keep your dog in good health and, in particular, free from eczema. It is a curious thing, but a town dog is often better exercised than one in the country, the reason being that, whereas the former is taken for his daily walk or two, the latter, with a garden at his disposal is expected to exercise himself when he wishes, which is not often. He is willing enough to go for a walk with his master or mistress or to hunt the hedges along a country road, but there is no pleasure in wandering aimlessly about a garden without a companion with which to play. Try



A Ball is Invaluable for Exercise

to give your dog his run in the morning before his main meal and then again in the evening before going to bed. A brisk walk with an occasional sprint is all that is necessary; galloping behind a bicycle or a horse is not good, but an hour's stretch, now along the road to harden the feet, now over the grass to chase a ball, is ideal. Again, what is the breed of your dog? That ever active little fellow, the Terrier and his like, must never be deprived of the safety valve for his tremendous store of energy, but the heavy, plodding Mastiff and St. Bernard or the little Peke and his brother toy dogs are quite content with a comfortable, steady stroll. Anyhow, whatever you do, do it regularly, and always with an eye open for condition of body and muscles.

Training.—And now we come to one of the most knotty points of dog management. We know what we all want, a kindly companionable fellow, free from all vicious taints, who is clean and well-conducted within the house and outside, is not given to terrifying bursts across the road, to jumping wildly around friends and barking furiously as though demented at strange dogs and noises. Is this possible without producing a dreadful animal that slinks spiritlessly along or cowers meanly in a corner at the slightest rebuke? Of course it is, but it depends entirely upon the owner. You must remember that your dog is not a mere chattel to be petted or shown off in a nauseating way or to be totally ignored according to circumstance at the time. He neither expects to be treated as a human member of the family nor does he want to be, but at the same time nothing can hurt an animal so much as indifference. Whatever is your treatment of him, so will he react, and therefore, before beginning training at the puppy stage, know what you want, possess yourself of patience and understanding and you will find that training will become an engrossing occupation followed by ample reward.

Indoor Manners.—Do not be afraid to start training early. Take your puppy as soon as he is weaned and teach him to be clean by going to a box containing earth or sawdust. Put him on the box several times a day especially after meals and you will be astonished how quickly he will learn to go to the place himself. Older puppies should be put out of doors and if, on returning, they then misbehave, a sharp scolding followed immediately by an ignominous thrusting outside again will soon cure them. Sometimes a dog will develop bad night habits in the house or soil the bed. In the first case, make him sleep in a closed basket for a few nights and then as early as possible in the morning put him out of doors for a short run; whilst in the second, if a change of bedding will not meet the case, giving him his food on his bed will soon make him respect his sleeping quarters.

Worrying at meals has already been mentioned and will not occur if a rigid rule is made and kept from the first, forbidding the offer of tit-bits from the table. To cure an older dog that has developed this bad habit, the only way is to banish him to another room at every meal time for a few days. He will not like this but will soon understand the reason for it.

Obeying orders.—Teaching obedience is probably the most difficult part of a dog's training for it envolves so much time, patience and understanding. It is difficult, too, to lay down set rules, for treatment must vary according to the age, intelligence and temperament of the particular dog. However, in the first place, excepting in the most extreme cases, never use a whip. To the great majority of dogs the mere sight of a whip is warning enough; if their owners are proper men in their sight, they know. A dog is remarkably sensitive to any inflection in the voice; he always remembers kindness and never forgets a blow or abuse, and accordingly, a rebuke given in the right tone will usually convey all that is necessary.

Be gentle but firm with your puppy and

never lose your temper. Indoors, he will always want to be in the room with you but there are times when you wish to be quiet and undisturbed by a fidgety, wandering little creature, so begin by teaching him to lie down. Say "sit" or "lie down" and press him down gently into the required position. Hold him there for a few seconds and when he attempts to get up, raise your finger and repeat your command. Do this at odd times for a few days, always using the same words, no more and no less, and he will learn quickly. Again, you will expect him to be a good house dog and bark at the approach of strangers. This he will do naturally, so encourage him at first with a pat and a friendly word, but if the caller is a tradesman or an acquaintance, always accompany the pat with the word "friend" and in due course he will learn to recognise footsteps, and "friend" will be the signal to stop barking on any other occasion.

Out of doors be very critical of your dog's behaviour. The speed of modern traffic is beyond the average dog's comprehension and with regard to any other nuisance created by him, do not forget that you are legally responsible. While in the puppy stage, teach him firstly to get used to a lead. To begin with, he is sure to rush ahead and tug furiously to get away, or later, disgusted, he will sit down and refuse to move. Nothing but patience will overcome this. Shorten your lead until he is kept at your left side and if he sulks, stroking and patting will soon restore his temper. You will probably have to do this several times but it is far better than dragging him along by main force. As he grows older he must learn the words, "Go" and "Heel". By now he knows better than to strain at his collar but you will probably like him to be trustworthy without the nuisance of a lead. Consequently, now and then call "Heel" at the same time bringing him back just behind you and a little to the left; a biscuit or something that he likes, as an occasional reward will go a long way towards achieving success. An older and more obstinate dog was once trained to heel by taking him regularly along a narrow path with his owner carrying a very thin switch cut from the hedge. As the dog made a dash to pass his master he promptly bumped his nose on the stick held ready for him. This was too much for his dignity and it was surprising how quickly he decided to walk to heel on command. Once a dog has learned to walk as his master wishes, he must be taught to respect the word "Go" implicitly. Without that word he must refuse to leave his master's side and then all fears of road crossings, and of interference with other people and animals will be at an end.

Before you can say that the education of your dog is complete there are two other points that need attention. They are, discipline in the garden and when you take him hiking in the countryside.

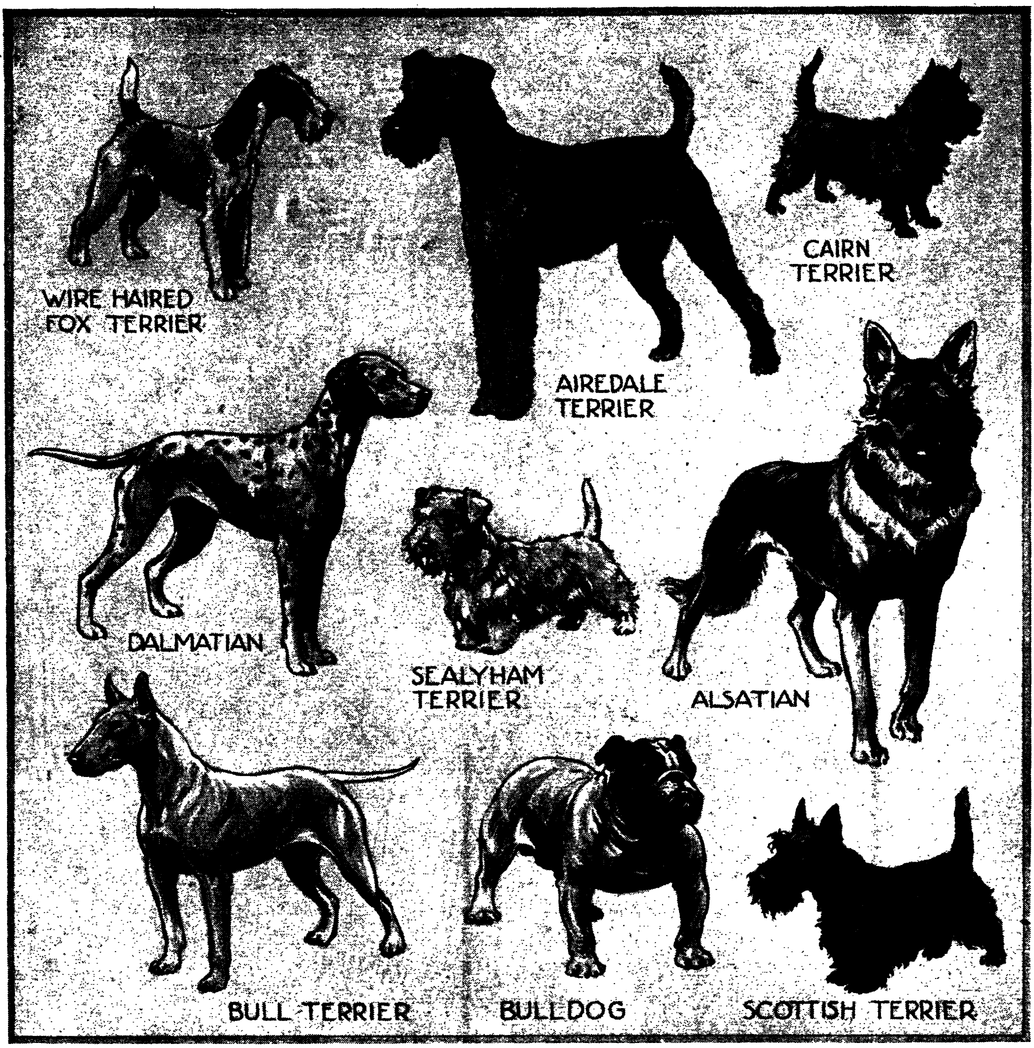
Soft earth is a lovely place for secreting bones and biscuits that so often we blissfully think have been devoured with great benefit to teeth and digestion organs. I remember once turning over a part of the garden that had been lying unused for a time and almost with horror uprooting one by one twelve of those nice hard squares that had been asked regularly for as a wind-up to each supper. Fortunately the ground was unused but what is to be said when flower beds are turned into a doggy cemetery or playground? There is but one thing to do, he must learn to respect your flower beds and those of your neighbours, otherwise it will mean restriction to a chain and that will curtail much of the exercise that is so necessary. Start him when he is young by leading him loosely round the paths checking every effort he makes to walk on the garden, with a stern scolding. Do this repeatedly until you are certain that he knows it to be forbidden ground. Then let somebody else take the lead while you walk round the path to a point as nearly opposite to the dog as possible. Have him released, call him and see what happens. This is the test; as often as not he will dash straight across the garden. Scold him, return him to the lead, have him brought round to you and repeat the performance again and again until your real wants are understood.

A holiday in the country with your dog can be very enjoyable or it can become very distressing, for it is a time when your responsibility will be tested to the full. Firstly, be careful of your dog's feet and his powers of endurance. Unless he is well conditioned, a tramp of eight or nine miles is more than the average town dog can stand; short stubble or heather pricks and irritates his pads and newly tarred roads may inflict a lameness that will last for several days. These things can be remedied; it is when you come to trespassing that the fruits of your training will be seen. A dog's joy is so unbounded and infectious when he comes to unlimited meadow land with its legion of new scents and mysteries, the rabbit burrows and the wonderful deep ditches and head high cover that nobody could possibly refuse to relax discipline. Still, he must never get beyond recall, and the first whistle should bring him scurrying back without hesitation. In the country, a wandering dog is always regarded with suspicion; however small he is, inestimable damage can be done to poultry, game and sheep in the breeding season by the mere habit of chasing. The law says that no dog is to be shot unless caught in the act of killing and that the owner is responsible for damage done, but it is doubtful if a farmer can be altogether blamed when, after he has sustained a series of losses from animals whose ownership cannot be traced, he takes a chance and destroys a strange dog that is out of control. Consequently, at every opportunity get your dog accustomed to birds and sheep in your presence and let him know that they must be ignored. A check cord may be necessary to make sure of control at first but a dog already well trained will understand a definite "No" very quickly without any device. Even when trained, it is still strongly advisable never to allow him to wander freely near game preserves; the hunting instinct is so strong that it is unfair to tempt a dog. Just as a strange cat crossing the garden will cause him to forget all manners in the excitement of the chase, so the sudden whirr of a rising bird is too much for his restraint and he may venture too far with disastrous consequences.

As a final note, it is hoped that exception will not be taken to the emphasis laid upon the duties of the owner. It is done because there does exist amongst some dog lovers a misconception of the true place and actual ability of the dog and thus a certain line of attack is given to those people who would have all dogs removed from family life. Your dog for all his wonderful traits of character should never in food, in shelter, or in treatment, be accorded the same rights as the human being. Everything that he does is in accordance with his own peculiar animal nature and the only things that he knows of the curious rules and regulations of the human being are those that you have taught him. He obeys, not because he understands the why and the wherefore, but nine times out of ten solely because his capacity for affection compels him to do what his master likes him to do. You can teach him to steal as easily as you can teach him to walk on the path. In very many ways he is a reflection of yourself and by him you can rise or fall in the eyes of the discerning. Consequently, keep him fit and healthy, order his manners firmly and insistently, let him in no way become a source of nuisance to your neighbours, above all treat him kindly and then, as the prehistoric woman said in the immortal work of Kipling, "He will be our friend for always and always and always."

Notes on the chief breeds.—

ENGLISH SETTER.—Seen either at its legitimate work as a gun dog or as a domestic companion, the English Setter is one of the most graceful and beautiful of all sporting dogs, his elegant form and feathery coat commanding instant admiration. White predominates as a ground colour in most



DOGS—2
(Class Picture No. 29 in the Portfolio.)

of the recognised strains and it is perhaps by an occasional crossing with the Pointer that in some types patches of black, liver, lemon or orange are to be seen. These patches ought never to be heavy and the Setter whose coat is slightly flecked with blue is still preferred to the tricoloured variety.

Their proper sphere is either on the moors when the red grouse are in quest, or on the stubble and amongst the root crops when September comes in and the partridge season begins.

POINTER.—The Pointer which belongs to the hound group of dogs is of Spanish origin and in England has been crossed with the Greyhound and Foxhound. He is a grand field dog and obtains his name from the characteristic habit of pointing or stopping in his tracks and remaining rigid in the proximity of game. When hunting, he holds his head high to follow the body scent of game. Standing about two feet high he is not unlike a Foxhound in appearance and is usually coloured in a combination of liver and white.

RETRIEVER.—The Retriever is a sporting dog of Spaniel descent varying in coat and size through interbreeding with the Newfoundland or Labrador, Setter and Collie. In the field, he performs the same work on land as does the Spaniel in water, finding and retrieving game with uncanny accuracy and gentleness. So tender is his mouth that a good Retriever will carry a bird a great distance without ruffling a feather. In colour he is usually black, and besides his sporting characteristics, he is very affectionate and companionable, an excellent man's dog.

GREYHOUND.—The Greyhound is the oldest and most conservative of all dogs. He is noted for his speed and is kept for coursing the hare.

They have been bred and reared with special regard to physical details of shape and make which contribute to pace and stamina, and many are remarkable for fine muscular development in combination with elegance of outline. They take instinctively to the exciting sport of coursing and very little training is necessary to fit them for successful competition on the racing track.

COCKER SPANIEL.—The Spaniel family is one of the most important of many groups into which sporting dogs are divided, not only on account of its antiquity as a breed, but also because of its many branches and subdivisions ranging in size from the massive Clumber to the alert little Cocker.

The Cocker has increased in popularity the last few years, and the reason is not far to seek. The affectionate and merry disposition of the Cocker and his small size compared with that of other Spaniels, preeminently fit him for a companion in the house as well as in the field. He is easy to train and very intelligent.

FOXHOUND.—The Foxhounds were the very first of the canine races in Great Britain to come under the domination of scientific breeding. Something different was wanted towards the end of the seventeenth century to hunt the wild deer, that had become somewhat scattered after Cromwell's Civil War. The demand was for a quicker hound than those hitherto known and people devoted to the chase began to breed it.

The first known kennel of Foxhounds was at Wardour Castle and was said to have been established in 1696. Improved breeding through the years has produced perfect specimens.

In elegance of form nothing has been lost and there can be no other hound to possess beauty combined with power and the essential points for pace and endurance in the same degree as the Foxhound.

Terriers.—The Terriers form quite a large group of domestic dogs, their name from the French, *terrier*, a rabbit burrow, indicating their original use for unearthing game. Beyond that of the Fox Terrier, the Bull Terrier and the Black and Tan or Manchester Terrier, the relationship of the other types to the species is rather remote, though all bear the distinctive short, arched skull, alert appearance and high degree of intelligence.

FOX TERRIER.—Fox Terriers comprise two well-known breeds, the smooth- and the rough-coated. Both are still used for their original purpose of going to ground after a fox and also for ratting, though the smooth-coated type is undoubtedly the better hunter. They are ideal dogs in a home; in appearance they are smart and alert, their intelligence is often extraordinary and they possess the companionable trick of adjusting themselves to the moods of their master. Despite their very affectionate disposition they have courage and tenacity of purpose to a high degree and make reliable house dogs. The colours of good Terriers are black, white and tan; types with liver-coloured markings should be avoided.

AIREDALE TERRIER. — The Airedale above ground and in water can, and does, perform in a very excellent manner everything that any other Terrier can do.

As a water dog he is of course in his element. For work on land requiring a hard, strong, fast and resolute Terrier he is, needless to say, of great value, and is said to be also, when trained—as can easily be imagined when one considers his power of scent, his strength, sagacity and speed—a most excellent gun dog. He is, in fact, a general utility dog for, in addition to the abovementioned qualities, he is an incomparable guard and a most excellent and faithful companion.

SCOTTISH TERRIER.—The Scottie is a lovable, game little dog, and a determined hunter of rats and other vermin. He is one of the hardiest of the domestic breeds, keeps remarkably true to type and his shaggy body is always spruce and attractive. In disposition he is very companionable and loyal and can be depended upon as a trusty guard of his master and his master's household. His teeth are very large for the size of the dog, a relic of the days when he hunted the fox amongst Highland crags.

SEALYHAM TERRIER.—Sealyhams are smart, plucky little dogs. They are hardy and game and much more intelligent, tractable and easily broken in, than the casual observer is apt to suppose.

They have the hunting instinct very highly developed, and they stand on short legs, having a thick skin, good, rough, weather-resisting coat, with strong wide head, strong jaws and last but not least, a big heart in a little flexible body. They will provide many a good day's sport for their owner, and prove their worth in many ways.

CAIRN TERRIER.—Cairn Terriers represent the oldest native form of British dogs. They were the original stock from which all the game little Terriers of Scotland were cultivated into separate family groups. They are active little hunters of vermin and are cherished with exclusive pride in their native country. They are affectionate, good house-dogs and guards.

BULL TERRIER.—The Bull Terrier is a cross between a Bulldog and a Smooth-haired Terrier and is a powerful dog, remarkable for its courage and determination. Although not prepossessing in appearance with his white coat and suggestion of soreness about the mouth and the eyes, he is nevertheless an ideal man's dog. He is resentful of undue pampering or of indifference, but to his master he is docile and affectionate, and will fight to the death in his defence. Although instinctively a fighter, there is nothing petty in his composition. He is neither aggressive nor treacherous and with children he is completely reliable and makes a perfect guardian. It has been claimed for him that to-day he stands as the true national dog of England.

COLLIE.—The Collie has a fertile, resourceful brain. Although no longer used as a sporting dog, he can be taught the work of a Pointer, Setter or Water Spaniel. He is clever at hunting, having an excellent nose. He is a good vermin killer, and is a faithful watch guard and companion. As an assistant to the flock master, the farmer, and drover, he takes his most appropriate place. He is shy in disposition and slow to make friends with strangers.

OLD ENGLISH SHEEP DOG.—The Old English Sheep Dog combines in his shaggy person the drover's drudge and an ideal companion. He is picturesque and intelligent, workmanlike and affectionate. He is mentally a busy dog, and even in the crowded streets of a city, he acts as if in obedience to an inherited instinct transmitted from the time when his legitimate duty was that of herding sheep or rounding-up a drove of cattle.

The modern bob-tail is not often put to shepherding work, but carefully handled in his youth he is still unsurpassed as a stock dog, and he is equally at home and efficient in charge of sheep, cattle, or New Forest ponies.

His qualifications as a sporting dog are considerable. He makes a capital retriever being usually under control and generally light-mouthed and taking very readily to water. He is an excellent house dog, and his naturally cleanly habits and affectionate disposition make him a most desirable companion.

BULLDOG.—The bulldog, one of the oldest of the British types was originally a surly, unsociable dog but possessed of indomitable courage. It was derived from the Mastiff and up to the 18th century, used for bull and bear baiting. To-day, close breeding has quite changed him, both in appearance and in disposition. Despite his ferocious mien he is a gentle and good-natured animal especially with children, but is of doubtful value as a watch dog. Although his forequarters indicate great strength and sturdiness he is often very difficult to rear.

The Pug, the Boston Terrier and the Toy Bulldog, a French variety, are descendants from the same stock. They are considerably smaller in size and all make excellent companions.

GREAT DANE.—In the Black Forest, Germany, its natural home, the Great Dane is still employed for hunting, but in England, where he was introduced in the 19th century, he has developed into one of the best watch dogs. He is really a Mastiff, standing nearly three feet high, and is renowned for his great strength and determination. Mainly owing to its imposing appearance, it is quite a popular breed, but despite his usual friendliness and fidelity his occasional excitability combined with his great strength often make this dog difficult to control.

ALSATIAN.—The Alsatian was known in England before the War, and it was the excellent and methodical military work done by these dogs in the Trenches in Flanders, which drew fuller attention to them and impressed alike our officers and Red Cross units at the front.

Incidents illustrating their sagacity, courage and resourcefulness under fire are almost like incredible fiction.

Captured specimens of the breed were adopted and brought home, and they proved to be so engaging and wise companions that enthusiasm in their favour led to many more being imported and bred from. Alsatians are exclusive; they attach themselves to one person only and show implicit obedience. Very few lessons are needed to make an Alsatian understand what is wanted, and he has a keen sense of direction and an unerring homing instinct; He shows a surprising fondness for young things, kittens, puppies, chickens and children and will stand treatment from a child which he would resent with dangerous anger from an adult.

MASTIFF.—The English Mastiff came to this country in the 15th century. He remains our most distinguished watch dog. His vigilance, his formidable presence, his aspect of ferocity, his deep penetrating voice, his great weight of body and strength of limb, give him supremacy as a guardian of lonely homesteads. He is not by nature a bad-tempered dog, but is quite docile, although he can be dangerous when roused to anger by unwarranted visitors.

DALMATIAN.—The Dalmatian is commonly known as the COACH DOG, a name appropriately derived from his fondness for following the carriage and for living in and about the stable, and accompanying his master's horses at exercise.

He is of a friendly disposition, capable of being trained to remarkable cleverness. His mental merits and unique personal beauty make him a most desirable dog.

CHOW.—The Chow although a descendant of the Eskimo group of dogs is an importation from China where he is fattened for the table. Although too large for a toy dog his handsome appearance, marked by the deep ruff and attractive carriage of the tail, has made him very popular in English homes. A fault lies in his uncertain temper, for he is always ready to accept battle and consequently needs careful handling, but to his master he is a loyal and good companion and is usually quite dependable with children.

POMERANIAN.—The Pomeranian in England is solely confined to the diminutive breed, taking his place as a lap dog. In Germany he is known as the Spitz and as a descendant of the Eskimo breeds was once of service with shepherds. Beyond his attractive appearance his utility is negligible as his temper is uncertain for training.

PEKINGESE.—The Pekingese is the most attractive and original of all Toy dogs, the nobility of his descent, the antiquity of his history, and the dignity of his character, making him the popular dog he is to-day. The study of his history is a mystery; it is hard to believe that three thousand years ago he existed in the Celestial Empire no different in type and character from what he is to-day. These dogs were kept with jealous exclusiveness in the palaces of the Chinese emperors and until 1860 no European had ever looked upon a Palace dog. In this year the French and British forces entered Peking and sacked the Summer Palace. Five of the little dogs were left behind and they were brought to England by Lord John Hay, one being presented to Queen Victoria, who kept it at Windsor until its death ten years later.

DACHSHUND.—People unfamilar with the sporting properties of this long-bodied breed are apt to refer smilingly to the Dachshund as "the dog that is sold by the yard", and few give credit to the debonair little fellow for the grim work which he is intended to perform, in doing battle with the vicious badger in its lair.

Dachshund means "badger dog" and it is a title fairly earned in his native Germany.

Given proper training he will perform the duties of several sporting breeds rolled into one. Possessing a wonderful nose, combined with remarkable steadiness, his kind will work out the coldest scent, and once fairly on the line they will give plenty of music and get over the ground at a pace almost incredible.

As a companion in the house he is a perfect gentleman, cleanly in his habits, obedient and unobtrusive.

The three varieties differ only in the matter of coat; they are the short-haired, the long-haired and the rough-haired.

SCHIPPERKE.—The Schipperke's disposition is most affectionate, tainted with a good deal of jealousy. He generally attaches himself to one person. He has a very inquisitive nature, and pokes his nose into everything, the slightest noise arousing his attention and causing him to investigate the cause. He moves with catlike agility. His alertness, quick ear and rather musical bark make him an excellent watch dog in a house. He is a useful size to keep indoors, and his cleanliness of habit is a further recommendation. He follows well and is an excellent ratter.

Ailments of Dogs.—Dogs as we know are hardy animals and when well kept are not so liable to the many complaints that befall the human being, but for various reasons any one of the diseases peculiar to the canine race may attack your dog. A great deal of unnecessary pain and discomfort may be saved by prompt attention and a little care, so a few notes on the matter may be of service.

Firstly, many serious troubles owe their origin to the presence of insect parasites of various types that attach themselves to the hair of the animal and work their way into

DOGS—3
(Class Picture No. 30 in the Portfolio.)

the skin. The regular bath and proper care of the kennel disposes of these in a normal way, but if the trouble becomes acute, then the parasites should be recognised and dealt with according to their special requirements. To find out the particular complaint examine your dog when he scratches himself, for no healthy dog should scratch unless he is changing his coat. An immediate bath in a disinfectant solution is not advisable until the insect is known, for this is only a superficial cure and does not touch, for example, the mange parasite that is lodged beneath the skin. Thus only a temporary relief is afforded for a complaint that may recur many times.

Fleas.—These are particularly troublesome to the long-haired breeds of dogs and the constant scratching caused by their irritation often induces eczema. As they are superficial insects a bath, as previously advised, or a thorough dusting of the coat and the bedding with a good insect powder will soon dispose of the trouble.

Harvest bugs.—These small, red insects generally appear round the nose, the joints of the legs and on the belly. They can be treated in the same manner as above.

Mange.—This dreaded complaint is of two types, the common and the follicular. The former is met frequently and is very contagious both to animals and human beings. It can be recognised by the parts attacked becoming bare and developing small spots that result in many sores caused by incessant scratching. The disease usually attacks the skin round the eyes, the flaps of the ears and the joints of the legs, then spreading all over the body. Do not be alarmed when it appears, for although the dog may be an unpleasant sight for a little while, treatment will get rid of the parasite in ten days and then the hair will slowly grow more luxuriantly and stronger than before. A sulphur bath twice a week, accompanied by a daily dressing of the parts affected with a good sulphur ointment, will afford a cure. In the meantime everything connected with the dog, kennel, collar, brushes and so forth should be thoroughly disinfected.

Follicular mange is fortunately very rare and unless the dog is a particularly valuable one it is generally advisable to have him destroyed at once. In this case sores do not develop early and there is little or no irritation, but bald, scaly patches with a dirty-greyish colouration appear, varying in size from that of a sixpence to half-a-crown. At the outset, the best thing is to consult a veterinary surgeon, who will be able to recognise the parasite with the aid of a microscope. The disease can be cured, but the treatment may last months and the dog seldom carries a good coat afterwards.

Ringworm.—This annoying complaint, due to a fungus, is contagious to human beings as well as to cats and dogs and the cure is often very tedious. Circular patches of bare skin appear in various places, though usually in the side of the face, under the chin and on the front of the forelegs. A slight roughening is noticeable with sometimes the appearance of a few small, red pimples.

A slow but effective remedy is to dab the parts affected with sulphur ointment every day and follow by a weekly bath, using a good brand of formalin soap.

Ticks.—These are often collected by dogs that roam around rabbit burrows or come in contact with sheep. They are bulbous-looking, grey insects that usually attach themselves to the head and neck, and as they grip the skin with suckers appear to be standing on their heads. It is a simple matter to remove them as only two or three at a time are usually seen and they can be extracted with the fingers, or better still with a pair of forceps. No other treatment should be necessary.

Worms.—Worms belong to another and more serious form of parasite. They are dangerous not only for the frequency of their occurrence and the insiduousness of their attack, but also for the numerous ailments that find in them their origin. There are two main kinds, the round one that chiefly attacks puppies, and the tapeworm that affects adult dogs. Fortunately, both are easily destroyed, but there should be no delay in getting rid of them, for they are a grave menace to a dog's health and in puppies often the cause of death.

In a puppy the symptoms of their presence are usually digestive troubles, obstinate diarrhoea, distension of the stomach after each meal and general dullness of coat and poverty of condition. The little animal does not thrive; he may have fits or vomit repeatedly and often eczema appears in the skin, causing continual scratching.

For the treatment there are various remedies on the market in powder or in capsule form. Choose one made for puppies by recognised specialists and obey the instructions implicitly. As the origin of worms in puppies is still obscure, it is just as well to dose them after they are six weeks old whether there are any symptoms or not; it will save a retardment in growth that would be almost certain to happen otherwise.

With regard to adult dogs it is also advisable to make a habit of dosing them every three months or so, for no matter how well they are kept, worms will persist in appearing now and again. The tapeworm is a very objectionable parasite, and besides the harm it does to the dog's vitality, it can be transferred to the human being, often with serious results. Its presence can be recognised by the bad breath, occasional vomiting and diarrhoea and poor appearance of coat; if eczema has appeared it will continue until the worms have been removed from the system.

Before dosing, using any of the prescribed powders or capsules according to the size of the dog; the animal should be kept without food from eighteen to twenty-four hours. He should then have a vigorous run to assist the action of the digestive organs and three or four hours later given a light meal. Sometimes, if the worms have been present a considerable time, their removal is very obstinate. If this is the case a teaspoonful of Epsom salts dissolved in a little milk sweetened if necessary for the average house dog, should be given each morning for three days before the medicine is administered. Seven days after the first dose, a second should be given to make the cure complete.

With regard to the ailments common to dogs other than those created by parasites, it is impossible to go into detail within the compass of these notes, but it must be remembered that the most ordinary cold, digestive complaint, or attack of nerves should receive prompt and efficient care at home. With more serious diseases the help of a veterinary surgeon must be sought at once, but it will be of great assistance to him if you are able to furnish details of early symptoms and render first aid before his arrival. Before giving a few hints on what to notice when your dog is out of sorts there is one illness that must be noted.

Distemper.—Despite a belief common to many people, it is not necessary for a dog to have distemper. At the same time he may have it on many occasions but always on account of contact with a person, animal or thing bearing the disease. It is a dangerous disease to very young puppies and again when they are producing their first teeth, but with the treatment of to-day a vigorous dog should always be cured. Distemper, caused by a minute virus, undergoes two stages, the first creating a high temperature with corresponding loss of appetite. This is not dangerous in itself, but it induces in the second stage many complications which are responsible for a large number of deaths. The disease can be fought successfully by having the dog innoculated immediately any signs of it appear amongst other dogs in the neighbourhood, or failing that, in the very early stages of the infection. Unfortunately, it may not be recognised until more than a week has elapsed when careful nursing and a course of medicine will have to be followed.

Symptoms, first stage.—The dog is dull and lifeless with little appetite and a tendency to vomit. His temperature rises temporarily and a cough develops.

Symptoms, second stage.—The eyes are dull and watery followed by a sticky discharge, the breath is offensive and the teeth become coated. If the lungs are affected the breathing becomes short and rapid, the fever increases and the dog begins to lose weight. Sometimes mattery discharges occur from spots around the thighs and at all times the nose becomes dry and hot frequently dripping with water.

Treatment.—Keep the dog quiet and warm in a well-ventilated room until the fever has abated. His eyes and nose should be constantly bathed with a soothing lotion and a little vaseline gently stroked into the inflamed parts. At the outset a dose of castor oil, followed by a course of medicine will be beneficial. Lintox, a well-known commercial product, has been found to give excellent results, but, if preferred, the veterinary surgeon will prescribe according to the stage of the disease. Food at first should be very light, such as soup, boiled fish and arrowroot, and always given frequently and a little at a time. When the fever has gone, more strengthening and stimulating foods may be given, such as a little raw meat, or beef tea with a tonic as a medicine. Ten days after the temperature has become normal the dog can be given gentle exercise and a week later should be fully recovered.

Notes on nursing.—A dog that is unwell is a very different animal from his former self. His natural habit makes him assume a false activity when the time for exercise arrives, but in between times he has no zest or joy in life. There is a restlessness in his behaviour, a lack-lustre way of moping about and a desire to hide away into odd corners. This may be due to constipation or other digestive troubles when suitable medicine should soon restore him, but it is as well to examine him thoroughly. Firstly, when he lies down, notice whether he is quiet or restless as though in pain. If his breathing is short and hurried and the mouth wide open there is definite pain, but if the mouth is closed there is probably lung trouble. As a further test for the latter, gentle pressure on the chest will cause slight pain and the dog will start or make a grunting noise. Next examine the eyes and the mouth. The whites of the former should be clear and not yellow as in the case of jaundice or red and clotted as in the case of brain trouble, and there should be no discharge as in the case of a cold or of distemper. If the mouth is opened, notice if the breath is offensive and whether the tongue or teeth are coated with a white fur or if any growths have formed. Lastly, a slight pressure in the stomach will tell you of any tenderness or swelling that may be present. With these observations a general estimate of the complaint can be made, but, and particularly if there is a high temperature, do not attempt to give treatment, for if the trouble is at all serious professional advice is urgent.

To take the temperature, the simplest way is to tuck a clinical thermometer in the dog's armpit or groin. See that it is completely covered with skin and leave for about two minutes, when the reading if normal should be 101 Fahrenheit.

Giving medicine.—A dog will seldom take medicine either in liquid or powder form naturally, though he will usually lick up oil with great gusto. Consequently, tilt up his head and hold the upper jaw with the left hand, gently pressing the cheeks. This will

Giving Medicine

cause him to open his mouth when the powder or the pill can be dropped inside, the latter being thrust down as far as possible with the forefinger. If the mouth is then closed quickly and held for a second or so, the dog will soon gulp down the dose. Liquid should be given from a spoon inserted at the side of the mouth with the teeth held firmly together. Be careful not to press the tip of the nose or the dog will struggle and from then will always object to medicine time. Sometimes pills and capsules are vomited immediately after taking. In this case you will have to be diplomatic; crush the pill and enclose it or the contents of the capsule in a thin slice of meat or anything that he particularly fancies. With bad cases of constipation all forms of medicine are often rejected and then an enema must be given.

Giving an enema.—An enema syringe is a very useful instrument to buy. It is quite cheap and will relieve many serious bowel troubles and also act as a feeding pipe in cases where the stomach must be rested. For constipation, make up an enema of two teaspoonfuls of glycerine to eight tablespoonfuls of warm water. This is for a dog of the Fox Terrier size, other dogs of course being treated proportionately. The end of the tube should be smeared with vaseline and when the air has been pressed out, should be entered into the rectum. Then press the bulb gently and slowly, in the meantime holding the dog's hindquarters a little from the ground. Occasionally, instead of the usual enema, warm olive oil is very beneficial.

Foods for invalids.—During illness, when the digestive organs need rest, or on recovery, when extra nourishment is required, the diet of the dog should have special care and attention. Just as with human beings, dogs when ill will turn away from food, but nourishment must be given somehow, and it is better to persuade them to eat normally than to use force. Consequently, a few of the more tempting varieties of food are suggested. Always remember the golden rule in invalid feeding a little at a time every hour or two.

Light foods.—Peptonised milk prepared with powders bought at most chemists is very easily digested in cases of vomiting, and milk thickened with a little isinglass is very useful in cases of diarrhoea.

For stomach troubles the white of an egg beaten up in a teacupful of water is soothing and in cases of great weakness such as is caused by distemper, a teacupful of Lactol and water mixed with the white of an egg and a small quantity of Valentine's extract, given in small doses hourly, will be found excellent. Dry Lactol mixed with arrowroot gruel is also very good if the bowels are working freely and if a more solid food is required, fish or sheep's brains boiled in milk can be tried.

Soups.—Soups are very appetising and sustaining and can be made from chicken's giblets and feet cut up and stewed for about three hours or from rabbits treated in the same manner with the bones crushed. After the liquid has been strained in each case it can be given cold as a jelly with rice or stale bread, or it may be given warm.

Other forms of meat.—If a stimulating food is needed after great weakness or a violent case of vomiting, meat juice is particularly helpful. It is best made by pressing raw, lean beef; in case of any difficulty, special machines can now be bought.

Raw meat is naturally the best tonic for a dog. Excepting in cases of dysentery or when the temperature is high a small amount given in shredded form makes a tremendous difference. There is no better food for bad stomach troubles.

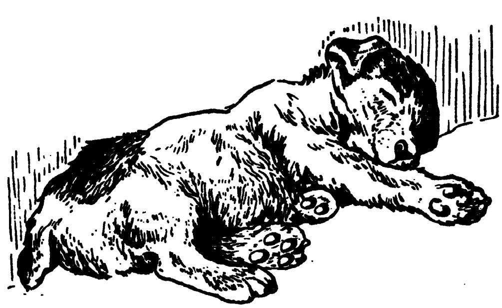
Meat tea is a well-known invalid food. It should be prepared in the usual way by slowly simmering for three hours in a pint of water a quarter of a pound each of small pieces of lean mutton, veal and beef. Strain after cooking and give as before as a jelly or warm with rice or stale bread.

Lastly, to quench the thirst, barley water will be found to be more suitable than plain water. In cases of diarrhoea and of vomiting it is particularly beneficial.

Disinfecting.—After an infectious complaint has been cured the final step is to prevent any recurrence of the trouble. To this end see that everything brought in contact with the dog is thoroughly disinfected. In the kennel a formalin candle should be burned after making the place as airtight as possible. Another very cheap method is to pour a little methylated spirit on a pound of flowers of sulphur placed in an old metal can. If you are nervous of fire this can be stood in a pail containing an inch or two of water. You can then set a match to the spirit and leave for twenty-four hours. After the kennel has been ventilated, all the woodwork and flooring should be thoroughly washed with a strong solution containing a good disinfectant. A new coat of paint or creosote, as the case may be, will make assurance doubly sure. All collars, leads, brushes and so forth should next be thoroughly treated, and if the dog has entered the house, carpets and other articles should be sprayed daily with a solution of one teaspoonful of Formalin to three pints of water. If a fine spray is used of the type used in the garden for green fly, in two or three days everything can be pronounced safe.

It may seem that all these precautions are unnecessary but the writer has very vividly in mind one case where four valuable dogs died within two years through lack of thoroughness in disinfecting after mange, and a further case of a whole family of eight people suffering severely from ringworm.

As a last word, is a dog worth all the care or the troubles that may befall him? To the dog owner and lover there is no answer. He knows. It may be a person, it may be a principle, it may be a possession, but for everything that we really cherish there are no such words as time or trouble. To the nervous prospective owner, take courage from the testimony of the greatest men and women; as for illnesses, why, your dog may never have any.



THE FAMILY CAT

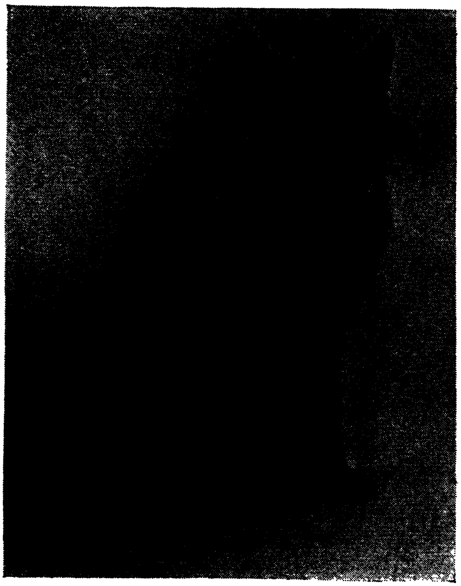
Photo: Thos. Fall

CHINCHILLA CATS

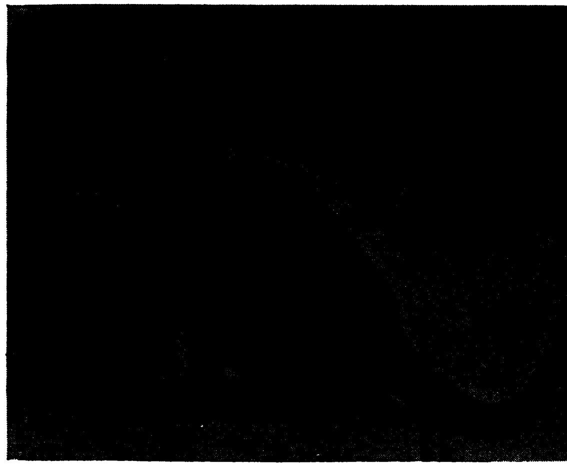
Introduction.—The adaptability of the dog to all sorts of conditions, coupled with his utility to man in his varied occupations and recreations, have given him for centuries the premier place amongst the domesticated creatures and it is only of recent years that the cat is at last receiving the recognition that is her due. A cat was just a cat; if not fed too well, she kept the premises free from mice; she looked very pretty and homely as she lay curled on the best chair that she could find; the feeling as she pushed her nose against you and, with tail upraised, slithered her whole coat along your leg, accompanying the gesture with a little welcoming mew, was very comforting and satisfactory. Still, she walked by herself and her nocturnal wanderings; her hostile attitude to the family friend and her habit of finding sanctuary in the nearest tree, all classified her as a creature of suspicion and as such she was tolerated rather than taken to the heart.

To-day, pussy is no longer a furtive, harassed creature; she still retains some characteristics inherited from her wild ancestors but her gentle disposition, her cleanly habits, her strong attachment to the home and the beauty of her many types and colourings now definitely established by an ever-growing number of cat clubs and societies, have earned for her a place of importance in the family circle.

The actual origin of the ordinary domestic cat is still a little obscure although the general assumption is, that the Egyptians, who undoubtedly tamed the wild cat of Africa, passed on the species via the old Phoenician traders into Etruria. From thence sprang a stock that mingled with the European wild cat and with the later addition of a Chinese variety eventually resulted in the well-known tabby. Thus, two distinct types of markings are noticeable in these animals; the one a narrow, vertical stripe; the other, a lengthwise stripe with a tendency to turn round the body. The curiosity of albinism and melanism, common in most creatures, produced the white and the black cat and these, together with the similarly obtained red or sandy colouring, culminated in the

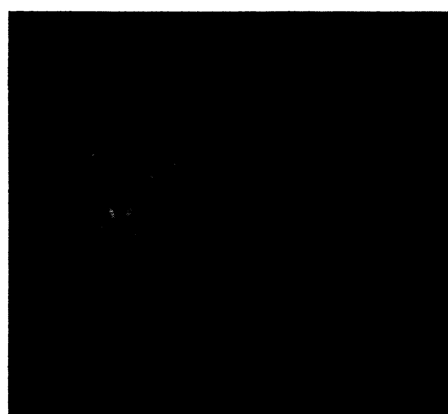


Brown Manx Cat



Abyssinian Cat

Black Cat



Photos: Thos. Fall

Striped Tabby Cat

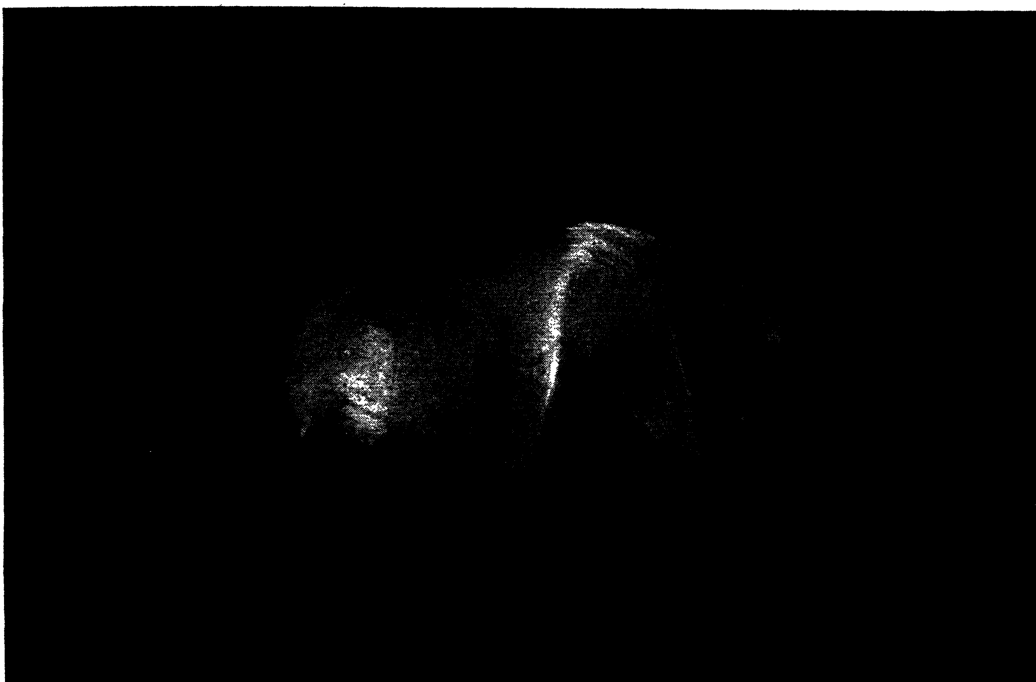


Photo: Thos. Fall

SIAMESE CAT

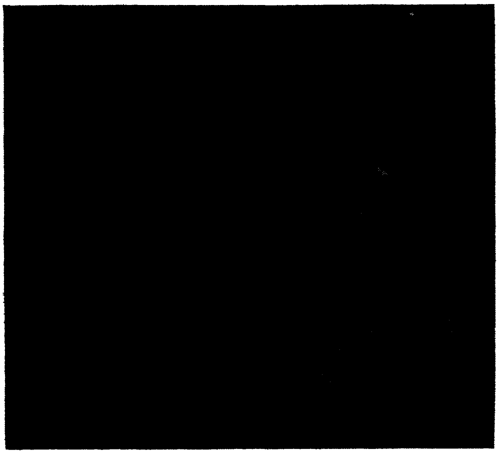
beautiful tortoiseshell markings. All of these appear in both long and short-haired breeds of cats, the coats of the former being the heritage of Eastern ancestors. From time to time various other distinctive breeds of cat have passed into the country and to-day some thirty varieties are established from which a choice can be made. Most types are named by their colour markings and by the length of their coats, whether long or short-haired, but a few are recognised by the place of their origin. In the latter case the following are perhaps the best known:—

MANX.—This tailless breed of short-haired cats is exceedingly popular and, contrary to current belief, originated in the Far East, being probably allied to the short-tailed cats of Japan, China and the Malayan countries. Besides the lack of tail, a tuft of hair only taking its place, it is quite a distinctive animal, for its peculiar uneven gait and attractive habits make it unique in the cat world.

ABYSSINIAN.—These cats, an offshoot of the jungle cat, are becoming comparatively rare although they are very intelligent and companionable. They are distinguished by largish ears and short reddish-brown, silky coats, each hair being ticked evenly like that of a wild rabbit.

RUSSIAN.—The Russian Blue as it is best known, is a long-barrelled, lithe animal with a beautiful coat that is very short, tight and lustrous. Its green eyes and slender, delicate-looking build add to its attractiveness.

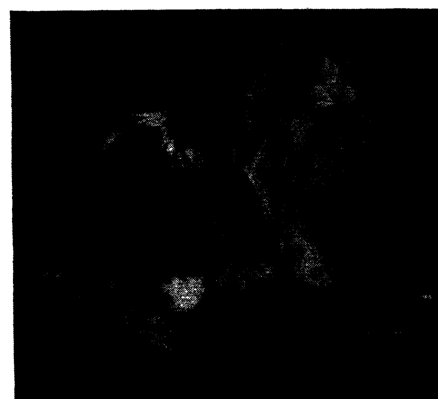
SIAMESE.—The most outstanding of the domesticated cats of the Old World are the Siamese which, contrary to their appearance, are unusually intelligent and affectionate.



BROWN TABBY CAT

WHITE PERSIAN CAT

BLUE PERSIAN CAT



Photos: Thos Fall.

TORTOISESHELL CAT

They are a slender, long-bodied type, marked by sleek, very close fur and remarkable blue eyes often distinguished by a definite squint. In colour they are usually a shade of cream or pink with the face, ears, feet and tail a dark brown. Another feature is the long, tapering tail in which a kink often appears, probably a result of crossing with the native kink-tailed cats. The pure white colour of the kitten indicates the semi-albinism responsible for the colouring in the adult.

Colour markings of other varieties.—

Short-haired.—Black, White, Blue, Cream, Silver Tabby, Brown Tabby, Red Tabby, Tortoiseshell, Tortoiseshell and White.

Long-haired.—Black, White, Blue, Red, Cream, Smoke, Silver Tabby, Brown Tabby, Red Tabby, Chinchilla, Tortoiseshell, Tortoiseshell and White, Blue Cream.

Hints on management.—Attachment to surroundings is much more marked in a cat than in a dog, so if you are contemplating ownership of a cat for the family, it is strongly advised to begin with a kitten of from six to eight weeks old. By then she can look after herself quite well, is train-able and will take ordinary food without undue fussiness. Now, training in the sense that a dog is trained is contrary to the natural instincts of the animal; she will live her life and, consequently, beyond instilling house cleanliness and giving her the attention that the conditions of her life warrant, very little can be done.

In the first place, she will leave no avoidable messes in her home; instinct forbids it, and accordingly a tray containing about four inches' depth of fresh earth should be kept in a corner so that the kitten can retire to it when necessary. After a week or two, if a garden is available, she can be put outside several times during the day and in a surprisingly short time will understand what is required. Cats hate any form of dampness, so it is better to keep this training for dry weather or otherwise she will only hide away and wait to be brought in.

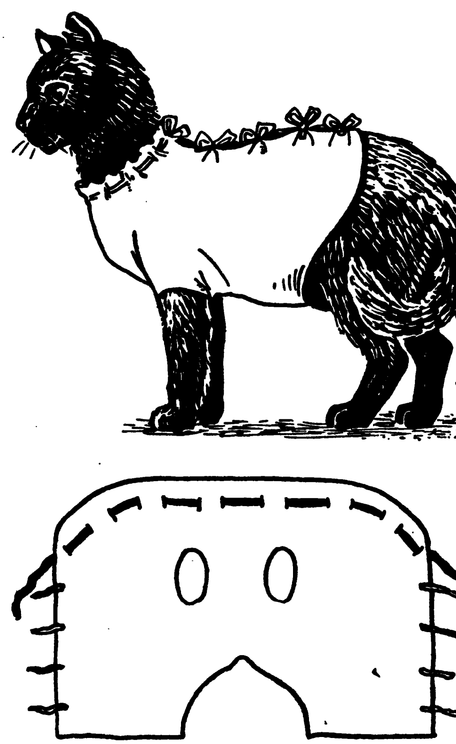
You will notice how very particular she is of her coat. Her tongue is papillous, or covered with small protuberances and consequently she is able to do her own brushing and combing. With many of the long-haired varieties, however, the task is more than they can manage, and to avoid tangled masses and knots of fur it is advisable to groom such cats regularly, using a brush of medium texture with an occasional dusting of cleaning powder. If the fur has become matted, the only way is to tackle each part separately with the fingers or a sharp pointed instrument, finishing off with a metal comb and a brush. As most cats resent handling, a great amount of patience is necessary, and probably only part can be done at once, but do not delay as the mat rapidly becomes worse. Whilst on the subject of coats, one of the complaints that befall long-haired cats, and particularly after the spring moult, is hairball in the stomach, caused by swallowing the hair when they lick themselves. This gives great distress to the animals, their appetite goes and they become quite emaciated. In the natural course of events the hair is ejected by vomiting brought about by eating grass. Cats will go immediately to coarse grass usually of the Cocksfoot type or to Catmint whenever possible, so it is always a good thing to cultivate a patch in an unwanted spot. Cocksfoot grass (Dactylis Glomerata) seed can be bought very cheaply from any good seedsman.

Feeding.—You have probably noticed how extremely sensitive a cat is with regard to food. A dog, if you let him, will gulp down a favourite morsel or disinter and gnaw the most disreputable bone with little regard to caution, but a cat will sniff delicately for quite a time until she is assured of the freshness and taste of the article in front of her.

Consequently, try to vary her diet as much as possible and see that it is wholesome. She is naturally most fond of meat, whether it is cooked or raw, or of fish as long as it is unsalted. A selection can easily be made from beef, mutton, or horseflesh. Rabbit, or a freshly killed sparrow, complete with its feathers, or a mouse, are good appetisers when she is out of condition. Boiled liver once a week is excellent as an aperient, especially for cats living a great deal in the house, and a bloater given whole will often be accepted with gusto when other foods are rejected. A little green vegetable given with six ounces of meat usually provides an ample meal for the biggest cat, though some will naturally ask for more. When giving rabbit or fish or remnants of any type, see that the bones are removed. Large bones are, of course, helpful for the teeth, but sooner or later a small bone will become lodged in the mouth or the throat, and that may necessitate a speedy visit to the veterinary surgeon. Entrails of fowls and rabbits are not advisable unless they have been cooked as worms are often introduced into the system in this way. If you want some good fish very cheaply for your cat, ask your fishmonger for the unwanted heads of cod or halibut. He is usually quite pleased to get rid of them for a penny or two and the amount of flesh to be found on them is surprising. Lastly, we must not forget milk—the standby of all cat lovers. Cats do love milk and two saucerfuls a day with a supply of fresh water always available will provide an ample allowance for pussy's drinking requirements. Cow's milk, by the way, even though diluted with water is not really suitable for a young kitten. The modern food, Lactol, undoubtedly gives more nourishment and provides a full meal until the eighth week, when solid food can then be introduced gradually.

Ailments of cats.—An ailing cat is often a very difficult proposition to tackle. Until recently her illnesses have by no means received the care and attention that have been given to those of dogs. The cat temperament and instinct have probably a great deal to do with the matter, for she objects in no uncertain manner to taking medicine or to being handled for treatment, and her bites and scratches are often stubborn in healing. However, the day has come when selection and breeding have reached such a pitch that it is necessary, and if material value is considered, foolish not to have proper medical attention if the case arises. Fortunately, specialists, knowing that more harm than good is done by forcing disagreeable medicine down the throats of fighting and spitting animals, have been able to evolve tasteless or sweet compositions that are acceptable to most cats. Still, a time comes when a bone has to be removed or when worm powders must be administered and then the mouth will have to be opened. It is quite an easy matter if you carry out the same hints as with a dog, though with a cat it is advisable first to place her in a bag with the head only protruding, or else to wrap her in a cloth so that her feet are held securely. For administering liquid medicine and for feeding during severe illness, spoons specially made for fitting between the teeth and cheek can be purchased; they save a great deal of mess and trouble.

Generally speaking, the common complaints that affect cats are very similar to those that attack dogs. Symptoms and treatment accordingly correspond, though, needless to say, medicines and dressings for cats differ from those made up for dogs. Special care must be observed with the latter, for, owing to the animal's natural habit of licking, any poisonous compound is easily taken into the system with disastrous results. Among the diseases most frequently met, distemper, mange, ringworm, worms, coughs and colds rank highly, with perhaps a more strongly marked prevalence of eczema and ear trouble than with dogs. Most of these have already been touched upon in the article on dogs, and need little further comment beyond an added warning with regard to distemper. With cats, although the symptoms are similar, the disease takes another form, and as such cannot be attributable or is contagious to dogs. Do keep the patient warm, reduce the temperature—special powders can be bought for this—and take added precautions against the development of lung trouble. A warm

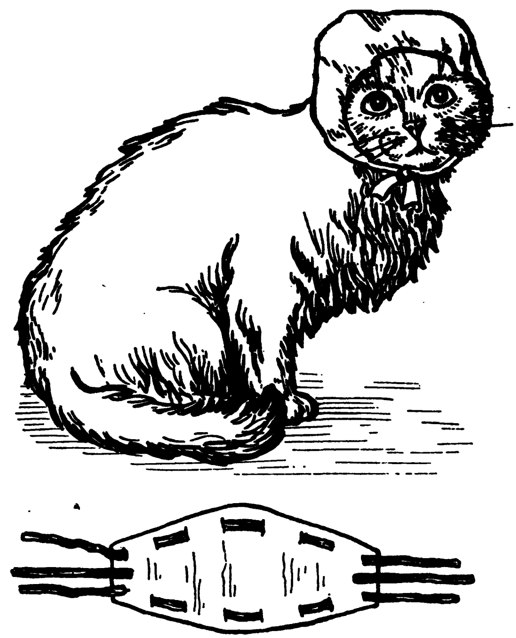


A Jacket for Chest Troubles

jacket covering the body and chest is strongly advised if the atmosphere is at all cold. If pneumonia is present, indicated by short, rapid breaths, a lining of medicated wool for the jacket will be far better than rubbing the chest with oils and liniments, as these tend only to irritate the animal. Sometimes the mouth becomes very foul owing to ulceration, when a daily mouthwash with a disinfectant, such as a weak solution of Condy's Fluid and warm water, ten drops to a tumblerful, is advisable.

Ear troubles—canker.—Canker in two forms is frequently found in cats. One takes after the nature of eczema, creating intense irritation and an evil-smelling discharge, and the other, a contagious affection, is caused by a tiny white parasite that seems to effect a giddiness in the animal as well as a continuous irritation. In both cases it is advised to clean the ears thoroughly with methylated spirit diluted with warm water in the proportion of about one to five. A piece of cotton wool twisted well down the orifice by means of a matchstick will serve the purpose. When this has been done several times, the ear should be dried and a thorough dressing with a good canker lotion or powder should be applied. While the discharge is continuing, the ears should be similarly cleaned every few days and in the meantime a daily dressing of the lotion should be made. As eczema will not respond to treatment if worms are present in the system, it is a good plan in the first case to give a course of worm powder.

Eczema.—This form of skin disease, not of a contagious nature, seems, as with dogs, to be closely allied to constitutional disorders. Some cats are especially subject to it insomuch that it occurs regularly with the seasonal changes. It can easily be remedied after the usual treatment for worms, by washing the parts with a boracic solution and then applying Sulpho. To heal the parts that have developed sores, the cat must be prevented from licking and, accordingly, a cardboard collar made to fit round the neck, although



A CAP FOR SORE EARS

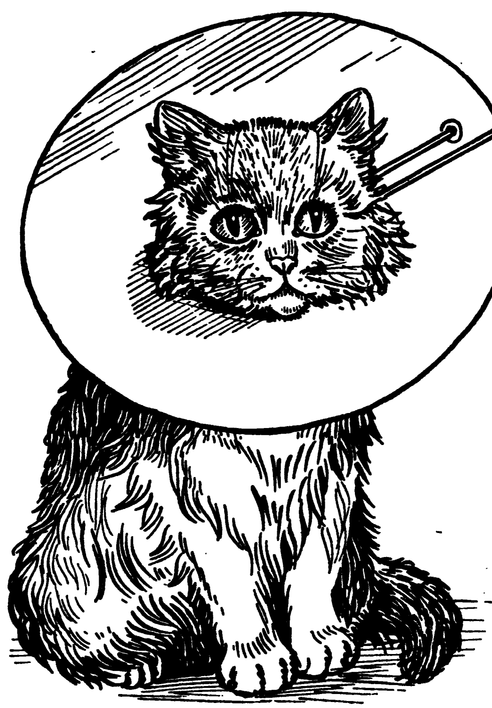
temporarily uncomfortable, is a necessary precaution.

Ringworm and mange.—A further note to the one regarding dogs on these two skin diseases is added, as it is felt that their contagious nature cannot be too strongly emphasised. Cats are particularly addicted to them as their wandering habit brings them in contact, not only with animals that are often not at all well kept, but also with places that have become infected.

If your cat does contract one of the diseases, recognised by the round bare patches in ringworm and the dry, scaly, bare skin in mange, do not be afraid to handle her. Provided that the diseased parts are kept dressed and that you wash your hands in a disinfectant solution each time, there is no need to worry. Sherley's Skincure has been found to be one of the best dressings for mange. It affords a speedy cure but is unfortunately of a greasy nature which makes it unwelcome if the cat lives in the house. Another preparation, Sulpho, is non-greasy, and very good, but the treatment requires more time and patience in its use.

Food during illness.—Very little can be said of invalid feeding for cats as the animal's habit is to shrink away from any form of outside help. She will refuse her food, even milk, and with wasting diseases such as distemper, will die from sheer exhaustion. Beyond forcible feeding, the only possible thing to do is to try all types of unaccustomed food given in an unusual way. Sparrows, mice, a whole fish, a lump of horseflesh, raw or cooked, not cut up or put in a plate, any of these may tempt her, and always have a saucerful of water handy. She will often lap water in preference to milk and this sometimes gives her an appetite for solid food. Lactol is, of course, a great help in sickness and especially if given with a beaten egg as an added attraction, but the very fact that it is a prepared food will too often cause its rejection.

Cats indeed are curious pets to deal with but they are extraordinarily interesting, and besides their attractive features there is always the sudden flash of the old wild instinct in a score of unexpected directions that gives a certain charm that the staid old house dog has lost.

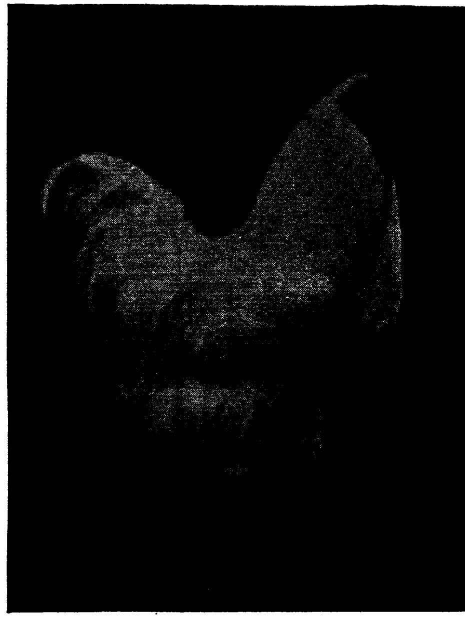


COLLAR TO PREVENT LICKING WOUNDS

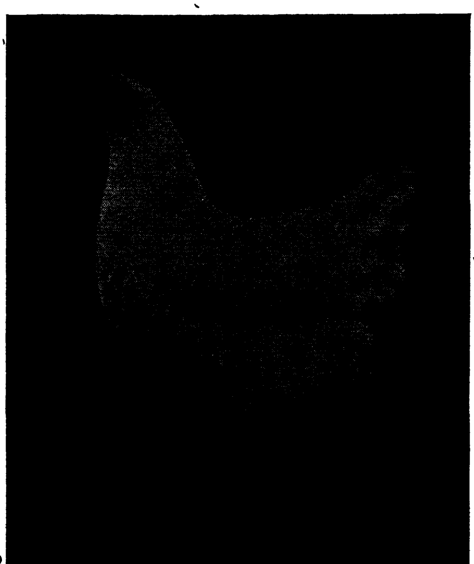
BACKYARD POULTRY KEEPING

Introduction.—The fact that eggs are such a valuable food and contain more nutriment than ½ lb. of beef or pork, encourages people everywhere to take up poultry keeping in order to supply their own households. In this article, I will deal with egg production for those people who live in towns and must necessarily keep their poultry intensively. When keeping the birds under these unnatural conditions, the closest attention must be paid to their management by giving them as much exercise as possible, by renewing the stock every two years, and by never breeding from these intensively kept birds.

When choosing the breed of fowl to be kept, the breeder must take into consideration what are his requirements. Usually the backyard poultry keeper requires a good egg producing bird which will also be suitable for table purposes. This is called a General Purpose Fowl. In this class of fowl the principal breeds are Wyandotte, Rhode Island Red, Plymouth Rock and Orpington. The chief characteristics of these fowls are:—



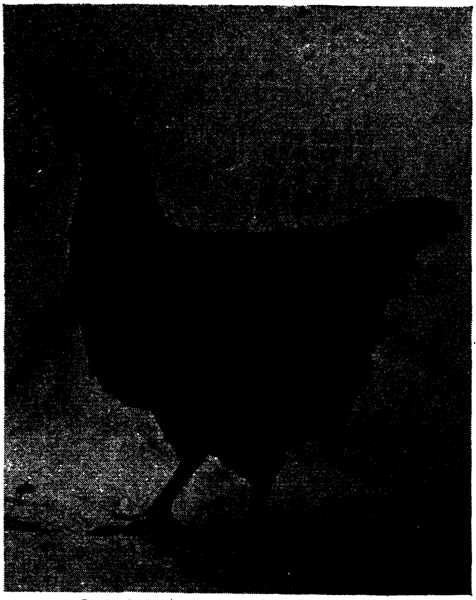
Reproduced by courtesy of "The Feathered World"
WHITE WYANDOTTE COCK



Reproduced by courtesy of "The Feathered World"
WHITE WYANDOTTE HEN

1. They are large in size, being broad and stout in shape.
2. They have small combs for their size.
3. They are quiet in disposition.
4. In general, they are good winter layers.
5. They all lay tinted-shelled eggs.
6. If necessary, they fatten well for the table because of their quiet disposition.

A very popular and fairly reliable hen for the backyard poultry keeper is the Rhode Island Red. It is an American breed; it is very hardy and has been bred more for utility than for show purposes. There are two varieties, the single comb and the rose comb. The rose comb is not so well-known over here. The Rhode Island Red grows



Reproduced by courtesy of "The Feathered World"
RHODE ISLAND RED HEN

quickly and chicks fatten very easily. In meat qualities it is good, except for the colour. The birds are good autumn and winter layers of large well tinted eggs. The colour of the plumage is a dark red except for the wing feathers and tail which are black.

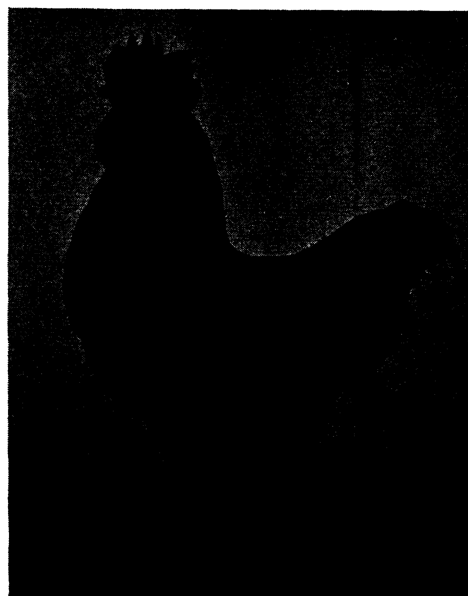
Before deciding on any definite breed, however, it is advisable for the poultry keeper to make careful inquiries as to how any breed has acted under similar conditions of climate and elevation. Then mistakes can be avoided before it is too late.

Choosing pullets.—When choosing pullets remember that the birds must be absolutely true to type, strong and vigorous, and suitable for the surrounding conditions.

Birds with any deformity, such as crooked breast bone, crooked toes, or deformed back, should always be rejected no matter what good qualities they have otherwise, because these faults denote a delicate constitution. No matter how well-bred a pullet is or what good points it has otherwise, it cannot possibly make a good layer unless it is vigorous;—this can be judged in the following way.

The birds should be a good size for the breed; the head should be neat and fine; the beak short and stout; the eye bright and prominent; the neck long and slender; the legs stout and set wide apart, and the plumage smooth and tight.

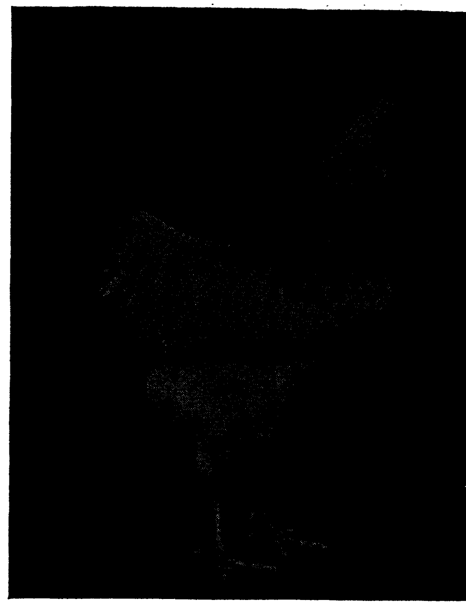
Next handle the birds. To do this, hold the legs firmly in the left hand with the head under the left arm. With the right hand, measure the distance between the breast bone and the pelvic bone on either side of the tail—the greater the distance the greater the bird's capacity as a layer. A bird with four or five fingers' width is likely to make a good layer, whereas a bird with only one or two fingers' width will probably turn out a very poor layer. The pelvic bones themselves should be fine and pliable and the skin smooth and soft to the touch. It does not follow that a bird which possesses all these points will be a good layer, but a bird which possesses none of them will most certainly be a poor producer.



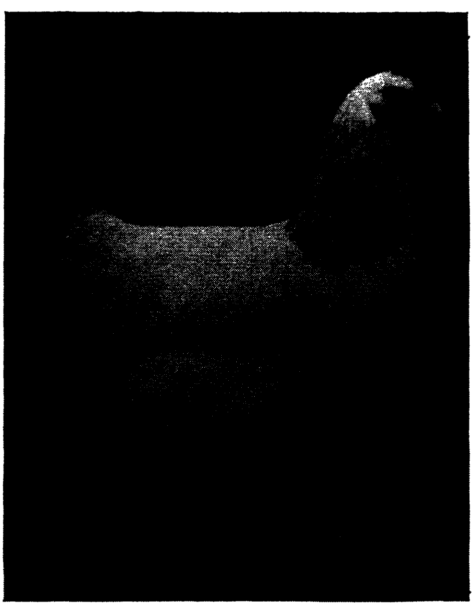
Reproduced by courtesy of "The Feathered World"
RHODE ISLAND RED COCK

The profitable age of a fowl ends at two and a half years, soon after its second laying season. The pullet as a rule lays more eggs than a second year hen, and a second year hen lays more than a third year hen. In order to keep up the supply of eggs, one third or one half of the flock should be renewed every year with early hatched pullets and the equivalent number of old hens disposed of. The best time to sell these old hens is in the months of July and August after they have finished their second laying season, and before they drop into their second moult. If there is a doubt as to whether a hen has ceased laying or not, the distance apart of the pelvic bones is a sure guide.

As the principal sources of loss in poultry keeping are due to keeping unproductive hens, every poultry keeper should learn to recognise an unprofitable bird, and the first step in weeding out useless ones is taken when the pullets are selected for the points already given in the autumn. These pullets should then be further selected the following spring, and, if the breed is a yellow shanked one, the bird that has laid well during the previous winter will have lost a considerable amount of colour from the beak and shanks. This loss of colour is not only an indication that the bird has laid, but it is also a fair guide as to the number of eggs produced. The colour disappears first from the vent, next from the eye ring, later from the beak and finally from the shanks. Therefore, a bird that has completely lost colour from all these places is a very good layer. A bird that has lost colour from the beak and not the shanks is a fair layer. A bird that has lost no colour at all is a non-producer.



Reproduced by courtesy of "The Feathered World"
LIGHT SUSSEX COCK



Reproduced by courtesy of "The Feathered World"
LIGHT SUSSEX HEN

Ring the birds that have lost the colour from the shanks. These birds may be again classified the following autumn, and then the late moulters are invariably the best all-the-year-round producers. It must be remembered that accurate culling can be done only when the pullets are early hatched and when the feeding, housing and sanitary conditions are all well managed.

Intensive system.—For the backyard poultry keeper whose space is so limited, the method of keeping the birds is to keep them intensively, a method by which the fowls are either kept entirely in houses or within very small enclosures.

Important points to remember in intensive rearing are:

1. Scrupulous cleanliness.
2. Deep scratching litter for the prevention of disease from manurial action and to give the birds plenty of exercise. This keeps down the tendency to internal body fat, and keeps them warm. If the birds have insufficient exercise, they become indolent and non-productive.
3. The feeding of sprouted oats when other green food is scarce. The oats are greatly appreciated and they can be sprouted anywhere at any season.
4. Taking every precaution to prevent the ground becoming tainted. The grass must be kept short and the space immediately surrounding the house should be of gravel, cinders, or any substance that can be removed and renewed when necessary.

Hens kept under these intensive conditions should never be used as breeding stock. Instead, buy sittings of eggs, or better still, day-old chickens and rear and retain the pullets as layers. If day-old chicks are bought it will avoid all the labour and expense of hatching.

Housing.—There is no necessity to build very expensive houses, but it must be remembered that no matter what house is being used:—

1. The house should be large enough for the number of birds it is intended to hold.
2. It must be well lighted.
3. It must be well ventilated.
4. It must be perfectly dry.
5. All the fittings should be movable so that the house can be easily cleaned.

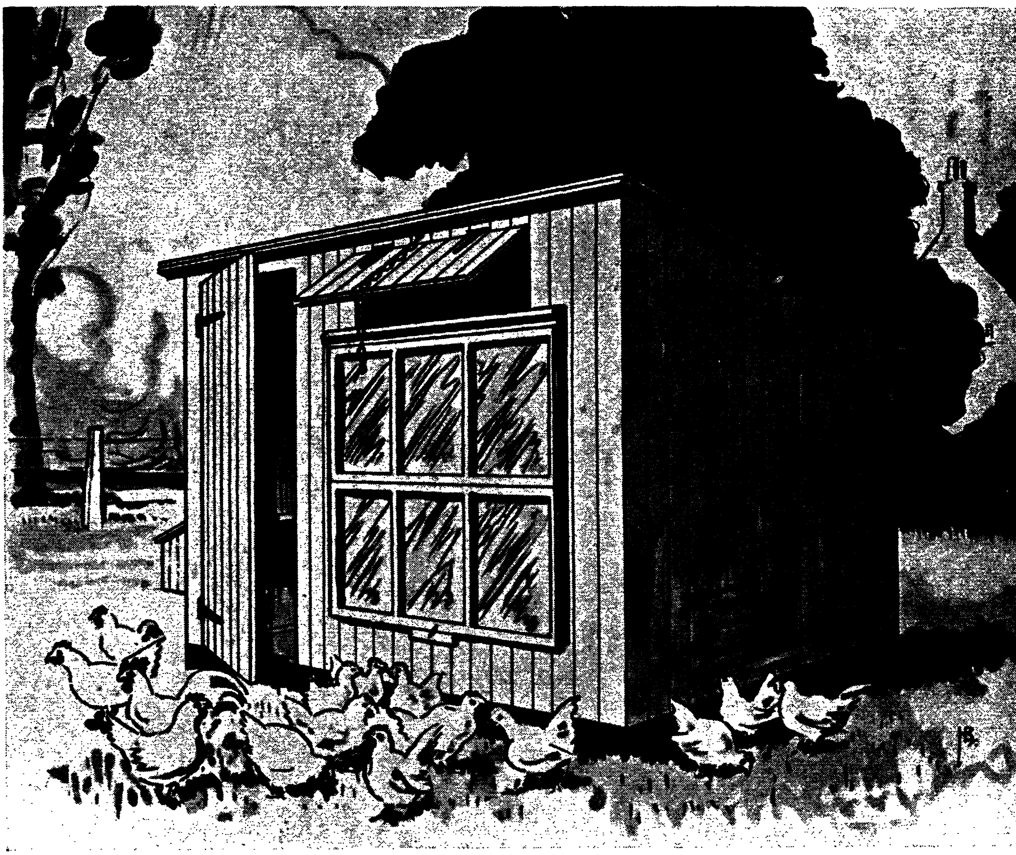
Stone and brick are the best materials to use for a permanent house, but wood has distinct advantages. It is cheap and easily handled, and if the owner wants to leave his home, a wooden house can be taken away, whereas a stone or brick house is a permanent fixture and cannot be removed.

The best wood to use is well seasoned white deal. It is quite inexpensive and good enough for ordinary purposes. The wood should be ⅞ in. to 1 in. thick tongued and grooved sheeting; or overlapping boards laid horizontally may be used. For the floor, a wooden one can be used, but a concrete one is better because it is easier to clean and easier to disinfect, there being no cracks or crevices for germs to hide in, and it can be made rat proof. However, a wooden floor is the least expensive and with care is successful enough. The size of the house depends on the number of birds to be kept in it. Allow 4 sq. ft. floor space for each bird kept on the intensive system. A house 8 ft. by 6 ft. would be suitable for twelve birds.

If it is found difficult to construct a suitable house, the names of firms specialising in such work can be found in any of the periodicals devoted to the rearing of fowls. Two of the most suitable types are illustrated, pp. 535, 536. It is not advisable to purchase a cheap house; the wood usually is thin, of a doubtful quality, and creates much trouble in a very short time. At the same time make sure that the house is constructed in sections, with holes bored and bolts provided.

Ventilation.—A house that is badly ventilated is always damp owing to the condensation of moisture upon the inside walls. When considering the ventilation, care must be taken that the opening to admit the fresh air and the opening to let out the foul air are so arranged that there is no draught on the sleeping birds on the perches. For the same reason, it is not advisable to place windows opposite one another.

Light.—In order to thrive properly the birds must have as much light as possible. An open fronted house built facing south, south-east, or south-west with the windows covered with wire netting, having glass shutters which can be opened, leaving the

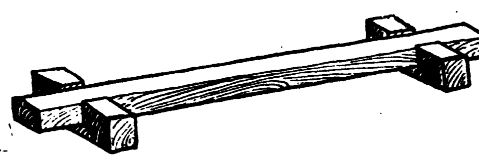


An All-Purposes Hen House

front of the house completely open to the sun, is the most suitable kind. The sun's rays purify the atmosphere and are a source of heat. Bacteria and parasites multiply more rapidly inside dwellings than in the open air, so since the sun's rays purify the atmosphere, care should be taken to allow all the sunshine possible inside the house.

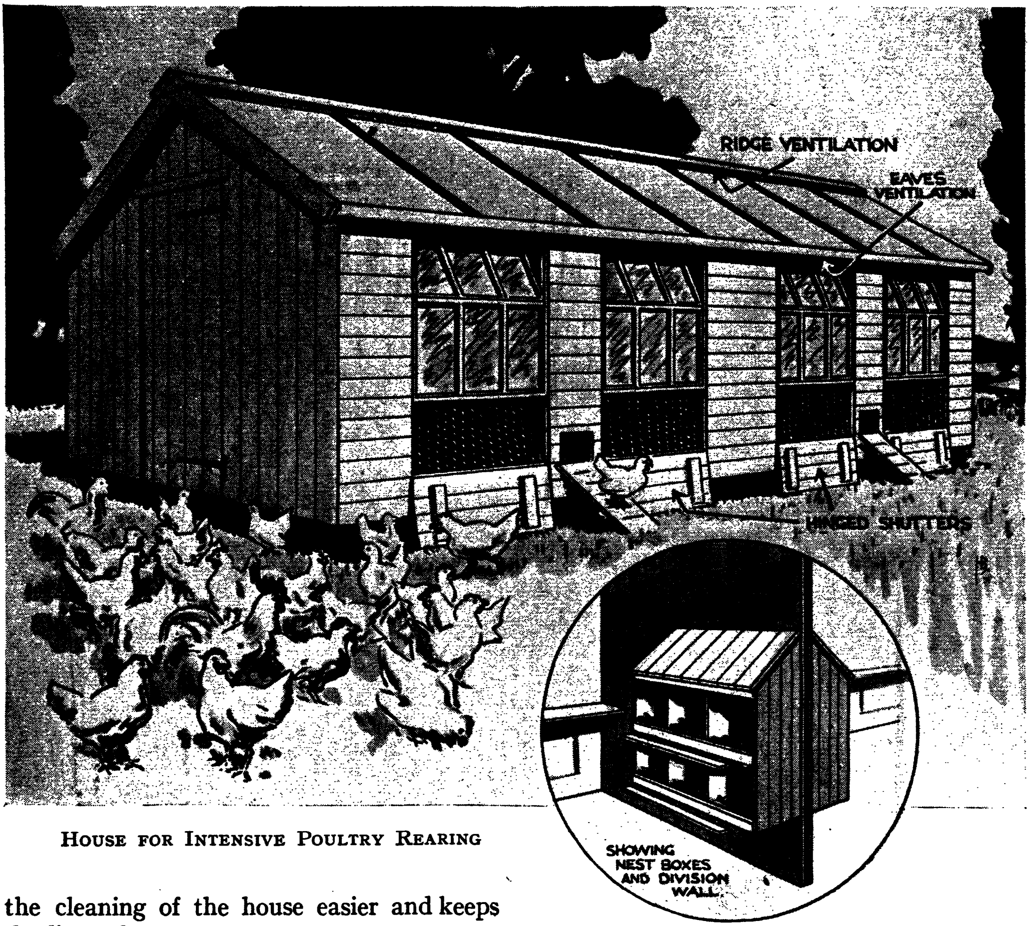
Heating.—Artificial heat is not required and if provided in cold weather reduces the vitality of the birds. The birds are kept warm by heat-giving foods and exercise.

Fittings.—*Perches.*—All perches should be movable to facilitate cleaning. They should be placed about 2½ ft. from the ground and never in ladder form. 9 in. to 10 in. perch space is required for each bird. The perches should be placed 9 in. apart. A suitable wood for making the perches is quartering 2 in. by 1 in.



A Simple Perch

Droppings board.—A droppings board will add to the cost of a house, but it also adds considerably to the comfort of it, both for the birds and the attendant. It keeps ground draughts from the sleeping birds, it makes



HOUSE FOR INTENSIVE POULTRY REARING

the cleaning of the house easier and keeps the litter dry.

Nest boxes.—These should be placed in the darkest part of the house, preferably underneath the window, and should be so constructed as to be easily cleaned. A convenient size for the boxes is $1\frac{1}{2}$ ft. by 1 ft.; allow one nest box for every four or five hens.

The daily cleaning of the droppings board is essential and the litter on the floor (straw, cut into short lengths, or peat moss—any material which will not gather into lumps) and the nest material should be changed as often as it gets damp or dirty.

The inside of all poultry houses should be lime washed or otherwise disinfected at least twice a year. Lime is a disinfectant that is cheap, is easily obtained and brightens the interior of the house. Paraffin oil is a very good insect destroyer one pint of which may be added to each gallon of the lime wash, and crude paraffin may be applied to the ends of the sockets of the perches. The outside of all wooden houses should be painted or tarred every year or treated with a good wood preservative such as creosote.

Feeding.—When feeding the fowl is considered, the two main objects are, firstly, to maintain a good standard of health in the flock, and secondly, to feed successfully at a cost which will allow a reasonable profit.

An adult fowl consumes roughly 4 ozs. of food daily, or about $1\frac{1}{2}$ lbs. weekly.

The uses the food is put to are:—

1. To build up bone, muscle, feathers, etc.
2. To repair waste.
3. To provide heat and energy.
4. To provide material for eggs.

The first three functions mentioned have the first call on the food and it is only after these needs are supplied that the additional food given is converted into eggs. The following are the most common mistakes made in poultry keeping.

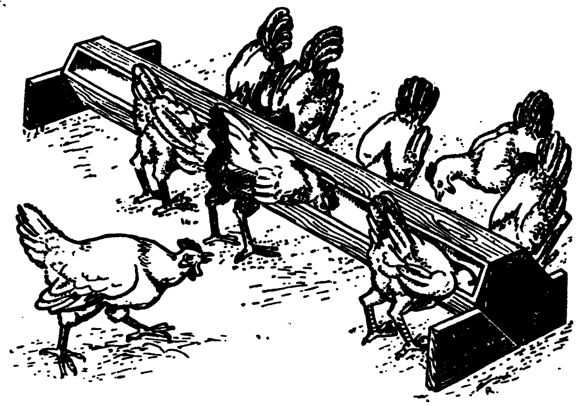
1. Want of variety in the food.
2. Giving variety of the wrong kind.
3. Neglect to use vegetable foods.
4. Feeding the adult stock too frequently, and the growing chicks not frequently enough.

The breed of the fowl has also to be considered. Large-bodied birds naturally require more food than light-bodied ones, whilst hens that are laying freely require more food than hens that are not.

1. *Want of variety in the food.*—No one food is complete in itself and it is only when plenty of variety is given that all the above functions can be carried out.

2. *Giving variety of wrong kind.*—A mixture of Indian meal, barley meal and potatoes, is undoubtedly a variety, but this mixture contains little or no material for egg production, for repairing waste, or for building up bone. On the other hand, a mixture of bran, pollard, fish meal or meat and bone meal, provides material for eggs but is not suitable for providing heat and energy; and it is only when these two classes of food are mixed with right proportions that the best results will be obtained.

3. *Neglect to use vegetable foods.*—Vegetables are valuable on account of their laxative properties. They purify the blood, and they increase the bulk of the food without increasing the cost. They may be used either raw or cooked and form one-third total bulk of the food.



A Feeding Trough for Dry Mash

4. *Feeding the adult stock too frequently, and the growing chicks not frequently enough.*—

The three principal methods of feeding are:—

(*a*) The dry mash method, which consists of grain morning and evening with a good mixture of dry meal constantly before the birds in boxes or hoppers. Water and green food are given separately.

(*b*) Wet mash method, which is the dry meal mixed with water or milk and fed in troughs two or three times daily.

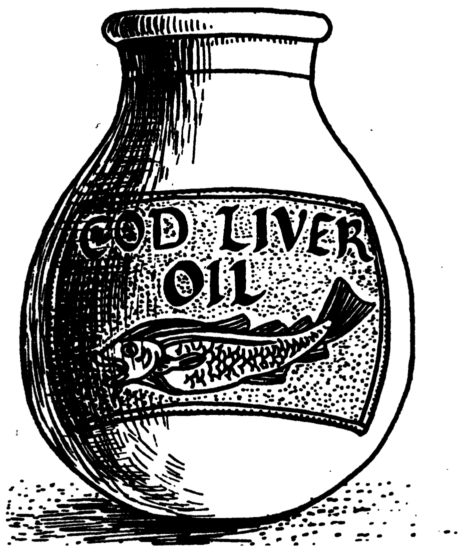
(*c*) A combination of both these methods, or alternate meals of wet and dry meal.

The last method has been found in practice to give excellent results, but no matter what method is adopted, the diet must contain grain food, green food, animal food, mineral food and water, and there are a number of patent foods on the market which contain the required percentage of the above. If, however, the owner wishes to mix his own foodstuff, the following is a good mash for layers:—

4 parts	by weight	of	pollard
2	,,	,,	bran
2	,,	,,	Indian meal
1	,,	,,	Sussex ground oats
1	,,	,,	meat and bone or fish meal

1 per cent of Cod Liver Oil.

With this mixture, if green food is lacking, alfalfa may be added in the proportion of one part alfalfa to ten parts other meals; if milk is very plentiful, the meat and bone meal or fish meal may be reduced to half quantity, but in *no* circumstances should the quantity be increased. It is also very beneficial to intensive stock to use a good brand of Cod Liver Oil. It keeps layers in splendid condition and prevents them losing the power of their legs, as sometimes happens with intensively kept birds.



USE GOOD COD LIVER OIL

With regard to the combination of both wet and dry mash method of feeding, the following should be a suitable daily menu:—

8 a.m. give a small feed of grain scattered in the litter, fresh water and fresh green vegetables, split turnips or mangolds. The grains scattered in the litter induces the birds to take exercise. The vegetables are hung up just high enough for the birds to reach them, thus keeping the litter clean and the vegetables from becoming soiled.

1 p.m. Feed a wet mash. This may consist of house scraps, cooked vegetables and the meal mixture mixed to a dry crumbly condition with milk or water.

Just before getting dark, the birds should be given a good grain feed in troughs so that they will have full crops to go through the night. This helps to keep them warm. Always have a hopper of dry mash and a box of crushed oyster shell and grit within reach of the birds. This completes the diet. The grit is necessary to digest the food. The sharp pieces of flint, of which it consists, collect in the gizzard and are used for grinding the food.

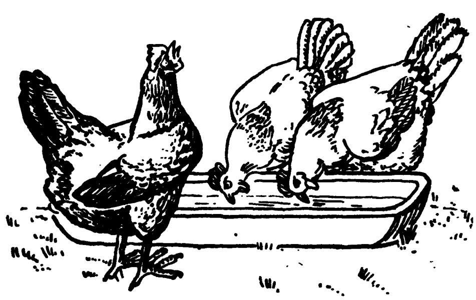
Grain.—The day's allowance of grain should average about 2 ozs. a head. Under this heading are included maize and its products such as maize, oats, wheat and barley and the meals which are made from these grains. Indian meal, fine pollard, Sussex ground oats and barley meal go chiefly to provide heat and energy; whilst bran, dried grains, alfalfa and the more bulky grain foods go to build up bone and produce eggs, so that when a ration is being planned, these facts must be remembered. Half the mixture should be composed of heat and energy producing foods such as Indian meal, pollard and Sussex ground oats; and the other half of bran, dried grains, alfalfa, etc. If there is too big a percentage of Indian meal or Sussex ground oats in the birds' diet, they will be inclined to put on internal body fat, and this is very detrimental to the output of eggs.

Animal food.—The fowl must have animal food in one form or another. The most suitable and inexpensive animal foods are fish meal, meat, bone meal and milk. This diet can also be overdone and the percentage of meat and bone or fish meal must not exceed 1 lb. daily for every thirty-five hens. If milk is given, the birds can have it to drink or mixed with their mash.

Mineral food.—Mineral food is necessary to build bone, repair waste and for the production of eggs. Fish meal and some of the coarser grain foods such as bran, milk and vegetables all contain a certain amount of mineral food. However, when the hens are laying very freely, crushed oyster shell which supplies additional lime is necessary. A hen requires roughly 4 lbs. of lime every year. If the supply is lacking and they are laying heavily, egg production will suffer. In addition to this, it is sometimes advisable to add a mineral mixture composed of lime, chalk, and iron in the proportion of 2 lbs. of minerals to every cwt. of grain.

Green food.—This is essential for health and also for egg production. Cabbage, raw turnip and mangolds may be given and these are inexpensive. If fresh green food is scarce, alfalfa, which is a dried green food, may be substituted, but there is no substitute which is really satisfactory for fresh green food. Sprouted oats, which can be sprouted any time of the year, are good when other cheaper green food is scarce.

Water.—A plentiful supply of clean fresh water is necessary for health as well as for egg production. One dozen eggs contain about 1 pint of water and an irregular supply will cause a serious decline in egg production.



SUPPLY OF FRESH WATER

Formation of the egg.—The principal part of the egg—the yolk—is in the centre. Surrounding it is the white. These two are separated by a very thin skin called the vitellini membrane. It is the yolk which forms the nourishment of the embryo. The yolk is held in position by two little twisted cords, or chalaze, of a denser albuminous nature than the white. The white of the egg is a colourless liquid of which there are three distinct layers: the inner layer, the second layer in which the chalaze end, and the outer layer which is a liquid. Next there are two membranes: the outer one sticks to the shell and the inner one sticks slightly to the outer. At the large end of the egg there is a space called the air chamber. This is formed by the two membranes separating.

Enveloping the whole of the egg is the shell, white or tinted, according to the breed of fowl by which it is laid. It is composed of carbonate of lime, phosphate of lime and animal gluten. The shell sticks together and gets its firmness from the salts of lime, so, as is often the case when soft shelled eggs are produced, there is a deficiency of lime in the fowl's diet.

Fertile and infertile eggs.—An infertile egg is one in which there is no life—no actual germ—and without this germ, no amount of heat can ever bring a chicken to life. An infertile egg will not go rotten because there is no life in it to die, and without death there is nothing to decay: an exception to this is when the hen which has produced the egg is suffering from a disease.

A fertile egg is one in which there is life, and under the proper conditions the chicken develops from day to day.

Formation of a chicken.—On the upper side of the yolk of a fertile egg is the germ spot which is the life in the egg. From this spot the chicken develops. No matter how we turn the egg, the germ spot always goes to the upper side of the yolk; that is why heat must always be applied from the top since it would lose some of its power if it had to penetrate the yolk as well as the white before reaching the germ. Eggs

NEARLY OUT

must be turned regularly—in natural hatching the hen does this—as if not, there is a danger that the heat will cause the yolk and the white to stick together and the embryo will die. This is a cause of many addled eggs. The purpose of the yolk is to feed the chicken during its development.

Natural hatching.—It is unnecessary for the small poultry keeper to go to the extra expense of purchasing artificial hatching and rearing appliances, because a flock of chickens such as he requires can be quite successfully hatched under a few hens. One important point here is to make sure that the stock from which the eggs you buy are produced is healthy, vigorous and fed and housed well. Pullets required for laying are best not hatched until March, and then they are in full lay for the winter months. When only two or three batches of eggs are hatched, the hens can be set in a quiet outhouse or shed. The nest should be large enough to provide sufficient room for the hen to turn her eggs comfortably, well ventilated, and not placed in too bright a light.

The nest should be made with a drop door in front so that the hen can leave the nest whenever she wishes, and then if occasion arises, she can be enclosed. Ventilation holes should be bored about 2in. from the top along the sides and also on top of the box. It is advisable to cover the bottom of the box with wire netting as a precaution against rats. Usually an old box is to be found which can be suitably converted: if not, ½ in. or ¾ in. wooden boards are used. A box from 1½ to 2 sq. ft. and about 20 in. high is a convenient size.

Making the nest.—In making the nest in the box, place a shovel-full of earth in the bottom. This is to provide moisture; it is also imitating the hen, who, if she is allowed to make the nest herself, will make it on the ground. Hollow the clay out into a saucer shape, taking care to fill all the corners so that there is no fear of the eggs rolling away from the centre of the nest and becoming chilled. Take out any lumps or stones. On top of this put the nest material which may be hay or moss litter which has been broken up finely.

Preparing the hen.—After the nest is prepared, the next thing to do is to prepare the hen. Make sure she is thoroughly broody, although it does not follow that every broody hen will make a good mother. The General Purpose breeds such as Sussex, Rhode Island Red and Wyandottes are the most reliable and careful mothers.

Before placing the hen on the nest she should be examined for insects. These are usually found round the tail, underneath the wings, and along the ridge of the breast bone. Whether the hen has insects or not, it is always advisable to treat every broody hen before placing her on the nest. Sodium fluoride or mercurial ointment destroys the eggs as well as the insects and can be obtained from any chemist. The powder is dusted on round the tail, underneath the wings and on the back. If the ointment is used, a piece about the size of a pea is sufficient: this should be rubbed in well, round the tail and underneath the wings. If the hen is badly infected a second application is necessary. One of the greatest drawbacks to natural rearing is the presence of insects and, if to begin with the mother is clean, there is not such a risk of the chickens being infested. It is best to place the hen on the nest at night, and on no account should she be given good eggs immediately. Try her with ordinary eggs, and if at the end of twenty-four hours, she is sitting peacefully, the eggs intended for hatching may be given to her. She should not have more eggs than she can cover comfortably. Ten will be quite enough for a small hen, whereas a large hen can cover thirteen to fifteen. During the twenty-one days of hatching, the hen should be kept in as quiet a place as possible. On no account should the nest be in a house where there are other hens running about, as she must not be disturbed.

Cooling and feeding.—You will probably find that for the first few days you will have to lift the hen from the nest in order that she may feed. In a very short time she will learn to come off herself, and, if a well-chosen hen, will return to the eggs immediately it is necessary.

The food may be whole oats, whole wheat or maize, the best of these three being maize, as it is more heat giving. Fresh, clean, drinking water must be provided and it is advisable to have a dust bath of dry sand or ashes for her to use as this helps to keep her from being infested with insects. Care should be taken when lifting a hen off the nest, as when she is disturbed she usually tucks some of the eggs tightly under her wings and when she is lifted, they might drop and cause others to be smashed. The best plan is to place the hand under the breast bone, feeling without spread fingers for any eggs being held and then to lift her boldly.

The length of time required to cool the eggs sufficiently depends on the time of year and on how long the eggs have been set. During the first week the time allowed is five to ten minutes. From the second week fifteen to twenty minutes may be allowed. The last day of the hatch she should be left on the nest all day. During the hatch, the eggs obtain much of the moisture from the earth at the bottom of the nest. If, however, the weather or the place is very dry, it is better to moisten the earth with water rather than sprinkle the eggs with it as is often done. The latter is harmful to the eggs.

Choice of eggs for hatching.—Usually the selection of eggs for hatching purposes receives too little attention, but it is of the greatest importance whether hens or incubators are being used. Buy the hatching eggs from reliable breeders. If inferior eggs are used, the result is a batch of weakly chickens. Make sure the eggs come from birds which have been mated for their good egg production.

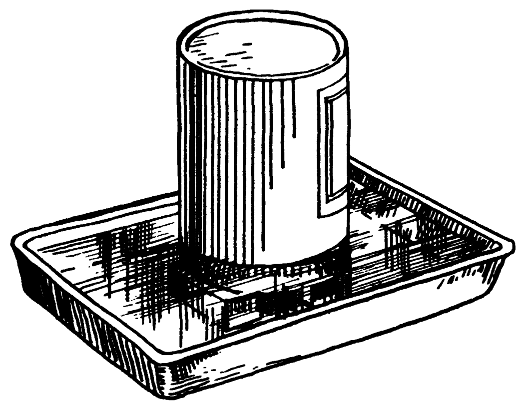
The first essential for the production of good hatching eggs is a good stock bird, thus both male and female must be vigorous and a good size for the breed. Vigour can be judged by the general appearance of the bird: full bright eye, short stout beak, stout shanks, smooth tight plumage and freedom from any deformity such as crooked back, breast bone, beak or toes. The stock must be quite free from disease and in the majority of cases if they are vigorous they will be. If there is reason to suspect the presence of Bacillary White Diarrhoea (see **Chicken Diseases**), it is advisable to have the stock birds' blood tested. The age of the stock is also important. The best hatching eggs are obtained from two to three year old hens mated with a young cockerel. On no account should pullets' eggs be set—these will always give rise to weakly chickens. Do not breed from hens very closely related as this also lowers the vitality of the stock. Fresh blood should be introduced each year by purchasing a cockerel bred from a good layer and un-related to the hens with which he is mated.

Do not try to hatch out chickens from abnormal eggs, whether too large or too small, thin, or rough-shelled. Any of these eggs would probably result in the germ dying in the shell, or else weakly chickens. The eggs to look for should not be more than ten days old; they should have strong shells and a good shape. Choose eggs which are slightly above the average in size. If storing them, care should be taken not to place them in extremes of temperature and always place them on their sides. It takes about three dozen eggs to produce six or seven pullets. This allows for a normal percentage of cockerels and infertile and addled eggs.

Testing the eggs.—Some poultry keepers disagree about interfering with the eggs during the hatching, but testing them has many advantages. If any of the eggs are addled or infertile there is no warmth in them; thus, they lower the temperature under the hen. When the eggs are tested, it is as well for a beginner to wait until the seventh day. At the end of this time, if any of the eggs are perfectly clear, they can still be used for culinary purposes. At the same time, if three hens are set together, if, after the first test when all the infertile and addled eggs are removed, one-third of the eggs are clear, the remainder of the eggs can be given to two hens and the third one set again, or else put off her broodiness. An experienced egg tester can tell if an egg is fertile at the end of three to four days, but for a beginner it is advisable to wait until the seventh day. It is best to do this at night, using a candle or lamp, over which hold a piece of cardboard with a hole cut in the centre slightly smaller than the size of an egg. If each egg is held in turn in front of this hole, the contents can be seen readily. If a fresh egg is held in front of this light, it will be quite clear with a very small air space at the large end. An infertile egg will look the same as a fresh egg except that the space will be increased. On the seventh day if the egg is fertile, a dark shadow will be seen on the yolk with tiny blood vessels diverging from it. Addled eggs have a cloudy appearance with sometimes a red line running round the egg. The appearance of an addled egg will depend on the age of the germ when it died.

Natural rearing of chickens.—When the chickens are all hatched, lift off the hen and give her a final feed alone. Then bring the hen and her flock to the place provided for them.

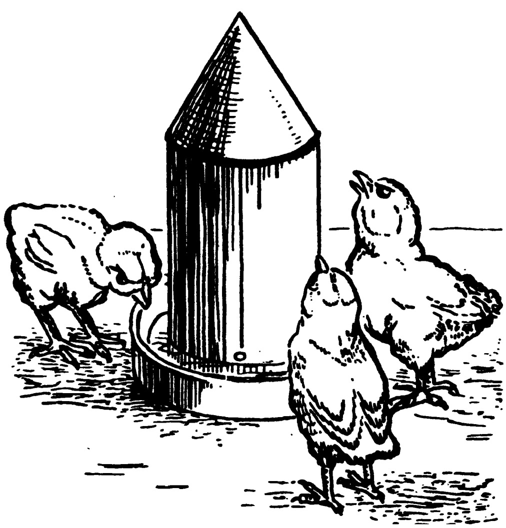
Place to rear.—Damp is fatal to chickens so make sure that the coop and the surrounding ground is absolutely dry. The soil should be well drained so as to carry off any water quickly in wet weather. The birds should be in a position so as to get the maximum amount of sunshine, and be protected against the cold winds and rain. If the sun is very strong, it is necessary to provide a shady place for them; in an enclosed yard a spot like this can easily be found. If there is a shed available, quarters can be provided for the hen and chicks here during the night. In the daytime the chicks should run about, but it is advisable to keep the hen in a coop for shelter and protection, as hens are usually given to fighting. This is fatal if there are other hatches at the same time. A simple wooden coop is all that is necessary. A coop of 1 or 2 sq. ft. is a suitable size, with a sloping roof. It should have a barred front, the bars nailed 3 in. apart. This front allows all the ventilation required and the chicks can come and go whenever they please. A coop this size will house the chicks till they are nine weeks old. If the soil is very dry, a wooden floor is unnecessary as the chicks would be comfortable on the ground. If rats are troublesome, nail a piece of fine meshed wire netting on the bottom of the box. In this case it will be necessary to put in some bedding—chaff or chopped straw. When the grass surrounding the coop becomes soiled, move the coop to fresh ground immediately. This will prevent gapes. If fresh ground is not available it is necessary to place fresh soil or grass sods over the place occupied.



A HOME-MADE DRINKING TROUGH

Care of coop.—The coop must be thoroughly cleaned daily and frequently disinfected. Between every batch of chicks, it should be lime washed.

Feeding.—Twenty-four to thirty-six hours after the chicken leaves the shell it does not require any food as the yolk bag is absorbed into the abdomen and it contains all the food necessary for the above stated time. However, the hen must not be forgotten. The chicks' diet must contain a variety of meals, a little animal food, plenty of fresh greenfood, some mineral food and water. Oatmeal should be the foundation of all meal mixtures for chickens. It builds up bone quickly and is inexpensive. Indian meal and sifted barley meal may be added to the oatmeal. If the chicks are reared out of doors, they can readily find animal food for themselves in the form of insects and slugs.



A Patent Device for Hygienic Drinking

Green food is very beneficial as it purifies the blood, acts as a laxative and promotes the growth of the chicken. This may be given in the form of fresh green grass, cabbage and lettuce. Mineral food is also required for bone formation. Oyster shell should be supplied as it contains lime. Milk and greens also have a small percentage of mineral value. Clean fresh water is absolutely essential from the very first. This may be given to them in the form of milk, which is 80 per cent water, or ordinary water. The first feed should be a scratch feed of pinhead oatmeal. This can be given alone or mixed equally with finely kibbled maize or fine cracked wheat. The chickens require this scratch feed five times daily.

When the chickens are about a week old, the following mixture of meals may be given:—

2 st. oatmeal or Sussex ground oats.
1 st. bran.
1 st. pollard.

If kibbled maize is not included in the scratch feed, 1 stone Indian meal may be added to the above mixture. House scraps or cooked vegetables may be added when the meals are being mixed in a wet mash. Four meals a day are sufficient until the birds are eight to ten weeks old. After this, three meals, one of them being whole grain, are sufficient until they are fully grown. Sour or fermented food must never be fed to chickens—all the food should be mixed freshly in a crumbly condition each time. Sloppy food is bad for them. Leave the food with them for about twenty minutes. After that period any food they have not eaten may be removed as the chickens would dirty it, and dirty food causes diarrhoea. Suitable troughs should be provided for them to feed in: these can be bought from 9*d.* upwards. If the owner has only very limited time to give to his chickens, he can feed them entirely on dry mash although this is more wasteful than the wet mash method. The mash is placed dry in hoppers which are before the birds constantly. A scratch meal of kibbled maize, or cracked wheat if given to them in the morning will give them exercise.

The orphans.—When the mother leaves the birds and they are left to their own resources, care should be taken to prevent huddling and overcrowding at night. This can be done by inducing the birds to perch by placing flat perches 6 in. in width in the coop. If the perches are ordinary narrow ones the chickens will get crooked breast bones.

Separation of the sexes. — As soon as the different sexes can be distinguished, the chickens should be separated so that the pullets can develop properly. The cockerels can be fattened and sold for table purposes as soon as possible. Pullets, being the most productive stock, should be given every opportunity to develop. Their diet should contain a large proportion of grain. If they are too freely fed and a lot of animal food is included in the diet, they will begin to lay very early, the result being that they will produce a small egg and their growth will be retarted. If it is noticed that the pullets are reddening up to lay before they are five and a half to six months old, they can be kept back by the following methods:—

1. Reduce the amount of food, only giving two very small meals per day, one of which consists of whole corn, oats, wheat or maize.

2. Change their quarters. Changing from one house to another will put them off laying for a week or two and at the same time the change to fresh ground will act as a tonic and help the growth of the birds. Pullets or fowls of any kind should not be moved from one place to another just before they begin to lay. If eggs are wanted, this always has the effect of postponing laying for a few weeks.

In the light breeds, the cockerels can easily be distinguished by their large combs. It is more difficult to separate the sexes in the heavier breeds as their combs are all small. The points to look for in the cockerels are long pointed silky saddle feathers, much bigger and coarser bones, and pointed silky feathers on the neck and tail.

Fattening the cockerels.—For fowls that are to be used for table purposes, it is unnecessary to say anything about the value of fattening them. They must be killed immediately they are fat enough, as if they are kept too long, there is a tendency for them to go back. The food given to the birds must always be soft mashes. Do not give them hard corn as this takes too long to digest. Give the birds as little exercise as possible. It is really best to keep them confined—a small part of the shed where there is not too strong a light could be portioned off. A good fattening mixture is as follows:—1 part ground oats, 1 part Indian meal, 1 part sharps, ½ part barley meal. This mixture should be mixed with soured, skim milk. This is better than sweet milk as the acid enables the fowl to digest the food quicker; helps to prevent sickness, and increases the appetite. Milk has also a bleaching effect on the flesh of the bird, and this increases the market value of it. The fowls should be fed twice daily at the same time each day.

Killing.—Before killing, the bird must have no food for twenty-four hours. This is to ensure that the crop and intestines are empty, as after the bird is dead, food that is partly digested goes bad very quickly and a loss will arise as the flesh is affected, especially in warm weather.

The cleanest and most satisfactory method of killing is by dislocating the neck. To do this, hold the ends of the wings and the legs firmly in the left hand. With the comb resting in the palm of the right hand, grip behind the head with the first and second fingers of the right hand, holding the head down. Draw the fowl out to its full length and bend the head suddenly backwards. Death follows immediately.

Preparing the bird for cooking.—*Plucking.*—Pluck a fowl while it is still warm, as the feathers come out easier and the flesh does not tear so readily. When plucking, hold the hen with its head downwards, so that the blood will gather in the neck. Pull the wing and tail feathers first, pulling them straight out, then start with the breast, plucking the feathers the opposite way to which they grow on the hen.

Cleaning and trussing.—A special sharp knife, a needle and some string are required for cleaning and trussing. Cut a slit in the skin at the back of the neck. Loosen the skin and cut the neck off from the shoulders. Then, leaving about 2 in. of the skin on, cut the head off. The piece of skin left will draw back over the back. Throw the head away and keep the neck. Pull the crop out and loosen the lungs by putting two fingers down the hole made. Next, make an incision, not too deep, between the vent and the tail. Cut out the vent, and draw out all the internal organs, keeping only the liver, the gizzard and the heart, if required. Remove the grit bag from the gizzard by cutting along the outside edge. With a trussing needle, about 8 in. long, and some white string, tie up as follows: place the bird on its back and press the thighs forward and down, level with the table. Pass the needle through the thick part of the leg, through the body and out through the other leg, turn the bird over and knot tightly on the back. Bring the ends of the string down towards the tail, make a single knot and tie tightly round the tail and the thigh bones, just below the hocks. Chop off the legs, leaving about 1 in. for shrinkage in cooking. Trim the ends off the wings and twist them back. The bird is now ready for cooking.

The feathers.—The feathers can be sold to firms who advertise for them. The small feathers from the back and breast are the most valuable and should be kept separately from the wing and tail feathers. Spread them out on papers till they are dry, then hang them up in bags.

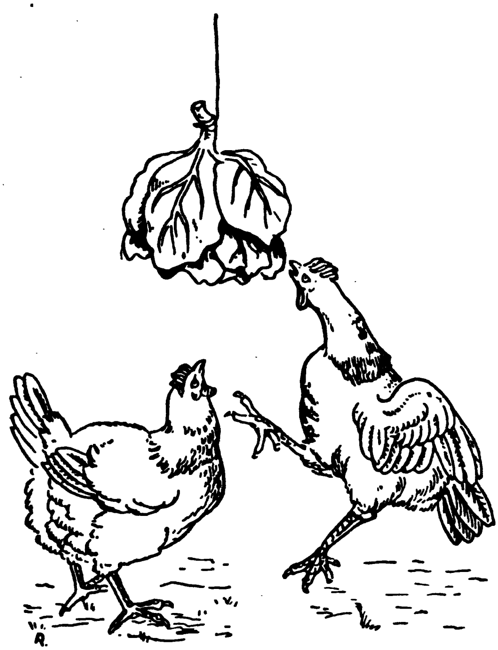
Preserving eggs.—There are several ways of preserving eggs for home consumption but no matter what method is adopted, the following rules must be observed:—

1. At least a fortnight before preserving begins remove all the male birds from the hens, as infertile eggs keep much better than fertile ones.
2. Preserve the eggs within twenty-four hours after they have been laid, as if the eggs are stale, the preservative will not prevent them going bad.
3. Clean the eggs with a damp cloth before preserving them. Never wash them as this ruins their keeping qualities.
4. Reject thin-shelled eggs.
5. Keep the preserved eggs in a cool place.

During the months of April, May and the beginning of June, eggs are usually cheapest and the weather is not too hot, so this is the best time for preserving them. A very satisfactory method of preserving eggs is by using a solution of water-glass. This can be bought at any chemist or grocer. Earthenware crocks, galvanised buckets or wooden tubs may be used as a receptacle for the eggs. To prepare the mixture, follow the directions on the tin carefully. When the mixture has been prepared, place the eggs in it each day as soon as they are cold. Always have a good covering of the water-glass above the top layer of eggs. When the vessel is full, a lid should be fitted on, or brown paper tied round the top like a jam jar in order to prevent evaporation. When the eggs are taken from the mixture for use, they must be washed to remove the soda which may be deposited on the shell. If the eggs are to be boiled, make a hole in the end of the egg with a needle. This prevents the shells bursting when put into boiling water.

The lime water method is another way in which eggs can be preserved. It is made in the following way: take 10 galls. of water and mix 2 galls. of lime, ½ gall. of salt and ½ lb. of Cream of Tartar with the water. Stir them all well together every day for four or five days. At the end of this period, pour off the clear solution on the top into a clean crock and place the eggs in it as for the water-glass. Treat them in the same way when they are required for use. The methods of preserving eggs which have just been described are intended for home consumption only.

Diseases of poultry.—With poultry it is best to try to prevent disease, not to cure it. To have healthy poultry the birds must have a sound and vigorous constitution and be well housed—that is, the houses must be large enough for the number of birds it is intended to hold—well ventilated and without draughts. It must also be dry, well lighted and kept clean, not only by



GIVE THE BIRDS PLENTY OF EXERCISE

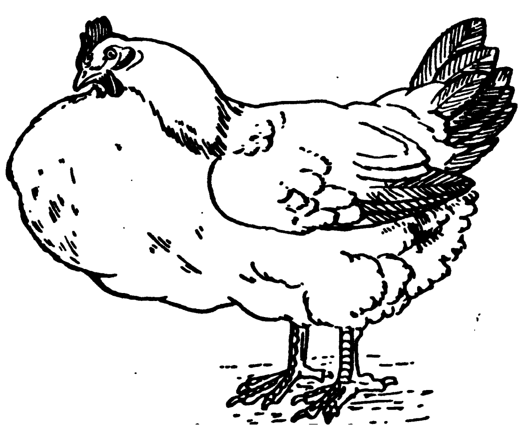
daily cleaning, but by thoroughly disinfecting at least twice a year. It is very important that the birds should be fed cleanly: never give them musty or decayed foods, and always give soft foods in troughs, never on the ground. Never allow any soft food to remain in the house after the fowls have eaten. The birds must be kept free from parasites as these reduce the vitality of the stock and make them more subject to disease. They must have plenty of exercise. This can be given by making them scratch in deep litter for grain, and picking at green food which has been suspended on a cord at a height just above their heads where they have to jump for it.

When a bird shows signs of illness, it must be removed at once from the remainder of the flock and the house thoroughly disinfected so as not to expose the other birds to infection. All dead bodies should be burned.

The following is a table of common ailments and their treatment:

DISEASE	SYMPTOMS	CAUSE	PREVENTION	CURE
Bumble Foot	Swelling on toes or foot.	Falling heavily from a perch or a cut from glass or a thorn.	Do not have perches too high. Clear away all broken glass.	Bathe in hot water. Lance with a short sterilised knife. Apply boracic ointment and bind up. Keep bird on soft hay.
Liver Disease	Green or yellow diarrhoea, dark coloured comb and yellowish look about the face. Loss of appetite.	Wrong feeding and germs which develop under insanitary conditions.	Reduce quantity of maize and potatoes. Feed unlimited supplies of green food. Make birds take more exercise. Give a level teaspoon of Epsom salts twice daily.	Once the liver becomes seriously affected, there are no known means of restoring the organ.
Tuberculosis	Birds gradually become light and waste away.	Caused by a germ which thrives in insanitary conditions.	Good housing. Kill all ailing birds to prevent it from spreading.	

Colds	Running from nostrils and eyes.	Overcrowding, want of ventilation or damp.	—	Bathe nostrils and eyes in warm disinfected water.
Roup	Running from nostrils and eyes. Puffy swelling round eyes and cheesy patches on tongue.	Neglected colds.	Treat all birds suffering from colds immediately and disinfect drinking water.	Isolate to warmer quarters. Remove cheesy patches with a piece of stick pared flat; bathe as for colds.
Cholera	Disease of the intestines. Green diarrhoea, ruffled feathers and drooped wings. Great thirst.	Caused by a germ which thrives in dirty surroundings.	Good housing; good food. Isolate all ailing birds.	Kill any ailing birds as the disease is very contagious and there is practically no cure.
Crop-binding	Enlarged crop, feels hard and tight.	Caused by indigestible material such as straw and feathers collecting at the entrance of the gullet.	—	Pour some castor oil and warm water into the crop; knead contents soft; squeeze through the beak.
Chicken Pox	Tiny warts and sores on head and face.	Unclean, bad housing and feeding, etc.	Breed from vigorous stock, good management and freedom from insects.	Bathe the heads with a little warm water to which Jeyes Fluid has been added and paint affected parts with iodine.



Crop Binding

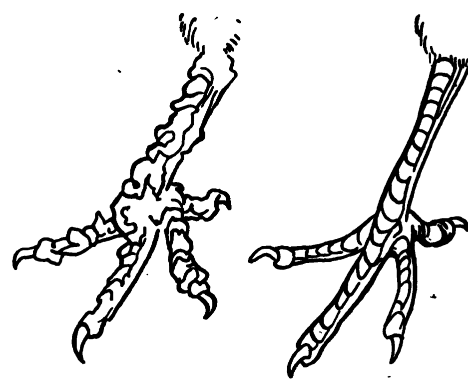
Poultry parasites.—Lice, red mite, ticks, fleas, and scaley leg mite attack the fowl externally. The commonest of these parasites are *lice*. They live on the waste matter of the skin and feathers and irritate the birds. Dust the birds with sodium fluoride. This kills the eggs as well as the lice. Shake it well between the feathers especially round the tail. Paint the perches with a very strong disinfectant. Black Leaf Forty is very effective if applied to the perches twice at intervals of a week.

Red mite.—Red mite is the most dangerous of all because it attacks the fowl, punctures the skin and sucks the blood. They are a pale colour until they have sucked blood from the birds, when they become a bright red. They live in the woodwork of the houses and come out at night when the birds are sleeping on the perches, or in the daytime when the birds are in the nests. To clear the house of red mite, remove and burn the litter and take out all the movable fittings. Then paint the inside of the house with lime wash or creosote. If lime wash is used, add 1 pint of paraffin oil to each bucket of lime wash. Paint the ends of the perches and the sockets thoroughly with paraffin oil. Red mite are very detrimental to the health of the fowl; laying fowls produce fewer eggs and young birds often die from the injuries of the mite.

Ticks.—These resemble red mite by sucking the blood but they differ from them by living on the fowl. They are most injurious to young chickens. As a rule they are found with their heads buried in the flesh on the head and throat and upper parts of the neck. To get rid of them apply a greasy substance such as sweet oil containing a few drops of paraffin.

Fleas.—Fleas live in damp dirty corners or in the litter in nest boxes. They can readily be discovered as they are about the only parasites that will affect the attendant. They can be got rid of by removing all the litter and burning it, and having the interior of the house lime washed. If the house is dry, clean, and well lighted, there will be very little trouble with them.

Scaley leg mite.—This is due to a mite which burrows under the scales of the shanks, forming whitish crusts which give the shanks a rough lumpy appearance. If the ailment is not too far advanced, it can easily be remedied by dipping the shanks only in paraffin oil. Care must be taken not to let the paraffin oil go above the shanks as it will burn the skin. If the mite have got a hold, some of the crust must be removed before the paraffin will take effect. This can be done by smearing the shanks with vaseline, allowing it to remain on for twenty-four hours, then scrubbing the legs with a stiff brush, using hot water and soap. This softens the crust and a lot of it can be removed by using a pointed flat stick. This treatment will stop the scaley leg for a time, but will not be permanent unless the house is thoroughly cleaned and



SCALEY LEG

disinfected and the litter destroyed. Scaley leg is contagious but it does not spread very rapidly.

The poultry keeper can suffer great losses through parasites, so it is best to prevent them. This can be done by good housing and cleanliness. Fleas will not live in a house that is dry, well lighted and regularly cleaned. Red mite can be kept away by following the rule for fleas and occasionally disinfecting the inside of the house thoroughly. If the birds are treated twice a year with sodium fluoride or Black Leaf Forty applied to the perches, they will be free from lice. The latter is also said to act as a preventative of red mite.

Diseases and difficulties of chicken rearing.—The diseases of chickens may be divided into contagious and non-contagious types.

The contagious diseases are:—Bacillary White Diarrhoea, Coccidiosis, and Gapes.

The non-contagious are:—Chill, Leg Weakness, and Insects.

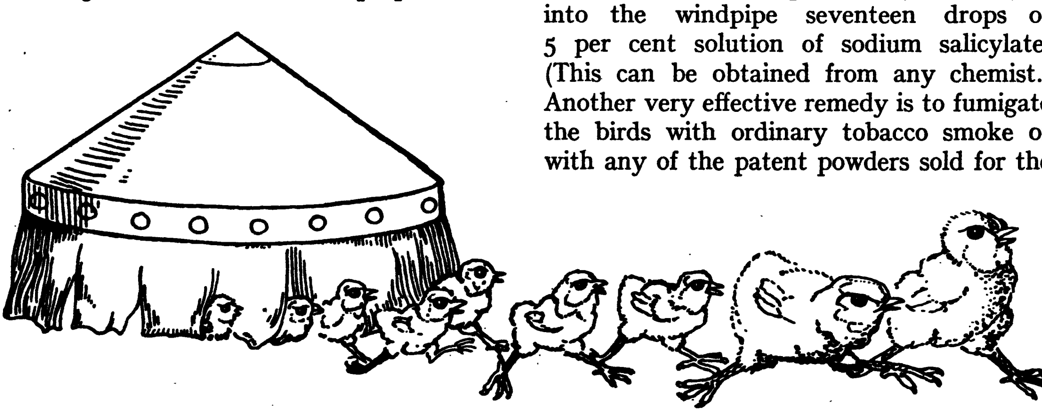
Bacillary White Diarrhoea.—This is one of the most fatal diseases that can attack poultry. The losses may be from 80 per cent to 100 per cent. It is caused by a germ in the intestines and in the blood. The symptoms are an acute white diarrhoea which shows itself in chickens from one to fourteen days old. Chickens over this are not susceptible. The birds die rapidly, and present a hunched-up, huddled appearance uttering plaintive cries. In all cases where there is a heavy death rate of chickens under fourteen days old, it is well to suspect Bacillary White Diarrhoea. There is no cure for this disease, neither is it desirable that birds that have been attacked should recover, because these cured chickens always remain carriers of the disease. The principal source of infection is through the egg. A carrier hen laying even one infected egg placed in an incubator with other eggs will spread the disease to all chicks in that incubator. Infection may also be incurred if eggs are placed in infected incubators, or chicks in infected brooders, and adult carriers may infect adult free hens. The principal preventive of this trouble is the elimination of all carrier fowls from the flock; the thorough disinfecting of all appliances; good food and sanitary methods of rearing. In order to discover the carriers a blood test is essential, and this can be carried out only by qualified veterinary surgeons in a laboratory. Any person, however, can take the sample for the test. This test will have to be taken twice every year for three years before an infected flock is certified free, and it is no guarantee that the disease will not re-occur if eggs or chickens are introduced into the flock from outside sources.

Coccidiosis.—This is also a troublesome disease of chicken rearing. It is caused by a germ found mostly in the ground, and it attacks chickens from about three weeks to about ten weeks old. The symptoms are an acute brownish blood-stained diarrhoea and the mortality is very high. As with Bacillary White Diarrhoea, adult birds may be carriers of this trouble and spread it all over the ground, but it is not transmitted through the egg, therefore baby chicks, unless they have been placed in houses that have not been disinfected, are not liable to attack. As this infection is spread principally through the droppings of adults, the ground becomes a source of infection; therefore, the only real preventive of this trouble is rearing the chickens entirely indoors until they are past the susceptible age, which is ten to eleven weeks old. To do this successfully, however, special attention must be paid to the feeding, the housing and the cleanliness of birds.

Gapes.—This is perhaps the most common disease of chickens and the name of it fairly well describes its symptoms. The chickens are continually coughing. They stretch out their necks and gape, as if they were choking. The feathers are ruffled, the wings droop, and they lose condition rapidly and finally die, either from suffocation or exhaustion. Chicks from two to eight or ten weeks old are most liable to attack. Strong, vigorous, well-fed birds readily yield to treatment but weakly ones die off rapidly. Gapes is caused by the presence of a small forked worm in the windpipe of the chicken. These worms obtain their nourishment by attaching themselves to the lining of the windpipe and sucking the blood. They cause severe irritation and obstruction of the air passages. As many as twenty worms may be found in the windpipe of a chicken. When chickens have been suffering from this disease the ground becomes contaminated, as the worms coughed up by the ailing chicks distribute their eggs over the ground. When these eggs obtain heat and moisture, they hatch and are largely eaten by the healthy birds. These eggs and worms will live for a long time in the ground, especially if it is damp. The eggs will develop in damp grass, round water troughs, under trees and even in the digestive organs of the chicks themselves. Damp clay soils and warm wet weather are favourable to the spread of gapes, because, as already stated, the ground over which chicks suffering from this disease are running, becomes contaminated and the eggs remain in it from one season to another. The ordinary earth worm acts as a host for the gape worm during the winter months, and the disease is very often spread through chicks eating the ordinary earth worm from contaminated ground.

The principal source of infection is the ground, therefore the best preventive for gapes is undoubtedly fresh ground for rearing each year, and when this can be obtained there will be very little trouble. Intensive rearing until the chicks are ten to twelve weeks old is also a good preventive, but can be attempted only when first class housing accommodation is available. If intensive rearing is not practicable and the ground is badly tainted, it may to a certain extent be disinfected by giving it a good dressing of fresh lime in the proportion of three tons to one acre, or watering it with a solution of sulphate of copper in proportion 1 lb. sulphate of copper to 3 galls. water. Ground treated this way in the autumn will be in fair condition for rearing the following spring. As gapes are most troublesome towards the end of March, April and May, the earlier the chickens are hatched the better, so that they will be as old as possible before the disease becomes troublesome. Moreover, if it is impossible to rear chickens altogether intensively, they should not be let out during the early morning or in the evening when the dew is on the ground and worms and insects of all kinds on the surface. As chickens can be infected only through the mouth, the birds should always be fed on troughs and never on the ground, and their drinking vessels re-filled, cleaned daily and placed on a fresh spot each day. Adult stock do not suffer from gapes, but they are carriers and distribute the worms and eggs through the droppings over the ground. Briefly, the best preventives of gapes are artificial hatching and rearing; intensive rearing as far as possible; fresh ground; cleanliness with regard to housing, food and all drinking troughs and vessels. Dressing ground previously used, with lime or copper sulphate helps to rid it of infection.

The great thing to remember with any of the cures for gapes is to take the disease in time. The chickens will be heard coughing at night long before they cough in the daytime. A very simple remedy is to inject into the windpipe seventeen drops of 5 per cent solution of sodium salicylate. (This can be obtained from any chemist.) Another very effective remedy is to fumigate the birds with ordinary tobacco smoke or with any of the patent powders sold for the

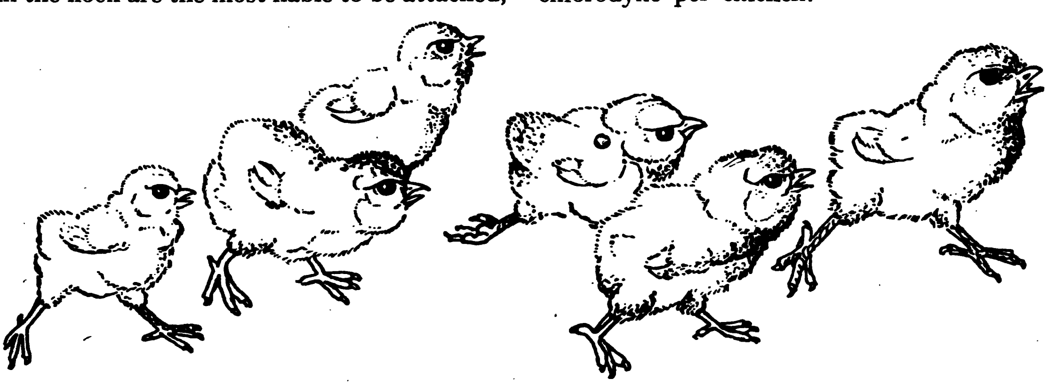


purpose. The method is as follows:—place the ailing chicks in a box covered with a piece of glass, and blow the smoke or powder in amongst them, compelling the birds to inhale the fumes. This makes them cough and sneeze and the worms are coughed up. The glass enables the operator to keep the birds under observation, and if they are noticed to faint, the top can be removed and the chicks exposed to the air when they will rapidly recover. A third excellent remedy is to bore holes in the bottom of the box, pour a few drops of carbolic acid on a hot shovel and hold it underneath the box. The fumes will soon fill the compartment and set the chicks coughing. This method is very cheap and quite satisfactory, although a second fumigation may be necessary a few days later to effect a permanent cure. In order to get rid of gapes completely, it is necessary to isolate all the affected birds, to burn all dead bodies and to observe perfect cleanliness in everything connected with the chicks.

Leg weakness.—This is one of the most common troubles with artificially reared chicks, and the reason of this is that the birds are usually early hatched, and on account of severe weather, have to be kept indoors for several weeks. When chicks get out of doors daily, leg weakness is unknown.

The birds stagger about. There is a great unsteadiness in walking. They sit about when eating and although the best birds in the flock are the most liable to be attacked, they rapidly lose condition and die. The causes of leg weakness are want of direct light, want of air (through overcrowding, overheating, etc.), want of green food, want of mineral food to build up bone and want of exercise. A chick that has a run out of doors every day does not want any of these things. When chicks, on account of weather, disease or infested ground have to be kept indoors, all these points must be remembered. Direct light on the floor is essential and so is plenty of space and fresh air. Plenty of green food, milk and oatmeal must be included in the diet. Deep scratching litter and the addition of a little cod liver oil in the proportion of 1 pint to every 4 stones of mash are excellent preventives of leg weakness. Make sure that the cod liver oil obtained contains Vitamins A, B and D, the guarantee of purity.

Chill.—Chill in the intestines, which shows itself in the form of diarrhoea, or chill in the lungs, very often causes severe losses with artificially reared chickens. Chill is most likely to occur during the first ten days of rearing when artificial means are used. A chill can cause severe diarrhoea in chickens, but this can also be caused by stale, sour, or musty foods, through want of green food or by an irregular supply of green food. The best treatment for ordinary diarrhoea is to remove the cause and feed the chickens for a day or two on a little rice boiled dry in milk. If this is not effective, dissolve in water and mix with their mash, 1 drop of chlorodyne per chicken.



INDEX

(*Italicised numbers indicate illustrations with or without text.*)

PETS, CARE OF

TIME-TABLES, SCHOOL

PRINTED IN GREAT BRITAIN BY PURNELL AND SONS, LTD.
PAULTON (SOMERSET) AND LONDON

LAY

MACMILLAN'S TEACHING IN PRACTICE FOR SENIORS