# ECONOMICS OF ENGINEERING

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# ECONOMICS OF ENGINEERING

BY


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## PREFACE TO THE SECOND EDITION

Conscious as we are of the imperfections of this book we cannot shut our eyes to the fact that there is as yet no other on the subject at all suitable for Indian students. The reasons given above are still as valid as they were when the book was first published, nine years ago.

A small but steady demand with a tendency to increase, and the interest in the subject exhibited by our own students has encouraged us to prepare this considerably enlarged edition. It is no longer necessary to apologise for our omissions to the student specialising in Civil Engineering. He should find most of what he requires in the following pages. The same applies to the Railway Engineer.

Three generations laughed at that writer, who produced a book on Chinese Metaphysics by combining the article on China with that on Metaphysics in the Encyclopædia Britannica.

It was left to a 20th century thinker to point out that his method was quite sound. As the title implies, this book is Economics plus Engineering, with occasional bits from other articles to fill gaps. No originality is claimed for the constituent parts. A text-book is no place for originality. Any reader who discovers any thing original and points it out to us may rest assured that it will be cut out of the third edition.

But this is the preface, not the book. It will be not improper to include here an article of propaganda that would be out of place elsewhere.

We feel very strongly that there will never be a really healthy Indian Industry as long as Engineering students look only to service for the reward of their labours, as practically all of them now do. We need a substantial proportion of adventurers of the type that regards even Rs. 2,000/- a month and a pension as utterly contemptible if combined with the necessity of taking orders from any one else. Such students might do a great deal worse than take up the study of the business aspect of Engineering, as an alternative to politics, especially as they would be a confounded nuisance in service. It will provide quite enough danger to make life interesting, and the prizes though few are often substantial. They should not waste any time in inviting us to take up shares in their ventures, but they can rely on our benevolent interest. We are here pointing out a few of the rocks many of them will certainly be wrecked upon. It is not impossible to avoid most of them if one knows where they are.

Readers of this edition should not attempt to read the whole of it. Much data is now included rather for reference than for committing to memory, even approximately. If our readers were all University students and this a text-book aimed solely at their examinations, it would have contained only what one could reasonably expect to be remembered. Such a book makes easier reading, but, on the other hand, is not of much use, once the examination has been passed. Its owner may sell it second hand to a first year student, as soon as he has graduated, and not worry about the fact that he is making a mess of our market. He would be unwise to do that with this edition. He is sure to want to it again.

Finally, we acknowledge with thanks the kind permission of the Bombay Electric Tramway and Supply Company to use their notes on "Store-keeping" and "Costing."

We take this opportunity to thank Mr. H. P. Vidyant, M.A., C.E., Retired Superintending Engineer, and Pandit Lachman Das, Executive Engineer, Benares Hindu University, for Irrigation and Building Estimates, respectively.

In a work of this kind we have necessarily drawn freely from all sources of information, and we believe that due acknowledgment to them has been made. However, in some instances, search of the original has proved fruitless, and apologies are made to all authors and publishers who may find their work used without any definite reference, such omissions being unintentional.

THE AUTHORS.

*Janmastami, 31st August.*

## PREFACE TO THE FIRST EDITION

This book is founded on the lectures in Engineering Economics, delivered yearly to the Graduate Class in Engineering of the Benares Hindu University. Its title is justified by the fact that it is chiefly concerned with the Economics of Mechanical and Electrical Engineering, but it includes a great deal that does not fairly come under that heading. There is, for example, a chapter on Law, which, it is hoped, may be of material assistance to those who contemplate launching a new enterprise, especially in the initial phase. It is an attempt to make the instruction given to Engineering students more practical in the business sense than has hitherto been customary in Engineering colleges. A good deal of it will, no doubt, appear rather elementary and obvious to the practised business man, unaware as he is of the way in which his preoccupation with technical problems, causes the young Engineer to grow up very unfit to manage his own money matters, and, of course, still more unfit to manage those of his employer. This deficiency of the Engineering student, as usually educated, is beginning to be recognised in England. Several institutions having within the last year or two added Engineering Economics to their lists of examinations. The present work, however, does not follow any of these syllabuses very closely. The most conspicuous variation is that the authors of this book have principally concerned themselves with Indian conditions and have given less attention to world trading.

For many years, perhaps generations to come, the conditions which the young Engineer in India must face will continue to differ materially from those which confront his English confrere. The principal difference is that specialisation can safely be developed much more in England or America than is expedient here. An English student may safely devote all his youth to becoming expert in any one of a number of small branches with a reasonable prospect of securing employment in some great firm which can afford the services of many such. Such a man would be almost useless in any of those mafussalite stations in which most Indian students must expect their future. There would be little scope for his advanced special knowledge, and the ignorance of other matters which must necessarily follow from his intense concentration on a particular aspect of Engineering would be a fatal handicap. The young Indian who professes a knowledge of Mechanical Engineering must also be able to cope with all, but abnormal difficulties in Electrical Engineering, and he who professes Electrical Engineering would be quite useless to his employer if he were afraid of his engine and boiler. Moreover, both should be able to undertake many jobs that in the West would be entrusted to a Civil Engineer or to an Architect. Finally every young Engineer in this country should be as good a business man as it is possible to become without a prolonged experience of the world at large.

It is this last requirement that we have endeavoured to satisfy in this volume. In the first part certain fundamental economic principles are explained. In the second a good deal of space is devoted to ordinary business procedure which, many people will think, would be more fittingly taught in a secondary school. That is also our own opinion, but we cannot afford to leave our students ignorant in the matter until it is In the third part the Economics of Mechanical and Electrical Engineering is specially dealt with. No endeavour has been made to cater for the Civil Engineer.

At the end of most of the chapters, sundry extracts from the periodical press or from other books, will be found. The authors have read many books, but they do not think it fair to suggest that other writers are responsible for the opinion they express on certain matters open to debate Their own and others' opinions are offered as suggestive rather than conclusive. Their aim throughout is to direct the student's mind along certain fertile lines of thought He belongs presumably to the rising generation that must presently inherit all the world and its difficulties. Our aim is to make him aware of both the unsolved and the solved problems, and so launch him in the profession as a thinking member.

THE AUTHORS.

## CONTENTS


| Chapter | | Page |
|---|---|---|
| I | Money ... ... ... | 1 |
| II | Money in the Great World ... .. | 23 |
| III | Capital ... ... ... | 28 |
| IV | International Money ... ... | 39 |
| V | Trading Abroad, and Transport ... | 45 |
| VI | Banks and Insurance Companies ... | 52 |
| VII | The Ledger ... ... ... | 60 |
| VIII | Auxiliary Books ... ... | 86 |
| IX | Origin of Industrial System ... | 100 |
| X | Business ... ... .. | 106 |
| XI | Organization ... .. ... | 113 |
| XII | Management ... ... ... | 120 |
| XIII | Location of an Industry ... ... | 143 |
| XIV | Choice of a Factory Site, and Buildings ... | 147 |
| XV | Reference and Report, Land Acquisition | 165 |
| XVI | Choice of Source of Power ... .. | 170 |
| XVII | General Organization of a Central Power Station ... .. ... | 193 |
| XVIII | Depreciation and Valuation... ... | 220 |
| XIX | Jobbing and Mass Production ... | 267 |
| XX | Inquiries : Progress Cards ... ... | 273 |
| XXI | Workmen's Time Cards : Gate Control ... | 287 |
| XXII | Depreciation : The Theory of Overtime : Machine Cards ... ... ... | 282 |
| XXIII | Stores, Tool Room, Raw Materials ... | 289 |
| XXIV | Store-keeping ... ... ... | 295 |

CONTENTS

| Chapter | | Page |
|---|---|---|
| XXV | Overhead Charges, Cost Summary, Selling Price ... ... ... | 318 |
| XXVI | Costing ... ... ... | 325 |
| XXVII | Estimating ... ... | 345 |
| XXVIII | Trade Cycle, and Economics of Mass Production ... ... ... | 474 |
| XXIX | Organisation for Mass Production ... | 479 |
| XXX | Contract and Specification ... ... | 487 |
| XXXI | Laws Affecting the Engineer ... | 522 |
| XXXII | Labour and the Industrial Revolution ... | 573 |
| XXXIII | Labour, Skill and Capital ... ... | 584 |
| | Appendix to Chapter VII ... ... | 590 |
| | Index ... ... | 603-618 |

# ECONOMICS OF ENGINEERING

## CHAPTER I

## MONEY

DEFINITION is a kind of scratching, and, generally, leaves a sore place, more sore than it was before.—Samuel Butler's Note-Book.

Let us suppose that about a dozen men are marooned on an island. One of these, Hira Lal, is a farmer, and, in his new home, continues to exercise that trade. A second is Munna Lal, a *mistri*, and a third, Janaki Ram, is a fisherman,—in the first instance. We shall see presently, however, that Janaki Ram is a man of ideas, destined for greater things. The remainder are mere labourers, and will be described collectively as "the coolies"

Now, Janaki Ram has discovered that once or twice, a month after a storm, but at no other time, his nets contain a small number of rather beautiful shells; and has treasured them till he has a collection of three thousand. Having done this, owing to some change in the oceanic currents, no more shells appear, and the number remains three thousand. All the men in the island admire these shells very much, and are willing to exchange what they can for them. Hira Lal gives cocoanuts, sugar-cane, *dahl* and the like for them. Munna Lal builds quite a decent little house for Janaki Ram in return for three hundred shells, and, after a time, finding that a necklace of three hundred shells, with no one to admire it, is rather a nuisance than otherwise, hires the coolies to help him for a wage of one shell per day. The coolies would like to have necklaces for themselves, but, not being very skilful, they are generally compelled to exchange their shells for fish with Janaki Ram, or *dahl bhat* with Hira Lal.

After a time, all the men on the island have more or fewer of these shells (the astute Janaki Ram more than any one else). They are **money**—that particular form of money which is called "**commodity money,**" because they are not only of use as a medium of exchange, but have a certain value in themselves, as ornaments only in this case. Under other circumstances, other useful or ornamental articles may similarly come to be used as media of exchange. In South Africa, among the natives, **cows are money,** and it would appear that that was also the case in Vedic India, since in the Vedas the same words are used to signify both cattle and wealth. In primitive America, a delicate kind of **leather,** called wampum, was the commodity money. In some parts of India, at the present day, **shells** are still in use together with gold and silver, which are the commodity money of most modern nations.

**The qualities of good money are :—**

(1) It must be generally recognised as a standard of value.

(2) It must be confidently accepted as a medium of exchange.

(3) It must be readily divisible into small parts, so that small things, as well as big things, may be exchanged by means of it.

Gold came to be adopted by nearly all civilised countries as a **standard money**. It is not only rare, but stable in value. It is almost indestructible, and loses none of its value by being divided into small coins. It is everywhere desirable and confidently accepted. Finally, as a small piece of it is of high value, a considerable amount of money in gold can be easily carried on the person.

When we change goods for money, we are said to **sell.** When we change money for goods, we are said to **buy.** This buying and selling by means of money enables us to speak of things as **being worth so much money.** So money conveniently measures **value** (we refer not to *value in use, but to value in exchange*) by a **common standard**. This measurement of value by money we call **price**. The price of an article is its value expressed in money.

It is just because money so conveniently measures the value of things that it is so excellent a medium of exchange. When we know that our money will buy more of this, or less of that, we are greatly assisted by **prices** in forming a judgment as to what to buy and what to sell.

## Prices

It is, or ought to be, evident that the price in shells of any thing or any service on the island depends on three things:—

(*a*) On the fact that the islanders have only three thousand shells among them, or, as a *pucca* economist would say, on the quantity of " money in circulation "

(*b*) On "the effective demand," or, in plain language, on how much those men, who have shells to pay for it, want (not need) it.

The third thing on which prices depend is—

(*c*) "The supply," which is to say on how much of it the others can spare.

These three are the only factors of price. The prices of things do not depend on—

(*a*) *Their utility*. If they did, a loaf of bread would be more highly priced than a diamond, and water would be more expensive than wine.

(*b*) *The amount of labour required to produce them.* If they did, the work turned out by the First Year Students in the carpenter-shop would be more valuable than that turned out by the Head Mistri, whereas it is of no more value than firewood after they have laboured on it for a week. Yet any one that cares to watch them can see that they work twice as hard as he does. It must not be too hastily assumed that his work is more valuable than theirs only because he is more skilful

• *The amount of skill* expended has as little to do with prices as the amount of labour has If both *mistri* and students made snow-shoes, their work would be equally valueless. There is no effective demand for snow-shoes in Benares.

## Token Money

We have now to consider move number two of the resourceful Janaki Ram. Like most of us, he is very averse from digging up his shells, and rather more fertile in expedients for avoiding it. His scheme, in this case, is one that was first invented by the Emperor Khubla Khan about one thousand years ago.

On being asked to pay a debt, he replies to his creditor somewhat on these lines :—

"*Achha Bhai!* But do you think you are wise to have so many shells lying about in your house? Those coolies—?

"Are you sure, they won't cut your only throat one of these dark nights? Don't you think you had better leave your shells with me and take this nice little chit instead." The "nice little chit" is like this :—

"I promise to pay the bearer ten shells on demand at my godown near the lagoon."

(SIGNED.) JANAKI RAM.

If the reader has a ten-rupee currency note, he should now take it out and look at it.

Now, absurd as it may seem at first sight, this game works not only on the island, but has repeatedly worked under other circumstances all over the world. In a very short time, Janaki Ram has three thousand chits circulating on the island, and has also lent the original three thousand shells at a substantial interest to the very people to whom the shells really belong. He has invented the **art of banking.** He is by far the richest man on the island, greatly respected, and regarded as a public benefactor, because he has doubled the price of everyone's produce, and doubled everyone's wages. All is joy till—.

## Inconvertible Currency

Janaki Ram overdoes it. He sees no reason why he should stop at three thousand chits. When he has lent his three thousand shells, he writes out as many more chits as he can find borrowers for : More **inflation** of the currency: An apparent profit for everyone who has anything to sell: Big rises of salary and wages for everyone. More glory for Janaki Ram!

But this is a risky game. We should say, in the case of a modern nation, that "It is off the gold basis." The promises on the chits could not be made good if all holders demanded payment in shells on the same day, which they would most certainly do if they inkled Janaki Ram's strategy. The turpitude of that Napoleon of commerce would become known to every one Not only would he be in a very awkward position, but the holders of the surplus chits (and also of the unsurplus ones on the principle of **marginal values**) would find that what they supposed to be real money was merely waste paper, and rather filthy waste paper at that. It is not only Janaki Ram, therefore, but also everyone that has his chits, that is concerned to avoid the disclosure. Accordingly, as soon as Hira Lal and Munna Lal discover the imposture, they declare the chits:—

## Legal Tender

There are very few chits (Bank notes, Currency notes) in the world now that have not long since been declared legal tender. Those who have resorted to this move have done so for substantially the reasons indicated in the above paragraph, but it is frequently represented as intended to "economise gold" The meaning of the phrase "**legal tender**" is that a debt incurred is legally discharged if payment is made in chits (in legal tender). Before the chits were made legal tender, a creditor might demand payment in shells, but now he must take chits or shells, whichever is offered him. But whether the chit is legal tender or not, it is token money having no intrinsic value as commodity money has; or, if, as is sometimes the case, it is made of an alloy of one of the precious metals, having a value in shells much less than it pretends to have.

## Cheques

The intelligent reader will have discovered ere this that Janaki Ram's argument about the danger of theft was rather thin.

It is as easy to steal chits as it is to steal shells. A cheque is a chit (not issued by Janaki Ram, the banker, but by one of the others who has deposited his shells in the bank) in this form :—

" Pay to Munna Lal or Order three hundred shells"
S 300-0-0 (SIGNED.) HIRA LAL."

If Hira Lal has three hundred shells or more with Janaki Ram, the banker, and if Janaki Ram has not embezzled them, this is as good as money to Munna Lal, as soon as he signs his name on the back of it (**endorses it**). Until then Janaki will not give the shells, and, therefore, it is of no use to any one that steals it As it stands, it is an " open cheque " ; any one can cash it once Munna Lal has endorsed it. If " or Bearer " had been substituted for "on order," it might have been cashed even without endorsement.

## Crossed Cheques

If Hira Lal, before parting with the cheque, had ruled two lines diagonally across it, writing " & Co." between them, Janaki Ram would not have given cash for the cheque under any circumstances. He would only have recorded in his books that he now owed Hira Lal three hundred shells fewer and Munna Lal three hundred shells more. A crossed cheque is thus a very safe form in which to transmit money. It never leaves the bank in a spendable form at all, and, therefore, cannot be stolen except by thieves who are very expert indeed, and the really educated thief generally finds it more profitable and safer to operate within the law.

There are other forms of cheques, notably one called in this country a "**hundi,**" and in others a "**bill.**" The bill is described in the chapter on international money. At this stage, it is sufficient to note that yet another **inflation** has taken place with its consequent results. The cheque, being the safest form of money, is gradually replacing all other forms wherever large sums have to be transmitted through intermediaries, all over the world. As it can never be to everyone's advantage to declare it legal tender, it never is so declared.

## Credit

One would think that getting the islanders to accept worthless paper as the equivalent of shells had exhausted Janaki Ram's invention, but one would be mistaken. Most of the money in the world has no material existence at all. We are about to bid a long farewell to the island of Janaki Ram; but before we do so, we may watch that eminent financier establishing credit by the most usual method.

Coming home from a night's fishing very early, one morning he is surprised to see a number of large tortoises burying their eggs in the only patch of sandy beach on the island. Now the particular part of the shore is the property of Munna Lal. It was assigned to him at the beginning, because of a scheme he had for building and launching a boat there, but the scheme has never been carried out. The beach is supposed to be practically worthless. The greedy Janaki Ram might have it for a mere trifle in ready money, were it not that he is burning to put into operation his third great idea which is :—

"If they accept paper on my promise, why should they not accept the promise without the paper?" There is another reason why he hesitates to issue any more chits. The others, when they discovered that he had issued six thousand chits on the strength of only three thousand shells, warned him very strictly that if he issued any more he would be boiled alive. (There are similar laws limiting the ratio of token money to commodity money, wherever both are in circulation together). Accordingly, Janaki Ram approaches Munna Lal in these terms :—

"It is very inconvenient hauling up my boat everyday. I would like to buy your beach, but I have no money by me at the moment. However, I have lent Hira Lal five hundred shells till the cocoanuts are ripe, which will be in three months from now.

"Sell me your beach, and I will transfer five hundred shells to your account in my bank."

Munna Lal, poor, innocent, suspecting nothing of the eggs, promptly agrees. And J. R. goes home, and makes a note in the fishy old note-book, which he is pleased to describe as "my bank," that he owes Munna Lal five hundred shells. That's all It doesn't trouble him in the least that Munna Lal begins the very next day to draw substantial cheques on his new account As fast as the cheques come in, he merely makes another note that he owes Munna Lal so much less, and some one else so much more. He has successfully established **credit,** the fourth, and most ghostly, form of money. That uneasy and uncontrollable phantom will haunt these pages to the end, so we need not say much more about it here. The problem of controlling credit is still baffling the statesmen of the world. In times of general confidence, it expands to an incalculable degree. There seems to be no way of measuring exactly how many shells it is equivalent to Let one or two serious failures take place, and it vanishes as if it had never been.

It is, for this reason, that, in times of general confidence, prices are unreasonably high, and, in times of depression, unreasonably low. The high prices are the results of the ghostly inflation, and the low ones of its disappearance.

Before we close this chapter, we must offer a word or two of apology to Janaki Ram and the business-men of whom he is the type. We have represented him as deliberately planning his various money-making devices. In actual life, he inherits them from his forefathers without clearly understanding their character. Only learned persons like the authors of this book are all-knowing and of inflexible integrity. The rest of mankind is amusing itself with a variety of trumpery games. They have a kind of elementary morality, which they describe in their childish prattle as :—

## Playing the Game

According to them, a gentleman is one who observes the rules of his own game. The young ones hold that it would be ridiculous in a game of football to refrain from kicking a goal unless the goalkeeper had been given a week's notice in writing. The older ones say that the rules of their game don't require them to warn the holder of a beach they are trying to buy for an inadequate sum of money they haven't got, that it is charged with a valuable food staff.

Many young students, on first realising the nature of business affairs, are horrified, and rush to the conclusion that business is not a game a gentleman can play at. It is a too hasty conclusion. A gentleman is one who "plays the game," whatever it is. The reader may elect to play the game of business or not, as he chooses, or any other game (Not ours, of course. He is probably not worthy to do that).

It will be his duty, as a player of the game, to observe its rules, and, if he can secure general agreement, to improve them. But he need not trouble himself about other peoples' games. He will never know enough about them to interfere usefully.

## Appendices to Chapter I

(A) The student, who, after digesting his text-book on a particular subject, wishes to extend his knowledge of that subject, should not proceed to invest in a number of additional text-books on the same subject. He will find, if he does, that each new book merely says, in other words, what the first did. At the best, it will be found to contain one or two good chapters which were the real reasons that it was written.

If any new books are bought, they should be monographs on particular branches of the subject. In the present case, after (not before) having learned all that this book has to teach him, he should proceed to books on—

(*a*) Book-keeping,
(*b*) Banking,
(*c*) International Trade,

Or on any of the subjects indicated by the chapter headings Or, if he desires rather to broaden than intensify his education, he may read books in which "Economics of Engineering" is a chapter heading, and thence go on to those in which "Economics" is a chapter heading.

There is, however, no hope that he will become an expert in any subject merely by reading books. It is obvious that no monopoly of knowledge is to be obtained in that way. He must observe the thing itself, which he may do either directly or through the medium of the periodical press. In this way he will gradually inherit the real fruit of education, which matures long after he has ceased to be a student in the ordinary sense of the word. This inheritance is the opinion of the man who has been instructed to observe data for himself and to form his own conclusions, instead of taking them ready-made. It is always from a view point not accessible to any one else, the view point of his own character; always contains a new element of truth, and is always valuable.

(B) The Ordinary General Meeting of the Shareholders of the Midland Bank, Limited, was held at the Cannon Street Hotel, London, E. C. 4, on Tuesday, the 27th day of January, 1925.

The chairman, (The right Hon. R. Mc. Kenna), who presided, said: "During the year that has just elapsed, Europe has made a remarkable approach to stable conditions of money. After almost unparalleled inflationary excesses, a painful struggle is being made towards balanced budgets, national solvency, and a sound monetary basis. In England, inflation was never carried to a point at which alarm could be felt for the permanent stability of our currency, but we have not been without our own anxieties. A reinstatement of the gold standard will be an event of first-rate importance, and, with your permission, I should like to say something on the subject of currency values which covers all such topics as the relation between currency and credit, price level, trade, and employment. Although the older economists throw but little light on the subject in its recent developments, some of the foremost of our modern teachers, both here and in America, are giving considerable attention to it. They point out that a close connection exists between currency value and the volume of credit, and they discuss the possibility of a more effective use of credit control as a means of modifying fluctuations in the price level, preventing trade crises, and mitigating the extremes of unemployment. But we are still in the stage of enquiry rather than of positive opinion, and there is no formulated body of doctrine generally regarded as orthodox.

The problems of credit are, in a sense, inherent in the banking system, but their full gravity has only become apparent since the War. Before 1914, there existed a condition which concealed the underlying importance of credit control. The growth of joint stock banking occurred when gold was the basis of all the principal currencies, and the movement of gold regulated almost automatically the issue of currency and the supply of credit

To day, we live under a new dispensation. In countries that have been forced off the gold standard, we have seen the latent possibilities of credit inflation and currency depreciation, which had never, in modern experience, appeared in their extreme manifestations.

## Changes in Purchasing Power

During the ten years that the currency notes have been in existence, our currency has varied widely in value or relation to its nominal gold equivalent, or, in other words, in relation to the dollar. The pound sterling is now finding its way back to parity, and will probably soon stand at its full gold value, not because it will have climbed uphill to meet the dollar, but because the dollar, under the pressure of the surplus supply of gold, will have come down to the level of the pound On the basis of the official index numbers, the price level in England has been more stable during the last three years than in the United States. Measured by the standard of purchasing power, the pound, which is not on the gold standard and has no regular restriction on its issue, has maintained stability better than the dollar, which is based on gold. How can this happen ?

To answer this question, we must turn our attention to a larger subject than currency. We have to consider money, of which currency forms only a part, and we must begin with a definition of the term.

## Creation and Cancellation of Credit

I understand by it all currency in circulation together with bank deposits drawable by cheque, which, in the aggregate, represent the purchasing power of the public. By far the larger part of our total money consists of bank deposits. The quantity of money is constantly varying, increasing or diminishing from time to time in consequence of the action of the banks. The price level is dependent upon the quantity of money, the rate at which it is expended, and the amount of goods and services available for purchase. The quantity of money is thus one of the three prime factors determining the price level, and it follows that whatever controls the quantity of money is, to that extent, determining its value.

I am afraid the ordinary citizen will not like to be told that the banks or the Bank of England can create or destroy money. We are in the habit of thinking of money as wealth, as indeed it is in the hands of the individual who owns it, wealth in the most liquid form, and we do not like to hear that some private institution can create it at pleasure. It conjures up a picture of an autocratic and irresponsible body, which, by some black art of its own contriving, can increase or diminish wealth, and presumably make a great deal of profit in the process. But I need hardly say nothing of the sort happens. All that is done by the banks, when they create money, is to increase the amount of debts due to, and from, themselves.

Now, although a bank loan increases the aggregate of bank deposits, it does not increase the aggregate of bank cash, and it follows that, so long as each bank adheres to its conventional cash ratio, the power of the banks to create money is limited by their power to obtain additional cash.

## Central Bank Control

The action of the Bank of England in lending or calling in, buying or selling, regulates the cash held by the other banks, and inasmuch as this cash is the basis of their loans to the public, it follows that the Bank of England ultimately controls the amount of deposits, that is to say, the amount of money.

The capacity to increase or diminish the quantity of money and thereby to depreciate or enhance its value, is inherent in the ordinary power of a central bank. If the currency is on the gold standard, this power can only be exercised within narrow limits, as the movement of gold will very soon act as a check ; but where this standard is not in operation, the full responsibility for maintaining the value of money falls upon the central bank. The obvious guides to the central bank in directing its policy are the movements of the price level and the general state of trade and employment Constant vigilance is needed on the part of the central bank to ensure that the causes of rising or falling prices are correctly diagonised. Nor does the need for vigilance end here. Many central banks do commercial business for their own customers. They not only meet the needs of the money market in the temporary fluctuations of supply and demand, but they make domestic and foreign loans on their own account quite independently of the market conditions at the moment. Such loans may cause excessive ease of money; their repayment excessive stringency; and unless care is taken to counteract these effects, when necessary, by a sale or purchase of securities, trade will be unduly stimulated or unduly depressed.

## Gold as Regulator of Credit

The larger movements in the sterling-dollar exchange have followed the course of the policy of the Federal Reserve Board. That policy has determined rates for money in the United States. When rates of interest were high, floating balances were held in New York, and dollars bought in order to lend in that centre. When rates were low, dollars were sold and floating balances in sterling retained in order to lend in London. Thus money rates may exercise a powerful, though temporary, influence on the exchange through the transfer of balances. Ultimately, the rate of exchange must approximate to the relation between the price levels in the two countries; but although this is the dominant factor, there are other influences to which the exchange is sensitive and which operate upon it before the movements in price level can exercise their full effect. The recent rise of sterling in relation to the dollar has gone considerably ahead of changes in price level; but if the rise is maintained, we may be sure the price levels will finally conform to the new relation of value between the currencies.

## Superiority of Gold Standard

I have endeavoured to explain the meaning of a managed currency and the method of maintaining its value by regulating the quantity of money through the control of credit, and I have shown that, during the last three years, a managed currency has been kept more stable than one based on gold. We can supplement this favourable view by the further observation that considerable economy is effected by its use, as there is no need to incur the cost involved in buying and holding gold as a reserve, But when so much has been said, and it must be granted that it is a great deal, the case for a managed currency must be regarded as closed. On the other hand, the gold standard has, in existing circumstances, great and striking advantages In the first place, it establishes an international measure of value, common to the whole world and universally accepted. It is automatic in its operation, and it relieves the central banks of a responsibility, which, notwithstanding our own fortunate experience, might not always be discharged with the knowledge and judgment indispensable for the prosperity of national trade. It is not, however, wholly inelastic. There is still scope under it for an exercise of discretion by the central institution, as we have seen in the recent action of the Federal Reserve Board

But, in the present state of knowledge and feeling, one of the greatest advantages of the gold standard is its moral effect. A nation will think better of itself, will almost regard itself as more honest, if its currency is convertible into gold. The fear of being forced off the gold standard acts as a salutary check on the extravagance of Governments who might be willing to face a mere fluctuation in exchange, but would not dare to suspend specie payment. It is a real advantage to a nation to have a currency founded upon a value which is universally recognised; it inspires confidence and facilitates international transactious. Even if the gold standard were not preferable for other reasons, its universality would be decisive in its favour. The argument may, it is true, be founded on psychological and not on economic ground; but it is none the less powerful, as we have not yet reached the stage where economic considerations alone guide us in judging the desirability of any particular method or system. So long as nine people out of ten in every country think the gold standard the best, it is the best. If, in the future, there were an immense increase or decrease in the output of gold and consequently a startling rise or fall in prices, reconsideration of the subject might be forced upon public attention, but, at present, there is no single nation, so far as I know, which is now off the gold standard that does not regard the return to it as the most desirable of all financial measures."

**Note to Second Edition:** The experiment failed, and after a period of unprecedented depression, England returned to a controlled currency unconnected with gold, in September, 1931. Please read the paragraph " Exchange between Gold Standard Countries" in Chapter IV. There was a very large war debt that required payment to the United States of America. The debt was incurred during the War for goods supplied to the armies, but America imposed prohibitive tariffs on all manufactured goods and demanded payment in gold. The traditional use of gold, as explained in Chapter IV, is to correct a slight inequality in the normal balance of trade. The stock of only one hundred and fifty millions proved totally insufficient to meet the debt charge. England was both able and willing to repay the goods she borrowed in War time, but America would accept nothing but gold; very naturally, as an annual influx of sixty million pounds worth of manufactured goods free of charge would have been in affect a ruinous competition with her own manufacturers. For six years England made heroic efforts to get the necessary gold by selling her goods even below cost elsewhere, but other countries objected as much as America did, and for the same good reasons. It was a period of insane competition and rising tariffs throughout the civilized world. Gradually the one hundred and fifty million gold reserve ebbed away into the national coffers of the creditor nations, America and France. At the present moment (November, 1933), both debt repayment and the gold standard are suspended, and the problem remains unsolved. The strange and unexpected development is that the United States of America is also in a serious mess, but for a totally different reason, which is analyzed in the Chapter on "Labour and the Industrial Revolution." The fortunes of the Colonies have closely followed those of England; India, because she is virtually under the same Government; and the Dominions, under the compulsion of economic law. That is to say, though India went off the gold standard by order, she, in fact, suffered less than if she had been forced off as Australia, South Africa, and the Mother Country were. Only one country, France, now remains on the gold standard. France has been able to maintain it by two factors—the first being a post-war devalorization of 80 °/o of the franc in terms of gold, and the second, her well-balanced self-sufficiency as an agricultural and manufacturing people. Even so, her difficulties are immense, and it now seems improbable that she will permanently adhere to gold. If she also resorts to a controlled currency, gold throughout the world will become a commodity like any other with the price fluctuating in accordance with the laws explained in Chapter I. At the present moment, the price of gold in pounds sterling or in rupees is nearly 50 °/o greater than it was before September, 1931. As the prices of other and now useful commodities have not risen in the same proportion, many Indians are selling their gold, and investing the proceeds in them. They are well-advised. The value attached to gold by the purchasers is a superstition, very ancient and respectable, but now trembling on the verge of exposure.

## "Gold: tyrant or constitutional monarch?"

"When Great Britain gave its allegiance to gold early in the nineteenth century, most countries quickly followed, except those of the Far East, which, for a time, remained faithful to silver. But later, one by one, Japan, the Dutch East Indies, the Philippines, the Straits Settlements, Siam, Indo-China, India, all except China, turned to the more precious metal. The reign of gold was almost universal. It was a prosperous reign, for never did man's wealth increase so rapidly; and the reign was that of a constitutional monarch exercising authority within the rules and precedents, serving the public, and imposing only such restrictions on liberty as were required to prevent one man's activities injuring those of others. And the monarch was equal to the demands made on him; at the appropriate moment he drew fresh reserves of strength from Ballarat, the Rand, or Klondyke.

"Then followed the iterregnum of the War and the systems of '**managed**' paper currencies, giving more freedom and liberty, bending under the pressure of the economic forces that gold had controlled and governed, for the time offering glittering attractions, but only too soon bringing anarchy and chaos. Man may some day become the master of his currencies, make them serve the purpose his reason dictates, and rely on his own deliberate action without any external compulsion. But in the confusion which followed the War experiments he craved for the order which gold had given. The rebellion was soon quelled. Within a decade of the Armistice the dominion of gold was as wide as ever. China remained in her original allegiance to **silver**—but over the rest of the world, with only a few minor infidelities and those mainly reluctant, gold prevailed.

"But the monarch who came back had changed his character. Those who returned to their old allegiance found that he was becoming a tyrant, his exactions excessive, his conduct capricious. They are falling away again from their allegiance, some indeed involuntarily, but even these are hesitating whether they wish to return.

"The responsibilities are divided between the monarch himself, his ministers, and external circumstances too difficult for them to control. In other words, gold itself is now showing signs of failing, revealing no new resources as in the last century; those who work the gold standard have failed to work it as satisfactorily as in the past; and above all, the economic adjustments which it is the function of gold to effect have become too difficult. Economic forces which formerly yielded to monetary influence have developed a power of stubborn resistance. Half the art of government, let us never forget, consists in the luck of having amenable subjects.

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"What man wants in the currency, with which he has to conduct his trade and conclude his contracts, is quite simple. He wants it to be stable in value, and acceptable by all with whom he has transactions. Now these requirements can conceivably be met in two ways, each of which is subject to dangers of its own. A scarce metal, mined with cost and difficulty, such as gold, may be used. If it is forthcoming in such quantity as roughly corresponds with the increase in the demand for it, it will retain a stable relation in value to commodities; and if there is confidence in its retaining this quality, it will serve the world's purposes True, it costs human effort to produce. But it does not perish, can be used frequently and indefinitely, and can be made the basis of a volume of other money many times its own value, so that its cost is a small—though not negligible—proportion of the transactions it facilitates. More important than the cost is the fact that it is very much of an accident whether new production of gold does correspond with the increasing demand for it."

"When a country adopts the gold standard, it makes its currency worth a stated amount of gold. It assumes the obligation to give gold in return for currency, or currency in return for gold, at any time, on this basis. Where gold itself circulated as currency, as in England, it was constantly flowing into and out of circulation, sovereigns being melted down and bullion minted. The Central Bank had, therefore, to keep a sufficient reserve of gold, so that it would always be able to give it on demand in exchange for its notes; and it is with reference to note issue that currency reserves were fixed.

"Since gold has gone out of circulation as coins nearly everywhere, the **real function of gold reserves now** is not to meet demands for internal use, but to adjust foreign payments, so that, as the Macmillan Committee in England has pointed out, the basis upon which reserves are fixed now needs re-examinations.

"The main operation of the system (if we omit refinements of it such as '**forward dealings**') may be described as follows. Englishmen needing foreign exchange to meet obligations abroad (whether to pay for imports or for investment) would sell pounds in the change market for the currency of foreigners who needed pounds for similar purposes. If the demand on each side was almost the same, nothing more would be needed. But if, as the net result of both current trade and capital transactions, more foreign currency was wanted than pounds, the pound would slightly depreciate, that is, it would take a few more pounds to buy a given number of dollars, etc. The fall would soon reach the point at which it would pay an Englishman, instead of buying foreign exchange, to demand gold from the Bank, and export it. If that went on for some time, the Central Bank would be concerned at the loss of its reserves. Its remedy was to 'put up the Bank rate,' that is the rate at which it was prepared to rediscount bills presented to it."

"In the last analysis, the fall of sterling in 1931 represents the victory of economic forces over monetary action. Instead of themselves yielding, they forced the currency to adjust itself to them."

"The gold standard will only function as an automatic regulator of price levels, of capital distribution, and of the course of trade under certain precarious conditions. Any large increase in the demand for gold may, in the absence of a purely fortuitous discovery of new gold areas, force down the general price level, with disastrous deflationary results. The gold standard cannot adjust the flow of liquid capital, if a higher rate of interest attracts the investor less than fears of losing what he has lent discourage him. It cannot readjust relative national price levels, if economic organisation offers too stubborn a resistance. It cannot correct a **balance of trade** which is leading to disaster if it is deliberately impeded by commercial policy."—"*Recovery*," 7th Edition, 1933, by Sir Arthur Salter, K.C.B.

## The Gold Standard

"If a country is on the gold standard, the value of its currency is fixed in terms of other currencies, and the price level of imports is fixed at the level of world prices. Any change in its foreign position must, therefore, be reflected, not in changes of import prices, but in changes in the general level of money incomes. If the demand for exports increases and capital is invested in the country in question, or interest is paid in excess of foreign purchases, then gold will flow in and a general **inflationary** situation will develop at home. But if the foreign trade position is degenerating for any reason—changes of relative demands or relative money costs being the most usual causes—then it is impossible for a country on the gold standard to stop a decline in money incomes at home. The consumption of imports must be reduced, but their prices cannot be raised. Equilibrium can only be restored by the outflow of gold, and ultimately, unless the country is to be stripped of gold and driven off the gold standard, by a reduction of money incomes and subsequently of imports It is the purpose of the outflow of gold to bring a **deflationary pressure** upon the banks and so reduce money incomes at home.

"When a country is off the gold standard, the mechanism is the opposite of this. There is no fixity in the value of a country's currency and hence no fixity in the price level of its imports. Changes in its foreign trade position exert no direct influence on the level of money incomes, but they do exert **a direct influence on the relative prices of imports and exports.** If a country's foreign trade position degenerates when it is off gold, the level of its foreign exchanges declines. The direct effect of a fall in the level of the exchanges is to raise the price of exports to the foreign consumer, by exactly the same percentage. The movement in the exchanges must continue until an equality in the value of imports and exports in the widest sense is brought about. This is a simple example of the second type of adjustment. Consumption of imports has been reduced not by the general and difficult process of income reduction, but by the swift and automatic change in the level of import prices. This is the great **advantage of free exchanges.**

"It should now be plain that the execution of the policy of Constant Consumer's Income is not compatible with the maintenance of a strict gold standard except by a series of fortunate accidents. If the productive efficiency of all countries on the gold standard is moving in the same direction at roughly the same rate and if there are no important changes in relative demand, the foreign trade position of each country will be stable. In such conditions, there is nothing to prevent the maintenance of both stable incomes and the gold standard. But if any of these elements change, it is not possible to maintain both. If the demand for British exports is falling, then it is inconceivable that we should both keep up the level of our money incomes and remain on gold. The mere movement of gold does nothing to adjust the elements in the system ; and unless it is followed up by a subsequent **reduction** of money incomes, England will lose all its gold and a monetary crisis will supervene. It was something not unlike this that occurred in 1931. Yet we have seen that the maintenance of stable money incomes is the main requirement of internal equilibrium. This constitutes a strong **prima facie case against the maintenance of the gold standard.** The alternative conducive to **internal equilibrium** would be a number of self-contained monetary systems with constant incomes in their own currency and slowly fluctuating exchanges to adjust changes in the commercial relations between them."

## Arguments for and against Gold Standard

"The argument which has always been adduced in favour of the gold standard and against free exchanges is that the **risks** of international trade are enormously increased by the exchange fluctuations which are inevitably associated with free exchanges. There cannot be the least doubt that the era of uncertainty, of wild fluctuations in the currencies of the world, and of the intrusion of unforeseen political disturbances in the money markets, which followed the abandonment by England of the gold standard in 1931 has been wholly detrimental to the volume of world trade, and is, in no small measure, responsible for the recent intensification of world depression. This is true of one particular **departure** from the gold standard and constituted an argument for its retention when we were on it, but this is not relevant to a discussion of the comparative advantages of a general system of free exchanges and the maintenance of a universal gold standard. In defence of the former—the maintenance of free exchanges—there are these final things to be said.

" First, that, in the course of time, the existing system of private financial enterprise leads to the growth of forward exchanges and the specialisation of special concerns to bear the risk of exchange fluctuations. These remove the burden of risk from those engaged in foreign trade itself and greatly reduce the cost of fluctuations and the tendency to restrict international trade.

" Secondly, is it apparent that these fluctuations will be severe in a period of comparatively normal trade? The changes in relative efficiency are long period phenomena, and with the variety in world trade which exists to-day, it is unlikely that the changes in relative demand will be very severe. It is, for example, unlikely that in periods of general world expansion the fall in the demand for English exports of the old staple kinds will not be offset by a rise in the demand for the luxuries in whose production we are so skilled. If then the anticipated changes are not so very great, the long period fluctuations in the exchanges will also be slow in appearing and small in amount. A condition of very slowly moving exchanges would be compatible with a policy of **de facto** stabilisation, with periodic changes in the level at which the shorter period stabilisation was aimed. Behind such a protected exchange the policy of a constant level of incomes could be successfully executed without greatly hampering the development of world trade"—" *What everybody wants to know about Money*," pages 341-344. by G. D. H. Cole, 1933, June.

The two excellent books just mentioned may be studied with advantage.

## CHAPTER II

# MONEY IN THE GREAT WORLD

THE commodity money throughout the great world is now gold. It is usually in the form of minted coins (**specie**), but, occasionally, for large payments, in the form of **bullion,** which consists of masses about the size and shape of bricks. Gold is so heavy that it would probably be quite safe to pile bullion by the side of a frequented road for half a day. The too-ambitious thief would find that he could not carry it at the necessary speed for the necessary distance.

Attempts to establish gold and silver jointly (**bimetallism**) persisted up to a few years ago, but they all failed owing to the impossibility of deciding once for all how many pounds of silver were worth a pound of gold. It is probable that no country is now on the gold basis, if we interpret that as meaning that it could give gold for all the paper it has in circulation. Up to the eve of the Great War, however, several of the great nations were on the gold basis inasmuch as their national banks undertook to exchange gold for their own notes on demand. In practice, it was found that all the chits were not presented at one time ; and even if an inconvenient number were, the resources of civilisation provided various expedients for discouraging the practice without absolutely forbidding it. This was the case in England and Germany, and, excepting certain kinds of token money, in France and the United States of America, also. The last is the only one now on the gold basis in the limited sense indicated above. It seems likely at the present moment (January 1925) that England will return to the pre-War practice some time during this year.

A **silver coin** is a chit made of an alloy of silver. It is token money more durable and sanitary than if made of paper, and enjoys more respect on account of a certain intrinsic value which would remain if the promise it implies could not be fulfilled. This intrinsic value is, in the case of the rupee, about twelve annas.

The forms of money with which the Indian student is familiar, are, therefore, three only in number—token money made of silver, nickel, and copper ; cheques ; and credit, rooted principally in the power and prosperity of the British Empire. If only the token money existed, prices in India would be anything the Indian Government liked to make them. They could be doubled or halved merely by doubling or halving the quantity of token money in circulation Credit, however, and the cheques, like Munna Lal's on the morning after he sold his beach, representative of credit, are very difficult to control. In peaceful and prosperous time, it expands. In times of war or political tumult, it shrinks. The latter very frequently restricts the supply of goods also, which has a reverse tendency, as we saw in Chapter I. It increases prices. Usually, a sudden disturbance raises prices first, and then lowers them, whereas one, long foreseen and dreaded, merely lowers them. The final result is the same in both cases—general lowering of prices and business depression. A government might, and generally does, with some success, counteract these fluctuations by manipulating the supply of both token and credit money, but--

We are now in a region of conflicting interests and opinions, which have not yet reached equilibrium. The business community generally finds a slow and continuous inflation—the most pleasing state of affairs. Rising prices encourage buyers with the experience that if one waits a little, a profit can always be secured. It is true that a time comes at last when it is discovered that a maund of money is required to buy a seer of rice, and when the exporters from other countries refuse to admit that the money has any value at all, but until then it is cheerful. On the whole, however, the **inflationists** are dwellers in the Pit of Illusion.

There are also **deflationists.** They are all those whose income is fixed, or who are already possessed of considerable sums of money, and not of other forms of wealth. For them, lowered prices mean that their own possessions increase relatively to those of the rest of the community. They can buy more of anything with the same money.

Instructed and unselfish opinion favours neither inflation nor deflation; but when every one is instructed, and in favour of stability, there will still remain the problem of credit.

## The Monetary System of England

Its unit is the "pound," the symbol for which is £, just as Re. is the symbol for the rupee. Rs. 500-0-0 means five hundred rupees, and £ 500-0-0 means five hundred pounds. The pound is divided into twenty parts, called "shillings," and the shilling again into twelve pennys or pence. Token coins are in circulation for the two last, the first a silver alloy coin and the latter a large and clumsy copper one about as big as a rupee. Just as Rs. 30-8-9 means thirty rupees *plus* eight annas *plus* nine pies, so £ 30-8-9 means thirty pounds *plus* eight shillings *plus* nine pennys.

In normal times, when England is on the gold basis, its mint will buy one hundred and thirteen grains of gold for a pound, or the Bank of England will sell pure gold for its own notes at the same rate. Under these circumstances, the value of a pound is definitely fixed (in terms of gold).

It is not definitely fixed in terms of any other commodity, but gold is a very good representative one to nail a currency system to. Some sufficient food stuff might be better in a poor country like India, but there are difficulties in that. The Bank of India would have to replace its values by large granaries, and there would be danger of loss through deterioration of the rice (gold). Gold does not decay, no matter how long it is kept; but, under certain circumstances, as in the United States of America, at the present moment, a great increase of it may increase prices, just as any other kind of inflation does.

If India followed the practice of England, the value of the rupee could be arrived at by simply comparing the amounts of gold that a rupee would buy at the Imperial Bank. of India with the amount that a pound will buy at the Bank of England. But, as we have seen, India is not on the gold basis. At present, about thirteen rupees are being paid for one pound, by those wishing to change rupees into pounds.

## The Monetary System of the United States of America

The unit is the dollar (symbol, $). The value of the dollar may be exactly computed in pounds, because both countries are normally on the same basis, namely, gold. It would not be so simple if one of them were on, say, rice basis. A pound is worth $ 4·86 (in words, four dollars and eighty-six cents). It will be observed that subdivision is on the decimal system. It is left to the student to calculate the present value of a dollar in rupees from the data already given.

As a result of the Great War, we can give only the names of the units of the other great western countries. Both France and Germany have now a purely token currency, over-shadowed by wildly fluctuating credit. The opinion of French merchants is that their "franc" is, at the moment, worth about one-ninetieth of a pound. That is what they are giving in Paris and other large French towns. Before the War, the value of a franc was one-twenty-fifth of a pound. The French system, like the American, is a decimal one.

With the exception of certain small neutral nations, other European countries are still in the post-War chaos, as regards their currencies, and it would serve no useful purpose to examine them here—as they were. But the student is advised that he may watch their struggles towards renewed stability. If he does so carefully, he will learn more about the nature of money than he is likely to learn from any book. He has an unique opportunity to observe the thing in its making.

## Appendix to Chapter II

From the "Pioneer" of May first, 1925: Part of the Budget Speech of the Chancellor of the British Exchequer, delivered on April 28, 1925.

"Announcing the return to the gold standard, Mr. Churchill said that such a return was a long-settled policy of the country, only the question had been a most difficult and delicate one of how and when.........It was unnecessary to adopt gold coinage. He appealed to all classes to continue to use notes. He would introduce a bill providing that, until otherwise provided by proclamation, Bank of England and Treasury notes be convertible into gold only at the option of the Bank of England, and that the right of tendering bullion at the mint to be coined be confined, in future, legally to the Bank of England, which would be obliged to sell gold bullion in amounts of not less than 400 ounces in exchange for legal tender at the fixed price of £ 3-17-10½ per ounce. Further steps would be deferred until we had sufficient experience of the working of a free international gold market on a gold reserve of approximately £ 150 millions."

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# CHAPTER III

# CAPITAL

IT will be sufficient, for our purpose, to define capital as 'accumulated money' in any or all the forms described above. From the engineer's point of view, the use of capital is to support the workmen, and buy the raw material for enterprise not immediately productive.

The owners of capital customarily hire it out on terms depending on the risk they run of losing it, or part of it. If the enterprise for which the capital is required, is one certain to prove remunerative, and if the persons requiring the capital are entirely trustworthy, the charge is between four and five per cent. at the present time. That is to say, between four and five rupees per annum rent (interest) will be charged for every hundred rupees borrowed.

We have said that if the enterprise is certain to prosper, and if the borrowers are entirely trustworthy, the charge is four or five per cent. per annum ; but this is a very rare combination. The most trustworthy borrower is a great and prosperous nation. If the enterprise for which it requires capital is, say, a system of irrigation or the education of its rising generation, both conditions are satisfied, and the interest will be the lowest possible. On the other hand, if the enterprise is war, a higher interest must be paid, because there would be no wars if the result was always certain.

In the present state of the world, there are a number of powerful nations willing to borrow all available capital at about four and a half per cent. Even if they are not borrowing money at the moment, their old creditors are so numerous that one can always be found ready to transfer his claim to anyone that wishes to invest in it, and has the money to pay for it. Perfectly safe **"guilt-edged" investments** of this character are always available throughout the world.

It should now be evident that no capitalist will invest money in, say, an engineering business floated by a company, if only four or five per cent. is offered. He will require a much higher rate of interest to compensate him for the risk and anxiety which has practically no existence for the investor in guilt-edged "**securities**" Nor would it be practical in the business sense for the company to embark in an enterprise which did not offer a still higher rate to cover depreciation on perishable plant and the like. For these and similar reasons, it is not of much use trying to interest the capitalist in a scheme which offers anything less than ten per cent. on the capital required. There should be a clear prospect of ten per cent. after allowing for depreciation due to wear and tear and other wastage of the property.

The above does not apply, of course, to national or municipal enterprises. These are often justified on quite other grounds than the possible profits. The sanitation of a city or the foundation of a university are exampies. Such undertakings are, in the long run, the most profitable of all, but the profits are not usually reaped by the people who initiate them. They are repayments to the unborn of a debt owed to our forefathers, and exist, where they do, because there are motives for human action more powerful and enduring than any of those that the science of economics takes account of.

## How Capital is Raised

"**Raised**" means borrowed from the community at large. Formerly, and still, to a certain extent, this was done by negotiation among friends who formed a "**partnership**" to carry on the work. Those who contributed capital were "partners" in the business. The partners who took part in directing it, were "**active**" **partners,** while those who merely contributed were "**sleeping**" **partners.** The great advantage of a partnership is that its operations may be secret. It may make very large profits without attracting competition, and enjoys generally the freedom of a private individual within the law.

But there is a great danger in partnerships, which prevents them from raising money easily. The liability of the partners is unlimited. Even a partner so sleepy that he lends money on the understanding that he is to have a share of the profits without inquiring what the partners are going to do, is liable, Any act of the managing partner or partners in the name of the partnership is regarded by the law as the act of all the partners. On the other hand, if the sleepy one lends money at a fixed rate of interest, he is a **creditor,** not a partner, and, in the event of disaster, may claim his pound of flesh even if the others are entirely ruined by his claim. The managing partners may incur debts, without the knowledge of the sleeping ones, exceeding a hundred times the account contributed by the latter : who are nevertheless compelled to repay them, whether the business, when it breaks up, has anything to show for the money spent or not.

We have stated the law in regard to partnerships very simply in order to emphasize its essential features. In fact, it is not only complex, but also rather vague. The points which the reader should fix firmly in his mind are :—

(*a*) Partnerships are **dangerous.**

(*b*) Anyone, who is his own lawyer in partnership affairs, has a fool for his client.

## Limited Liability

This invention was perhaps as great a factor of industrial advance in the latter half of the nineteenth century as the steam engine was in the first half. In commercial progress, it ranks with the invention of token money and double-entry book-keeping. Its principle may be very briefly stated.

The liability of the partners is limited, either by the number of shares the partners have taken, or by a certain sum they have guaranteed; nearly always by the number of shares

Thus, if a person applies for one hundred ten-rupee shares in a new company, or buys the same number of the same nominal value in an old one, he cannot be called upon for more than a thousand rupees first and last. He may, in the first case, have paid only five rupees for his ten-rupee shares (the shares were "partly paid shares"), in which case he may be called upon for the balance. He may, in the latter case, have bought the ten-rupee shares in an old and successful company for much more than ten rupees each. But, that was consciously, and by negotiations which did not concern the company. Share money, consolidated into large blocks and sold by quantity instead of by number, is called "**stock.**"

The reader should now understand how much more easy (not simple) it is to raise money for a limited liability enterprise than it is for a partnership. The shareholder knows exactly what risk he is running. He may (in fact, he probably will) lose the money he subscribes, but he cannot lose more. We are justified in saying he probably will, by the fact that more than half the new companies that are floated every year fail to continue floating. They sink after a year or two leaving no trace except, occasionally, a disagreeable smell. It may be said, therefore, *that subscribing for shares in a new company is a species of gambling.* It is, but it is very amusing; the proportion of prizes is quite high, and now and then the prizes are tremendous.

If the company is so successful as to make, say, fifty per cent. on its capital, that fifty per cent. is a mere trifle compared to the lucky shareholder's real profits. He may now sell his ten-rupee shares for rupees fifty or more each, thus bagging not fifty per cent., but four hundred per cent., and at once setting free his capital for fresh adventures.

It was the prospect of such prizes that charmed the savings out of the pockets of Western peoples from 1860 to the present day, and financed the great material advances of that epoch. It also leads foolish and credulous people to buy shares in enterprises which have no attraction but the optimism of their promoters, and no reason for their existence other than the anxiety of these gentlemen to unload a worthless property on the public.

The law does what it can to protect these innocents. It insists that the invitation to subscribe (called the "**prospectus**") shall contain no deliberate lies or suppressions of the truth. It cannot, of course, guarantee that the cheerful optimism that always characterises these documents is honest. The reader, in his happy visions of a possible four hundred per cent., has forgotten the possible creditors of the limited liability company, but the law remembers them. Their security is not nearly as good as it was in the case of the partnership. The law protects them by requiring the company to disclose the fact that its liability is limited in all its dealings. Finally, we may say of company law what we said of partnership law that no one should meddle actively with it without expert assistance. But if he has a taste for gambling, or if he has reason to think the enterprise worthy of support, he may buy shares. Most of us try a flutter in that direction now and then, and can exhibit singed feathers as a result.

At the worst, one loses the money paid for the shares ; or if the shares are partly paid, the unpaid portion in addition.

## Classification of Shares

The promoter of a company, endeavouring to raise money from the public, usually appeals to two classes of investor in the first instance—to the man who would very much like to make more than the four or five per cent. he could get from guilt-edged investments, but who hates the idea of losing his money ; and to the reckless person who thinks the chance of four hundred per cent. well worth the risk. To the first he offers **preference shares.** The preference is of various kinds. Usually, the preference shareholder is guaranteed that he will receive his limited dividend before the ordinary shareholder gets anything, say six or seven per cent., but no more, no matter how large the profits may be. Sometimes the shares are **cumulative preference shares.** If the company fails to make a profit in any year, the preference shareholders must be paid their arrears before the ordinary shareholders get anything in subsequent and more prosperous years. Occasionally, there is **preference as to capital** also. In that case, if the company fails and its assets are sold, the preference shareholders have the capital they subscribed returned first, and the ordinary shareholders get what is left.

The third kind of share is the **debenture** issued by a successful company, which requires more capital for development. It is merely an acknowledgment of money borrowed at a fixed interest and for a fixed period, on the security of the company's property. The interest is usually, but not always, less than that offered to preference shareholders, but, of course, more than could be obtained from guilt-edged stock. Theoretically, a debenture shareholder gets his interest whether the company makes any profit or not, but, in practice, he does not always find it wise to insist on his rights in that respect. There may be a risk of killing the goose, which, if not laying golden eggs at the moment, may, if it lives, still do so at some future date.

Once these shares have been issued and paid for, or partly paid for, they continue to be bought and sold by the community at large, like any other form of merchandise. The price at which they change hands varies in accordance with fluctuations of trade, and is sometimes lower, and sometimes higher, sometimes the same as the original or nominal price. If the market price of a hundred-rupee share is one hundred and five rupees, it is said to be at a **premium** of five per cent.; if ninety-five, at a **discount** of five per cent.; and if it is still one hundred rupees, the shares are **at par.**

The bazar in which shares are bought and sold is called "**the stock-exchange.**"

There is a stock-exchange in most great cities. It is a private corporation controlled by its members, whose profession it is to deal exclusively in stocks and shares. There are other persons who deal in stocks and shares, but the reader should note that outside dealers are not usually gentlemen in the sense explained in Chapter I, whereas a member of the stock-exchange usually is. The members divide themselves into two classes in a properly organized exchange—**jobbers,** who buy and sell on their own account; and **brokers,** who act as agents between the public and the jobber. Ostensibly, a jobber is equally ready to buy or to sell any share on the market. When approached by a broker inquiring his price for a particular share, he quotes two prices—a high one at which he will sell, and a somewhat lower one at which he will buy. Only when he has done so, should the broker disclose whether he has a commission to buy or to sell. If the broker is a gentleman, he is concerned only to do the best he can for his client. It is not "playing the game" for a broker to speculate in shares himself, as it might give him interests opposed to those of his clients.

## Bulls and Bears

The jobber, who quotes prices at which he is quite as likely to become a seller as a buyer, is depending on the "turn of the market," or difference between his selling and buying price for his profit. He is neither a bull nor a bear. But one who consistently quotes **high** prices, will, of course, always be asked to buy, and **never** asked to sell. He is a bull (for the time being). He either believes that prices are presently going to rise on their own account, when he will sell his accumulation of stock at a profit, or he is combining with other bulls to create the illusion of a real demand, which, as every one knows, raises prices, quite apart from any real fluctuation in their value. The bull hopes to have sold at a profit before the illusion is discovered. The final buyer, who is left to discover the illusion, is, in general, not a jobber, but a member of the general public. It is illegal in most countries to "**corner**" any particular share, that is, to buy more of them than there are on the market. The idea of cornering is that when the unfortunate sellers have to make delivery, they find that they cannot do so, and have to appeal to the nice kind bull to sell them a few shares to make up their deficiency. He, of course, having plenty of shares, will be quite ready to do so—at a price.

The whole proceeding is, of course, a rank steal, and illegal; but though it is a crime, it is not so easy to bring home to the criminals, as it would appear to be at first sight. When the thing is discovered, it is also discovered that all available shares are in the possession of a number of innocent optimists who think their shares really worth what they ask for them According to them, nothing could be further from their minds than cornering. Another set of gentlemen, totally unconnected with the first, of course, insist that the real criminals are the wicked bears who sold shares they had not got. Why should they not claim delivery of the shares they bought in perfectly good faith ? Also why should the optimists be compelled to sell the shares they have bought in perfectly good faith for less than they honestly consider them to be worth ?

As a matter of fact, the bears are just as much to be blamed as the bulls. They have been selling shares hoping to create the illusion of a tremendous supply, and so create an artificial fall of prices. If they can succeed in raking together more shares than the bulls can buy, then when settling day comes the bulls will have to sell to realise the money they have contracted to pay for shares they never expected to be delivered. Then it is discovered that the pessimism of the bears has become really dreadful. They don't want the shares at any price now. However, just to oblige their old friends, they are willing to take a few at about a tenth of the price the poor old bulls paid for them. It is a bear victory !

Neither the bulls nor the bears deserve any sympathy from the general public. They are, in fact, a nuisance, and are engaged in one of the most childish and mischievous games that adult men engage in. We must confess that we are childish enough ourselves to be much amused at their little games, and, for that reason, have perhaps given them more space than they deserve. Our reason for mentioning them at all was to warn the reader that wild fluctuations of the price of anything which last only for a few weeks have very frequently no rational basis. He should not rush to buy a rising stock just because it is rising. If he does, his fate is likely to be to assist a bull operation without sharing in the profits. Nor should he rush to sell any valuable shares that he may happen to have, simply because the price has suddenly started to fall. The bears will welcome his assistance, but they will not give him a commission on their modest gains, if they are successful. It is almost a general principle, that to buy when everyone else is buying is as foolish as to sell when everyone else is selling. The reverse is a better rule. But better than either is to form one's own judgment of values independently of the mob, and to act accordingly.

The reader, who, in spite of our manifold warnings, is still determined to have a try for that four hundred per cent., will have, in the first instance, to get into touch with a stock-broker (unless his particular folly is a new company) who ought to be a member of the stock-exchange. Remember that respectable stock-brokers do not advertise—it is against the rules of their game. He may give an open order to buy a particular stock. He will always have to pay the higher of the prices, quoted in any good financial paper, a day or two after the transaction takes place. On the other hand, if he gives a selling order, he will get the lower price. Jobbers must live.

He may, if he likes, give a conditional order to buy at a price not greater than the one he is willing to pay. The broker will require a commission of rather less than one per cent. of the money involved in the transaction as a rule. It is less for a straightforward guilt-edged investment than it is for the more speculative shares

Sometimes people who deal are called "**middle-men,**" as if it were a reproach to deal rather than to make. The reproach is not deserved if the middleman's business is well-organised, and if he deals fairly. The work of merchants, retail shopkeepers, agents brokers, bankers, insurance men, and other commercial workers, is indispensable under present conditions, because it provides goods at the points where they are needed, and give **us the useful distribution of articles after they are made.**

**Private Companies** are none of our business, of course; but we will be expected to know what they are. They are limited liability companies whose shares are not sold to the public. Sometimes they are merely dodges of wealthy men to avoid the payment of income-tax.

## Appendices to Chapter III

(A) Quoted from "Elementary Principles of Economics," by Professor Irving Fisher.

"A stock of wealth existing at a given instant of time is called "**capital.**" (**Wealth** consists of material objects owned by human beings and external to the owner). A flow of benefits from wealth through a period of time is called "**income.**"

Many authors restrict the name "capital" to a particular kind or species of wealth or to wealth used for a particular purpose, such as the production of new wealth; in short, to some specific part of wealth, instead of to any or all of it. Such a limitation is, however, not only difficult to make, but cripples the usefulness of the concept in economic analysis.

For the **production of wealth,** three things are necessary—**Labour, Land,** and **Capital.** The wealth which is produced is shared up between those who labour, those who own land, and those who own capital.

We give different names to the shares of the produce which are taken by the workers, the landlords, and the capitalists.

The share of the worker is called "**salary**" or "**wage**"; the share of the landlord is called "**rent**"; the share of the capitalist is called "**interest**" or "**profit.**"

Payment for use of loan is "**pure interest.**"

Payment for **risk** ——— ... }
Payment for administrative skill ... } is "**profits.**"

In dealing with the production of wealth what a complicated thing labour is, including not merely hard work, which may or may not have a useful result, but the making of hard work really fruitful by guiding it with *intelligence*, informing it with *invention*, and multiplying it by *organisation!* We cannot too often be reminded that it is necessary, not only to work, but to work in the best way, and that, while much work badly used may produce little wealth, a little work well used may produce much wealth.

## The Laws of Supply and Demand and the Distribution of Wealth.

The distribution of wealth between labour's share (wages and salaries), the landlord's share (rent), and the capitalist's share (interest and profit), is determined by the laws of demand and supply. Notice that here we are speaking of **distribution,** and not of **production.** Whether there is much production or not depends on how the labour, land, and capital are used, Demand and supply affect rent as they affect prices. If a lot of people have to live in one place, they all demand houses, and therefore there is a big call for land at one place. So the demand sends up the price of the land, or the rent paid for the use of it. Is it possible, in such a case, to increase the supply of land to the people who want houses? Curiously it is, because by making a tramway or railway we could enable people to live farther away and get back quickly to the spot where business calls them together. So the homes of the people could be spread, and, in effect, a larger supply of land could be made available for them, in which case the rent at the busy spot would fall.

With capital, too, demand and supply affect payments. When we come to wages, we also find that demand and supply affect them as they affect the prices of goods.

(B) The following are the titles of interesting novels dealing with stock-exchange operations :—

"The Pit," by Frank Norris.

"Letters of a Self-made Merchant to his Son," by E. Lorrimer.

## CHAPTER IV
## INTERNATIONAL MONEY

IN this chapter we are concerned with the mechanism by which money is transmitted from one country to another which has a different system of currency, such as any of those described in Chapter II. Incidentally, we shall, if we watch carefully, become aware of a method of substituting credit for currency, second in importance only to the method of creating bank credits.

Let us suppose that a certain gentleman, named B. C. Chatterjee, of Calcutta, has collected and shipped to London a quantity of rice, which he has sold to a gentleman there, named L. D. Coueslant, for £ 3,000-0-0, on the understanding that it will be paid for in three months. Now, Mr. Coueslant has got money only in pounds sterling, whereas Mr. Chatterjee would naturally prefer to be paid in rupees. He has to pay the farmers who grew the rice, and these have no use for pounds. Accordingly, he **draws a bill** on Coueslant. The bill is in this form:—

"Three months from date pay to my order the sum of £ 3,000-0-0."

To L. D. Coueslant, Esq., (Signed.)
London. B. C. Chatterjee.

If Coueslant has agreed to these terms, he will, on receipt of the bill, write across the face of it:

"ACCEPTED, L. D. COUESLANT,"

and send it back to Chatterjee in Calcutta, who may realise ready money in rupees on it (after endorsing it) by selling it either to a bank, or to some merchant in Calcutta, who has occasion to make a payment in London, no doubt, for something he is importing from there. The buyer and Chatterjee will have to decide between them what a bill payable in sterling a month and a half in the future is now worth in rupees. The amount they deduct, because it is not immediately payable, is the **"discount."** The number of rupees they decide (no doubt after a long argument) to accept as the equivalent of one pound is the "**rate of exchange**" usually quoted as so many pence to the rupee.

The need for trade or exchange is so great that if we were all making things we should make them in vain.

The buyer may, in turn, endorse it, and resell it, and it may at last reach Coueslant with a dozen endorsements by so many successive owners. If Coueslant fails to pay up when that happens, the last owner can claim from the person who endorsed it and sold it to him, and so right back to Chatterjee who originally drew the bill. Every endorsement is an additional security. A glance at the title page of this book will show that the names of the drawer of this particular bill and of its drawee are of extraordinarily good repute. In such cases, the drawer (Chatterjee) may discount his bill immediately he draws it in anticipation of acceptance.

The important thing for an Indian to notice is that *the rate of exchange between England and India is settled by negotiation between Indian merchants.* The English merchant has nothing to do with it, nor has the Indian Government, except inasmuch as it may appear in the bill market as a seller or buyer of bills on its own account. The Government, by thus intensifying demand or supply, may greatly influence the price (rate of exchange) of bills, but it does not determine it.

We are supposing that the buyer of the bill sends it directly to his London creditor who collects from Coueslant in due course. This may happen, but Chatterjee is just as likely to find a customer in a merchant who has to make a payment in Pekin. His bill is a very sound one, and such bills on London circulate all over the world as a kind of international money. If this particular bill should come on the market again in Pekin, Chinese merchants will have to decide how much a pound is worth in their currency. It is always the merchants of the other country that have to decide the rate of exchange between that other country and England. London has nothing to do with it.

As the rate of exchange between India and London troubles Indian thought a good deal, it may be worth while to consider the factors on which it depends. Bills are like any other commodity in that the *price depends on demand, supply, and the total quantity of money circulating in the country* in which their price is determined.

"**Demand**" means the desire to possess a thing combined with the ability to buy it and the willingness to buy it. Demand *varies* with **price**. When price is high, the demand is less than when price is low. We often make up our mind as to whether we will buy this thing or that because of the question of price. Changes in demand also occur through **sheer fancy**, as when it is the fashion for ladies to dress in velvet or in fur, or to use a particular sort of ornament. Another interesting thing about demand is that, a fall in the call on one thing may be, and often is, accompanied by an increased demand for something else. Demand varies greatly with **spending power**.

**Demand**—is from merchants desiring to make payments in London, that is to say, from Indian importers. If there are more than usual of them (imports are relatively high), the merchants in question will get fewer pence for a rupee. The **exchange "moves against India."**

"**Supply**" means the quantity of things that can be sold at a certain price.

*Price is arrived at any moment by the action and reaction of supply and demand.*

No matter how valuable a thing in use may be, if a large quantity of it comes on the market at one time, its price will fall. It is none the worse because it is cheaper; it is simply that it has come on offer in large supply.

It is also very interesting to notice that the demand at any price, however low, for an article, is limited by human needs, and that, therefore, there is point for every article at which demand will cease. For example, our capacity to eat bread is limited by our physiological needs. If, therefore, ten times as much wheat came to market as the nation needed, it could not be bought; no matter how cheaply it was offered

**Supply**—Of what? Of bills? Not exactly that. It would be better to describe it for the moment as a supply of pounds. Looking at in that way we will see that supply may be increased in two ways—by **inflation** of the English currency and by many men like Mr. Chatterjee (exporters) drawing bills on London. Either or both of these working together tend to cause more pennys to be given for a rupee (to make the exchange move in favour of India).

Finally, there is the quantity of money, circulating in India. An increase in that raises prices all round including the price of a pound sterling (causes *the exchange to move against India*).

This last factor shows the government to have the same power over exchange that it has over bazar prices (provided it can control that part of money which is credit). Moreover, bazar prices are lowered by the same operation that improves exchange; namely, **deflation.** The question is—does India want lower prices in the bazar ? On that point the reader had better read Chapter II once more.

**Exchange between Gold Standard Countries :** Cannot vary much. If a merchant in New York finds that he is asked to give much more than $ 4·86 for £ 1-0-0, he buys gold at his own national bank, and sends that to his creditor.

He makes up for a national deficiency in exports by exporting gold. The maximum adverse exchange he has to fear is the freight and insurance charges on the gold. It means very roughly that the pound, under these circumstances, costs him about five dollars.

### Banker's Drafts

Are bills drawn by Indian banks on their London correspondents or branches to the order of their Indian clients, and sold to the latter without or rather in anticipation of acceptance. The rate charged by the bank is rather higher than the rate at which bills may be had in the bill market ; but for the person who has only occasionally to make a payment abroad, the banker's draft is the best and safest method of doing it.

### Money Orders

Any post office in India will sell small bills called "foreign money orders" to any one that applies for them, drawn, of course, on the English post office. Their rate is still higher than that charged by the bank ; but, for quite small amounts, the saving of banker's commission and general fuss and worry at both ends makes the money order the best and most convenient method of sending money abroad.

The tax on all bills is proportional to the amount for which they are drawn. In this they differ from the cheque which bears a one-anna stamp for all values.

## Smith on Smith

We have already remarked that Chatterjee's bill on Coueslant of London derived great strength from the names of these gentlemen. It is extremely painful to our modesty to have to insist so much upon that, but it is necessary. There is another way in which the bill might have been less excellent than it was. There might have been no rice. The existence of the rice, presumably worth more than £ 3,000-0-0 in London, safely shipped, insured, and on its way consigned to Coueslant, made it practically certain that he would be in a position to pay when the time came to do so. **A bad bill** is one drawn by some hard-up gentleman in one city on some "*bhai*" in another, who is just as hard-up as he is. The Smith in Calcutta who draws a bill on Smith in London (or an inland bill on Smith of Bombay) does so in order to discount it, and raise money for some immediate necessity. He hopes that, when the fatal day of the bill's maturity arrives, the luck may have turned in his favour, and he may be able to meet it.

Good bills, like the first one described, are "**trade bills.**" Bad ones, like the second, are "**kites**," or collectively, "Smith on Smith." Both are legal ; but the first is legitimate, while the second is not legitimate business. It is not playing the game to draw or accept a bill without a reasonable prospect that it will be honoured.

The appendix consists of two cuttings from the Pioneer of March 27th, 1925. During the War, and for nearly ten years after it, Germany supplied her financial necessities by an enormous inflation of her paper currency. The exchange, accordingly, "moved against Germany" till her mark, originally worth one-twentieth of a pound, became worth only one-twenty billionth of a pound. At that stage, a fresh start was made with a currency founded on a large loan of gold from her late enemies, the old mark being abandoned as lost.

**It will be noticed that on the finance page** of to-day's issue of **The Pioneer**, the quotation for the German mark is given as 20·08¼. This, of course, is the rate for the new gold mark, which has long since replaced the paper mark as the medium of currency for the transaction of business in Germany. To all intents and purposes, the old paper mark has been defunct for some months, the currency having been stabilised last November at one billion paper marks to the new gold mark.

**Latest Foreign Exchange**

BY SPECIAL CABLE FROM LONDON

*Calcutta, 23rd March.*

The following were the exchange rates on London at the following places on the 24th March:—

| | | | |
|---|---|---|---|
| Paris | ... | ... ... | 91·50 |
| Italy | ... | ... ... | 117·64 |
| Berlin (Gold marks) | | ... ... | 20·08¼ |

## CHAPTER V

## TRADING ABROAD, AND TRANSPORT

THE word "**indent**" has a meaning in India and the East generally, peculiar to these countries Normally, it means a contract between two persons; but here it means an order to supply goods under certain conditions embodied in the order, or rather that was its original meaning. At first, when trade with the East was in its infancy, an indent form was supplied to the importer in India by his supplier in the West. It contained an elaborate set of conditions binding the buyer to take delivery of the goods; to pay for them within a stated period; allowing the exporter to sell them to a third person, if the first failed to take delivery, without forfeiting his claim on the original buyer, etc., etc. To all these conditions, the buyer agreed when he signed the indent supplied to him by the seller. But this state of affairs no longer exists to any extent. Only the custom of calling an order an "**indent**" remains of it.

The conditions of sale are now usually embodied in a document called "**the quotation,**" which is the seller's reply to the buyer's inquiry. It usually begins with a very exact and careful description of the goods, called "**the specification.**" Then comes the price together with the time at which payment is expected, wholly or partly in advance, on delivery of railway receipt or bill of lading, or some fixed date later. Finally, in a very contracted form is stated how much of the cost of transport and other expenses, in addition to the price, is to be paid by the seller.

"F. O. B. London" (Free on Board the Ship at London) means that the seller will pay the charges of transport up to the moment when the goods are loaded on the ship at London, but no more.

"Ex. Ship" (Out of the Ship) means that the seller will not pay for any charge for unloading from the ship at the port of delivery.

"Ex. Warehouse Calcutta" means that the price is that at which the goods will be delivered in Calcutta. The buyer will have no freight charges at all to pay for the transit over sea, but he will have to pay for getting the stuff from the warehouse to the railway station in Calcutta, and all subsequent charges.

C. I. F. (Cost, Insurance, and Freight).

F. O. R. (Free on Rail).

It will be seen that the conditions embodied in these abbreviations are of great importance. There is a great difference, or ought to be a great difference, between the quotation for a Lancashire boiler (say) quoted F. O. B. London and the quotation for the same size of boiler, C. I. F., F. O. R. Calcutta. The former, though it may look much cheaper at first sight, may actually be the dearer of the two.

There is an ambiguity about the 'C' in "C. I. F." It may mean that the seller will pay custom (import duty) in certain cases. On the other hand, if the quotation is "In Bond," there is no doubt about it. The goods are sold **inside** the custom-house, and the custom-house officers will see to it that the duty is paid before they are removed.

Whatever the conditions quoted may be, it is the seller who, now-a-days, proposes rather than dictates them by his quotation. The indent or order is a formal agreement which does not generally repeat all the details. It takes the form of a request to supply in accordance with the quotation.

## Bill of Lading

If the goods are supplied F. O. B. London, the owners of the ship in which they are loaded will acknowledge the receipt of them in a terrifying document (made out in triplicate) called a **bill of lading**. It contains a description of the goods, and in the margin a copy of the marks on the packages; the name of the ship and of her master (Captain); the port of destination; the route; the name of the person or firm that will be entitled to receive the goods on arrival (the consignee); the "**lien**" of the shipowners on the goods, (their power to hold them as security for their charges) ; and for what kind of damage or loss the ship-owners will be responsible or not.

The law would enforce these conditions, of course, just as it would enforce the conditions on the back of a railway ticket, but most of them provide for contingencies that do not generally arise.

Of the three copies that are made of the bill of lading, one remains with the ship-owners, one with the master, and the third is sent to the consignee (the person or firm to whom the goods are being sent). This bill of lading, which the consignee receives, is a "**negotiable instrument**" like a bill of exchange or a cheque.

*The basis of a cheque is money in the bank. The basis of a bill is the credit of the drawer and drawee. The basis of a bill of lading is the goods in transit to which it is the title.*

Just as the payee of a cheque may endorse it and hand it over with all the rights which it implies to anyone else, so the consignee of a bill of lading may endorse it and hand it over to some one else to collect the goods. If he lives somewhere distant from the port, he will probably find it most convenient to hand it over to one of the shipping agents that carry on business in such places. The agent will receive the goods in return for the duly endorsed bill of lading, pay all charges, and send the goods on to him. No trouble at all. But the agent will expect to be paid for his services.

The arrival of a "tramp" (wandering cargo steamer) at its destination is notified to the consignees of the goods on board her by advertisement in the local newspapers, whereupon they are expected to make arrangements to receive their goods ex. warehouse or ex. ship, as the case may be.

## Railway Receipts

Except that they are cheap and shabby affairs printed on flimsy paper, they are, for all practical purposes, bills of lading for goods sent by rail. They are not at present "negotiable instrument," but there is a proposal to make them so.

## Cost of Transport

Like all other things on the market, it varies with supply and demand, and, unlike most of them, is very much influenced by local conditions, as, for instance, whether there is or is not a direct road or railway connecting the termini.

We shall have to take a fairly wide view in order to discover such general principles as there are.

The student should think of it as made up of two separate charges—the cost of loading and unloading ; and the actual carriage cost. Loading costs are proportional to the number of loadings and unloadings, commonly four in number :—

(1) Lorry (2) Railway (3) Lorry (4)

The words indicate carrying, and the figures loading or unloading.

If both seller and buyer have railway sidings, this reduces to—

(1) Railway (2)

If both have their places far from the sea, in different countries, and not on railway sidings, it becomes—

(1) Lorry (2) Rail (3) Ship (4) Rail (5) Lorry (6)

A sea port where the docks have not got a railway siding is rare. As a rule, goods can be loaded directly from the ship into the railway waggons, and vice versa.

A loading or unloading will cost, say, annas eight per ton. It may be much less for goods of a special character, such as coal or grain, for the lifting of which special lifting devices usually exist at loading points, and it may be much more for heavy and bulky machines where no facilities exist.

The charge for carriage by sea depends on the nature of the goods, and a ton may be interpreted as meaning so many cubic feet of space. It is about one-twentieth of an anna per ton per mile. Carriage by rail is about ten times as costly, while the motor lorry will usually work out at about two annas per ton per mile. All these figures are very rough, and are given only as data for the following examples—

About fifty tons of goods have to be sent overland between two points ten miles apart, neither point being on a railway, though both are close to railway stations. Should they be sent by road or rail ?

If they are sent by road, there will be only two loading charges, costing fifty rupees. The cost of carriage will be Rs. 62-8-0 for five hundred ton miles at annas two per ton mile : total Rs. 112-8-0.

On the other hand, if they are sent by rail, the loading charges will be Rs. 100-0-0 and the carriage cost Rs. 115-10-0 : total Rs. 215-10-0.

On the whole, this example indicates the motor lorry as being the cheapest form of transport. It is very unlikely that the railway runs directly between the points. The distance by rail may well be fifty instead of ten miles. Moreover, there is likely to be much delay.

If the reader works out the above example, substituting one hundred for ten miles, he will find that in that case the railway has much the better of the comparison, even if the distance by rail is two hundred instead of one hundred miles by road. With other somewhat different assumptions, as to cost per ton mile, and cost of loading and unloading, we might have found the lorry cheaper up to fifty miles, but the result of all such calculations is to demonstrate that, only for short distances, can the motor lorry compete with the railway. It usually has an advantage in speed of delivery up to rather greater distances.

The relations between costs of transport by sea and by rail are similar. Where both termini lie on a comparatively straight coast line, and the number of loadings is the same, the sea is much cheaper for all distances.

We will leave this subject in a vertical direction. Reader—" What on Earth do you mean by that ?" Authors—" We mean, of course, that we will conclude with a bird's eye view."

The great advantages of the sea are that there is no capital cost for the road and that the road goes to so many places. The advantage of the rail over the road is the low tractive effort per ton, and its great handicap, as compared with both the road and the sea, is the heavy interest charges on its capital cost. This last charge, namely interest on capital cost per ton mile, diminishes as the density of traffic increases. Wherever the traffic is dense, the railway can compete with the road down to a distance of about ten miles, that is to say, between great centres of population, but not within them. Wherever new inland country has to be opened up for commerce, the motor is the best for any distance, until such time as traffic becomes dense enough to bear a railway.

## Appendix to Chapter V

Selected cutting from the commercial pages of **The Calcutta Statesman.**

### FREIGHT MARKET.

CALCUTTA, SATURDAY.

A fair business in jute bookings for the Continent March shipment has been done during the week, and the Hansa Line are again out of the market for March. Rather more interest has been shown in forward seed positions.

Bookings reported amount to about 6/7,000 tons linseed, jute for U. K. Continent March-April.

CALCUTTA TO LONDON, LIVERPOOL, DUNDEE, MIDDLESBORO, GLASGOW.

(Less 10 °/o rebate not exceeding 5*s.* per ton).

| | | | | *s.* | *d.* |
|---|---|---|---|---|---|
| Jute | ... | Per 50 c. ft. | ... | 40 | 0 |
| Cotton | ... | Do. | ... | 40 | 0 |
| Gunnies | ... | Per 50 c. ft. | ... | 43 | 9 |
| Hides | ... | Do. | ... | 43 | 0 |
| Tea (less 5*s.*) | ... | Do. | ... | 47 | 6 |
| Shellac | ... | Do. | ... | 45 | 0 |
| Linseed | ... | Per 20 cwt. | ... | 40 | 0 |
| Wheat | ... | Do. | ... | 37 | 6 |

BELFAST, BRISTOL, CHANNEL, LEITH, AND HULL.

300 tons 5*s.* over London rate; 501 tons to 1,000 tons 2*s.* 6*d.* over, more than 1,000 tons 1*s.* 3*d.* over.

### Rotterdam, Hamburg, Bremen.

*Antwerp.*

(Nett Rates.)

| | | | | s. | d. |
|---|---|---|---|---|---|
| Jute | ... | Per 50 c. ft. | ... | 35 | 0 |
| Gunnies | ... | Do. | ... | 37 | 6 |
| Hides | ... | Do. | ... | 37 | 6 |
| Linseed | ... | Per 20 cwt. | ... | 35 | 0 |
| Shellac | ... | Per 50 c. ft. | ... | 38 | 9 |
| Deadweight | ... | Per 20 cwt. | ... | 32 | 6 |

## CHAPTER VI

## BANKS AND INSURANCE COMPANIES

THE management of these institutions and its highly developed technique does not come within the scope of this book, but it has been thought advisable to include a short chapter describing them from the outside, so that the young engineer may know what services he may expect from them. From this point of view, *the business of a bank is to receive and safely guard money not needed at the moment.* No charge is made for this service, as the bank relies for its profits on the investment it makes of the money so deposited. Most of the money in the bank never goes out in a community sufficiently civilized to make a proper use of the bank. As we saw in Chapter I, the bank, on receipt of a crossed cheque, has simply to make a note that it owes one of its depositors so much less, and another so much more. It is not necessary to disturb investments. It very often happens that the accounts of payer and payee of a cheque are in different banks; but even in these cases, the banks arrange mutually by means of institutions called **clearing houses** to ~~let~~ one cheque cancel another without any disturbance of investments.

It is, of course, very profitable to have the investment of large sums of money received without equivalent in this way, and, therefore, the banks offer inducements to the general public to deposit its funds and to leave them in the bank's custody for as long possible.

Money deposited on the understanding that it may be withdrawn or transferred to another client of the bank at any moment without notice is on **current account.**

As a rule, a bank makes no charge for keeping a current account, unless it is a very small one; nor does it allow any interest on the money "on current account."

If an undertaking is given to leave the money deposited undisturbed for three months, six months, or a year, the bank will allow interest on it, at a rate which is higher the longer the period undertaken. Such amounts are said to be on **deposit account.**

The *other side of a bank's business is*, of course, the **investment** of the money entrusted to it. It is on this side of its business that the bank requires to be watched. Every bank exhibits the state of its affairs more or less openly by means of a document called its "**balance sheet,**" which is issued at least once a year and usually once a month.

The balance sheet shows, on the left, under the heading **liabilities**, how much it owes, and, on the right, under the heading "**assets**," how much property and of what kind it has to meet these liabilities. A typical balance sheet contains items like the following:—

| *Liabilities.* | *Assets.* |
|---|---|
| (1) Shareholders' Capital (being the money originally subscribed by the bank's founders). | (5) Government Securities. |
| (2) Deposits. | (6) Other Securities. |
| (3) Bills Payable. | (7) Notes. |
| (4) Reserve. | (8) Specie. |
| | (9) Bills Receivable. |
| | (10) Mortgages. |
| | (11) Bank buildings. |

The totals of the two sides are the same, the "**reserve**" being the apparent excess of assets over liabilities. We will discuss the items of this balance sheet one by one.

## Shareholders' Capital

This is the amount actually paid. It may be much less than the shareholders' liability, if the shares are "**partly paid**" **shares** (see Chapter III). If so, the uncalled capital is an additional safeguard for depositors, but an additional risk for any one buying shares in the bank.

## Bills Payable

Bills drawn on the bank, which will become due for payment in from three to six months from the time they were drawn (see Chapter IV).

It is generally the assets' side which conceals the rotten spot in a bank's position, if there is one. Items numbers 6 and 10 are the likely places.

## Government Securities

It is very desirable that this should be the principal item. Government securities can be turned into ready money at any time with little or no loss.

## Other Securities

This item must exist. As we have seen, Government securities are not very profitable investments. But other securities should not be the principal item of the assets. "Other Securities" may mean any thing.

## Notes and Specie

Are quite safe and quite "**liquid**" ("liquid" means immediately available to pay any call on the bank). But money in this form brings no profit, and, therefore, the bank cannot reasonably be expected to have much of its funds in this form.

## Bills Receivable

These are bills drawn on other institutions or persons which the bank has bought for sums less than their face value (which it has "discounted"). Every one of these will become actual cash within a few months yielding a substantial profit on the money invested in them. A large proportion of the assets in bills receivable is a good symptom.

**Mortgages** are as undesirable an investment for a bank as bills are desirable. Mortgages represent claims on real property. But the testing time of a bank is a time of panic, when credit has suddenly shrunk away to nothing, and though the property is there, there are no buyers for it.

Forced realisation of real property, in these circumstances, invariably means heavy loss.

## Bank Buildings

No matter how palatial they are, they should not figure largely in the balance sheet. Of all the bank's assets, they are, or ought to be, the least liquid, and should, therefore, be written down to a nominal figure very early in the history of the bank.

## Insurance Companies

Deposits made in an **insurance company** are called **premiums;** are received at regular intervals; and in fixed amounts. It is not expected that the depositor will reclaim the money at any time before a pre-arranged date. He may, in these circumstances, receive a proportion of it called "**the surrender value**" of his policy. An **insurance policy** is the written agreement between the insurance company and the depositor. With these exceptions, the insurance company is a very similar institution to a bank; that is to say, it receives the money of the public, and finds its profit in re-investing it.

But the idea of a person who deposits his money with an insurance company is quite different from that of the depositor in a bank. The latter wishes merely to have his money safely guarded. The former is providing against some possible, but improbable, accident. The accident, which is possible for a single individual, will never happen to large numbers of people at the same time, and the insurance company is a kind of co-operative device for obtaining for the individual, as much as is possible, of the certain destiny of the average man.

An insurance company may safely say to each of ten thousand young men all aged twenty—"Pay us Rs. 100 a year for the next thirty years; and when you have done so, we will pay you Rs. 3,000-0-0 and even more, if we are fortunate in our investments. Moreover, we will pay to your heirs the full Rs. 3,000-0-0, even if you die next year." This is quite safe for the insurance company. Nearly all these young fellows will live to be more than fifty.

This kind of insurance is called "**life insurance,**" sometimes rather absurdly, "**life assurance.**" There is no assurance of life, but a young man may be assured in this way, that if he dies prematurely, he will leave as much as his more fortunate fellows. If he survives, he will have to share with all those who survive with him the expense of providing for the few who die, but that is a trifling matter.

Investment in a life policy is essentially a young man's investment. During the first ten years of his career as an earner, he should take out a new policy in a different company every time he obtains an increase of salary. Never having learnt to spend the premium, he never misses it.

The ordinary forms of insurance are Marine, Fire, Life, Accident and Sickness, Fidelity, Guarantee, and Burglary.

Generally speaking, an insurance company will insure against the risk of any accident, which may, but does not, usually happen—against your house being burnt down; against total disablement; against being struck by lightning or by a meteorite; against being sued for damages by some person whom you have run over with your motor car, against the damage to the car itself; against any liability you may incur for injury to your workmen under the Compensation Act, just as cheerfully as it will insure you against living too long or dying too soon. There are a number of financially powerful companies with experience extending all over the world, and over several generations, who know exactly what all these probabilities are and what premium they should charge in each case in order to insure a modest profit for their shareholders A company, which, for any particular benefit, offers to accept smaller premiums than are customary, is either inexperienced or is taking a risk. It should be avoided.

**Insurances of property,** either against *loss by fire or loss by sea*, are **contracts of indemnity**; that is, in the event of loss, the actual loss sustained alone is recoverable, although that loss may be made to include, under the terms of the policy, not only the cost of reinstatement, but the loss of profits during that period.

## Fire Insurance

**Nature of the Contract:** The essential feature of *fire insurance* is that it is a contract of indemnity. No one may make a profit on his insurance; and the company will only pay the amount which the assured can prove he has lost. Although primarily intended to distribute, amongst as many people as possible, the loss caused by fire, this form of insurance also has the indirect effect of lessening the risk of fire. For the experience of the offices shows what class of structure is peculiarly liable to be burnt, and what precautions are most likely to prove effective. Buildings which do not conform to a reasonable standard of safety have to pay a higher premium. There is thus a powerful inducement to the assured to make their buildings as safe as possible.

**Constitution of a Fire Office:** The risks of fire insurance are not capable of such exact or scientific calculation as are those of life insurance. It must always be more or less a matter of chance how many houses are injured by fire in a given town in a given year, and the fire offices are forced by competition to ask the lowest premium they can safely accept. There is thus always some risk of loss in this business. But the continued prosperity of a fire office is not of the same paramount public importance as that of a life office; for their contracts are only for a year. If, at the end of a year, it is found that the premiums charged are not large enough to cover the losses, they can be altered. The rate of premium varies with the risk.

## Accident Insurance

Accident insurance is not a contract of indemnity, and therefore where the assured is injured in a railway accident, and recovers damages against the railway company, he does not have to give credit to the insurers for the sum recovered. Accident insurance was the first form to be developed outside the standard classes, and is first found as a form of insurance against risks on railway journeys. It has now been greatly extended, and policies are issued entitling the assured to "**sick pay**" during disablement arising from any **form of disease** or **accident,** called "**health insurance,**" and these have become very popular. In some cases the policies are both life and accident—paying a lump sum on death, or a weekly payment during disablement.

## The Law of Insurance

**Insurable Interest:** It has always been the object of the legislature to prevent insurance from degenerating into a form of gambling. To remedy this mischief, the

"Gambling Act," as it is popularly called, was passed. This Act is still in force, and it is by virtue of it that *the assured must have an insurable interest in the risk.* The first section provides that no insurance shall be made on the life of any person, or on any event whatever, wherein the person for whose benefit the policy shall be made shall have no interest, and every such insurance is void. The second section enacts that the name of every person for whose benefit a policy is made shall be inserted in the policy ; and the third that, even where the assured has an interest, he shall not recover from the insurer a greater sum than the value of such interest.

It has been decided that every man has an insurable interest for an indefinite amount in his own life, for his estate can thus be guarded from the loss it will incur through the cessation of his earnings ; and as these future earnings cannot be limited or fixed in any way, so neither can the amount insured. Therefore, in the most common form of life insurance, where a man insures his own life for the benefit of his family, no question of insurable interest can arise.

**Good Faith :** It is the duty of a person seeking to effect an insurance to display the utmost good faith.

**Material Representations :** In the ordinary policy of life insurance the facts which the assured is required to communicate are set out in a document called "the **declaration,**" in which the assured has to state his age, business, state of health, other policies, etc., and the declaration is always *made part of the policy* and any misstatement or concealment in it is enough to make the policy voidable.

The balance sheet of an insurance company should be scrutinized even more anxiously than that of a bank. We need not recapitulate what was said in considering that. Except that there is no need for its assets to be as liquid as those of a bank, much the same applies. Panic does not affect an assurance company as it does a bank ; but wars, epidemics, and disastrous fires do. Insurance should not be made in a campany which does not average out such risks over a large area ; which has not very large funds to cover them ; or which has not a long history extending over at least a life-time. Those companies which collect premiums weekly should also be avoided. It is no doubt a convenience that some one should call regularly for the money, but it is a luxury too expensive for a young man.

## Annuities

Just as an insurance company will insure a young man against living too short a time, so it will insure an old one against living too long, which, though no young man will believe it, is a far more dreadful fate. (We do not mean, of course, that it arranges to wring his neck as soon as he is past work). Its offer to another ten thousand young fellows each aged seventy or three-abouts takes this form :—

" Give us that Rs. 3,000-0-0 you got from us when you were fifty, and we will give you Rs. 25-0-0 a month as long as you live." Rupees twenty-five a month is ten per cent. per annum on rupees three thousand, much more than these ancients could hope to get from any other form of safe investment. Moreover, they are relieved from all anxiety for the future. Their daily portion of *dahl bhat* is perfectly safe even if they live to be a hundred. (Incidentally, they have relieved their heirs of the sin of wishing for their deaths, and have made sure that they will be attended with anxious care to the very end). Neither is the insurance company taking any risk. It is quite certain that the majority of them will never live to get their Rs. 3,000-0-0 back again The certainties of life are thus made to cancel out the uncertainties, and united humanity achieves yet another triumph over destiny and the grave.

**Annuities** are usually of three different types :—(1) *Perpetual annuities, e.g.*, pension granted by a grateful government to a man and his heirs in perpetuity, a leasehold property running for 999 years ; (2) *Annuities on a person's life which terminate at death, e.g.*, as is found in most life insurance and endowment schemes ; (3) *Annuities for a fixed number of years.* This is found in engineering problems ; a **sinking fund** is a particular case of this kind of annuity. We shall deal with this problem later on.

# CHAPTER VII

## THE LEDGER

WHENEVER a business comes to grief, it is almost invariably found that its books have been badly kept or have not been kept at all. Moreover, it may be confidently asserted in nine cases out of ten, that it failed simply because its books were not regularly posted.

The reason is this: The healthy human mind is so constituted that it unconsciously diminishes and forgets unpleasant things, while it cherishes and magnifies the pleasant ones. The pleasant thing in business is the income, the unpleasant one the expenditure. The man who trusts to his memory always forgets what he has spent as soon as ever he can, and remembers what he has received, and more than he has received indefinitely. With his mind in this balmy state, it is only a matter of time before he burns his fingers.

The central sacred book of business is the **ledger.** It may be, and usually is, kept in several different volumes, called by various names, such as the "**sales ledger,**" the "**purchases ledger,**" the "**cash book,**" and so on. Nevertheless, they are all to be regarded as one book. All the entries recorded in this chapter are from one ledger only, namely the ledger belonging to R. N. Tewari.

Engineers should be familiar with *Newton's Third Law,* generally translated from the Latin, in which it was formulated as "Every action has an equal and opposite reaction." In many text-books, and by many teachers, this is so expounded as to give the impression that it means that every force is accompanied by a sort of twin that stares it perpetually in the face. The real meaning of Newton's phrase is more accurately expressed by "There are two ways of looking at everything." We say that the horse pulls the cart *forward,* because that is our way of looking at it. The horse, however, if he could speak would say, "I could get on much better if this wretched cart was not always pulling me *back*." The stress referred to is the same in both cases. It is only the point of view that differs.

The useful applications of this principle (like many of the generalisations of genius, absurdly obvious and simple once, it is stated) are very numerous, and the engineer reader is doubtless familiar with many of them.

We are here concerned with the facts that every sale is also a purchase from the other point of view, and that every transfer of goods or money involves both a giving and a receiving.

**Double-Entry Book-keeping**—an Italian invention preceding Newton about two centuries,—has, as its central principle, the invariable record in the ledger of both aspects of every transaction--the giving in one place, the receiving in another.

We come here to another, and totally different, meaning of the word "**credit,**" used in previous chapters to describe that form of money which is essentially faith in the probity, and continued prosperity of a man, a business, or a nation. In *book-keeping*, a **credit** is the record of a giving, and the act of making the record is called "**crediting.**" The record of the receiving, which is the other aspect of the same transaction, is called a "**debit,**" and the act of making it is **debiting.**

We will consider the very simple case of one R. N. Tewari, who makes and sells one hundred cane-bottomed chairs. In narrative or journal form his proceedings are as follows:—

He obtains on *three months' credit* (note yet another subtle variation in the meaning of this overworked word):—

(1) Wood worth Rs. 500 from Messrs. A. Das & Co., Ltd.
(2) Cane worth Rs. 100 from Messrs. P. Mitter & Co., Ltd.
(3) Nails worth Rs. 50 from Messrs. M. Ganguli & Co., Ltd.
(4) Screws worth Rs. 25 from „ „
(5) Glue worth Rs. 2-8-0 from „ „
(6) Varnish worth Rs. 25-0-0 from „ „

Having made the chairs, he—

(*a*) Sells them to Messrs. S. Chakravarti & Co., Ltd., for Rs. 1,000-0-0.

(*b*) Is paid for them.

(*c*) Pays his own debts to the suppliers of his raw material.

The double entries of these events are as follows. (Note that the openings (folios) of the ledger are numbered, not the pages, or rather that pages facing each other bear the same number).

---

Messrs. A. Dass & Co., Ltd. (*folio 1*).

*Dr.*

| 1925 | | Rs. | a. | p. |
|---|---|---|---|---|
| | | | | |

Messrs. A. Dass & Co., Ltd. (*folio 1*).

*Cr.*

| 1925 | | Rs. | a. | p. |
|---|---|---|---|---|
| Jan. 1st | By wood ... ... | 500 | 0 | 0 |

Goods Account (*folio 2*).

(This kind of account is called " Impersonal.")

*Dr.*

| 1925 | | Rs. | a. | p. |
|---|---|---|---|---|
| Jan 1st | To wood from Messrs. A. Dass & Co., Ltd. | 500 | 0 | 0 |

Goods Account (*folio 2*).

*Cr.*

| 1925 | | Rs. | a. | p. |
|---|---|---|---|---|

Messrs. P. Mitter & Co., Ltd. (*folio 3*).

*Dr.*

| 1925 | | Rs. | a. | p. |
| --- | --- | --- | --- | --- |
| | | | | |

Messrs. P. Mitter and Co., Ltd. (*folio 3*).

*Cr.*

| 1925 | | Rs. | a. | p. |
|---|---|---|---|---|
| Jan. 15 | By cane ... | 100 | 0 | 0 |

Goods Account (*folio 2*).

*Dr.*

| 1925 | | Rs. | a | p. |
|---|---|---|---|---|
| Jan. 1 | To wood from Messrs. A. Dass & Co., Ltd. | 500 | 0 | 0 |
| Jan. 15 | To cane from Messrs. P. Mitter & Co., Ltd. | 100 | 0 | 0 |

Goods Account (*folio 2*).

*Cr.*

| 1925 | | Rs. | a. | p. |
|---|---|---|---|---|
| | | | | |

Messrs. M. Ganguli & Co., Ltd.

*Dr.*

| 1925 | | Rs. | a. | p. |
|---|---|---|---|---|
| | | | | |

Messrs. M. Ganguli & Co., Ltd.

*Cr.*

| 1925 | | Rs. | a. | p. |
|---|---|---|---|---|
| Jan. 20 | By nails ... ... | 50 | 0 | 0 |
| ,, | ,, screws ... ... | 25 | 0 | 0 |
| ,, | ,, glue ... ... | 12 | 8 | 0 |
| ,, | ,, varnish ... ... | 25 | 0 | 0 |

Goods Account (*folio 2*).

*Dr.*

| 1925 | | Rs. | a. | p. |
|---|---|---|---|---|
| Jan. 1 | To wood from Messrs. A. Dass & Co., Ltd. | 500 | 0 | 0 |
| „ 15 | „ cane from Messrs. P. Mitter & Co., Ltd. | 100 | 0 | 0 |
| „ 20 | „ nails from Messrs. M. Ganguli & Co., Ltd. | 50 | 0 | 0 |
| „ „ | „ screws „ „ ... | 25 | 0 | 0 |
| „ „ | „ glue „ „ ... | 12 | 8 | 0 |
| „ „ | „ varnish „ „ ... | 25 | 0 | 0 |

## Goods Account.

*Cr.*

| 1925 | | Rs. | a. | p. |
|---|---|---|---|---|
| | | | | |

Messrs S. Chakravarty & Co., Ltd.

*Dr.*

| 1925 | | Rs. | a | p. |
|---|---|---|---|---|
| Feb. 28 | To 100 chairs ... | 1,000 | 0 | 0 |

Messrs. S. Chakravarty & Co., Ltd.

*Cr.*

| 1925 | | Rs. | a. | p. |
|---|---|---|---|---|
| | | | | |

Goods Account.

*Dr.*

| 1925 | | Rs. | a. | p. |
|---|---|---|---|---|
| Jan. 1 | To wood from Messrs. A. Dass & Co., Ltd. | 500 | 0 | 0 |
| „ 15 | „ cane from Messrs P. Mitter & Co., Ltd. | 100 | 0 | 0 |
| „ 20 | „ nails from Messrs M. Ganguli & Co, Ltd. | 50 | 0 | 0 |
| „ 20 | „ screws from Messrs M. Ganguli & Co. Ltd. | 25 | 0 | 0 |
| „ 20 | „ glue from Messrs. M. Ganguli & Co., Ltd. | 12 | 8 | 0 |
| „ 20 | „ varnish from Messrs. M. Ganguli & Co, Ltd. | 25 | 0 | 0 |
| | To balance ... | 287 | 8 | 6 |
| | | 1,000 | 0 | 0 |

Goods Account.

*Cr.*

| 1925 | | Rs. | a | p. |
|---|---|---|---|---|
| February 28. | By chairs to Messrs. S. Chakravarty & Co., Ltd. | 1,000 | 0 | 0 |
| | | 1,000 | 0 | 0 |

The account has been "balanced" by adding the difference to the deficient side. If we were to go on with other items on a subsequent occasion, we would begin with "By balance Rs. 287-8-0" on the credit side. In this way we would carry forward our credit surplus. All the accounts of a ledger are usually balanced once a month.

Cash Account

*Dr.*

| 1925 | | Rs. | a. | p. |
|---|---|---|---|---|
| March 28. | To cheque from Messrs. S. Chakravarty & Co., Ltd. | 1,000 | 0 | 0 |

## Cash Account.

*Cr.*

| 1925 | | Rs. | a. | p. |
|---|---|---|---|---|
| | | | | |

Messrs. S. Chakravarty & Co., Ltd.

*Dr.*

| 1925 | | Rs. | a. | p. |
|---|---|---|---|---|
| Feb. 28 | To 100 chairs ... | 1,000 | 0 | 0 |

Messrs. S. Chakravarty & Co., Ltd.

*Cr.*

| 1925 | | Rs. | a. | p. |
|---|---|---|---|---|
| March 28 | By cheque ... ... | 1,000 | 0 | 0 |

On March 31st, if he is an honest man, Mr. Tewari will send cheques to his three creditors ; and if he is a good business-man, he will close the fairly satisfactory chair episode by crediting the cash account and debiting these gentlemen with the amount sent, in each case.

It is quite imperative that the reader should thoroughly understand this simple example. The method may seem cumbrous at first, but he will find with experience that it is the only sure and trustworthy method which will prove adequate to all emergencies. When it is thoroughly understood, he may go on to ones more complex, and to the study of text-books dealing exclusively with book-keeping. In such books he will find many interesting variations and extensions on and of the above, but in no trustworthy book any departure from the principle of double-entry.

The accuracy of the ledger is checked at intervals by "*taking out a trial balance.*" There are two ways of doing this—by **postings** and by **balances** Posting is a general term for debit and credit entries. The total credit entries should, of course, equal the total of all debit entries. This is the best and most thorough check.

In certain of the accounts taken singly, like the goods account above, there is a balance item. The total of debit balances should equal the total of credit balances. This is a quicker, but not such a satisfactory check.

Theoretically, a trial balance is no check at all. It appears to be quite possible to enter the debit and credit of a particular transaction of the same, but quite wrong on both sides, which, of course, would not prevent the trial balance from coming out perfectly correct if the same error had been made in both. Actually, however, the trial balance is a powerful check, and that for more than one reason.

(*a*) Very often the different volumes of the ledger are kept by different persons. The credit and debit are very unlikely to be both entered wrong to the same extent by different persons.

(*b*) In the act of taking out the trial balance, every item is closely scrutinized, and, therefore, errors are likely to be discovered.

(c) The fraudulent clerk, or book-keeper, in his nervousness, is almost certain to make some trifling errors of a few pies. Wherever such errors are revealed by a trial balance, there is ground for suspicion. The accounts in which they occur should be very carefully checked in comparison with the **vouchers.** The "**vouchers**" are the original documents on which the ledger is based. (See the next chapter).

But all the above falls to the ground unless an exact balance is insisted upon. There must be no "*near enough*" about a ledger trial balance.

**Loose leaf ledgers** must not be used. It is permissible and convenient to have other books of accounts of this type, but not the ledger. Every volume of it must be solidly bound, so that it is impossible to remove a page without leaving traces of the operation.

## Profit and Loss Account

This is not one of the ledger accounts. It is an approximate document produced once a year with the aid of the ledger, but unlike it, having many of its items mere guess work, such as, for instance, the loss by depreciation of buildings and machinery. If the income shows a surplus over expenditure, including dividends paid to shareholders or partners, or if the expenditure is greater than the income, the difference is added to the deficient side as "Transferred to Capital Account." It appears again in the balance-sheet, which will presently be described as "Transferred from Profit and Loss Account."

The profit and loss account, if it fulfils its purpose, shows whether the business is prospering or not. It does not pretend to show whether it is solvent or not. That is reserved for the—

## Balance-Sheet

The reader has already seen the balance-sheet of a bank in an earlier chapter. The balance-sheet of any business is constructed on the same lines; on the left, under the heading "**Liabilities,**" are shown all the business owes, including the capital subscribed by its founders, and, on the right, under the heading "**Assets,**" all that it has. It occasionally includes among the assets such items as "**Goodwill,**" which means the additional value of material assets, because they are assets of an established business enjoying the "goodwill" of a number of old customers, and "**Patent rights.**" Both of these may well be of great value, but the value may vanish in a few months. They are not satisfactory assets. They are the rotten spots corresponding to "other investments" and "mortgages" in the balance-sheet of a bank.

## Auditing

There is no reason why the ordinary five-eighths engineer should not be able to understand a set of account-books honestly kept. But book-keeping is a skilled profession, and the dishonest book-keeper would probably succeed in throwing dust in his eyes. It is advisable, therefore, to have the books checked from time to time by an expert accountant. This process is called "**auditing.**"

**Object of Audit:** This is primarily (1) to discover errors. The fallibility of the person or persons keeping the books must be considered. You may invent a perfect system of book-keeping, but no ingenuity can prevent a wrong figure, or some other error in posting or entering, from creeping it occasionally. The audit is supposed then to bring errors to light both *clerical and of principle*; (2) to detect fraud—(*i*) fraud may involve direct misappropriation of money; (*ii*) the books may be manipulated for some other purpose—to make the business appear a more flourishing one than it really is, or the opposite, in accordance with the scheme or policy of the manipulator; (3) the misappropriation may be of assets other than money, for example, goods or securities. It is, however, with regard to receipt and payment of money specially that irregularities are most likely to occur.

**Plan of Audit:** Every audit should be so conceived as to leave nothing to chance. The production of **vouchers** should be required for all payments, and it should be ascertained that such payments have been legitimately made *for the benefit of the business.*

**Different kinds of Audit :** Audit is conducted by persons unconnected with the business—one engaged from outside to check the books and make an independent investigation into the financial position of the undertaking.

An audit may be conducted in whole, or in part, by the members of the staff of the business concerned.

Where the auditor and his staff are occupied throughout the year in checking the books, the audit is said to be **continuous one** in contradistinction to a **periodical audit** where such checking is differed till the close of the financial period when the balance-sheet and profit-loss accounts are made.

It may be deemed advisable, under certain circumstances, to institute a **surprise audit**. Remember however that distrust often breeds dishonesty, and furthers the weakening of the good relationship between employer and employee, which is likely to ensue, as a concomitance of unjustified suspicion is not a condition which should be lightly evoked. Surprise audit should, therefore, be conducted with due regard to the susceptibilities of the staff.

The following books are recommended for further reading—" The Primer of Book-keeping," " Book-keeping and Accounts;" both, by L. C. Cropper, are excellent straightforward text-books.

# CHAPTER VIII

## AUXILIARY BOOKS

THE best known of these is the **journal.** Many people think it an indispensable book and as many others think it a useless relic of the now obsolete single entry system. It is, as its name suggests, a day by day record of all transactions that take place. Ledger entries are copied from the journal.

It is undoubtedly an advantage to be able to see in one place everything that happened at a particular time, just as it is an advantage to be able to see in one place in the ledger all that happened with regard to a particular firm. But it is better to have no journal at all than to make it an excuse for delaying entries in the ledger.

The really respectable good old style English book-keeper enters everything in the journal in order to study it, and be quite sure that it is right. He makes notes (in the journal) as to what ledger accounts should be debited or credited with particular items or parts of items. Having done this, he rolls up his sleeves to the elbows, fills his *davat* with fresh ink, gets a new pen, washes his hands three times, and proceeds to copy the entries into his ledger in the loveliest writing he is capable of. If he had the misfortune to make a blot, or a mistaken entry, he would rush madly from the office, and probably destroy himself. He very properly regards the ledger as the symbol of his honour, and treats it accordingly.

**The bank book** is a copy of the firm's account in the bank's ledger. All the reader has to do with it is to keep it properly locked up in a different place from that where he keeps, with the same care, his cheque book. The bank book is sent to the bank periodically to be posted up to date. **The cheque book** is a book containing blank stamped and numbered cheques, also supplied by the bank.

**The Order Book.**

No. 99

Date..........

*From*

MESSRS. A. B. & Co.,

*Benares.*

*To*

Messrs..........................................

..........................................

Please supply. ..........................................

..........................................

..........................................

..........................................

..........................................

(Signed)..........................................

..........................................

No. 99

Date.........

*From*

MESSRS. A. B. & Co.,

*Benares.*

*To*

Messrs..........................................

..........................................

Please supply..........................................

..........................................

..........................................

..........................................

..........................................

(signed).. ..........................................

..........................................

Please quote above number in rendering invoice and account.

**The order book** is like this. The order is made out in duplicate, and the right-hand copy is sent to the suppliers, the left or "**counterfoil**" remaining as a record. Alternatively the order may be written only once over a carbon sheet, but that is a sloppy method.

In a business of any magnitude the signing of orders tends to become a troublesome matter, and the important and responsible officer who alone should have power to do it, is likely to find it a tiresome duty. Sooner or later some helpful person is sure to suggest a rubber stamp. The correct reply to this is "Get thee behind me, Satan."

Very often each department of a big business has an order book of it's own; each with a distinguishing letter as A 99, B 99, C 99, etc. The head of the department, or indeed any subordinate, may fill up an order form. But, only the *Burra Sahib* should sign either foil or counterfoil.

## The Bill, Invoice and Credit Books

Except for the heading "**bill**," **invoice** and **credit notes** (the last usually in red) should be in conspicuous letters at the head. These three are practically identical in form and wording, and are in duplicate as the orders are. They each embody a list of goods, their prices, and any other information the merchant may wish to give his customer, as, for instance :—

Discount for cash payment.
Interest charged on overdue accounts.
How and to whom payment should be made.

"E. and O. E." meaning *errors and ommissions excepted*, which is a way of saying that the merchant reserves the right to make corrections later if he discovers some mistake.

The invoice is sent when the goods are despatched. It is not, as its wording would seem to imply, a demand for payment. It is an intimation to the customer that he has been debited with the goods, as Tewari debited Chakravarty with the hundred chairs in the last chapter.

INVOICE No. 67

Date.........

Messrs.........................................

...............................................

Dr. to Messrs. A. B. & Co.,

Benares.

...............................................

...............................................

...............................................

...............................................

INVOICE No. 67

Date.........

Messrs.........................................

...............................................

Dr. to Messrs. A. B. & Co.,

Benares.

...............................................

...............................................

...............................................

...............................................

E. & O. E.

All payments, etc.

Except that the heading is "bill" instead of "invoice," and the number is different, the document which follows a few weeks later, probably at the end of the month, is a duplicate of the above. This time, however, it means "Kindly pay up."

In the meantime, however, the firm may have returned some of the goods for some reason satisfactory to itself. It is not good business to refuse such returns from a good customer, even though the reason may not appear very convincing. They are usually accepted, and a "credit note" is sent, which intimates to the customer that he has been credited with the goods, just as the invoice, which would be more properly called a debit note, informs him that he has been debited.

**Receipt Book.**

No..................

Date..................

Received from..................

..................................

..................................

..................................

..................................

Rupees..................

in $\frac{\text{full}}{\text{part}}$ payment of

Bill No..................

Rs ........a.......p......

---

No..................

Date..................

Received with thanks from..................

..................................

Rupees..................

in $\frac{\text{full}}{\text{part}}$ payment of our Bill No............

Anna stamp, if Rs. 20 or over.

Rs.........a.......p......

The *Burra Sahib* initials the counterfoil and signs the foil.

## Petty Cash

This is a fruitful source of income for the dishonest clerk, and requires careful watching. "Petty cash" means small sums for emergency expenditure. It is not possible to avoid it altogether, but unless carefully watched, it will grow and grow until it altogether supersedes the proper method of ordering formally, as described above. The standing orders should include one specifying the maximum value of a single petty cash order, and another specifying the maximum monthly total of petty cash orders. Let us suppose the latter is Rs. 500-0-0. This rupees five hundred is the "**imprest cash.**"

On first taking over his duties, the petty cash clerk is given his imprest cash, and at the end of every month, the money he has spent is returned to him in return for his vouchers. A **voucher** is a written evidence that money has been spent on proper instructions. It is the duty of the office-organizer to see that proper instructions are always given. A verbal order is not a proper instruction. A statement in the handwriting of the petty cash clerk himself is not a proper voucher. A. V. P. P. cover, without the initials of a responsible officer over the same date as the post mark, is not a proper voucher.

If a messenger has to be sent into the bazar to purchase some trifle, the following form should be used.

No............

Date..........

To.....................................

Please supply.....................

.......................................

.......................................

.......................................

.......................................

.......................................

.......................................

.......................................

.......................................

.......................................

For....................................

.......................................

(Signed)

No............

Date..........

To.....................................

Please supply.....................

.......................................

.......................................

.......................................

.......................................

.......................................

.......................................

.......................................

.......................................

.......................................

.......................................

.......................................

(Signed)

No............

Date..........

Received from

.......................................

.......................................

.......................................

Rs...............a..... p......

for....................................

.......................................

.......................................

(Signed)

Only the two inner forms are filled up. The two outer ones are torn off in one piece, and go with the messenger. The merchant retains the central one, and sends the outer one, back with the messenger, duly receipted.

Each departmental foreman may have one of these books. It should not be necessary to trouble the *Burra Sahib* every time a box of tacks or the like is required. The petty cash clerk should be instructed to advance money on sight of the two inner forms initialled by the foreman. It is his duty to see that he gets the receipt within an hour or two, and the change, if any.

## The Petty Cash Book

The petty cash book may be kept in journal form. The ledger should contain a petty cash account, which should be credited everyday with the amount spent " As per vouchers No. A 33, E 57, F 20, etc.," and debited once a month with imprest cash renewal. The debits corresponding to the petty cash account credits will be in various accounts. A bottle of gum, for instance, will be debited in the stationery account. The imprest cash renewal is credited in cash account.

## The Stamp Book

The stamp-book is a journal record of all letters and parcels sent out, the addresses and the value of the stamps affixed.

## Filing and Indexing

It will not be long, even in the smallest business, before you have an immense accumulation of letters and miscellaneous papers of all kinds. Most of them you will never read a second time, and might as well destroy. But, owing to some malign demon, if you destroy the least important of them, you are certain to want to consult it within a week or two. But even if you chance that, and keep only the ones that strike you as likely to be useful for reference later on, the accumulation will be such that looking for any particular one will be like looking for a needle in a hay-stack. You must endeavour to keep not only all the letters and papers you receive but also copies of all you send out, and store them in such a way that you can lay your hand on any one of them at any time with the least possible delay. There are a number of systems, of which we will describe one only.

All letters as they come in are numbered thus 75-2-25. This means that this is No. 75 in a *binder* (*file*) numbered 2. If your business is a small one, you may use one such file at a time for all papers. If it is a large one, you may keep any number going at the same time, one for each department of your activities. As the letter or paper is fastened in the file, it should be entered with its reference number in a **subject index book**. Thus, if the letter referred to above is one from a Mr. Dass, recommending a foreman blacksmith, it will be referred to twice; once under the letter D thus:—

Dass (recommending foreman) 75-2-25, and again under F thus:—

Foreman (recommended by Dass) 75-2-25.

It is possible we have omitted one or two necessary books from this lecture, but we hardly think so. But we have omitted many that are to be found in many offices. The ordinary clerk can never be tired of copying from one book into another. Moreover, he always has numbers of friends that will only be too pleased to do the same at your expense. In this connection you should remember that you are an engineer and act on the sound engineering principle that a machine is all the better for being simple. Complexity is occasionally necessary to achieve the object in view, but it is always an evil and should be avoided as far as possible.

In this chapter we have described the indispensable books of an ordinary business, and, for the sake of a clear understanding, have given no alternatives. None of these forms is to be regarded as sacred. As far as the office is concerned, however, the list should be considered practically complete. It is a good engineering principle that a machine is none the worse for being simple, provided it fulfils its purpose. It is only the shallow-minded that are impressed by a needlessly elaborate machine.

The *purpose of an office organisation* is to free the responsible head of all routine business, at the same time enabling him to trace every happening, together with the responsible person, no matter how much time may have elapsed since it did happen.

It is the first duty of the director of any business to rid himself of all routine work. Every detail of it should be entrusted to some subordinate with very clear and exact instructions. It is the sure sign of a good manager that he never seems to have anything special to do, and has always ample leisure to attend to anything exceptional. It is the sure sign of a bad one that he is always busy, always distracted, and never has time to spare for anything.

There is one kind of business worse managed than that in which the manager does everything himself. It is that in which subordinates are allowed to adopt the apparently delightful and simple course recommended for the manager, and hand on their work to their subordinates. In that case the work is done or left undone by the coolies in the end. The manager should not do any routine work himself, but he should see that it is always done by the man he intended should do it. *He should be present and vigilant before the first employee arrives in the morning, and should be the last to leave in the evening.* He should not fuss about those employees who do their work properly. Where that is not the case, he should inquire carefully, and without prejudice, what the reason is. He will, as often as, not find that a good man is being turned into a careless one by having too much work elbowed on to him. In that case the work should be transferred to some one else. It should not be taken over either temporarily or permanently by the manager himself. When every man has as much work as he can do well, in a full day, and no more, then the manager can get on with his own work, which is the careful and continuous consideration of new developments and improvements.

## Correspondence

A few instructions on business correspondence will not be out of place in a country which is purely agricultural.

**Correspondence.**—Many businesses depend almost entirely upon it and in all businesses correspondence has daily and essential part both in its ordinary routine and in its special effort. The difficulties of a certain negotiation may often be avoided in correspondence when interview would be fatal. As a means of persuasion and expression a well-written letter forces itself everywhere, whereas interviews may be curtly denied, although tongue is a nicer instrument and pen is a surer instrument. But it must be remembered that a letter is a committal and in law the best evidence against the writer. An incriminating letter will do more harm than any injudicious conversation; it stands or rests in file or docket, and is always a proof against you.

A business man will attend to his correspondence or see that it is attended by the person whose duty it is, the first thing in the day. All correspondence should pass through responsible hands.

The most effective letters breathe of sincerity and enthusiasm for the merits of the proposition offered and the advantage to the customer if he should close with the offer. The letter should look from the contents as much as from the typing as though it were a special letter sent to one individual and to him alone. Upon this innocent deception its success hangs. A hasty and embittered correspondence should have no place in a business man's affair.

**Property in a letter.**—Once it has been posted, the writer parts with the property in it, but the writer can afterwards restrain the publication of its contents if it would damage him—the recipient is really owner of the paper upon which it is written.

If the letter is marked "**private,**" it is subject to the same rule, the limitation being one merely dependent upon the honour and good faith of the recipient.

A letter marked "**without prejudice**" or said or implied to be written "without prejudice" conveys statements or proposals which are not to affect the general position of the parties. In case of litigation letters so marked are not read in courts with other correspondence.

but are treated in the nature of overtures which did not result in a settlement and therefore ceased to have any effect. A *letter may often form a contract in itself.*

**Libellous letters.**—In this the "*publication*" of the libel is essential. But the only letter which escapes the inference of publication is one which has been entirely written and sent under cover by the writer, being received and read by the person to whom it is addressed without the intervention of a third party.

The contents of a **post-card** are public to the world and apart from the law of libel, post-cards should be seldom and very cautiously used in business matter.

When a paper is to be printed, take care of capitalization, punctuation, and style.

**Style of letters.**—Letters should be convincing and attractive. It should be clear, precise and tactful. It should explain its purpose. It should be courteous and agreeable Avoid long and unpunctuated sentences.

**Punctuation.**—Preserve the sense; avoid long sentences. Every sentence should end with a full stop, every separate statement in a sentence with a semicolon, while a comma should separate all clauses and phrases.

**Composition and direction.**—Letters may be—(1) **opening** of a correspondence. In this case you should have special regard to its purpose so as to secure to all a favourable impression. (2) A **reply** should cover all the points raised. In replying you must have before you the letter just received, as well as the series of your own and your correspondent's. The answer should be complete. The name and address should be carefully and correctly written and should be under the supervision of the most careful clerks. The **address** should be very carefully written, otherwise the good effect of the letter will be thrown away. Incoming letters should be stamped with date of receipt, endorsed if answered, and may be entered in a **"Letters Received"** Book.

**Commencement and finish of a letter.**—The ordinary form would be "*Dear Sir,*" or "*Dear Sirs*"; concluding "*Yours faithfully.*" But on strictly official and formal occasions, or when an order is solicited in retail business, the style should be "*Sir*" or "*Gentleman*"; concluding "*Yours respectfully*" or "*Your obedient servant.*" The more familiar "*My dear Sir*" should not be used in ordinary business correspondence, but may be used alternatively with "*Dear Mr.*" when written to a personal business friend. The letter should then conclude "*Yours truly*" or "*Yours very faithfully.*"

When the **signature** is not of a partner, better use a rubber stamp with the firm's name, the individual either signing "*for*" or "*pro*" the firm or the firm "*per*" himself, his full name being better than initials.

**Note-paper.**—The paper upon which a business correspondence is written and the **envelope** which covers it, claim careful consideration. Quality should not be overlooked in either. *It is a poor policy to save money on the vehicle by which you make your introduction.*

The **heading of note-paper** is to be very carefully printed. It should contain the name of the firm, telegraphic address, telephonic numbers, cable codes, etc., where possible, names of the partners and addresses of branch houses.

Envelopes may also afford a place for names, but they will be more effective when quite plain.

# CHAPTER IX

## ORIGIN OF INDUSTRIAL SYSTEM

**Industrial engineering** is the systematized and formulated science of management. It deals with the efficient conduct of manufacture of any thing, any constructional or transportation works. or, in short, any organization in which human labour is mobilized and directed to do some work.

For its fundamental and **underlying principles,** it depends on engineering—mechanical, electrical, etc. ; economics, sociology, psychology, accountancy, and the like ; but then it has a distinct science of its own, embodying all these principles. Industrial engineering does not consist merely in managing accounts or running a power plant, but in a harmonious co-ordination of all these things and others for the efficient conduct of construction or manufacture of anything.

**The cycle of operation,** involved in the above-mentioned process of manufacture, can be summarized thus Convert money into raw material and labour, turn this raw material and labour into a finished product or service, and finally convert this finished product or service back into money. The difference between the first money and the last money is the **profit** which invariably depends on the market conditions and commercial competition. Our profit as in a hydro-electric scheme depends not only on the volume passing from one level to the other, but also on the losses and the efficiency of conversion which may be either commercial manufacturing or administrative. These losses in our analogy of hydro-electric scheme may be hydraulic, mechanical, or electrical.

The industrial engineer may have mechanical or electrical engineers to direct and supervise special departments like the design or construction or the running of machinery, but his business is to co-ordinate all these elements for the one great, central purpose of *efficient* *and economical production.* He has to deal not only with the forces of Nature, but with men and their methods. His work not only covers the technical field, but extends all over the management of men and the definition of direction of policies. He begins with analysis.

**The main aim** of the analytical functions is to spot out the weak points and apply the necessary remedies to the attainment of higher efficiency and better products.

The second phase of industrial engineering—the **active, creative and synthetic phase**—does not limit itself to the production of the same old article more economically, but devises new ways and means and develops new ideas and aims at doing a new thing better than the old.

This science does not deal so much with the mechanical and abstract side of things such as the design and construction of machinery, but is concerned with **selection, arrangement, installation**, and **operation** of machinery and their influence on the total cost of the product to be turned out.

It does not concern itself so much with the properties and characteristics of materials as with the ways and methods of performing work and the methods of securing high efficiency in the output of men and machinery. To this end it deals with the recording of times and costs and the keeping of accounts.

It deals with **management**—with the conduct and direction of any industrial organization. Further, it deals with **men and their mentalities**—with the influences which stimulate their ambition, enlist their co-operation and assure the maximum output. Also it deals with **markets**—with the economic principles affecting them and the method of creating, controlling and enlarging them. Thus the most important elements of industrial engineering may be summed up as—**men, methods** and **machinery, materials, management** and **markets.** Also it deals with **money** which supplies the gauge and limit by which other factors are all measured and adjusted.

This money problem is one which is limited not only to the industrial engineer but to every sort of engineer—civil, mechanical, or electrical.

The chief function of the industrial engineer is to see if any discrepancy exists *between* expenditure and, if so, to analyse the causes and apply the remedies.

Further the industrial engineer has to be aware of another force—**competition,** which though in one way has been a tremendous force for economy, in manufacturing, is still a source of waste, by causing duplication of plants and organizations.

As we have already seen, the industrial engineer has often to deal with men and in all such cases the *psychological element is* of immense or even of controlling importance. When we are dealing with men, we cannot apply the principles of science—in spite of their being undeniably true—without heed to the personal equation;—or else failure will follow. Thus success in handling men and women—which is in no small measure essential to the industrial engineer—is founded on knowledge of human nature—which is psychology.

Thus we have seen that the industrial movement embodies in itself chiefly three elements—the **technical** or **scientific, economic** or **commercial,** and **human** or **psychological.**

## Reflex Influences of the Industrial System

We may sum up these influences of the industrial system in three words—as **aggregation**, **standardization** and **specialization**. Let us consider them in detail one by one.

**Aggregation** means the continued accumulation and enlargement of the industrial unit and is the essence of capital, machinery and operatives. This aggregation is a functional necessity and even an organic part of the industrial system. Let us consider its good and bad aspects. Taking the case of a factory, naturally a big one is better than a smaller one. Its overhead charges—for *superintendence, maintenance* and *administration*, are decidedly less per unit of product manufactured than in the smaller one. If wisely managed, it is often in a position to undersell its small competitor and deliver at an equal price an equal or a better product. It is often true that a big concern attracts the best brains available, and its influence, prestige and control of trade connections are likely to be greater.

Let us consider the second aspect—**specialization.** In this the work of an individual is limited and he is to repeat the same small element of the entire process.

Thus we can easily see that under this system, the skilled all round artisan disappears. An old cobbler can completely make a shoe, whereas in a modern shoe factory we cannot find any workman who can do more than a single part or process of it. It was only when small elements are repeated that parts of the work could be separated, that is *specialized.* The complete process is thus *cheapened*, because each part of it has been cheapened. Thus this product can be sold at a lower price which naturally finds a larger market. And this in turn leads to an enlargement of the plant, this leading to aggregation and the whole cycle repeats itself.

Then we shall consider **standardization,** which means the execution of work by standard or fixed patterns. *This is a result of aggregation and goes together with specialization.* In this the skill is centred in the designers, and the *actual workman becomes a mere reproducer.*

**Standardization** is reduction to type and this can be carried to any degree of completeness. The parts comprising any machine or made separate by individual workmen are such that none of them might have a chance to know the complete manufacture. In this not only the pattern is standardized, but even the time of production is scheduled and the workman has to follow them implicitly.

Thus the idea is everywhere to concentrate the skill and thought on the production of the best possible type and to make the reduplication of this a merely mechanical process. The production of the original requires much talent and expenditure; but then this labour through constant repetition attains unimaginable rapidity.

The natural **result of standardization and specialization** is what is known as "**mass production.**" We shall say more about it in a later chapter. In this though, as already explained, the individual skilled artisan disappears, articles are manufactured in a variety of standard types and the buyer can very easily select one to suit his requirements. Further it has another advantage—**interchangeability of parts,** which facilitates renewals and repairs. Thus three important advantages are inherent in the system—**cheapness, promptness** and **easy renewal** and **repair.**

These three aspects—aggregation, standardization and specialization—are all interlocked. It was only when a large number of men or machines are collected that, it became desirable to bring the article to be manufactured to a standard pattern, and when this had been done, the parts could be separated or specialized. The cost of production being thus cheapened, the article finds a larger market and the increased demand makes it more necessary to extend the plant ; thus aggregation receiving a new impetus and the whole cycle repeats on itself.

**Unfavourable aspects.**—The first is that these aspects specially standardization and specialization gave a death-blow to the above skilled artisan. There is very little opportunity or scope for a modern workman working in a factory to know beyond the manufacture of a single part of any article, and neither does he care to learn because his wage inducements forbid it.

The second unfavourable aspect is that private standardization (standardization of a special manufacturer's product) is wholely undesirable, because it *results in inflexibility* and *stagnates progress.* There is a strong criticism, and a just one, that Americans are losing their mechanical supremacy through overstandardization and adherence to standard products. It is to be noted that the lesser the standardization, the more is the scope for elasticity and further improvement, thus improving the quality of the product and reducing the price of production. And it is partly the duty of the present industrial engineer to check the wave of overstandardization and thus avoid the crisis of ossification and inflexibility which are a natural consequence of overstandardization and overspecialization

*The main theme of specialization is to replace breadth by depth, extensiveness by intensiveness, thus making the standard product better but impeding all further advancement.*

In this connection we have to consider another aspect of the problem—the *relation between the employer and workman.* This is the submergence of the individual in the class. And it should be noted that when a plant employs thousands, it is very improbable that an individual can show himself or that he will have an impetus or ambition. Nor it is probable or possible for the superintendent to note any man particularly or encourage or reward any man individually for his better talents or work.

Then we are to note that a direct *result of the submergence of the individual is the elevation of the class into the attitude* of the individual, which becomes all the more powerful in its demand for recognition Here the standard of work sinks to that of the least efficient ; but the wages tend to rise to the highest owing to the power of union and collective bargaining. This is not at all welcome to the employer, but a situation against which he cannot murmur, for he himself had created the situation—not the innocent worker.

# CHAPTER X

## BUSINESS

As so many of our readers are likely to take to business it is deemed necessary to write a few words on it.

*The root of business is service to the community.* This statement is undeniably true, but the modern aspirant to business' success is not seeking the root of business, but its fruit.

### Maxims for a Business Man

There are plenty of maxims which hold good in business life to-day, as that of Lord Chesterfield, "Dispatch is the soul of business; and nothing contributes more to dispatch than method"; or that of Francis Bacon, "A man must not expect to sow at once; but he must prepare business, and so ripen it by degress"; and also that French one, with more subtlety, "Activity makes more fortunes than prudence."

### Temperament and Training of a Business Man

The business man is a compound of **temperament and training.** The former is the more important one. A man with the temperament can acquire the training, which is a matter of experience or observation, and until he has acquired it he can hire it in the person of someone else. But the training without the temperament will never rise to high success. It cannot carry its possessor into the ranks of the captains of industry and commerce.

Every successful business man is a blend, in due proportion, of **caution and self-confidence.** But the most conspicuously evident characteristic of the good business man is **quickness of decision.** He can weigh up a proposition and decide upon it without delay. He must have sound judgment, or his quick decision becomes mere rashness. But with quick decision and good judgment a man is bound to succeed in the business world.

The man of business temperament is essentially a man of action.

Success in any business depends largely upon the man in it having a *definite purpose.* We have too many purposeless workers. Have your object something tangible and definite, and employ your whole energy to reach it, always keeping a clean record. To have recourse to dubious methods, even if they look promising for a time, always spells failure in the end. But with hard work and straightforward dealing a man will eventually "get there," as the saying is. We consider there never was a time when the opportunities in business were so promising.

He must have sufficient *sense of responsibility.*

Under the term **'responsibility'** is included financial responsibility. **Untarnished credit,** the reputation of meeting every obligation on its due date, is the business man's most valuable asset. He who practises the policy of prompt payments should, of course, see that he gets the utmost farthing of advantage from his cash payments.

## Business Qualities

**Accuracy** is an essential business quality—accuracy in work and accuracy in statement, Accuracy in taking a size, in estimating a quantity, in making a price, in dates, and in figures—this is essential. Inaccuracy causes waste of time in tracing the error at a later period. It may waste money in having sent the wrong goods in either kind or quantity, and the inaccurate man is a dread to his business associates and expense to his business. The spirit and practice of accuracy can and should be cultivated. It consists simply in taking pains, in paying attention to details at the beginning of a business career.

**Tact** is yet another essential business quality. Many men fail through want of tact. They are accurate trustworthy, but their assurance and assertion of accuracy amount• to aggression, and it is positively dangerous if they are allowed to conduct negotiations. Accuracy may become a fault when it travels beyond its province, and tact must come to the rescue if business is to go smoothly. Tact will carry much further than argument or logic, and the best salesmen are those with the qualities of a diplomat, not those with the qualities of an accountant or a disciplinarian.

Another necessary quality is the **ability to distribute work and responsibility,** and the **judgment** when and where to depute it. **Truth** and **honesty, scrupulousness** and the practice of the golden rule indeed carry their reward, and the exercise of these qualities is not inconsistent with money-making. But upon far higher grounds than that of business policy *these qualities should be practised and encouraged. Their reward is personal rather than material.* However, **shrewdness** which becomes sharp practice and business instinct carried to the point of sweating do too often carry their reward of gold.

## Business Ability, Adaptability, and Training.

In these days the greatest successes in business have been men who, with a thorough general training, have been able to apply their minds to the opportunities which presented themselves at every turn.

In modern business there are **three prime factors—the man** or the personal factor, **money** or the financial factor. and **system** or the methodical factor.

The sciences enter largely into modern business—chemistry and physics, mechanics and metallurgy—and expert knowledge of these things and experience cannot be picked up. It is the result of years of training. But expert knowledge is apt to narrow a man's outlook. With a few exceptions—where business aptitude is not prevented or killed by deep scientific knowledge—*the knowers are not the doers.* The scientists usually find second places, as aides-de-camp, chief intelligence officers, to the captains of industry. They have not the skill to put this science to the most profitable use for themselves. It is the same with inventors. How common is it to find that the inventor never reaps the benefit of his invention! The act is proverbial. The study of law and finance constitutes the best training for a commercial career. Such a knowledge can be picked up if the man has the aptitude to assimilate it, and to store it in his mind until he has a use for it.

A provincial apprenticeship training, a few years of experience in one or more city businesses, particularly in the buying department, and a year or two on the road constitute the best possible trade education. In other words, change and movement not only widen the experience, but give more, and sometimes better, opportunities

*There is no reason to despair. We must not forget that as long as some men are clever and some stupid, some strong and others weak, some rich and others poor, some thrifty and others extravagant, some theorists and others practical, some lazy and others industrious, so long will there always be a place and an opportunity for competent Indians, whether they have money or not, in almost any land in which an Indian can live. To the right class of men, trained and keen, there are endless prizes in store. It is for you to grasp them by your industry, honesty ability, civility, punctuality and self-help.*

## Elements of Business

The **capital** of a business is its backbone, the **personnel** of a business is its brain, and the **system** in a business is the life-blood, making the organism healthy or diseased, sluggish or energetic, moribund or vigorous with strenuous life. The analogy must not be pressed too far. In the human organism decay and death come as a matter of course, no matter how much care be taken ; but in the business organism life is perpetual if the elixir of life called business system be injected into the veins.

**Hard work** and **good intentions** go far, but they are frequently powerless in face of running expenses which drain the exchequer and sap the credit before the profit-earning stage has been reached.

There is only *one way in which the man with limited means at his disposal should tempt the god of fortune.* Before casting the die, he may make arrangements for accommodation from a more liberally-provided social or business friend, should such accommodation prove to be necessary. If the man has a good practical knowledge of the branch of trading or manufacture that he elects to follow, and if he can also show a clean record for shrewdness and integrity, he should not have far to go in his search.

There would be nothing philanthropic or altruistic about this accommodation. It would be purely a business matter with the house, who reap their reward upon the profits of the goods sold. Their security is ample, so long as they have the power to examine his position at any time. Of course such an arrangement would not be entered into with a man of whom they knew nothing. But the man who receives such accommodation should not tie himself up so that he could not call the business his own, and any over-stringent agreement which gives the house the power to turn him out of his own business at any time, should be rejected. Under an accommodation agreement the obligation would decrease as business improved, until the man was able to stand quite on his own legs. One commendation may be urged with force. With any firm making such an arrangement he should be perfectly open, revealing his whole position and concealing nothing. He is building up his credit, than which there is nothing more valuable to the business man. His credit and good name may stand him in times of stress in as good stead as a bank balance, and he cannot without grave risk afford to toy with them.

But there is another truism that is equally well-known, but frequently overlooked—the capital necessary in a **cash** business is much smaller than that necessary in a **credit** business. In many businesses as the debts owed by customers are as high in the aggregate amount as the value of the stock on the shelves and in the warehouse.

Then among the various credit businesses those in which the credit is the longest are the least desirable. Even if a man acquire a business where credit is long, he should try to inaugurate at once a system of shorter credit. Shorter credit gives the business man a wider field for the employment of his money, and the customer benefits by lower prices. The buying power of the trader is increased by the possession of larger capital. There is more in this statement than meets the eye.

**Cash reserves,** or what is of the same value in trading, banker's accommodation, is in many classes of business especially valuable at many seasons of the year. It would be uneconomical finance to have the cash employed in the business large enough to meet these demands upon it and remain to build up a non-interest-bearing bank balance during the remainder of the year. But it is wise to take advantage of all cash discounts upon such purchases.

In many departments of trading, **speculation** is a recognized feature of business. Especially in raw materials, and semi-raw materials the prices of which may fluctuate widely, there is scope for the shrewd man who can gauge the immediate future, and who is bold enough to seize what he believes to be his opportunity. Such a man would be seriously hampered in his operations if he did not have cash reserves at his disposal wherewith to conduct his operations. There is, of course, risk in the practice.

## Extension of Business

A business should be gradually extended, department by department, in accordance with public demand. Overworked departments must be split up as the business grows. Departments like the business which they make up, grow because the public demand their growth.

A **business man should know** the following :—

(1) Raw materials—where they are available,—where they can be purchased and where they can be sold—their selection, valuation and transport to places where they can be sold to advantage.

(2) Where to ship for transport and how to load and deliver goods and to whom.

(3) He should visit museums and exhibitions, examine the different exhibits, inquire their places of production—whence they are to be imported and where they are to be exported and their places of manufacture. He should have a thorough knowledge of the country and

country produce—good and bad, and of any other thing which he is going to deal with in his business capacity. He should have a good idea about their price and make a graph of their variation of price and the causes of fluctuation of price. He should know how to adulterate the goods, and the adulterants. He should further know the cost of labour necessary for manufacture, transport, etc.

## CHAPTER XI

## ORGANIZATION

HIGH economy, secured by organizing industry, town and country life and the means of transport, enables a big population to create economic wealth under conditions which conserve the first essentials of the health of the people. The meaning of a good wage must be studied in the light of these things. It serves us nothing to speak of wage, or rates—high or low, unless we create conditions under which a wage produces the means of a happy and comfortable life. If a town is badly constructed, with narrow streets and ill-ventilated, badly-lit houses, and if it has few open spaces and play-grounds, and poor places of amusement, and if the means of transport within it and around it are inadequate, no wage rate paid in it, however high, can afford the wage-earner a really good wage. In such a city no rumuneration whatever can alter the main conditions of existence. Such conditions spell poverty because the means of life have not been properly thought out and organised.

Thus we have continually to apply our efforts not only to the production of commodities, but to the production of the right kind of commodities in the right place. The possibility of health for all emerges from such considerations. Most certainly everybody cannot be rich, because the state of being rich is the state of possessing advantages superior to those possessed by the majority. The state of wealth is another matter, if we interpret **wealth as well-being.**

The real source of wealth is not treasure-hunting, but **well-directed hard work.** There is no other means by which a nation can make itself prosperous. It is true that in ancient times one nation could make a raid on another, steal its possessions, and make slaves of its inhabitants. That was a not infrequent happening. To-day such wholesale despoiling and enslavement are, happily, no longer existing, and we live in a world in which the prosperity of any one nation is bound up with the prosperity of every other nation. Even if we had the power to ruin other nations, our action would only recoil on ourselves, because *we can only live by trading with prosperous customers.*

There is no reason why, with the wonderful scientific devices now known to mankind, modern men and women should not by their labour make each other healthy, happy and comfortable. The quantity of wealth in its economic sense (commodities having value in exchange) necessary to serve the conditions of health and happiness is not so great that we may not hope to achieve its output. Every department of human productive endeavour is now furnished with working appliances which make the modern worker the equivalent of tens or even hundreds of his predecessors of a century ago. *Thus each man, given proper* **organization,** *becomes a company of men, and each man's hands become a score, a hundred, or a thousand.*

It is true, then, that the nation can hope to grow wealthier, but not by any royal road. The only avenue to a better economic condition is that of **well-organized** and scientific human endeavour on national and international lines.

**Organization** is fundamentally a practical plan for subdividing the conduct of any undertaking into parts, each small enough to be handled by an individual, by a method that enables all to work together. The efficiency of organization depends on the wisdom and skill with which this division is made—the success secured not only in selecting efficient individuals, but in arranging that each may work at his best efficiency, and all work may keep balance and harmony in achieving the desired result.

**The actual executive function**—that is, the function of getting things done as distinguished from determining what shall be done—must always be **autocratic. Policies** may be determined as **democratically** as is desired. The more intelligent, educated, trained minds that are brought to bear upon the consideration of policies, the more liable these policies are to be correct. However, democracy in industry, as in everything else, must, if it is to be efficient, go hand in hand with training and research. Organisation in industry grows out of, and is based on, the fact of specialization—there can be no organization without specialization.

There are two different types of organization :—

(1) Line Organization.
(2) Staff Organization.

(1) **Line organization** is essentially simple mathematical subdivision. It is essential to discipline and essential to the continuous existence of the whole body.

Each staff must have a line organization within itself for discipline and continuity ; but every complete organization must embody the principles of both line and staff to secure the best results, the staff supplying expert functional guidance, applied through the line's direct control.

(2) **Staff organization** is a division according to functions such as by which a military department does all the engineering work for an army, another supplies clothing, etc Staff organization is essential to efficiency, each branch of it in its own particular function.

**The principles of efficiency are :**—Ideals ; common sense and judgment; competent counsel ; discipline ; the fair deal ; reliable, immediate and accurate records ; planning and dispatching ; standards and schedules ; standardized conditions, standardized operations, written standard practice, instructions ; and efficiency reward.

Under line organization, the foreman is supposed to decide every question for the men under his particular control—employment or discharge, wages, jobs, difficulties with materials, difficulties with tools, difficulties with processes, difficulties with other employees. If the question is too big for the foreman, he goes to the superintendent, and if it is too much for the superintendent, he puts it to the general manager, and it may finally go to the board of directors.

We need to incorporate the staff idea into our settled industrial policy, so that expert direction as to relations with employees, as to equipment and its maintenance, as to materials, as to methods and conditions, as to performance, shall operate throughout our works not in series but in parallel, and shall be available at every point, to every man, in every job, at every time.

The performance of work is first divided into two phases—**planning and execution.** Each of these phases is separated into four major functions. The four functional representatives in the planning department are "the order of work clerk", "the instruction card man", "the time and cost clerk," and "the shop disciplinarian."

(1) To unite systematically a body of individuals for the purpose of working towards some common end. (2) Must go hand in hand with training and research. To unite the divisions and departments of a business into reciprocal and concrete relations and duties.

(3) To bring individuals into systematic co-operation as a whole.

**For success in organization a careful analysis** of all the facts influencing business organization is very important. Such an analysis must consider the type of industry, the nature of the sequences involved, the necessity of supervision at various points, the best methods of control, and the ways in which responsibility can best be apportioned.

There must be a thorough investigation of the number of departments required. Nearly every industry finds it advisable to make a primary division into at least **finance, production,** and **sales departments,** although it would not be hard to find instances of successful organizations with many variations of this division.

The relation which the various departments will bear to one another must be determined accurately.

**Building a new organization :—**

The first step should be a **job analysis** of the principal positions. It is then possible to determine which positions shall be held by the heads of departments who compose the executive staff, and to prescribe the duties of all executives including foremen.

General standard instructions defining duties and responsibilities may be prepared and an organization diagram drawn. This should, if possible, be done before the personality of the staff has been determined upon, because it then gives an opportunity to prepare job specifications as a guide for hiring.

In a new organization the first step is to make **a job analysis** of the duties of all executives. In most cases outside advice is helpful in doing this.

Such a job analysis should take on the form of a fairly complete plant survey, such as has already been considered. Each executive is asked to write out his conception of his duties, responsibilities, and relations to all other executives. Beginning at the very head of the organization, each executive is not only to write this analysis of his own job, but that of all his subordinates. In nearly every business the sales, accounting, purchasing, or production departments have attained a domination which stretches the capacity of those at the head beyond efficiency and infringes upon the initiative and ability of those in other departments.

The report should locate all points of friction and waste due to organization, and it should not hesitate to make recommendations for change. *Experience has proved a multitude of times that an organization with an enthusiastically co-operating force is more efficient than a model scheme worked by a disgruntled force.*

## Keeping the organization up-to-date

It is, therefore, necessary to provide for regular systematic reports and conferences. The plan for these should decide what they are to cover and when each report is to be made. These reports should cover definite periods. In some industries these will be regular calendar periods of days, weeks, or months; in others a payroll period may be found a desirable unit. In the case of certain seasonal industries, or in those where the production is by batches of articles that come with fair regularity, more valuable reports are received when measured by production periods.

The question of the form of these reports is of considerable importance. In many cases they will need to be graphic, and in all cases they should be prepared according to standard instructions.

## Forms of Industrial Ownership

The money paid in by the stock-holders when the company is first started is its capital stock or capital. This is used to provide buildings, machinery, patents, etc. That part of the capital which is not permanently crystalised—that part which remain in liquid form—is called the "**liquid capital**" in contradistinction to the other or **fixed capital.**

**How to proceed** when an order has been received. The fundamental proposition is that nothing shall be made—no order to manufacture shall be given out without authority of some duly authorised and responsible official. Such an order to manufacture an article or a number of articles is called a **production order.**

The production order is, therefore, first sent to the engineering or drafting department and is there reduced to these specific elements, although in case of strictly standard products, standardized lists of details may be filed in the office and may be taken off as a matter of routine on either case, the production order next appears as an itemized list of materials and jobs, immediately understandable by the shop officials. The superintendent of the shop or department or his duly authorised sudordinates then secure the materials needed by a requisition upon another department which has custody of all materials. This department is called the **stores department.** The materials being secured, the various jobs of work upon them are then given out to the individual workmen sometimes by central work despatching office, sometimes by foremen of the various departments. These separate orders to do specific parts of the work are generally called **work orders** or **job tickets**. Each job ticket, for convenience in accounting with the men, has its serial number; but each job ticket carries, in addition, the number of the general production order to which it belongs.

Each work-order or job when finished is delivered to the finished-stores department or to the assembling or erecting department by which it is in turn delivered to the finished stores. Notice of the completion of the entire production order or of each instalment of it until it is complete, is returned by this finished stores department to the office from which this production order was originated—and the cycle is thus complete.

The original production order number appearing as the ticket or instruction card accompanying the job passing through the shop serves to identify it and direct it surely to the intended destination through its way.

Thus *the cycle of manufacture begins and ends in the stores department.* The stores department is the responsible agency for seeing that a stock of both finished product and raw material is always maintained sufficient to meet the expected demands; that all shopping orders are issued to the stores department and not to the manufacturing department and that whatever manufacturing orders are necessary for the maintenance of the warehouse stock of the finished product, shall be issued by the store-keeper. A very important function of the stores department is therefore to insure against delays or interruptions either to manufacture or to shipment which would occur if items in the stock of either raw material or finished goods were allowed to run out, and at the same time to avoid. lying up an unnecessary amount of capital in wasteful idleness by keeping too large a stock of either raw material or finished product on hand.

The actual procurement of raw material is generally handled by a sub department called the *purchasing department* which is responsible for quality, prices and arrivals of requisite supplies.

# CHAPTER XII

## *MANAGEMENT

MANAGEMENT :—"Management is the art and science of **preparing, organizing** and **directing** human effort applied to control the forces and utilize the materials of nature for the benefit of man." Industry is managed "for the benefit of man," which includes wages, good working conditions, **safety**, profits, good products, **reasonable prices**, proper preservation of natural resources, efficient and economical use of the forces and materials of nature, and as great security and satisfaction to all concerned as is possible. No one of these things is dominant. No one element in industry, whether owners, employees, or consumers, can claim the right to all the benefit of industry. It prepares by selection, training and introduction, organizes through rules, policies, orders and assigned responsibilities; and directs through supervision and planning the human effort in industry.

Management is concerned with getting things done; with determining the form of business organization, fixing policies and relations between individuals scheduling and planning work, enforcing discipline, and all the other duties that are concerned with putting knowledge into action and tangible form.

Management investigates the reasons why things are done, accumulates the knowledge that make the art possible, classifies that knowledge so that it may be used, works out general principles and standards that make action sure and swift and that enable the manager to substitute certainty for guess work in his art.

The ordinary philosophy of management is, as stated by Taylor, "autocratic authority at the top, delegated authority and imposed responsibility all down the line and anarchy everywhere." The work is finally done by, and the efficiency of actual execution is usually dependent upon, the man of lowest capacity, of least knowledge, of

* The American Society of Mechanical Engineers.

least possible breadth of vision, of least power to control conditions—that is, the actual workman. His only source of all help and instruction is usually but one step higher in knowledge or in power, and that is a job boss or foreman.

**Scientific management.**—"Science" means tested, standardized and classified knowledge.

It is the study of the plans for executing the work and of the ultimate operations of the work itself by the highest expert skill obtainable; the definition of the best means for doing the work by the most competent specialist obtainable; the reduction of these results to standard definitions and standard instructions; the provision of the best apparatus for doing the work, and its maintenance in the best condition, again by specialized skill; the careful training of the workmen by competent instructors to do the job in the best way with these best appliances, and in the minimum of time; lastly, the provision of some incentive sufficient to secure the workmen's co-operation, to make him willing to do the work in the way and in the time that have been studied out. This incentive may be a day wage, a piece rate, a differential piece rate, a bonus, a premium, or a purely sentimental reward—"an imaginary value."

It involves the three great steps, first **analysis** or the accurate estimation of productive elements and preventable wastes. The first step is **research** and **experiment** which is much the same as analysis and testing of original facts. Analysis is the basis of later action. Second, **standardization** of attainable maxima of performance, and establishment of conditions by which the men may practically meet their maxima; third and last, devising an **incentive** by which the interest of the employer is visibly and convincingly advanced, parallel with the interest of the employer, as workman approaches and reaches or even surpasses the standard set.

The difference between it and the ordinary management is that it provides only for the transmission of orders, and maintenance of discipline with little or no assistance or instruction to the workers.

To put it in still another way—by co-ordinating the elementary ideals of management—line for permanence, authority, discipline, staff for development of high functional efficiency—"scientific management" restores both to the job and the man, the indentity—the individualism—which under ordinary management is lost by a policy of wholesale dealings and mass relations.

## Definition of a Standard

"A standard under modern scientific management is simply a carefully thought-out method of performing a function, or carefully drawn specifications covering an implement or some article of stores or product. The idea of perfection is not involved in standardization. The standard method of doing anything is simply the best method that can be devised at the time the standard is drawn. Standard specifications for materials simply cover all the points cf possible variation which it is possible to cover at the time the specifications are drawn. Improvements in standards are wanted and adopted whenever and wherever they are found. There is absolutely nothing in standardization to preclude innovation. But to protect standards from changes which are not in the direction of improvement, certain safeguards are erected. These safeguards protect standards from change for the sake of change. All that is demanded under modern scientific management is that a proposed change in a standard be scrutinized as carefully as the standard was scrutinized prior to its adoption, and further that this work be done by experts as competent to do it as were those who originally framed the standard. Standards adopted and protected in this way produce the best that is known at any time. Standardization practised in this way is a constant invitation to experimentation and improvement."—Bulletin Number 5 of the Carnegie Foundation for the Advancement of Teaching.

**To standardize an organization** first determine which department of the business is to dominate; then determine the exact lines of authority and their limitation.

In each department the question of policy, equipment, sequence of production, operation and methods should be considered, *e. g.*, the methods of payment and control of overtime and absences should be fixed. The production manager should issue standard instructions as to machines and tools, their care and supervision, inspection allowances, and grades permitted. Similarly, the sales, purchases, office stores, handling of materials should be standardized.

**Ford on standardization:**—"Standardization (to use the word as I understand it) is not just taking one's best selling article and concentrating on it. It is planning day and night and probably for years first on something which will best suit the public and then on how it should be made. The exact processes of manufacturing will develop of themselves. Then if we shift the manufacturing from the profit to the service basis, we have a real business in which the profits will be all that any one could desire." (McClure's Magazine, June, 1922, pp. 26-27.)

**Standardization and individuality:**—Whenever a general programme of standardization is set out, the standardized objection is always raised that it destroys individuality. The truth is, it is only through an intelligent use of standards that an individual gets any opportunity to live and express himself to-day. The person who insisted upon using the unstandardized method of individual walking for all of his movements and refused to merge his individuality in standard street cars, automobiles, and rail road trains would soon be reduced to that most unstandardized type—the tramp.

The standardized way of doing a thing is simply the best way as demonstrated by experience. For the great mass of things that must be done every day, standardization is the only possible means by which we can perform our duties and leave any opportunity for individual growth and thought So in industry, the more thoroughly standardization is applied in the fields where it belongs, the greater opportunity there is for invention, growth, development, and individuality in the lines where these qualities are valuable.

**Dangers of false standardization:**—It is sometimes claimed by opponents of standardization that (1) excessive standardization has a tendency to perpetuate bad as well as good features of industry; (2) when a product has been thoroughly standardized and special equipment developed to produce it, the expense of changing to a better standard is so great that improvements will be postponed to an undesirable degree; (3) some firms, having a highly standardized product, purchase and suppress patents which would enable competitors to produce an improved product, rather than make use of these patents to improve their own product; (4) creates a tendency on the part of management to rest upon its own achievements, rather than to seek improvements

The answer is that such a policy is a false standardization, in that it is applied only in some spots, and not throughout the industry. If genuine standardization were also applied to management policies, and the best standard were adopted, this would provide for continuous study and experiment and the adoption of all things that were proved to be superior to present practice. It is certainly not good standard policy to maintain an outgrown standard at any point. Such a policy is rather fossilization than standardization

**Forms of incentive** found in practical use in workshop and factory may be mentioned.

1. Encouragement of ambition to excel in quality or in quantity of output.
2. Special privilege in the form of extra vacation and leisure allowed for sustained efficiency of high order.
3. Research and invention remunerated or otherwise by patent, royalties, sale of rights, increase in salary or wage, promotion, awards under suggestion schemes.
4. Co-operation, profit sharing and co-partnership.
5. Contracting.
6. Wage payment schemes.

The first appears to be based on a natural pride in achievement which all healthy persons feel, or should deal, in their work.

The second is based on a natural desire for relaxation, freedom from restraint, pleasure and recreation, all of which are keenly appreciated.

The **analysis** of all the facts influencing business organization is extremely important. This takes into account the type of industry, the nature of the sequences involved, the necessity of supervision at various points, the best methods of control, and the ways in which the responsibility can best be apportioned. The finance, production and the sales departments are the three most important divisions to consider.

**System** :—The keynote of modern business success is system. System makes profits and earns dividends where the absence of system will court ruin and bring bankruptcy. System, grafted upon a losing business, will transform it into a paying proposition. The systematician is the modern business expert, the business doctor. Every business that is doing badly may have, and ought to have, its symptoms diagonised, and the proper remedies applied.

**Efficient control** from headquarters is at the heart of any good business system. By efficient control is meant primarily the apportioning of duties and responsibility among the members of the staff, and a supervision to ensure that the responsibility is efficiently exercised.

**System in management** :—A system must do what an individual cannot accomplish. System is the method by which organization works to secure the desired results and to maintain control of every item of work in hand at all times. The applications of system in which we are most interested in industrial engineering will relate generally to six cardinal points. First, the general institutions and forms of management ; second, the provision and custody of material; third, the handling and paying of labour and men ; fourth, the care and maintenance of tools and machinery ; fifth, the determination and direction of operations or manufacturing methods ; sixth, the recording of expenditure and costs—that is of money and the last—markets—belong to the commercial or sales organization and though equally susceptible scientific treatment is not included in the scope of this study.

The manager in industry seeks to add to his own abilities the highly specialized knowledge of staff advisers, such as chemists, production engineers, accountants, personnel managers, etc.

## Principles of Scientific Management of Industry.

SCIENTIFIC MANAGEMENT OF INDUSTRY IS BUILT UPON :

| I | II | III | IV | V | VI | VII |
|---|---|---|---|---|---|---|
| Scientific Method. | Location and Lay-out of Plant according to Scientific Method. | Standardization. | Cost System. | Planning. | Personal Department. | Plant Training. |
| 1. Analysis ... | 1. Raw materials. | 1. Product ... | 1. Record of costs. | 1. Scheduling | 1. Job analysis | 1. Trained instructors. |
| 2. Assembly of facts. | 2. Market ... | 2. Equipment | 2. Budget... | 2. Control ... | 2. Man specifications. | 2. Proper methods. |
| 3. Classification of facts. | 3 Transportation. | 3. Policies ... | 3. Exact measurements. | 3. Functional Foremanship. | 3. Hiring Tests | 3. Reward for skin. |
| 4. Drawing conclusions. | 4. Equipment | 4. Responsibilities. | 4. Control ... | 4. Time and motion studies. | 4. Planned promotion. | 4. Apprenticeship. |
| 5. Testing conclusions. | 5. Labour ... | 5. Personal relations. | | | 5. Systematic introducton. | 5. Research. |
| 6. Use of Allied Sciences. | 6. By-products | 6. Specifications. | | | 6. Knowledge of psychology. | |
| | 7. Climatic conditions. | | | | 7. Low labour turnover. | |
| | 8. Similar and Allied Industries. | | | | 8. Scientific determined wages | |
| | 9. Social Relations. | | | | 9. Shop representation. | |
| | 10. Financial facilities. | | | | | |
| | 11. Fire hazard. | | | | | |

* Production Management, page 24, 1922, by A. M. Simons, B. L.

**Management as distinguished from leadership:**—While leadership is an important part of a management, it is only a part. Leadership without organization may form a mob. Successful management must add organization to leadership. This gives order and efficiency. Organization without leadership is apt to be a dead mechanism, but work done under unorganized leadership is usually temporary in character, often destructive than constructive and always inefficient and wasteful. It is possible to drive it on so that it runs, but it will lack in spirit. It will have no initiative, and will often be as inefficient as unaided leadership. Leadership is the driving and inspiring force, which, when using organization, makes up successful management.

**All executive officers should be rated according to the following qualifications :—**

(1) Appearance, manner and bearing—see how far he impresses his men with these qualities.
(2) Initiative.
(3) Leadership.
(4) Planning ability.
(5) Co-operativeness.
(6) Ability in developing men.

## Allotment of Duties

Sectional control is recommended, even in the comparatively small factory. The point emphasized is that the efficient control is only possible as a result of diffusion of responsibility.

**Works manager :**—The manager of an industry has control of the machinery of production This official is the supreme head of the factory and is directly responsible to the proprietor or directors for the smooth and successful running of the factory. He is the man that has got the sole control of both the productive and administrative sides of the factory. All the officials are subservient to his authority and all appointments are made in consultation with him. He operates it for the benefit, not only of himself but of the owner, of labour and of the consumer.

**To the owner** of the capital he must report a reward sufficient to insure the accumulation and investment of such capital as may be necessary for continued production. He should converse the investment of owners and to insure that accumulation of capital necessary to the conduct of industry in an efficient manner by securing reasonable and attractive profits on the investment.

**To labour** he must guarantee, as far as possible, continuous employment under healthful conditions, at wages that insure the standard of living proper to citizens of the present society. He must so organize and direct the labour that the fatigue incurred is not injurious to health, and that the energy expended is applied with as little waste as possible to the production of goods. He must supply proper equipment in order that the labour of today may be assisted by the labour of the past, as embodied in the knowledge and inventions of the past workers. He must assure the body of workers who look to it for direction of sufficient return for labour performed under healthful conditions to enable them to maintain that degree of bodily and mental efficiency demanded by citizenship in a democracy and intelligent productivity in industry.

**To the consumer** he owes the duty of providing goods at as low a price as is consistent with the proper returns to those directly connected with the industry. This again means that he has no right to charge to the price the cost of his own inefficiencies and waste. He must insure to consumers a supply adequate to meet their demands, produced with the least possible waste of materials, capital, equipment, and human energy, at a price no higher than that required to meet the conditions of payment to owners and labour already described.

It is impossible for management to fulfil its function and to meet the tests described without a thorough going application of scientific methods.

A good manager must further know **how to ask questions**. He must constantly ask that of himself, of material, of machines, and of processes as well as of his associates. **The essence of scientific analysis** is systematic procedure. And the quickest way to test most of original facts is by comparing them with standards. In other words, the first step consists of **research and experiment.**

At the second step they speak of stabilizing conditions by **standardization.** By this is meant a special application of the principles of classification.

Standardization in this field consists in the preparation of tables, slide rules, and other more or less mechanical methods of thinking over in much shortened time the work of analysis, research, and experiment, and then preparing standard instructions for the use of such methods. These instructions must be furnished to all departments of management concerned in carrying out the work. They should provide for continuous re-analysis as a basis of further improvement.

The third step according to Taylor is "control of methods to a common end."

The manager, by putting good systematic purposeful questions, must find out all the facts and compare them with standards. The next step is to assemble them for study. The third step is to classify the facts before beginning to use them. Then the manager should begin to draw conclusions. What is called the scientific attitude is of great importance here. This simply means that he must look at each phase of the problem from a wholly unprejudiced point of view. At every point all sorts of interests such as pride, financial interests and personal prejudice, are to be set aside. Thus the principal distinction between a scientific management and every day hit-or-miss method is that the scientist knows exactly what he is doing, why he is doing it and just what results are achieved, while the ordinary methods of management lack certainty and abound in chance work and guess work on all these points. The final step consists in testing the results of conclusion by experiment.

**Production manager :**—He is considered to be the most important man in factory for, as his name implies, he is directly responsible for the actual production. His usefulness is judged by the efficiency attained by the works in the productive capacity. He is responsible for the quantity, quality and cost of the product manufactured, and is judged by their results. His critics are the inspector, progress man and costs clerk, and he must always satisfy these people. If necessary, he may occasionally take the help of the works manager or planner in order to maintain or improve the efficiency of the products manufactured.

**Management may be held responsible amongst other things for:**

(1) Installation and maintenance of a suitable wage payment system.

(2) Planning in advance, what, how, where and when work shall be done.

(3) Analysing, scheduling and distributing, routining and dispatching orders through the works.

(4) Standardizing material, sections, processes, tools, appliances, machines and standards.

(5) Supply of the necessary machines, tools, materials in time and in correct quantity and quality, standard instructions and stores.

(6) Inspection of supplies of materials, parts and work in process.

In short, the scientific method of management can be summarized as follows:—

(1) Analysis.
(2) Assembly of facts.
(3) Classification of facts.
(4) Drawing conclusions.
(5) Testing conclusions.
(6) Use of allied sciences.

**Works engineer:**—He is responsible for the care and maintenance of power plant, light, and buildings. He has the control of the millwrights, electricians, bricklayers, carpenters, repairers, etc., and is expected to keep all machinery relating to the power plant as efficient as possible. On the event of any further extension he should advise the works manager as regards the type of machinery that is advisable to instal.

## Foreman

The foreman is the representative, the emissary, the delegated, authorised spokesman for management and the management must bear the results of all his activities. He can easily involve the firm in labour struggles that may cost millions. He can still more easily cultivate a spirit of antagonism that will be even more expensive in the long run. That is why a foreman should know well how to instruct and direct labour.

The section foremen are chosen for their specialized knowledge—the lathe section foreman being a practical turner and so on. Each foreman is responsible for the output from his section and for the intelligent interpretation of principles of organization as it affects his own section.

The foreman must obviously understand the principle of the process and also its practical application. This does not mean that he should be the smartest workman in that section. Each foreman is responsible for the output from his section and for the intelligent interpretation of the principles of the organization as it affects his own section. The foreman is also responsible for the allotment of work, the **chargehands** business being to see that the instructions of the foreman are carried out. He is also expected to make a periodical check of the work that is being produced and to give advice and instruction to the operator. He is rather an instructor than a supervisor.

The understanding characteristic of the section foreman is his ability to explore the capabilities of his section in regard both to the plant and the operator.

## Selection and Duties of a Foreman

The foreman has usually been chosen because he was the best workman in his gang. The section foremen are chosen for their specialized knowledge of the particular department in which he is to work.

When selecting a person for the foreman's post the selection should be guided by the following considerations:—

(1) Physical qualities—beauty and charm;

(2) Discretion, will-power, taste, tolerance, sense of human, moral sense, sensuousness, sensibility, common sense.

(3) Training and practical experience.

(4) Accuracy and judgment.

(5) Analytic and synthetic ability.

(6) Tactfulness.

(7) Assertiveness.

(8) Energy and persistence.

(9) Originality and ingenuity.

(10) Humility and *sincerity*.

## Foreman's Training

Foremen may be trained as efficiency engineers, as cost accountants, as planning assistants, as salesmen, or as trade instructors. They must be trained for nearly all such positions.

## Analysing Foremanship for Training

*Forman and his job.*

These duties of a foreman are in accordance with their relation to (1) **supervision,** (2) **management,** (3) **instruction**. Under supervision should be placed all those duties which have to do with seeing that things are done. Management is concerned chiefly with costs and covers all points where foreman is responsible for watching the cost of operations.

Instruction covers all that a forman does in teaching workers.

Within these three classes of duties, there will be wide variations according to the industry, the form of organization and the extent to which functions have been specialized and handed over to other departments. In this connection we might take the following as the items which should be included in the training of a foreman.

(1) Safety engineering—health and employees' welfare.

(2) Employment management—placing transfer promotion, grading or introducing new workers.

(3) Industrial history.

(4) Corporation finance.

(5) Industrial organization.

(6) Stores-keeping.

(7) Cost accounting.

(8) Management engineering such as supervision, training, co-operation with management and other foremen.

(9) Power transmission.

(10) Materials (storage and movement).

(11) Planning work, selecting men, materials and machines.

(12) Discipline.

**Departmental foreman :**—This official is the head of a specific department such as machining, assembling, etc.

**Section foreman :**—This official is under the control of the departmental foreman, but has got the charge of a particular section of a department.

**Estimator :**—His business is to prepare and submit to the sales manager the probable cost to manufacture or repair a particular thing so that the sales manager can send out the quotation of the firm to their customers.

**Draftsman :**—His duty is to design the various parts of the product and submit it in the form of a drawing for guidance to those that are concerned in the manufacture. He may occasionally take the help of a tracer or a junior assistant who prepares blue prints.

**Planner :**—In the case of a small factory, often, the works manager himself is asked to be in charge of the duties of the planner also. The work of this official is to devise the necessary factory lay-out to meet the required production and the planning of all manufacturing operation. He has also got the control of designing and making of tool and is often in charge of the tool room also. He determines which parts of an article shall be manufactured in the factory and which shall be ordered from outside, and is the man who determines the proper sequence of all manufacturing operations.

Because he is in the charge of the tool room, he is able to plan the work of this department to meet the requirements of manufacture, and he has also to facilitate production by supplying the necessary jigs and tools specifically required for a particular operation.

**Rate fixer** :—He has to work in co-operation with the planner and his work is to fix the rate or time or both for the operation. He must always so decide them that they are advantageous to the workman and economical to the factory owner.

**Progress man** :—Mainly his duty is to facilitate production and to see that things are taking place in the proper sequence. In some factories he has got the powers to guide and control, but in others his work is of the routine type. In order to make his position clear his duties may be explained in various circumstances under the following headings—(*a*) progress manager, (*b*) progress man, (*c*) progress clerk, (*d*) progress chaser.

(*a*) The **progress manager** has got complete control of the administrative and productive branches including progress, stores, purchasing records and general clerical work. He is required in places where manufacturing works are planned and high degree of efficiency is required.

(*b*) The **progress man** belongs to the progress organization, and is generally of the aggressive type. He must be capable of estimating the time required to manufacture a thing and it is his duty to see that all the works are executed in the due time specified in the order. To this end he must have sufficient power and initiative to have the works executed punctually. In a large factory which manufactures only one type of article, the progress man has to look after the manufacture of all parts, from the time the order is received to the time of its completion. But in a small factory he may be the head of the progress department, and his duties will not materially differ from those already enumerated.

(*c*) The **progress clerk's** work is mainly of the routine type. He neither makes progress nor does facilitate it but merely records it. His work is to make out small job cards and he receives them back when they are completed. He generally acts as a connecting link between the planning department and the manufacturing department.

(*d*) The **progress chaser** has generally to go round the works, note the progress and urge material and parts when required. If he anticipates any delay, he ought to report it to his chief. He is almost a junior progress man and in small factories he takes the place of the latter. Generally, he is outside the control of the manufacturing foreman, but in some cases he helps the departmental foreman to facilitate production.

**Inspector** :—Though his status varies, his duties are almost the same in all cases. His function is to inspect all the parts that are being manufactured at each and every stage. He passes only those that come up to a predetermined standard and reject all the others which may be defective either from defect of material, errors or bad, workmanship. He must be free from the authority of all concerned that he can perform his work efficiently.

He should inspect and see all material purchased from outside, and after each part has been manufacturd, he has to examine and certify that they are "O. K." and others are scrapped and instructions must be given to the concerned officials for their replacement.

**The head store-keeper** has got the complete control over the stores department of both the clerical and manual sides of the organization. He is responsible for the discipline and efficient working of his department and his status is equal to that of the heads of other departments. He is the official custodian of all factory stocks and stock records.

## Buying and Buyers

The **buyer** must have a thorough knowledge of the demand and supply. He must be honest, hardworking, and must understand his business. He work is in accordance with the necessities of the factory, and is in charge of purchase of all material, part and equipment. He must always act to the best advantage of the factory. He must be discriminating and unsentimental, of good judgment, and confident in his own judgment.

The buyer should know the exact specification of the thing 'to be purchased, when the material will be used in the plant, its rate of deterioration, the expense of storage including interest on investment and at what time the meterials should be removed from the stores department. This department should be informed about any changes in design of the article manufactured.

The questions that a buyer must decide when considering any buying proposition are: (1) "Are the goods suitable for my trade ?" (2) "Is the quantity that I propose to buy too great for the selling capacity of my organization ?" and (3) "Is the price at which I am offered the goods the lowest that can be obtained, or can I do better elsewhere ?" In any case there must be a continuous, adequate **supply.**

He is given a free hand in the business and must keep himself in close up-to-date information regarding markets. He must accept, duly authorized requisitions as the basis of his activities, and must always satisfy the needs of the factory in the most economical and advantageous terms. In the purchase of equipment he is not given so much liberty, but he has got the power to purchase or replace small tools-drills, taps, files, etc.

**Purchasing clerk :**—He generally acts as an assistant to the buyer or merely as a routine clerk of the head of the concerned books to the purchasing department. He must keep the required records, speed up outstanding orders, and passes invoices for payment.

The secret of a big store's success lies in its management. Although the manager does not undertake the actual work—this is done by his departmental heads and assistants—he is really the responsible man. He sets the policy of the house, altering it for good or bad as the case may be. Every assistant should be engaged by him, and no resignation should take place without the full facts being brought before him. The greatest importance should be attached to the **personnel** of the staff. It is the staff which comes into actual contact with the customer. Again, each buyer must be selected with the greatest care, for the buyer can make or mar his department. To possess the right buyers is one of the main elements in the success of a store.

**The receiving store-keeper** receives all materials from outside, checks records and arranges for inspection, and is responsible for it till the material reaches its destination.

**The material store-keeper** receives and stores raw material and issues it to the concerned department when required on the receipt of duly authorized order.

**The progress store-keeper** receives from the inspector partially manufactured parts when their work is completed in one department, and holds them and issues them when ordered to the succeeding department.

**The component store-keeper** receives all the finished but component parts and issues them when ordered to the assembling department.

**The miscellaneous store-keeper** holds and issues when required such parts as are not covered under any head like—waste, lubricants, bolts and nuts.

**The tool store-keeper** holds and issues when ordered such tools as jigs, etc , and replacements in the form of drills, taps, files, etc.

**Store clerk** has to keep all records concerning the receipt and issue of material and parts—such records giving the order numbers, and the quantity of material in stock. He must also issue requisitions for the replenishing of material when the minimum figure is reached.

**Warehouseman :**—This man receives the finished product and, according to the instructions from the sales office, has to issue them to the dispatching department. He keeps the records that are necessary, and reports to the management the state of his stock so that the operations of the factory might be modified accordingly.

**Dispatch clerk :**—He receives the finished product from the warehouseman, examines them if they are alright and conforming to the specification and packs and dispatches the goods in accordance with directions from the sales office.

**Time and wages clerk :**--In small factories these two duties are grouped together whereas in bigger ones they are separate. First he has to record the time spent in the factory by each operator from the clock cards on which will be noted the times of entering and leaving the factory. Then he has to determine the time spent by each workman or a certain order and from that determine the bonus earned. The matter is then dealt with by the wages side of the organization. Then a wage list is prepared showing the name of each operator, his hourly rate, the wages earned for the week and the bonus he has earned, if any. Then necessary deductions are made for the health and unemployment insurances and the final amount being checked and certified as correct is placed in an envelope and paid to the operator at a notified time. Then the wage list and work orders are sent to the costing department.

**Cost clerk :**—He receives from various sources the cost of material and manufacture. His sources are job tickets, operation cards, etc. He thus determines the prime cost and then adding to this the standing charges gets the manufacturing cost of the job.

## Selling & Salesmanship

The last great industrial function recognized by a separate department is selling. In several senses it dominates the whole. Things are not usually made unless they can be sold. In cases of special manufacturing, such as machinery made to order from individual plans, the manufacturing plant produces what the sales department specifies. In the case of standard stock manufacturing, like watches or sewing machines, it turns out an article for which the sales department can find a demand. On the other hand, the operations of the sales department will not result in profits unless they are carried on with a correct knowledge of manufacturing department costs, of the limits of the manufacturing department's ability or capacity, and so on. There must be close co-operation and co-ordination. The engineering department is, to a considerable extent, the co-ordinating centre between manufactures and sales. But being a little nearer to the latter, it is usually found forming a subdivision or part of the selling department.

The man who visibly or apparently stands nearest to income and profits has the first consideration. Raising the prices is the salesman's function, and lowering the costs of production is the engineer's function. Attention to lowering production costs by cultivating higher efficiency, by eliminating wastes of material, of labour, of power, or of any other industrial element, is now at a phase of rapid increase. It is here that the greatest opportunity lies for the industrial engineer and the works manager.

**Sales manager:**—The success of any industrial concern depends in no small measure on the proper organization of the sales department. The sales manager should take care of all the inquiries received, send out quotations, book orders, and issue the necessary orders and instructions to the concerned department. He must look to all correspondence and prompt delivery and dispatch of articles, and generally act as the representative of the customers.

The salesman must be frank and enthusiastic. Enthusiasm is worth a great deal. All enthusiasm is magnetic, and the salesman with this magnetism about him will attract the interest and sympathy and finally the business of those before whom he places a proposition.

The chief fault of salesmen—particularly of retail salesmen—is fawning. In ninety-nine cases out of a hundred it fails entirely in its desired effect. Servility, which is so different from a courteous deference, should have no place in business relationships.

After the personal qualifications of manner, the first qualification for a salesman is familiarity with the goods he sells.

## Advertisement

Advertising is just printed salesmanship, and salesmanship is persuasion to buy. All advertising should be planned with this clearly in view.

The basic object of modern advertising is to build up goodwill, to make sales. First and last, that is the object of real advertising—to build up goodwill, to make sales; and any method of publicity that does not build up goodwill or make sales is sheer waste of money.

Advertising, which is in any way deceptive, cannot build up goodwill and, though it may make immediate sales, it is not the foundation on which a business is securely grounded.

In order to induce the public to read advertisements more than they do at present, it is necessary to create a better standard of advertising—more dignified, more pleasing to the eye, more generally acceptable to the reader of culture and taste. The advertiser who perpetuates inkblots in order to shut down his fellow advertisers is simply fouling his own nest.

It has been said above that real advertising is printed salesmanship and accordingly it must embody the essential principles of salesmanship. Every successful attempt to sell passes through the stages of—

| | |
|---|---|
| 1. Arresting. | 3. Persuading. |
| 2. Interesting. | 4. Clinching. |

To persuade the reader is a very different matter ; it is necessary to give some written or pictorial argument in favour of the goods advertised, and in general these will be of the same nature as the arguments a salesman would *employ when persuading a customer by a personal talk.*

*Forms of publicity and their effect as advertising medium.*

1. In the press—dailies, weeklies, monthlies and quarterlies of every description—most powerful advertising weapons.

2. In directories, year-book, local guides, novels, souvenir matter—theatre programmes—good, but money should not be spent for special display unless such display is of an outstanding nature.

3. On boardings, electric signs, railway stations, trams, buses, sky signs, kites, etc.—rank next to the press as an advertising medium for appealing to the public in general. For general publicity it may possibly take first place.

4. Inside trains, trams, buses, tube-lifts, theatres, good.

5. By competition, premium schemes, etc.—good when done with proper care.

6. By advertising novelties—calendars, blotters, water bottles, etc. Individual discretion to decide whether such a novelty can be advantageously employed.

7. By catalogue, booklet, letter, leaflet, etc.—good, except the handbill which does not produce any effect.

8. On letter-headings, bill-heads, lables, etc.—good.

9. By show-cards and window tickets—good.
10. By window displays—ordinary and special—good.
11. By samples—in no form of advertising can more money be wasted than in giving of free samples to all and sundry, and a scheme of this kind should be considered very carefully before it is launched.
12. At exhibition—in trade exhibition it is good, but in general exhibition the case is not so satisfactory.

**How and where to advertise :**—In selecting papers where advertisement should be given clearly, quantity in circulation is not everything—other points to be taken into consideration are the probable number of readers per copy of the paper, the life of the advertisement (how long the paper is kept and read), the attractiveness of the advertising pages, the position assigned to the advertiser's own announcement, the number of advertisements of a similar class carried in the issue, and the faith which readers have in the trustworthiness of the literary matter.

Advertising on the boardings and on buses is only resorted to when the press advertising has made the public thoroughly familiar with the policy of the establishment in detail. Outdoor publicity has many advantages of its own, such as large spaces, use of colours, and long life for the announcement.

A position next to reading matter is always in demand; an outside column is better than an inside (next to binding) column, because advertisements there are more easily read; a top space is preferable to a bottom space; a right-hand page is usually favoured over a left-hand page in a weekly or a monthly; and the covers of a monthly are of special value. Picked positions are the top right-hand outside and the top left-hand outside next to literary matter, and especially when the reading matter is relevant to the advertisement.

It will contain a strong "selling talk" set out in a simple, sincere, straightforward manner—as an honest merchant talking about his goods to a purchaser of discrimination.

It will set out what are the particular advantages possessed by the article, and what are the reasons why it should specially appeal to the reader.

If a headline is used to attract attention, the message it gives will be strictly relevant to the article advertised.

The type arrangement will be as simple as possible—the aim is to make the wording clear and easily read. Freak twistings of words and phrases are poor expedients. Jumbles of different faces and sizes of type are also bad.

Emphasis can be gained by white space in an advertisement as surely as by heavy, black ink-blots, and the effect is far more dignified and impressive to any reader of discrimination.

The illustration used, if any, will be strictly relevant to the article advertised. It is not well to insert a picture which bears no logical relation to the selling talk.

The name of the firm, in the case of retail advertising will be prominently displayed, and it is often advisable to have this name specially drawn by an artist, and registered as a design, so that it will be distinct and different from that of any other firm. The border and decoration, if any, will be in harmony with the illustration and particular display type used.

A catch-phrase or "solgan" is more a general-publicity device than a selling argument. The idea of it is to give the public something that sticks in the mind and comes automatically up to the surface at unguarded moments. To find a really good catch-phrase is no easy matter.

The following books are recommended for further study:—

| Serial No. | Name of books. | Author. | Publisher. |
|---|---|---|---|
| 1. | Factory Lay-out Planning and Progress. | J. W. Hiscox | Sir Isac Pitman & Sons, Ltd., London. |
| 2. | Production Management. | A.M. Simons, B.L. | American Technical Society. |
| 3. | Modern Business Practice, Vols. I, II, III, IV, VIII. | F. W. Raffity, Editor. | The Gresham Publishing Co., London. |

# CHAPTER XIII

# LOCATION OF AN INDUSTRY

## Location of Site for an Industry

THE pull of a market operates upon the finances of an industry as truly in accordance with the Newtonian laws, as the pull of gravitation operates upon the ball of a pendulum. We have seen Newton's Third Law in connection with Ledger (*vide* pp. 60 and 61).

Newton's Second Law is useful to the engineer and industrialists in calculating the most advantageous location of an industry. We may visualize an industry pulled in a multitude of directions by different forces. Raw material pulls in one way, market and labour in others, while tradition and prejudice adds to the inertia that must be overcome.

Again, we should remember that a force always acts continuously regardless of all other forces. While the effect of a force may be destroyed or counteracted so far as appearances are concerned, its effect never ceases.

We often find that a comparatively small force, which might be overlooked at first, acting through many years may be much more powerful in determining the success of an industry than some much greater force which acts only at the time of building.

**Sources of raw materials**:—If the industry uses a quantity of some raw material, the location of this material may be the first consideration. Another thing that should be considered in relation to raw material is the question of its control—whether it is in the hands of a monopoly which may become hostile or whether it will continue to be produced at the same rate and the possibility of competition from other sources.

**Relation to market**:—Production is for sale, and the question of reaching the largest body of consumers at the lowest cost may always be of prime importance in determining the location of an industry.

**Transportation facilities**:—Further nearly every industry to-day at some stage of operation is dependent on transportation and there are great advantages in having access to both road and rail transportation.

**Labour supply**:—Industry is coming more and more to recognize the importance of the human element. It is a foolish disregard of facts not to precede the location of any firm by a labour survey of the locality.

**Grouping of industries**:—There are important advantages in the grouping of industries. The presence of many industries of the same kind assures a large supply of specialized labour. Grouping also assures the presence of subsidiary industries. Power is of paramount importance for many industries.

**Land values**:—The original cost of land and its prospective price movements is often given an exaggerated importance, as when it is made almost the only decisive factor in choosing between a city and country location. Some firms seek to secure the advantages of both locations by placing their selling department in some desirable marketing centre, while the factory is placed in the country. This plan has the **disadvantage of adding geographical distance** to the other forces that already tend to make complete interdepartmental co-operation difficult.

**Future**

**Expansion.**:—Closely connected with the question of rent and the comparative merits of city and country locations is the necessity of providing room for expansion. For examples, if all adjoining land is occupied and held at a high valuation, direct expansion may be so expensive and is often prohibitive.

Again the **possibility of disposal of bye-products** sometimes determines the profitableness of an industry.

**Climatic conditions** are dominant in certain industries. The weaving of the better grades of cloth calls for a **damp atmosphere**, which, if produced artificially, adds to the expense.

**The attitude of local government**:—The regulations which a municipality or the local government may enforce and its policy in regard to taxation and other matters are of importance. **Banking facilities** are sometimes a dominant consideration. These are of much more importance for a small or medium-sized industry than for a very large one.

The attitude of the local government may be the dominant considerations in the location of certain industries. Very often the elements such as social surroundings, transportation facilities, climatic conditions may, through a long period of years, offset other influences and the advantage of paying a high economic rent for better location is often well appreciated by businesses.

**Re-location of an Industry** :—This is the personal preference of the owners or managers. It is quite probable that in some cases the additional energy and enthusiasm which would accompany the satisfaction of a personal choice might be reflected in better management to such an extent as to offset some other considerations. But in general, personal and traditional considerations should be given very little weight.

**Subdividing a plant** :—When any business expands, it is always complicated with the necessity of deciding whether it is best to enlarge the original plant or to build branches. Balance each one of the items already mentioned against the present location for the production of such a section of the product as must be provided for. Generally, the location of the market is one of the deciding elements. If the production is very bulky, the transportation item or the supply of raw materials may be factors worthy of consideration and branches may be desirable.

**Objection to branches** :—The necessity of duplicating involves much of the "overhead" costs of management. And further there is also the difficulty of securing sufficient high-grade executives to open a new plant. On the other hand, there is a tendency for a large organization to grow bureaucratic, lethargic and incompetent. It is also quite possible for a single organization to grow so large that adequate supervision may almost be impossible. Such a corporation forms a mass of traditions, habits and customs, some of which are aiming its largest assets, and others that heavily handicap it, but all of which are apt to be carefully cherished. Establishing a new branch, free from some of these traditions, may point the way to better methods in some cases.

# CHAPTER XIV

# CHOICE OF A FACTORY SITE, AND BUILDINGS

**THE Site and Buildings** influence all the work of the factory. Choosing a factory site is not only a matter of least initial cost, but the proper choice is the first important step in the organization, and lays the foundation for more profits and losses than the inexperienced would imagine. Taking it for granted then that there is an existence of favourable business or economic conditions for any particular enterprise, and that the requisite funds for floating the concern are assured, the following things must be considered :—

(1) Location of a site for the factory.
(2) Lay-out of the buildings and factory grounds.
(3) Design of factory buildings.
(4) Machines to be employed, their purchase and erection.
(5) Power plant for driving machinery, and fuel supply.
(6) Essential welfare conditions for securing a contented labour force.

**1. Choice of site :**—The first consideration we have then got to take up is that of the **choice of site.** The important factors playing their parts in the choice of a particular site for a particular factory or power plant, may be enumerated thus :—

(1) Its location with respect to physical condition, labour supply, residential possibilities, transport connections, roads, connections with towns and future development.
(2) Facilities for power, water, lighting, and necessary atmospheric condition.
(3) Cost, as regards size, taxation, future cost and future expenses.
(4) Isolation, to secure freedom from causing nuisance by noise, smoke, dirt, fuel, and carting, etc.

**(a) Physical conditions**:—Although for small plants and factories the physical condition of the site is not of much importance, it is so in the case of a large scale concern. In those cases attention must be paid to the **foundations** of the proposed site and to the **contour** of the ground. For big power stations river-side sites are usually chosen and those sites are usually on alluvial flats; so **borings** must be made to ascertain the nature of the substrata and their capability of carrying the heavier weights. Concentrated weights up to 15 tons per sq. ft. have to be arranged for; as in the case of large stanchions to carry the dead load of the roof, over-head bunkers in the case of boiler houses, and the live load of the travelling crane. A good bed of stiff clay, or compact gravel—provided there is no underlying stratum of sand or peat—will make an excellent foundation. Sometimes in a site with alluvial soil or mud, owing to the other advantages to be mentioned latter, accruing from the position, we have got to undertake the costly procedure of driving piles into the underlying sub-soil and of floating a concrete raft.

In the case of big power stations, care should also be exercised in **fixing the datum line** of the station. The relation to the water level of the condensing water supply, whether sea, river or lake, has to be fixed, especially in tidal rivers or estuaries. The limits of spring and ebb tides and of flood levels fix (*a*) the level of the condenser pipe line and (*b*) the levels of coal jetties and also of the engine room. Upon this depends the excavation necessary on the site and, therefore, the cost of the building to a certain extent. It will also have to be considered whether (1) the site is well drained and (2) whether there are facilities available to dispose of the drainage without creating a public nuisance.

**(b) The labour question** in the choice of a site, especially for a peculiar or special sort of manufacture, is of no less importance. The *centralisation of industries* helps a good deal in this direction, because in the industrial centres there is always a good demand or market for skilled labour, and labourers, knowing this, always go there for jobs. Skilled labour is always available in such places. Special trades require labourers specialised in them, but those labourers are generally geographically segregated. It is an advantage to locate the factory where the supply is plentiful. This need not necessarily locate the site in a town. A neighbouring district with efficient transportation facilities, or one with attractive local conditions, may serve the purpose. The district should have a sufficiency of vacant property or enough room for development, for with the growth of industry, the population of the area naturally increases. Thus a serious problem arises when the district outgrows its capacity for accommodation, and the growth of the manufacturing area is stopped by the surrounding landowners. Given suitable residential areas, however, and comparative nearness to a town, it is frequently possible to attract the best class of productive labour to an outlying district and yet have, at the same time, the town surplus always available through the railway or tramway connections.

**(c) Residential possibilities** :—There can be little question that consideration of workers' domestic amenities—as apart from bare necessities—ought to be an important consideration in the selection of a factory site. The point needs no sentimental stressing; suffice it to remember that not only do home conditions react on the intelligence exercised and the interest taken in the days work, but given congenial conditions at home and at work there is a far greater inducement on the part of the worker to stand by their adopted employers to the advantage of both sides, by obviating the waste that arises from frequent change amongst employees. It is to the employer's interest to do his part towards making **labour** *become an intelligent constructive partner rather than an ignorant destructive partner*. Economic considerations need not stand alone, and it is easier to give proper weight to labour conditions before selecting a site than afterwards.

**(d) Transport** :—For large work or for works handling raw materials in any bulk and generating their own power, the transportation facilities for raw materials and fuels must be duly considered. For works in an outlying district at any rate, a **railway siding** is a necessity for the efficient supply of coal and raw materials.

For dealing with raw materials overseas, it is judicious, if possible, to have the plant by the sea, and in that case good wharfage becomes a necessity. In the case of small concerns, a district board **road approach** is a desirability. Also it must not be lost sight of in the latter case that the land going to be occupied for the factory building should provide a roadway link between the District Board road and the buildings. Owing to the oversight of this seemingly minor particular, it was found in one case that a factory building, for which a certain piece of land was acquired at a cheaper cost, but at a little distance from the public road, many times the cost of the acquired land had to be paid, for linking up of the factory building with the public road, as the proposed roadway crossed the land of two or three other owners. The proximity to a public roadway does not only facilitate the transport of raw materials, fuel and the labour, but it also facilitates the conveyance of manufactured products to the market. An extra mile of cartage cost is small in itself, but to add an extra mile of cartage cost to every load of goods inward and outward over a period of years represents a burden on production cost which no factory can afford. The **handling cost** of the contractor in the construction of the factory is one of the first points to be considered. This is important, because an out-of-the-way site may entail an enormous amount of cartage that will eventually add more to the construction cost than the location would save in site cost. The nearer the site is to the source of raw materials and fuel, the less will be their transportation cost; and the nearer they are to the market, the less will be the freight charge for the products and, therefore, the less their price. But it must also be noted that in most industries the raw materials have a greater bulk than the finished products, except in certain cases, their freight charge is a heavier constituent of the cost of the product.

On the other hand, under present tendencies, a **water fronting** will be increasingly valuable in the future, for although water-borne traffic is slow in transport, the economy affected in freight charge is a large factor. Also it serves as an alternative way for transport in case there is a railway strike or the land roadway becomes unusable (as it often does in Bengal) during the rainy season. In the rainy seasons, some of the tea gardens of Assam, for instance, have to resort to boat transport of their teas; because the *kachcha* roads to the neighbouring railway station deteriorate so much that lorry service becomes impossible. Canal facilities are of great importance when the district is within convenient reach of, and in direct communication with them, and with the probable reorganization and development of waterways and canals, the importance will be still higher.

Apart from the question of transport, proximity to water is extremely desirable for (1) an abundant supply of condensing water, which effects great economy by dispensing with costly water condensing apparatus; (2) the provision of water, if free from hardness and corrosive qualities, for boiler feeding.

**(e) Local power and lighting facilities** will often affect the selection of a factory especially in the case of a small installation. In such cases the cost of production of power by their ownselves for their own purpose is, except in special cases, (like the utilization of waste heat for local purposes) always greater than buying it from a bulk supply would be. Also in the latter case the dispensing with a separate power plant and its necessary attendants, improved, and efficient methods of electric drive, largely reduce the production cost. * Those districts, where there is a bulk supply of energy for power and lighting purpose, have a great advantage for the location of a factory site. In the case of big installations and out-of-the-way places, sometimes it is necessary to develop one's own power, and in such case the supply of cooling and feed water is an important consideration. In the case of large power plants it is of prime importance. Artesian wells are becoming more often sunk now-a-days for the water supply, where a river site or other public supply of water is not available or very costly. The quantity of water required for gas plants and steam plants, may be as high as 9 gallons per B. H. P. hour, respectively, in a tropical climate like that of India.

* Vide Economy and Safety of Electric Installations, pages 30-32, by B. C. Chatterjee.

(f) **Atmospheric conditions** have also to be taken into account very frequently in considering a factory site. Certain industries require special atmospheric conditions for their products, and it will add greatly to the production cost, if those conditions have to be produced artificially. Obviously, therefore, the district which provides these conditions naturally for the greatest period of the year, if only to a minor extent, lead to a reduced production cost, which, in many cases, is worth careful consideration. For the cotton industry, a humid atmosphere is essential.

The considerations of **cost of the site and of the building** cannot be entirely separated As distinguished from transportation cost, we have the handling cost inside the factory building, which, although it does not add to the prime cost of the building, indirectly influences it. For, in order to minimise the handling cost, recourse is had to single-storied buildings, which cover a large area of land, and, therefore, involve a greater cost of site. The interest on this prime cost sometimes adds much to the running cost of the business. Also as has been already mentioned in the construction of a building in out-of-the-way places, the construction cost becomes a heavy one owing to the cartage of the raw material of construction from a distance.

(g) **Future development** should always be provided for in deciding site. By building a new factory, surrounding land values should be increased owing to the additional population which the industry brings to the district. This increases the land value and therefore an investment in additional land will often pay in view of possible future development. In a populous district this may not be the case, as the estimated increased value may fail to pay a profitable interest on the additional capital involved. In a heavily populated district, where land is costly, a safe minimum of space may be the best to aim for. How this is utilized depends greatly upon individual requirements.

(h) Due regard must be paid in the case of **intramural sites, to local taxation, bye-laws and regulations**, *e.g.*, restrictive regulations as regards heavy transport, by-laws as regards the construction of buildings, all add to the running as well as the prime cost of the installation.

(i) Another consideration, which must not be overlooked, is: whether the site has within a convenient distance an **establishment for the repairwork** of the factory and for the other numerous aids which the business may call for.

Thus the **strategic location for the factory** involves a wide vision. It may be said that the place where the sum of the cost of raw materials, transportation of the same to the factory, manufacture (including the capital cost of land, buildings, plant, power, repairs to plants, cost of labour), the transportation of finished product and the final disposal of the same will total the smallest possible sum, is the most suitable. A great excess in one of these factors may neutralise advantages in all the others.

The real or **economic rent** is worth paying for a good site. The price is paid for natural advantages due to the site.

## II. Lay-out of Building & Factory Ground

When the adequacy of a site has been established and before the concern is committed to the site, a tentative plan of the general lay-out of the building and operations must be made.

A site having been provisionally agreed upon, it is necessary :—

(*i*) to examine the adequacyof the fund to meet the initial cost for that particular site ;

(*ii*) to have a clear definition of the quantity of finished product per week of 48 hrs. which the factory is required to give at the commencement of operations. and also the ultimate capacity to which it may build up.

This will give an idea of the number, size and character of the processes and of the number of men, machinery, buildings and quantity of power and ground area required. We may then proceed to the consideration of (1) buildings, (2) machines and plant, (3) labour saving and economy.

The site being determined, the question is now to make a lay-out plan of the building with due consideration to economy of handling cost, suitable accommodation for the various purposes of the manufacture and future development.

The single-storied building entails a smaller handling cost no doubt. But this single-storied building should not be disposed off in parts under different roofs, for it will lead to a greater cost than that of a building under one covered roof. The latter type of building should be preferred, especially for a small concern. The handling cost can also be minimised if the building is so designed that the materials during their process of manufacture have an undirectional flow without crossing or recrossing their path, thus causing interference, muddle and delay. Thus the raw material should enter one side of the building and the finished product should come out ready for despatch from the other end. Road and transport facilities for the incoming and outgoing processes should also be provided for at the time of laying out.

The building should also be of such capacity as to provide accommodation for all the intermediate storage space during the process of manufacture and the storage space both for the raw materials (if covered space is a necessity) and for the finished product. The Indian Factories Act of 1911, as amended by the Indian Factories (amendment) Act of 1922, provides that (1) there shall be provided for each person employed at one time in any room of a factory where mechanical or electrical power is not used, 36 square feet of floor space and a breathing space of at last 500 cubic feet; (2) where mechanical or electrical power is used, there shall be provided for each person employed at one time in any room a breathing space of at least 700 cubic feet. Accommodation for the convenience of the labour should also not be lost sight of in the preliminary lay-out. Thus ample room should be provided for lockers for workmen's clothing, their meal-rooms, office for staff, etc. If the factory generates its own power, room should be made for it in its convenient position in the building.

If the factory is comprised of single building, it must be sectionized in order to accommodate the various phases of manufacture, or it may, on other hand, consist of a number of comparatively small buildings, spread over a broad piece of land, and some of these building may be in a remote position.

If all the departments are to be housed under one roof, the disadvantage are the limited floor space, which impedes freedom of action by reason of the crowded state of the various departments (thereby impairing efficiency and increasing manufacturing costs), prevents the complete isolation of what may be termed (from a general manufacturing stand-point) the obnoxious processes.

If there are a number of buildings, the largest and most easily accessible building should be utilized for the more important phase of manufacture, the more remote buildings being used for the accommodation of processes that are few in number, or for the manufacture of parts which (save for assembling) can be completed in one section. It may be taken for granted that the machining department occupies the premier position, and the allotment of the other buildings is, therefore, in relation to this. All machining processes are under one roof, which also shelters the tool-room and, if possible, the finished part store. The raw material store, foundry, and press shop (these being feeder departments) are accommodated in buildings in close proximity to the machining department, whilst the assembling department should not be far away, the more remote buildings being allotted to the wood workers, metal workers, etc., seeing that their association with the machinery department is not very pronounced. It may also be added that, apart from judicious allotment of the various buildings, the whole factory must be linked up by an efficient transit system, by which means the most remote building will be brought within "easy distance," so that its remoteness will not be quite so apparent.

## Facility for Extension

Every industry is of course expected to thrive and therefore ample room on the site should be left for additional building for future development. Otherwise, the original building will be overcrowded by men, machinery and products. The best method to relieve this congestion is to lay-out the first building in such a way that the additional requirement of room, either for a part or whole of the process, can be best met by duplicating or extending the building without interfering with the main channel of material flow through the factory; or, in other words, the main direction of the progress of work and the flow of material should be at right angles to the direction of development.

In planning the position of the various departments, the same principles operate in any factory, there must be co-ordination of the different factors, with a view to ensuring a maximum of production.

The actual sequence of departments from receipt of material to the despatch of product is a matter of great importance, calling for very careful consideration. Similarly, the geographical relation of the terminal points reacts on administration. A strictly straight line system may not, therefore, be as sound in practice as a horse-shoe arrangement with external traffic control brought together, both as to goods received and goods despatched, in one area. For instance, a railway siding will probably be best placed across the poles of the horse-shoe, serving both stores and warehouses.

The best arrangement is to have the offices and stores at the entrance with sufficient provision to ensure that all persons and goods shall only be able to enter under close surveillance.

The factory is dependent on outside sources for raw material supplies, and the location of the receiving department must be in such a position as will permit of direct communication with the road. It does not necessarily follow that this department must be located at the works entrance, for a road may be in evidence which will permit vehicles to be unloaded well inside the factory, but this does not alter the fact that direct communication with the outside road is essential.

But the location of the receiving department is not governed by this factor alone for there is the question of internal transport to be considered. The department receives, but it does not hold, and so a destination must be found for the material, which would obviously be the raw material store. This store, being a "feeder" department, must not be remote from the departments requiring the material, and yet it should not be far removed from the receiving department. It may be considered desirable (with a view to minimizing the handling of material) to attach the receiving department to the raw material store and this is to be commended if the location is alike favourable from the stand-point of receiving and issuing.

The engine and boiler houses should be parallel to one another and should be behind the offices.

The plan of the building being settled, the laying-out of the machines and plants should now be thought out. The machines should be arranged in direct sequence to the operations; so that the flow of material from operation to operation should be as direct as possible. The lay-out of the machines, of course, depends upon the particular industry and its special conditions.

As the **machining department** is interested in practically the whole of the output of the foundry and the smithy, these departments should be within easy reach. The smithy, too, should not be far from the raw material store, seeing that it is from here that all supplies are drawn. Theoretically, the same applies to the foundry, but in practice it is usual to hold foundry supplies in a separate store, which would be as near to the foundry as possible, and if this procedure is favoured the location of the raw material store is not of much interest from the stand-point of foundry supplies.

It is in connection with the foundry output (and also that of the smithy) that the location of the raw material store deserves consideration, for in many factories castings and forgings are classified as "raw material," being received as such in the store from the foundry or smithy, and delivered to the machining department from the store. Should it not be convenient, however, to locate the raw material store equally accessible to both the founding and smithing departments, the same procedure could be followed as suggested in regard to supplies, *viz.*, the provision of a separate store for foundry work.

The **pattern shop** must obviously be within close proximity to the foundry, whilst the **tool room** must be equally accessible to the machine shop. Assuming, however, that the pattern and tool departments are amalgamated (as suggested earlier), the position of the combined department should be selected with a view to rendering efficient service to both the machining department and the foundry.

The **inspection department** proper will be located, if not under the same roof as the machining department, at least in an adjacent building, so that facilities for rapid and continuous inspection may be afforded. The finished part store should be near this department.

The location of the **assembling department** must not be remote from the finished part store, whilst it is equally good policy to bring this department within the purview of the main inspection department. Assembling being the consummation of machining, the closest co-operation is essential, and this co-operation is made possible through the medium of inspection.

In conjunction with the assembling department, the position of the **packing and dispatch** department must be considered.

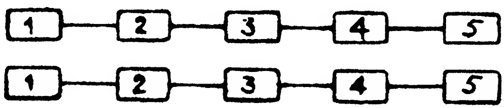
**The metal-workers'** department, for example, should be nearer to the assembling shop than to the machining department.

**The wood workers' department,** which is usually self-contained in the sense that it is not dependent on other departments for supplies, can also occupy a somewhat isolated position, and the same may be said in regard to the engraving department. The **paint shop**, on the other hand, is intimately concerned with transit, yet a certain amount of isolation is desirable on account of the peculiarity of the process.

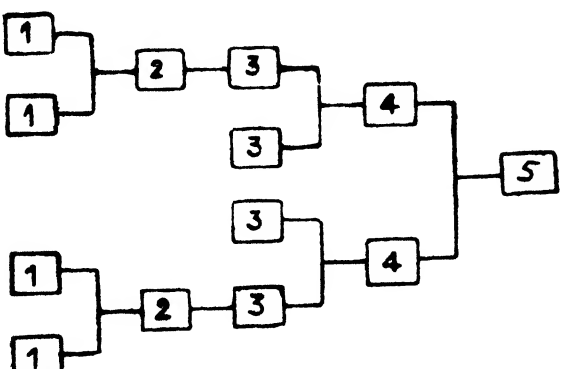
The following are some of the usual arrangements to be preferred :—

(*i*) Where the material, as in jute, paper, saw mill and box plants, flows from one end of the building to the other, the machines may be arranged in simple sequence thus :—


(*ii*) Say in a button factory, there are similar processes, but on different materials—so the arrangement here takes a 'parallel sequence' system thus :—




(*iii*) As in an engineering workshop, where the process of manufacture involves several auxiliary operations, or the combination of several components ultimately to be combined into a complete article, the arrangement takes the form of an 'assembly or tributary sequence' thus.



Cases may arise where none of these systems is strictly applicable, but satisfactory arrangements can always be made if the guiding principle is adhered.

The buildings should be such that every department can be extended without duplication A small building on these lines is just as cheap and more valuable, even in liquidation.

The factory as a whole should have only one exit for work-people, which should also be the entry. Exits or entries for goods should be closed at least an hour before stopping time.

But no workshop should have only one entry. The workman should not be able to watch **both** doors at once.

It will be required to provide in general :—

Power House—close to road or rail and to water supply.

Foundry—next in proximity to road or rail.

| | | |
|---|---|---|
| Smithy | ... | next. |
| Machine shop | ... | do. |
| Store | ... | do. |
| Offices—including drawing office | ... | do. |

In the Northern Hemisphere light should be from the north side.

The pattern shop may be above foundry, and the drawing office, which must have good light, above administrative office. If the power transmission is by rope or shaft, the machine shop should adjoin power house. The boiler, if there is one, should be within its own walls.

If French trusses are used, the building must run east and west, and get light from north wall, 75 °/o of wall should be window.

If it is unavoidable that the long way of the building is N. & S., the roof should be saw-tooth with vertical windows facing north.

This type of roof is of growing popularity. It looks well from the railway, and **very well** in a photo as one building looks like many

The machines should be arranged, as described above, but they should not be congested. Ample room, should be left for the erection, dismantling, etc., of such machine and also for its contingent material service For the latter the final position of a piece of work or a machine product at the conclusion of an operation serves as an initial position for the next operation. Thus, as far as possible to minimise handling cost, the level and position of each machine should minimise human labour in lifting against gravity in its service, and facilitate the direct flow of material. Also the batches of machines engaged on different components or stages of manufacture should be separated by alley ways and the necessary space required for intermediate storage of semi-manufactured material, where necessary.

An important question that often interferes with planning is that of power. Where the power is great, a considerable amount of waste must occur if heavy machinery is located at a distance from the main drive. This question generally arises where the power is to be transmitted by shafting only. Occasionally it happens that, for this reason, the power plant has to be situated in the middle of a factory. It is desirable, as far as possible, to shorten the power drive, to avoid angles and multitudinous counter-shafts. When the distance is great or the arrangement of department militates against efficiency in this respect, a considerable saving can be effected by the use of motors, either departmentally or for each of the heavier machines.

Due consideration must also be paid to the heating, lighting and ventilating of factories.

At the time of planning a factory due consideration must also be paid to the fulfilment of the Factory Laws and other conditions for the welfare of the labour and economy. Thus for a factory, where there is enough of women-labourers, a room may be left for the nursing of the children of the mothers employed or as a day-nursery for children who cannot be left at home. There must also be a suitable meal room and sanitary and washing accommodations for the workmen. Facilities for interviewing applicants for employment, the payment of wages, accident treatment, time recording and gate control and general offices should be provided for near the works entrances, and a decently furnished room for receiving important visitors, committee meetings and the like.

Accommodations for clothing, umbrellas, bicycles, and space for protecting and drying outdoor clothing in wet weather should not be overlooked.

## Buildings

Buildings are necessary for protection from weather and also to ensure, as far as possible, uniform conditions of temperature, lighting, humidity and air circulation; and also for the protection of plant and material from theft. Thus in a tropical country like India where the sun is so strong. to make provision for the avoidance of incidence of direct sun-light with its consequent glare and heating effect in the buildings, it is better to have the buildings layed-out with their **length east and west.** Sufficient lighting is obtained from windows on the northern wall. Cases may arise where it is not possible to get the building running east and west; then the same effect can be had by adopting the **saw tooth** roof paterns with windows facing north instead of the ordinary truss-shaped roof. Often the former type is preferable. For, in the case of widths too big for single span buildings, multiple spans of 20-25 ft. are adopted with saw-tooth pattern northern lighting together with windows on the northern wall.

Although single-storied buildings do not make the economical use of the land area they cover, and the double-storied buildings do, yet, as has been shown, they reduce the handling cost. To this we may add the advantages of better lighting, ventilation, less vibration, cheaper foundations, and a smaller building cost generally. The length and width of the building must be sufficient, no doubt, to accommodate the machinery in their proposed order of arrangement, but on the width depends the cost of the roofing and therefore of the building. Also the greater the width of the building in the case of absence of roof-lighting, the higher must its ceilings be to provide for higher windows for adequate lighting at the middle of the floor. The question of height of the building is also affected largely by the provision for overhead cranes or heavy shafting, etc.

Due considerations must also be paid to the carrying away of rain-water from the roof of the building. The **plinth** of the building must also be high enough to be dry and also to be safe from inundation by rain-water from heavy showers, etc.

The **ventilation** of the building is an essential factor in its design. In our country, India, complete control of air conditions with respect to temperature, humidity, and quantitative rate of change, is not possible without adopting mechanical means involving considerable expenditure. However, such natural ventilation, as is possible, can be secured by designing the roof in such a way as to have a direct opening to the outside air, properly protected from the elements and preferably on the northern aspect of the building.

The last point we have got to consider is the **economics of the buildings** with respect to their materials of construction. The whole of the buildings should be as fire-resisting as it is possible to make them. The buildings may be of brick, combination of brick and steel, re-inforced concrete or steel frame and metal enclosures.

In localities where bricks are easily available, the adaptability of brick construction and its rapidity of erection in one storey, shops of large area, commends them as being the most suitable and economical material. The long walls may be easily stiffened by steel piers or stanchions where extra strength (other than that for supporting the steel roofing structure) is required.

The combination of steel and brick for buildings has the same advantage as above with the additional merit of allowing the shops to be divided into any number of bays, the partition walls of concrete slabs gaining their strength from the steel stanchions and roof girders, and being rapidly and economically erected.

Reinforced concrete is also largely used. In out-of-the-way places, such as in the hydro-electric power station buildings, where the ballast usually costs nothing and freight charges for large and heavy girders are high, the economy of this method of construction is self-evident. But one disadvantage of these buildings is that they cannot be adapted, unless provision is made at the beginning, to purposes other than that for which they were constructed.

The last method of steel frame and metal enclosures (usually corrugated iron) is only used as a temporary means for emergencies. The great disadvantages are that the up-keep of these buildings is high and it is difficult to keep the temperature constant in these buildings. In Urban districts special sanction has to be obtained for them.

## Bibliography

C. H. Wordingham's "Central Electrical Stations."

A. T. Weston's "Factory Construction and Installation in Bengal."

# CHAPTER XV

## REFERENCE AND REPORT.

## LAND ACQUISITION

UNDER the modern democratic system the rulers of a district, a municipality or a nation are chosen by large masses of the lay public. The rulers so chosen of course reflect fairly accurately the mentality of those who chose them, differing from them not in the extent of their knowledge, or desires, but in being more energetic, and articulate. Simultaneously with this transition from autocracy to democracy and from the rule of the most able to the rule of the average man, the problems of Government have become not less, but much more complex, and difficult ; and expert knowledge of a vast range of subjects of which engineering is only one, and that far from the most important, has become indispensable.

In spite of this apparently insuperable difficulty, democracy has often been very successful and in times of peace at least has resulted in approximation to the ideal. "The greatest possible good for the greatest possible number". The rule of the expert, on the other hand, too often means the greatest possible good for the expert with a few brilliant exceptions, such for example as Asoka and Akbar.

Though there have been many reactions to expert autocracy, nearly always but not invariably military expert autocracy, and these reactions are here and there throughout the world successful even in these days : on the whole, the stars in their courses appear to favour democracy, and it is more and more generally agreed that short of absolute mass suicide, it is better for the intellectual and spiritual health of a people that they should be interested in and control their own affairs even very imperfectly than that they should be expertly and efficiently ruled by the most able men in the community.

We, therefore, advise you that your duty both as experts and elements of a democractic state is to regard yourselves always as guides, but never as rulers. It is the prerogative of a Government or rather its duty as representatives of the people to say what they and the people would like to do ; but before they can say that it will or can be done, a **reference** must be made to the expert. A "reference" from a Government or a municipality is, therefore, of the same nature as an inquiry as described in the chapter on "Trading Abroad". It is concerned with what the scheme is required to accomplish rather than with what it is. It will, however, usually include a summary of previous reports on the same or similar schemes, and any other matter available with Government that might help the expert or expert body to prepare a new scheme.

**The report** will almost certainly be in two parts separated in time by some months. In part I there should be as many alternatives as exist in the nature of things. Exact estimates are not required, but no aspect of any of the alternatives should be neglected altogether. In every case the report on an alternative should include :—

(*a*) What the scheme would probably accomplish.

(*b*) All necessary rough plans.

(*c*) Capital costs with a time table showing when they would have to be disbursed.

(*d*) Running costs including depreciation and details of staff salaries and wages.

(*e*) Any other matter which the reporter thinks might assist Government in coming to a right decision, *e g.*, adverse or beneficial results on persons not directly interested. All of this part I should be easily understandable by a layman. The reporter must not use his expert knowledge or his technical vocabulary to mystify or to impress the superior body with his own learning ; still less, of course, to serve a private interest or a private ambition.

Part II. This is the complete report on the selected scheme. It should include :—

(*a*) A summary of all previous references and reports.

(*b*) Complete specifications and estimates for the selected scheme.
(*c*) Complete detailed plans.
(*d*) Financial statement and time table as before, but much more fully and carefully worked out. If it is proposed to raise cost by a loan, the times for, and sources of repayment may be indicated.
(*e*) Terms of contracts (See Chap. XXVIII)

This report should be fully technical as it may be referred to other experts before final sanction.

**Land Acquisition**

There are acts controlling land acquisition which apply only in certain localities such as, for instance, the Calcutta Improvement Act, and others which apply over the whole of India. Only the latter will be considered here. The all-India Acts are :—

(1) The Land Acquisition Act of 1894.

(2) The Land Acquisition Act (Mines) of 1885.

(3) The Indian Electricity Act of 1910 (Sub-Sections 2, and 12 to 19 only).

All these Acts are old, and the most important aspect of an old Act is not so much the Act itself, as what a long series of judges have decided as to what exactly it does mean. The latter may differ considerably from what those who originally framed the Act intended; or even evidently intended. These "precedents" also cover a great many emergencies that were not foreseen at all when the Act first became law. Therefore, we will make no further reference to the Acts themselves but will be content to indicate in a general way what may or may not be done under the law as it stands; with the customary warning that the man who is his own lawyer has a fool for his client.

No one has any right of access to land until the Local Government has notified in the official gazette that the land is needed or is likely to be needed for a public purpose. Thereafter any officer authorized by Government may do all that is required for a thorough survey, including digging bore holes into the sub-soil, cutting jungles and fences where necessary, and marking off boundaries. But he must give seven days' notice to the inhabitants before entering a private dwelling house or its enclosure even then. The damage done in any such preliminary survey (*e.g.*, to crops or fences) must be paid for by the officer as part of the expenses of the survey. If the amount is disputed, the case must be referred to the Collector or Local Revenue Officer.

Nothing beyond this preliminary survey must be done until Government sanction is received. This inevitably means a long delay. Thirty days after the **first notification** are allowed for receiving "**objections**". An objection really means a claim for compensation. Any interested person (not only the owner of the land) is entitled to object and to have his objection considered; but no objection can ever be decisive. The Local Government has absolute power to acquire, either on its own behalf or for a private company, *e.g.*, a railway or water supply company, any land required for a public purpose. There is nothing in the law to prevent a Local Government from acquiring land by ordinary purchase, but as this procedure would leave it open to actions for damages by third parties, it is not usual where there is any probability of such claims.

Claims for compensation by third parties, as for example, that the contemplated works destroy an ancient right of way, are usually disposed of by providing in the scheme for some alternative. The **value of land** itself is based on the value immediately before the first notification was published *plus* fifteen per cent. as compensation for the possible inconvenience. That value is assumed to be from twelve to fifteen years of the income (rent) of the land, or if the land is not in actual use of similar neighbouring land which is in use. The amount is fixed in the first instance by the Collector. His decision may be appealed against in the courts where, however, his opinion would carry great weight.

If after the preliminary survey and report Government decide that the land must be acquired, **a second notification** to that effect is published. The Collector will then dispose of objections, and as soon as his awards are given, Government or the Company for which Government is acting may assume complete possession even if there are appeals pending. There is nothing now to prevent any of the usual rights of an owner. The original scheme may be abandoned and another substituted, and part or all of the land may be disposed of. Unless specifically excluded, minerals under the land pass with it. The acquisition of land may be expedited in case of urgency but in only one case is there any power of immediate acquisition. That exception is an accident or an apprehended accident dangerous to human life, but in that case the action must be reported to Government within three days, and its necessity will have to be proved.

# CHAPTER XVI

## CHOICE OF SOURCE OF POWER

THE modern tendency is towards the concentration of power production in large central stations either generating from coal-fired boilers and steam turbines or from natural water-power in those districts which are fortunate enough to possess it. Where such a source of public power supply exists, and offers unlimited power, or rather far more power than the factory is likely to need at, say, not more than two annas per kilowatt hour. there is no need to consider a private generating plant ; unless, of course the concern is of a magnitude comparable with the central station itself. The advantages of the public supply for comparatively small works are :—

(1) All available space and capital are available for the prime purpose of the factory.

(2) No managerial ability is required in connection with the power supply, electrical transmission to small isolated motors being about as fool proof a method of power distribution as there is.

(3) Greater reliability. (Because a large central station can afford to employ the most expert and scientific management.)

(4) A considerable reduction of "banking losses" which are losses due to the plant being shut down or partly shut down. A central station in an urban district commonly has an outlet for much of its power in street and house lighting during the hours when power is not required for industrial purposes. It may transmit some of its banking loss to consumers by means of a differential tariff, that is to say, by charging more in the day-time when loads are heavy, but the extra cost is not as great as it would be in a private station.

The choice of a prime mover will, therefore, have to be considered only if :—

(*a*) there is no public power supply at a reasonable rate.

(*b*) the factory process is one requiring heat for purposes other than power production All heat engines waste great quantities of heat, which may occasionally be made use of for various purposes.

(*c*) the factory process involves the production of cheap fuel as a bye product which may be used to generate power privately, either by means of gas producers or steam boilers.

If any of these conditions exist, a choice must be made among the following :—

Steam Engine, and Boiler.
Oil Engine.
Gas Engine.
Water-power.

We shall now consider these in detail in the order given.

## Turbines

Occupy much less space than reciprocating engines and are simpler in mechanism, but their condensing equipment must be more refined to suit the high vacuum if the turbines are to work efficiently and economically. For powers higher than 2000 kW. the steam turbine has ordinarily no competitor except in districts where water-power is readily available for commercial uses. But small and medium power turbines from 500 to 1000 kW. do not compare favourably with reciprocating engines and are not so economical as steam engines in fuel nor so reliable. But low pressure turbines are often used in connection with existing reciprocating engines. Another drawback of the turbine is that it requires highly skilled attendance and its repairs are difficult. For units more than 1000 h. p. capacity the steam turbine will usually prove the most economical and above 800 h. p. capacity the turbine will cost somewhat less than the engine.

## Horizontal Mill Engine

The modern high class mill engine fitted with corliss or drop valve gear installed with proper auxiliaries is one of the most reliable and durable power plant up to

1000 B. h. p. The reciprocating steam engine is very economical for small plants having from 1 to 3 units of not more than 500 h. p. each. In modern practice such engines are used when the size of the unit does not exceed 750 kW. out-put specially with D.C. generator and to use turbines for larger units.

## Vertical High-Speed Engine

This type of engine occupies a smaller floor-space but greater head room than the horizontal type, and is slightly more efficient on account of the higher speed at which they are usually run.

## The Uniflow Engine

This engine has a high efficiency. It occupies less floor-space than a corresponding tandem compound horizontal engine and its maintenance cost is smaller. In this engine there are only one cylinder and piston instead of a number as in a compound engine and the large exhaust ports allow a higher vacuum to be made use of.

## Locomobile

The engine boiler and all the auxiliaries being combined in one unit, they occupy a much smaller floor-space than any other steam engine. The foundations are simpler. The cost of upkeep is smaller, and the whole plant is more compact than any other type. The boiler offers a great facility of inspection, its cleaning is simpler and the reliability of the whole plant is very considerable. But they are slightly more difficult to repair. On the whole, the locomobile is much superior to the separate engine and boiler for powers up to about 350 B. h. p., and banks of these engines have been installed for large powers with success.

## Internal Combustion Engine

## Producer and Gas Engine

Gas engines working in conjunction with producer gas, *i.e.*, either with suction or pressure gas plants are very efficient where fuel is concerned, and in cases where waste material, such as wood chips and sawdust or leather cuttings can be utilized there is a considerable reduction in the running costs. As auxiliary, the gas plant has no superior, the stand-by losses are less than for steam plant and the smoke nuisance is eliminated. Waste gases from blast furnaces are utilized with advantage for running gas engines, although it is necessary to install a gas purifying plant to thoroughly clean the gas before it is burnt in the engine. Small gas engines run by suction gas plants from 20-1C0 B. h. p. are very efficient. Engines burning town gas can be quickly started and are very reliable. They are most suitable for intermittent work, but usually above 200 B. h. p. it becomes too expensive to run gas engines by town gas.

The **fuel consumption of gas engines** or **producers** ranges from 0'99 to 3 lbs. per B. h. p. hr. 75 to 90 Cft. of gas per B. h. p. are required of approximately 150 BTU. per Cft.

## Diesel Engine

Regarding fuel economy it is the most efficient prime mover at present on the market. Engines of this type have now been made up to 10,000 B. h. p. with considerable success.

The main disadvantages of the Diesel engines are :—

(1) Its high initial cost.

(2) Its high maintenance cost, and

(3) The comparative expert attention required for driving.

## Semi-Diesel Engine

This two-cycle engine has about 8 to 10 per cent. lower thermal efficiency than the Diesel engine.

The oil engine plant is very simple in construction, ready for instant service without stand-by losses; it causes no smoke, dirt or dust nuisance and it requires the minimum amount of operating labour.

Its disadvantages are that its installation and repair costs are high and very large units are not yet available.

## Kerosene Engine

The Hornsby Akroyd types are built up to 250 B. h. p. The fuel is pumped in a hot tube hot bulb or vaporizing chamber which are kept hot by being left unjacketed and by combustion of a portion of the charge, enough for ignition, to take place. Kerosene engines are the least efficient of the oil engines.

**Gasoline engines** are practically unused for power station purposes on account of expensive fuel and low relative economy.

**In the crude oil engines** careful arrangement must be made for preheating the oil for vaporization and the air also. Exhaust gas jackets are generally used for the purpose of providing the necessary heat.

*Economic limits between which prime movers of the various types may be advantageously used.—*

**Table I.—Economic Limits For Prime Movers.**

| Type of engine. | Power limits within which the type may be practically employed. | Normal consumption per horse-power-hour at full load. | |
|---|---|---|---|
| | H. P. | Steam, lbs. | Fuel, lbs. |
| Stationary steam engines:— | | | |
| Slide-valve, non-condensing ... | 15 to 50 | 37·5 | 5·5 |
| Slide valve, condensing ... | 30 to 100 | 22 | 3·3 |
| Corliss or Sulzer, simple condensing ... | 50 to 200 | 17·5 | 2·5 |
| Idem, compound | 80 to 1000 and upwards. | 13 | 1·85 |
| Semi-portable steam engines:— | | | |
| Simple, non-condensing ... | 20 to 50 | 16·5 | 2·4 |
| Simple, condensing ... | 40 to 80 | 13 | 1·9 |
| Compound, condensing ... | 60 to 300 | 9·5 | 1·35 |
| Triple-expansion, condensing with superheater ... | 300 to 500 | 7·6 | 1·1 |
| Steam turbines condensing ... | 500 to 1000 and upwards. | | |

| Type of engine. | Power limits within which the type may be practically employed. | Normal consumption per horse-power-hour at full load. | |
|---|---|---|---|
| Internal - combustion motors :— | H. P. | | |
| Illuminating gas... | 1 to 30 | 17'50 cu. | ft. of gas |
| Oil ... ... | 1 to 20 | 0'75 | lbs. oil. |
| Producer gas, suction ... | 115 to 300 | 0'88 | lbs. coal. |
| Producer gas, pressure ... | 100 to 1000 (and over). | 1'00 | lbs. coal. |
| Diesel ... | 50 to 5000 | 0'42 | lbs. soil. |

The limits indicated above of course are not absolute. Many small steam engines with vertical boilers are in use, for example, in units of very few horse-power each.

## * Hydro-Electric Plants

Next we come to hydro-electric plants, and it may be stated that a central steam electric plant cannot compete with a normally-conditioned hydro-electric plant.

The most important points for **consideration of the economic basis of a hydro-electric plant** against a steam design are the following :—

(1) The location of raw materials with reference to the power, the distance to the market, and transportation facilities.

(2) Quantity of available power and how far the power supply is reliable, continuous and regular. If the flow is variable, it must be supplemented by steam or other power.

(3) The cost of development of the water-power including the building, business plant, the charges for

* Vide Chapter II "The Hydro-Electric Practice in India," by B. C. Chatterjee.

interest, insurance, taxes, deterioration and repair cost. The cost depends upon the head, the quantity of water and uniformity of flow during the year.

(4) If the process of manufacture requires steam for use and the quantity of steam necessary as in textile mills.

(5) Cost of transportation of products and of supplies.

(6) The total operating cost of the water-power plant at a given place as compared to that of a steam plant erected at a more advantageous place.

(7) The opportunities of obtaining good employees.

**The chief conditions affecting the cost of water-power are :—**

(1) The head and the fixed charges on the development.

(2) The quantity of power produced in its relation to fixed charges and the uniformity of flow during the year.

(3) The load factor in its relation to the efficiency of the wheels, pondage and reservoir capacity.

(4) The cost of supplementary power necessary to make up for the fluctuation of the water-power.

(5) The location of the power station.

The depreciation in water-power plants will range from $1\frac{1}{2}$ to $2\frac{1}{2}$ °/o per year ; repairs 1 °/o.

In general, *to make the final selection* the following points should be carefully compared :—Reliability of Operation, Fuel Economy, Capital Outlay, Available Floor Space, Flexibility and Overload Capacity, Maintenance and Repair Costs, Ease of Starting, By-products, Depreciation, Water and Lubrication Oil Consumption

**For final selection of the prime mover, reliability of operation** is considered to be more important than fuel economy. If reliability is sacrificed to fuel economy and if a set shuts down due to an unreliable prime mover, there would, in all probability, be a greater loss due to the shut down than a few per cent. saving in fuel would balance. In this respect steam engines have no competitors. Small horizontal gas and oil engines up to 100 B. h. p. do, however, compare very favourably with steam plant of the same output. Internal combustion engines are, as a rule, somewhat erratic in their performance where reliability is concerned, and considerable trouble is often caused by their shutting down or failing to develop full power, due to hidden causes. This is rarely the case with the normal steam engine which will run consistently for years with very little attention. The sudden stresses set up in the reciprocating parts of internal combustion engines, specially if it be one of single cylinder, are more liable to cause serious breakdowns than is the comparatively smooth running of a steam engine.

**The available floor space** is sometimes a deciding factor in the choice of prime mover. The Diesel engine occupies less floor space than any other prime mover of the same capacity, and of the steam engines, the locomobiles deserve consideration.

With regard to flexibility and overload capacity, the steam engine is vastly superior to any internal combustion engines; while the former is generally capable of taking an overload of 25 to 75 % of its full capacity, the latter can hardly deal with a 10 % overload and that also for comparatively much shorter periods. While producer gas plants are extremely unsuitable for running on varying loads, a steam engine would readily answer to any kind of load variation.

Thus we see that before a final verdict may be given for the choice of any particular type of prime mover for a place, all the available information with regard to the geographical position of the place, the kind of work that the factory is to undertake and the extentions that are likely to be made even in the future are to be thoroughly considered. But as a main guidance, we may summarise that suction, gas or oil engines are cheapest for outputs up to 100 kW., for higher outputs up to 400 kW., the "locomobile" steam-boiler and engine can hardly be beaten for convenience and economy, though it has keen competitors in the Diesel and Semi-Diesel engines. Similarly, for outputs from 500-1500 kW. the Uniflow and Lentz engines are rivalled closely by Diesel and Semi-Diesel engines; with cheap oil the latter would be at a considerable advantage. Up to 1000 kW. there is no advantage in using turbines rather than reciprocating steam engines For outputs exceeding 1000 kW. the steam turbine is generally the most economical prime mover, but large gas engines can be used with advantage where coke-oven or other cheap gas is available, especially if the annual load factor is high, say 50 °/₀ or over.

The steam engine has the advantage that it is more reliable and its running is simple and may be entrusted to comparatively inexpert labour. Its initial cost is low. But the fuel cost of small engines is notoriously high ; it may go from 10 lbs. to 20 lbs. per B. h. p. hr. So when the coal consumption (2-5 lbs. B. h. p. hr.) of big steam-driven power stations are compared with that of these small stations, the waste involved therein is obvious. The preferable type of steam prime movers are either the locomobile or vertical high-speed engines. Regarding the boiler for such small plants, it may be said that its thermal efficiency in ordinary use is pathetically low and this becomes more so when the boiler is being worked by comparatively inexpert labour, as is usually the case in our country. These inefficiently fired boilers are not only economically bad, but the dense smoke given out by them, when worked inefficiently, becomes a public nuisance. Thus a small steam engine with its boiler apart from its reliability, simplicity and flexibility of operation has little to recommend it. Again the steam boiler requires soft, clean water for its feed water, so the site for such a plant is restricted to localities where such a quality of water is available. The question of coal for the boiler binds it to be near a railway siding or a place having water and coal transport facilities. But where the coal is cheap and readily obtained, or where there is an economic outlet of the waste steam for purpose other than power, the steam plant is undoubtedly the best to adopt.

Thus it is seen that, except in the especial cases mentioned above, the balance of advantages and disadvantages weighs emphatically for the use of internal combustion engines as the prime movers most suited for small power capacities. The great disadvantage of these prime movers, however, are that their working cannot be entrusted to unskilled labour and that their initial cost is high and their repairs cannot be done in an ordinary workshop, so that in an out-of-the-way place, the repairing of any vital parts may lead to a great delay and increased expense. But its compactness, adaptability and general convenience place it far ahead of the steam engine with its necessary boiler, fuels, chimney, etc., and engines of this type are now-a-days available in suitable standard sizes from 1 h. p. to 100 h. p. or over.

Now the problem of alternative choice of an oil, a gas or a suction gas engine, depends largely upon the locality. In the vicinity of a public supply gas work or near iron and steel factories, the gas engine will undoubtedly be the suitable prime mover. Whereas in a place where the coal, for the producer, is difficult to get, and the cost of oil is not prohibitively high, the oil engine suits the situation. But if the factory enterprise is one that produces a combustible waste product in sufficient quantity, such as spent tan, rice husks, saw-dust, etc., a suction gas plant using the waste product is undoubtedly the most economical and the best plant to adopt. But in a case where the coal is available and the oil is costly, and where there are difficulties regarding water supply which prohibit the use of a steam engine and boiler, a gas plant using slack coal is worth consideration. But in every case, before the choice is finally made, it is better to prepare an estimate of the fuel, labour, lubrication, stores and repair charges for each type of prime mover and add to this the capital charges for individual cases. The minimum sum per kW. will indicate the suitable prime mover to be adopted.

In calculating the fuel cost per Kilowatt hour several important items are to be considered and the cost may be mainly divided into the two following divisions, *viz* :—

(1) Capital costs, consisting of interest to be paid on the capital, and depreciation of the plant.

Generator prices, deduced from Burton's catalogue (1923).

Lancashire boilers with all mountings but without brick work. Price in rupees, 50 h. p. + 4500 ; 160 lbs. pressure, 30 lbs. per h. p. hour.

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Slow speed horizontal steam engines up to 400 h. p. simple and compound without condenser; R = I h. p. × 75.

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Condenser and pumps allowing 30 lbs per h. p. hour. Price in rupees, R 20 = I h p. + 3000.

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Oil engines (Non-Diesel) up to 300 h. p., R = B. h. p. × 180.

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Suction gas producer ( waste products—not anthracite ) up to 250 h. p. ; 160 B. H P. + 7500.

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Steam electricity generating sets (engine & dynamo).

Up to 300 kW.

R = 150 × kW.

---

Oil generating sets up to 20 kW.; price in rupees is 750 kW. 20 to 300 kW.; price in rupees is 150 kW. + 7 00.

---

The following is approximately true of a steam engine :—

Total coal in lbs. per hour = 2 I h. p. + 400 or (A)
Coal per h. p. hour = 2 + 400/I h. p. (B)

The corresponding equations for Crude Oil Engines are :—

Total oil in lbs per hour = 0·45 I h. p. + 2·5 (A)
or Oil per h. p hour = 0·45 + 2·5/I h. p. (B)

These equations mean that for small horse powers the oil engine is much cheaper to run, but that over 100 H. P. the higher price of oil may counterbalance the small consumption.

Example.—If the price of coal is Rs. 15 a ton and of oil is Rs. 75 a ton, which type of engine will cost less for fuel at 10 h. p and at 5000 h. p.

at 10 H. P. $\frac{\text{Coal costs } 420 \times 15}{\text{Oil costs } \quad 7 \times 75} = \frac{420}{35}$.

The oil engine is much cheaper to run

at 5000 H. P, $\frac{\text{Coal costs}}{\text{Oil costs}}\ \frac{10400\times 15}{2252\cdot 5\times 75}=\frac{2080}{2250}$.

The steam engine costs less to run by 10 per cent. (two in twenty). This means a saving of Rs. 16,000 per annum in cost of fuel.

Example.—Which would be the cheaper at 400 h. p. allowing for capital cost. Fuel prices as above, say generating sets for both and boiler and condenser for steam.

Capital cost of steam plant is Rs. 95,560. We will allow one-fifteenth for depreciation and 5 per cent. for interest on this, say Rs. 11,000 per annum.

Coal at Rs. 12 per ton will come to Rs. 14,400.

Total annual cost for steam—Rs. 25,400.

The oil generating set will cost Rs. 52,500. We will allow 10 % depreciation and 5 % interest.

Annual cost—Rs. 7,875-0-0 per year.

Fuel cost—Rs 12,025 per year.

The oil engine has much the better of the comparison, and this will, in general, turn out to be the case up to two or three thousand horse power. But the important and uncertain factor is the price of oil. At the present moment oil engines are cheaper to run up to two or three thousand horse power. The world's supply of oil, however, is being prodigally expended, and, in the absence of great new discoveries, it is practically certain that the next decade will see famine and famine prices. On the other hand, we have supplies of coal for centuries.

Working cost, consisting of:—Cost of fuel per k.W. hour; cost of oil, water, etc.; cost of labour; cost of repairs and maintenance; management expenses, etc.; less income from by-products.

If we suppose the managing expenses to be approximately the same for all classes of prime movers, and the load factor is assumed to range from ·2 to ·28, the following tables would indicate the comparative costs of fuel per kilowatt hour.

## TABLE—I.

## COST OF FUEL.

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Type of prime mover. | Nature of fuel. | Average cost per ton of fuel in shillings. | Average lower cal. value of fuel in B T. Us. per lb. | Average over-all thermal efficiency of prime mover per cent. including boilers or producers. | Average costs for fuel in pence per Kw. hour. | Remarks. |
| Diesel 50-250 B. H. P. | Crude oils | 250 | 18300 | 26 | ·97 | |
| | Tar oils | 150 | 16000 | 26 | ·67 | |
| Gas engines suction gas producer (Up to 200 B. H P.). | Anthracite | 80 | 15120 | 17 | ·67 | Assuming producer efficiency of 80 per cent. |
| | Coke. | 30 | 12500 | 17 | ·28 | |
| Gas engines pressure gas producer (100—1500 B. H. P.). | Commercial coal | 45 | 14000 | 21 | ·28 | Assuming producer efficiency of 80 per cent. |
| Gas engines producer and recovery plant. | Commercial coal | 45 | 14000 | 6 | ·17 | Allowing 70 per cent. income from by-products but 12 per cent. decrease in thermal efficiency due to recovery plant. |

TABLE—II.

## COST OF FUEL.

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Ordinary Steam Engine (100—1500 B. H. P.). | Commercial coal. | 45 | 1400 | 13 | ·455 | Assuming boiler efficiency of 75 per cent. |
| Uniflow and Lentz (100—1500 B. H. P.). | Commercial coal. | 45 | 1400 | 14 | ·43 | Assuming boiler efficiency of 75 per cent. |
| Locomobiles (100.—350 B. H. P.). | Commercial coal. | 45 | 1400 | 15 | ·395 | Assuming boiler efficiency of 75 per cent. |

If the steam power has been selected, the next problem is to decide what type of boilers should be used,

## Choice of Boilers

The selection of the type and size of the boilers to be used in a particular locality for a particular purpose should be made with judicious care after weighing the pros and cons of the various factors involved.

There are two main classes of boilers :—

(1) Drum fire tube.

(2) Water tube.

The former comprises various types of which the following are commercially successful :—

(*a*) Vertical simple or multitubular boilers.

(*b*) Lancashire boilers.

(*c*) Dryback marine type.

(*d*) "Galloway" type.

(*e*) Locomotive type.

And the water tube comprises the following types :—

(*a*) Straight tube boilers of which "The Babcock and Wilcox" is the best known.

(*b*) Bent tube boilers.

The "Stirling" boiler is the best known of this type.

(*c*) Marine type water tube boilers.

The following are the factors which are to be taken account of in selecting the type of boilers :—

(1) Capacity of plant to be supplied with steam and the steam consumption per k.W.h.

(2) The quality of fuel and feed water.

(3) The nature of the load.

(4) Floor space available.

(5) Accessibility for transport of materials.

(6) Durability and simplicity of design.

(7) Facility for management and labour available.

(8) Efficiency and economy of running cost must be considered along with the initial capital outlay.

The measure of the capacity of a boiler is heating surface and evaporating power, and the sufficiency of these to provide a given h. p. in an engine depends on—

(1) The type of engine.
(2) The class of the fuel used.
(3) The draught available.

The type of valve gear and the working pressure will materially affect the steam consumption per I. h. p. hour.

(1) The maximum output of the Drum boilers, *i.e.*, Lancashire and Dryback marine type, is limited in consideration of their drum becoming of unwieldy sizes. The maximum output is limited to 500 h. p. in case of non-condensing engines to 600 h. p. for condensing engines. It can be increased to 20 °/o more in case of turbines.

In the case of water tube boilers, the output is 6250 h. p. when used with turbines. They allow of such a high output due to their being made in sections and none of the individual parts being too heavy or bulky.

Steam consumption per kW. h. can be ascertained with sufficient accuracy from the following :—

Single cylinder non-condensing uses 30-40 lbs /I. H. P. Hr.
Compound non-condensing ... ...25·27 lbs./,, hour.
Compound engines ( condensing ) ...18-20 lbs /,, ,,
Triple expansion ( condensing ) ...12-15 lbs./,, ,,
Large size steam turbine ... ...11-13 lbs./,, ,,

For economic working and to avoid priming when boiler is subjected to overloads, an ample supply of steam should be provided. Generally, about 50 °/o more than calculated above is provided in the case of Drum type boilers. Boilers are rated by their normal evaporation from and at 212°F.

(2) Having determined the total quantity of steam required for power we can approximately determine the grate area required. The quality of fuel has much to do with the quantity of fuel that can be burnt per sq. ft. of grate area and the quantity of water that can be evaporated per lb. of coal.

The Indian coal available in the market having a calorific value of 11800 B. T. U. can be burnt 15 to 20 lbs. per hr. per sq. ft. of grate area in drum types and about 22 to 25 lbs. in water tube types. The water evaporated per lb. of coal depends upon the quality of the coal and the efficiency of the boilers. Generally, about 10 lbs. of water are evaporated per lb. of coal of above quality in Lancashire boilers and 8 lbs. in case of water-tube boilers. Dryback marine boilers fitted with economisers often approach the efficiency obtained by water tubes.

Note—that the average calorific value of British coal is about 14000 B. T. U., so in calculating the capacity a proportionately increased size will be necessary in India.

Drum type boilers are adapted to bad water as they can be easily cleaned, while the water tube types are not well adapted for use with hard or corrosive water.

(3) The nature of the load determines partly the type of boiler to be used. Boilers for economic working should be rated to supply load at the estimated daily average load factor of the house, so it should be able to supply the maximum load for a small number of hours. Under emergency cases the drum type boilers fail to supply overload without running the risk of damage to furnances and of incomplete and wasteful combustion though they can meet sudden rushes of demand for short duration with their large water space. While in water tube boiler steam can be raised more rapidly and the boiler can be forced to a high degree of overload, it is unable to meet sudden rushes of demand due to small water space without great variation of pressure. It possesses the advantage over the drum type of the refractory nature of the brick work lining facilitating combustion.

(4) The selection of boilers depends to a great extent upon the floor-space available. Where the power required is small and floor-space limited, vertical multitubular boiler can be safely recommended, though the efficiency of this type of boiler is less than that of the Lancashire.

The **space required** for Water tube boiler 2·2 sq. ft. /kW.
" " " " Dryback marine type...7 sq. ft. /kW.
" " " " Lancashire boiler......3·5 sq. ft. /kW.

In the case of power houses with units of plant exceeding 500 kW., the Dryback and Lancashire type becomes prohibitive on account of space occupied and the increased cost of buildings, pipe work and attendance. The water tube boilers occupy only about ¼th the space occupied by the Lancashire of the same rating. Hence for large power houses water tube boilers are indispensable.

(5) For export work and in places where the transport of minimum weight is necessary, the water tube boilers are indispensable. They, being of detached sections and no section being too heavy or bulky, afford great facilities of transportation where the boiler is required in outlying stations. The station type possesses advantage over the Babcock & Wilcox in that the drums are smaller and hence can be more readily transported to up-country stations; which are often difficult of access.

(6) *Durability and simplicity of design:* Generally, the water tube boilers are safer than the drum types. They are also more immune from the danger of disastrous explosion than other types. The design provides more facilities for inspection, cleaning and renewal of tubes. Accumulations of soot on the exterior of tubes may be removed by a steam hose and jet for which access is given by small hand holes built into the side walls of the brick work setting or by scrapers. As a unit the water tube boiler and setting is more complicated than horizontal return tubular or vertical boilers. While in the drum types, one must go inside the drum to do any of the above things.

The tubes can be easily inspected by taking out the caps and placing a lamp at one end and also can be easily cleaned.

The chances of overheating are much greater in drum types, and the parts are subjected to stresses due to unequal expansion entailing possible rupture. The only disadvantage the water tube boilers possess is that they contain a large number of tubes, the caps of which need to be removed occasionally for inspection, and renewal of the tubes are the source of trouble. The Lancashire type possesses reliability and freedom from repairs.

(7) *Facility for management and labour available.* Where the power required is small, hand stoking is resorted to, and skilled labour is required for this purpose. Often for want of skilled labour a wrong class of mechanical stokers is selected leading to inefficiency. Mechanical stoking is always resorted to for large units.

(8) *Efficiency and Economy:* A water tube boiler possesses a higher efficiency, for it provides a better circulation of water and less heat radiating surface. It also can be subjected to a higher pressure than the drum types, leading to increased efficiency. The efficiency claimed by the manufacturer is 75 to 80 %, while the drum types have an efficiency of about 60 %. The efficiency depends upon the rate of evaporation per sq. ft. of heating surface. This rate has a critical value, *i.e.*, the efficiency of any type of boiler will be less if the rate of evaporation be increased beyond or reduced below the critical value The efficiency may be impaired through not selecting the most suitable type of boiler for the particular class of fuel available.

The initial cost and the cost of setting of the water tube boilers are much greater than the drum type ones. Hence, before deciding upon the type of boilers to be adopted, it should be thoroughly worked out whether the interest and depreciation on the increased capital outlay incurred in the case of water tube boilers can outweigh the cost of saving in coal due to increased efficiency and the facilities provided with respect to floor-space and cost of transportation, etc.

To sum up, Lancashire boilers can be recommended in stations of moderate sizes where there is space for them and their economiser, as they are easy to manage, require practically no repairs, are easy to manufacture, affording ample competition as to their price, have large water space, and can be banked up without excessive loss of heat. The Babcock & Wilcox boiler can be recommended in cases where floor-space is limited, very high pressures are required and where units are large. Where little floor-space is available, the marine boiler is efficient and useful. It has the serious drawback of bad circulation, excessive repair and is not adapted to as high pressures as water tube boilers are.

## STANDARD LANCASHIRE BOILERS

| *Size of Boilers.* | | *Weight of Boilers for following steam pressure.* | | Weight of Boiler fittings | Heating surface. | Grate Area. | Chimney height in feet. | *Coal Consumption per hr.* | | Total steam per hour. |
|---|---|---|---|---|---|---|---|---|---|---|
| Length ft. | Diam ft. | 120 lbs. tons p. sq. in. | 180 lbs. tons | | | | | Per sq. ft. of Grate Area. | Total. | |
| 22 | 6·5 | 11·25 | 15 | 3 | 570 | 25 | 100 | 20 | 500 | 4,000 |
| 24 | 7 | 14 | 18 | 3·5 | 680 | 29·75 | 120 | 24 | 700 | 5,600 |
| 28 | 7 | 15·75 | 20 | 3·5 | 800 | 32 | 130 | 25 | 800 | 6,400 |
| 30 | 8 | 20·25 | 27 | 4 | 1000 | 38 | 180 | 32 | 1220 | 9,769 |
| 30 | 8·5 | 23 | 30 | 4·5 | 1050 | 40 | 185 | 33 | 1320 | 10,560 |

The evaporative capacities are for a good quality of coal of about 13,500 to 14,000 B. Th. U. and assuming the boiler to be fitted with economiser of adequate and properly proportioned heating surface.

## STANDARD SIZES OF BABCOCK & WILCOX BOILERS

| Heating surface. | Evaporation per hour (Actual). | CONSTRUCTION. | | | | | | Furnace. | Approximated weight (Packed). | SPACE OCCUPIED. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Tubes. | | | Drums. | | | | | Single Boiler. | | | Two boilers in battery. |
| | | | | | | | | | | Over Brickwork | | Height when hand fired. | |
| | | Wide | High. | Long. | Number. | Diameter. | Long. | Area. | | Length. | Width. | | Width. |
| Sq. ft. | lbs. | | | | | ft. | ft. in. | Sq. ft. | tons | ft. in. | ft in | ft. in. | ft. in. |
| 119 | 360 | 3 | 4 | 6 | 1 | 24 | 10′-5″ | 5·20 | $3\frac{3}{4}$ | 9-6 | 4-5 | $10\text{-}5\frac{1}{8}$ | 8-0 |
| 983 | 3000 | 6 | 8 | 16 | 1 | 36 | 21-11 | 19·15 | 12 | 21-0 | 6-10 | 14-1 | 12-2 |
| 1827 | 5600 | 9 | 9 | 18 | 1 | 48 | 24-3 | 33·50 | $18\frac{3}{4}$ | 23-0 | 8-7 | $16\text{-}1\frac{7}{8}$ | 15-8 |
| 3580 | 11000 | 16 | 10 | 18 | 2 | 42 | 24-1 | 67·50 | $31\frac{1}{4}$ | 23-0 | 12-8 | $17\text{-}3\frac{3}{8}$ | 23-10 |
| 8283 | 25000 | 27 | 14 | 18 | 3 | 48 | 25 | 168·00 | $69\frac{3}{4}$ | 23-6 | 19-1 | $22\text{-}5\frac{1}{4}$ | — |

## Appendices to Chapter XVI

(George I Rhodes in Standard Hand book for Electrical Engineers).

A. "*Engine or turbine room operation* offers a less fruitful field for improvement since the inherent economy of the units, more particularly of the turbines, is less under the control of the operators. With engines, however, it is highly important that valve settings be maintained properly The proper loading of units has some influence on economy The balance of exhaust steam produced and that needed for feed-water heating is particularly important at light loads, when ordinarily there is an excess of steam which is wholly wasted Electric drive of some of the auxiliaries frequently serves as a corrective. Air leakage into the condenser is an important source of loss.

B. *Boiler-room practice* affords probably the most fruitful field for improvement, as it has hitherto been the most neglected. Numerous instruments, meters and devices are on the market which make possible a continual check on the efficiency of the boiler room. It is not only possible to know the over-all efficiency, but to determine readily just what are the causes of inefficiency ; there are automatic devices, also, which remove some of these causes. A careful study should be made as to the variation in efficiency with peak load and load factor, so that the inherent improvement in economy with good load factor shall not be mistaken for the results of better operation. Determinations should be made as to the proper number of boilers to use, the relation between active fire hours and banked fire hours, and just when it is profitable to let the fires go out. It is highly important that the boilers themselves be kept clean both inside and out ; means are available to facilitate this work, both chemical and mechanical. The firemen should be carefully instructed in proper methods of firing and closely watched to see that they follow instructions"

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# CHAPTER XVII

## GENERAL ORGANIZATION OF A CENTRAL POWER STATION

IT is obvious that the success of an undertaking depends upon the management, and the management of the scheme depends upon the organization. Too much care and thought cannot be bestowed on these. Every individual case is governed by its own local and peculiar conditions, and no universal rules of organization can be laid down for all works. A few important guiding principles may be laid down here.

For any big enterprise a company should be formed and the Board of Directors or the Municipal Committee should be the ultimate controlling power and subject to their control the supreme authority must be vested in the engineer. The director's duty is to say **what** must be done and at **what maximum cost.** The engineer's duty is to say **how** it is to be done, and if there are financial limitations, to acquaint his directors with **all** possibilities, within their power. It will be seen that a knowledge of pure science and technology will be necessary in almost all problems and hence whether from the theoretical engineering side or from the side of practical operation or from the purely commercial side the successful engineer with a sufficient commercial knowledge and aptitude will be the best person to control the whole scheme. His function will thus be consulting and managerial. He will plan and supervise all new works. He must be thoroughly conversant with the works of every department and the responsible head of each department must be in close and direct touch with him. He should, however, strictly confine his dealings to the heads of the department and on no account go over their head or interfere in any way with their subordinates for whose work they are responsible to him.

We consider that much friction and nepotism will be avoided if all subordinate posts are filled by the directors from a list approved by the chief engineer.

The head of each department must thus work under the chief engineer who should be well-acquainted with the work of each of his immediate subordinates, and must often examine fully the details of the work. He must not be a figure-head or a puppet, but must make his influence felt in every department, guiding its work and shaping its policy in all matters.

He should support his staff, see to their prestige, and make their authority respected by those under them, while among the various members of his staff he must promote good feeling and loyalty to the undertaking as a whole, securing a healthy spirit of emulation between departments without provoking jealousy and thus harmonise the works of the various departments which must thus work in conformity with one another. Every employee should have a right to appeal to the chief engineer, and vexatious or malicious complaints should be severely dealt with. But no subordinate should ever be rebuked in the presence of others.

The chief engineer should delegate the work somewhat as follows :—

(1) Second engineer to take control in the absence of the chief engineer and to help him at other times in purely engineering matters.
(2) Private secretary to the chief engineer.
(3) The chief works' clerk.
(4) The electrical engineer.
(5) The steam engineer
(6) The mechanical engineer.
(7) The distributing station engineer.
(8) The installation inspector.
(9) The street lighting inspectors.
(10) The head of the standardising department.
(11) The chief draftsman.

In a small station, groups of these departments would of course, be controlled by a single person. These various departments, though distinct and self-contained, are mutually dependent, and the work of one department is complementary to that of the other.

**Arrangement of the equipment in the Power Station:**—(1) There must be ample operating space around every machine and necessary apparatus. (2) The switchboard should be well-lighted and so situated that men may move about it, without interfering with the operations of the other machines. (3) There should be every facility for extension as almost every paying plant is a growing one. The main switchboards should be so fixed that they may not be damaged by water, steam, oil, broken belts or ropes. They must be so placed that they are easy of access for the mains from the generators and from the streets

**Control:**—The control of the construction of a plant should be as efficient and thorough as may be practicable. All material supplied, and every operation should be carefully inspected and a systematic record kept. Such a record will be equally useful to the contractor, the directors, and the engineer.

**Market Analysis:**—First survey the area if necessary and prepare a list of all existing power plants and users in the city, note their condition, output, operating personnel, fuel consumption, the periods and character of power service, the rate paid for power and light. From a complete power canvass determine how much of the power business can be secured for the installation under consideration.

To the prospective customers explain the advantages of electric power as compared with mechanical drive, the efficiency of transmission, independence of the machine arrangements from location of shafting, cleanliness and greater possibility of machine speeding. The most important point is to show him the reduction in cost for the power used by pointing out the fact that he will pay only for as much power as is doing actual work for him and that he will be independent of labour or fuel price, boiler, pumps, engines, breakdown and repairs and that his power charge will be a fixed item while otherwise it is highly problematical, and that electric lighting is immensely superior to all other illuminants.

**The feasibility and practicability** of a scheme are not entirely established if only the power and the market are available. We have yet to consider the question of Government Control and the State Laws regulating the fuel, land titles, etc., and in the case of hydro-electric plants the rights and the practicability of an economic development.

The investment balance, or the summation of the capital outlay and the returns promised by the enterprise, the interest, sinking fund, cost of maintenance, operation, depreciation, taxes and insurances on the one hand and the receipts from sale of product on the other should be carefully considered. The balance assuming the total investment, interest payable during construction period, cost of lands, rights, franchises and legal and engineering services on the one hand and the debits for this balance such as fixed charges, interest, depreciation, administration, taxes, insurance and operating costs should be carefully considered for determining the feasibility and practicability of a scheme. The larger capacity developments will show a greater surplus. If the investment balance shows a satisfactory profit, the success of the scheme is almost a certainty.

**Presentation**:—The engineer should sum up the findings from his investigation of the market, power capacity, feasibility, practicability and cost of the factory or installation, and submit his report with such documentary proof and legal opinions as the occasion requires. The report should be exhaustive in every detail, which is a link in the complete chain. It should contain all arguments, comparative costs and output data and the reasons why the recommended programme will guarantee the most resourceful and remunerative scheme. He should then give a description of the structural plan of the proposed works with brief stability proofs of the essential parts, and a concise specification of specially adapted construction programmes and methods. He should present the detailed estimates supported by quotations of materials of recent date with delivery cost to site.

The estimates should be made after the designs are completed and checked, and should give details of every structure, their dimensions, weights, quantities, etc., and specifications of every class of structural material, proper qualification of labour and labour costs. It should conclude with a summing up of all the different materials required, grouped in accordance with proper classifications as to their character and cost. Add to the total cost the charge for superintendence, inspection, insurance and finally some arbitrary per cent. addition depending upon the thoroughness of the detailing of items for contingency allowance covering accidents, breaks, washouts, delays, etc. The quantity should always be quoted in positive figures, if possible.

It should close with the investment balance based upon the most remunerative scope which can now be definitely determined and from this the cost of the product per kilowatt-hour for assumed load factor can be calculated.

It is not a wise or useful policy to suggest an alternative programme, because only the most feasible project should be advocated; nor should estimates be quoted in lump sums for power house equipments, dam, canal, etc. As the lump cost cannot be correctly known to the author of the report without his having developed it step by step through detail items, there is no reason why these should not be given in the report. Enter all calculations in a computation book devoted to the particular project. Every entry should be clear and precise, each separate calculation should be given in a separate page and a comprehensive index for checking the items should be added. All sheets containing plans should be of uniform size; dimensions should be given in figures and identified by dimension lines; the lettering should be clear; location, plan, longitudinal and transverse section of all structural features with important details should be given.

**Requirement of Investors:**—The project must be carefully examined by experts of reputation, men who are of the highest ability and experience, who can and will vouch for the technical features of the construction, for the expenses, involved for the market available, for the legality of the enterprise, and in fact for its probable complete commercial success.

"**Modern tendencies in power-plant design** point to inexpensive plants of high operating economy. Expense of construction is reduced by simplicity in design using few large units; reliability is secured by the use of the highest quality of materials and apparatus rather than by duplication, with its attendant complication. Operating economy is secured through better control of combustion, the use of highly efficient apparatus whose efficiency adds relatively little to the cost of the entire plant, and the attendant reduction in labour cost through the simplicity of the plant and the small number of operating units. The development of stokers, allowing very high rates of evaporation in the boilers with high economy, has reduced the investment costs in boiler equipment and building and also improved operating economy by reducing the amount of coal consumed in banked fires. There is a strong tendency towards compactness of lay-out, allowing only sufficient floor-space for the dismantling of apparatus during repair. The perfection of the mechanical design of turbo-generators permits the use of skeleton foundations in which the condenser can be placed with great space economy. The electrical switching equipment still has a tendency towards expensive complication, which, the writer believes, will gradually give way to simplicity and ruggedness, except in the largest plants." (George I. Rhodes in "Standard Hand Book for Electrical Engineers).

**Determination of the capacity of the power plant:**—It is extremely important to ascertain the load or capacity of a plant at the outset, as the initial cost of the undertaking depends on the size and duty the plant is called upon to perform. Since all the various processes of a manufacture are not carried on, nor all the temples in a city lighted at once, we have to find out what is the maximum demand, the diversity factor and the load factor. If the maximum demands at various quarters in a place occur at all times of the day and night, the diversity factor of the power station will be good and the plant required will be small and inexpensive considering its earning capacity. If in addition the demand for power throughout the working hours is fairly constant, the load factor will be good and the plant will be earning a good return on its cost at all times. Hence, first determine the maximum demand very carefully.

Suppose that by actual survey and power canvassing we have determined the following demands in the Cantonment of Benares:—

(1) Public Lighting 25 k.W. steady load for an average of 12 hours a night throughout the year from 6 P. M. to 6 A. M.

(2) Pumping 7·5 k.W. steady load for 24 hours all the year round.

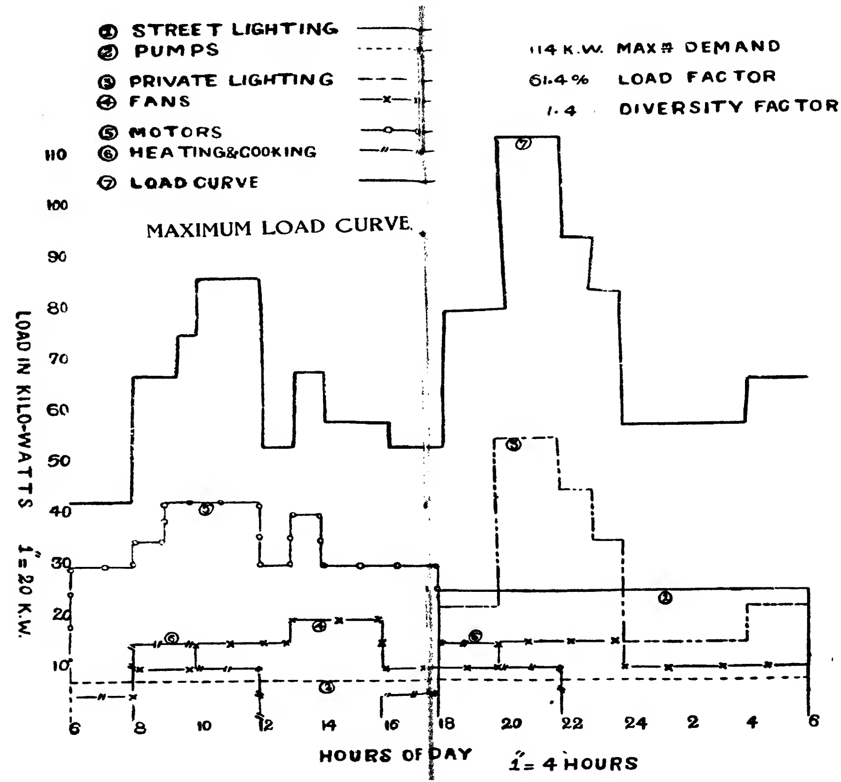
(3) Private Lighting, 80 k.W. of lights installed, maximum demand 55 k.W. between 8 and 10 P. M. Maximum load variable.

Details of hour and load as shown in the curve drawn from power canvass for the consumption assumed.

(4) Fans—24 k W. of fans installed, maximum demand 19 k W. between 1 P. M. and 4 P. M. A good all-day load and a fair all-night load for 6 months in the year.

(5) Motors—57 k.W. installed, maximum load 42·5 k.W. between 9 A. M and noon. A good load all day and no night load whatever.

(6) Heating and Cooking—17 k.W. installed, maximum load 14 k.W. Details as shown in the curve obtained from the power canvass.



1 STREET LIGHTING
2 PUMPS
3 PRIVATE LIGHTING
4 FANS
5 MOTORS
6 HEATING&COOKING
7 LOAD CURVE
114 K.W. MAX# DEMAND
61.4% LOAD FACTOR
1.4 DIVERSITY FACTOR
MAXIMUM LOAD CURVE.
LOAD IN KILO-WATTS 1" = 20 K.W.
10 20 30 40 50 60 70 80 90 100 110
6 8 10 12 14 16 18 20 22 24 2 4 6
HOURS OF DAY 1" = 4 HOURS

Construct the "maximum load curve" of each of the various components or parts of manufacturing processes in question putting *time as the abscissæ* and *kilowatts as the ordinates.* Obtain the total load curve and the ordinates of all curves hour by hour and so get the maximum load of the plant. The average values are, of course, much lower.

Now note the following :—

(1) The area of each curve to the base line is a measure of the number of units marketed

(2) The ratio of the area under each curve to the total area of the rectangle in which it is contained is the load factor of that particular curve.

(3) The peak of the aggregate curve shows the number of kilowatts the plant must be capable of giving.

(4) The ratio of the area of the curve to the rectangle gives the load factor of the plant on the particular day for which it is drawn.

Similar curves of power requirement are made for the whole year and the annual consumption and load factor are deduced from them in the same way.

Owing to the diversity factor the maximum demand on the plant which is the summation of the maximum demand of the various components occurring at different times (here 163 k.W.) is much greater than the maximum load on the plant which occurs at the same time (here 114 k.W.)

**Selection of units is most important in designing a station.** The amount and form of reserve plant may depend upon it as the reserve may be in the form of additional plant over and above that required to deal with the load of safe over-load in the machines required for normal running. The reserve plant is almost always wanted at short notice owing usually to the sudden breakdown of a big machine. If the running machines have an overload capacity, there is the great advantage that such stand-by can be called into operation instantaneously, and the machines having usually a great factor of safety, there is less deterioration and less likelihood of breakdown. If the reserve is an additional plant, it will take some time to start and in an alternating current system, there may be serious delay. The cost of such reserve will be much more than in the form of extra overload capacity in a running machine.

The points that are to be considered for **determining the size of the sets** are :—(1) The total capacity of the initial instalment of plants required, say during the first 3 years ; very great foresight and scrutiny of the conditions is necessary for this. It should be remembered that it is on the skill of the engineer in gauging the needs of the public that success will in part depend. (2) The ultimate probable capacity of the station. (3) The percentage overload considered necessary as a reserve. Having determined the total initial capacity of the plant select the number of generator units in the light of the percentage reserve considered necessary, which means that if one machine breaks down, the remainder shall not be overloaded beyond the safe limit. Make the initial instalment large enough, all the generators of equal size and absolutely uniform, so that the part of the machines may be interchangeable. This is subject to the consideration that to make the plant economical the smallest machine must not be greatly in excess of the minimum load on the station.

**The advantage of having such units will be seen from the following considerations :—**

Suppose a power plant is required for a tea garden or sugar mill in which the nature of the load is very variable, light load at the beginning which rises to a peak value sometime by the middle of the season and again gradually declining to zero when the crop is finished. If one big unit is worked, the result is (1) in the time of light load it is worked at a very low efficiency ; (2) the depreciation of a big machine is high ; (3) there being no reserve, in case of a breakdown, the whole factory will be stopped resulting in great loss to the company.

If, however, small units with reserve, as stated before, are installed, (1) at light load only a small unit will run with high efficiency ; (2) the depreciation cost will be much less ; (3) the reliability of the installation is guaranteed and there is no chance of breakdown causing considerable loss to the business. But the total capital cost and room area will be somewhat more expensive.

Further, if the machines are made with interchangeable parts, there is the further advantage that even if two or more sets are broken, one set may be set aside and the parts substituted so that with the overload capacity of the remaining sets they can always take up the maximum load without any difficulty, as it is never likely that any reliable manufacturers will design machines with particularly the one and the same weak part to break every time.

A jute mill near Calcutta had two 1500 k.W. sets. During the season one set had a severe breakdown for some reasons, when the other set took up the load; there was no further reserve ; the result was that owing to overload that set was also badly damaged and the company had to suffer great loss in consequence in that season.

In the case of a small plant however the full capacity should be laid down at the start and although a single generating set with spare parts may be sufficient in small stations, it is seldom advisable to attempt running without spare plant, and thus two identical sets each capable of running the whole of a small installation may be installed. If the plant is of moderate size, three identical sets are recommended One to work at times of light load, two to work at times of heavy load and the third as a spare. Sometimes a battery or a small petrol or oil-driven generator may be used at light-load hours.

The size of boilers should be as large as possible, but practically speaking, the Lancashire boiler reaching its limit of size when it is 30 × 8 and pressure of 200 lbs. In hydro-electric practice the generator units are more generally determined by the hydraulic conditions than by any other factor and as a rule duplicate units of like capacity are selected to meet unforeseen emergencies. The units are of the largest practical output, only they will be within the limits of economical standard designs.

## Selection of Experts

When the directors have decided to establish a factory or an electric installation, there are three methods of engaging responsible experts to carry out the works :—

(1) **A consulting engineer** may be appointed to design and superintend the erection of the work, and a resident engineer may be subsequently appointed to take charge of the work and to manage it, while in a running condition. If the consultant has had actual practical experience of designing and erecting similar works before, he knows all about the work that is to be done, and provided the consulting engineer plays the game, success is guaranteed. There are, however, two objections, to this method—(a) The consulting engineer generally charges a fee which is a percentage on the capital expended and thus he is likely to increase the amount of initial capital outlay; and (b) when once the plant is erected, the consulting engineer's responsibility is practically at an end ; whereas if he had to run the station himself, he would be more likely to take care that every detail was *pukka*.

(2) **A resident engineer** may be appointed to prepare the design and subsequently to manage and run the station. The advantage is that the remuneration of the resident engineer being independent of the initial capital outlay, in order to assure the ultimate success of the scheme, he will expend as little capital as is consistent with good and efficient working of the plant and thereby avoid unnecessary interest and depreciation on the initial cost.

The answer to the question of appointing a consulting or a resident engineer depends upon the magnitude of the undertaking. If the scheme is big, a high class engineer of good experience and standing may be engaged at a decent salary for designing and carrying out and subsequently running the whole scheme. For a work of small scale it is best to secure the services of a consulting engineer having extensive experience in designing similar plants before, and a man of more moderate attainments may be engaged for a smaller salary, to carry on the works along the lines laid down by the consulting engineer and to take charge of running and managing the plant thereafter.

(3) **The third method** is to dispense altogether with the engineers in the first instance and to invite a contractor to design and carry out the entire scheme and to appoint their own engineers. It is very simple, but nothing could be attended with more disastrous results. It is obvious that the contractor's business is to sell his shares and push his own trade and his scheme will naturally be so designed as to benefit himself most and may only incidentally suit the requirements of the authorities. This method, although financially insane, is, most unfortunately, the almost universal practice with the municipalities, zamindars, rajas and maharajas of India, and in a different guise is often seen in India when a supplying company is promoted by a manufacturing company, in which case the supply company is compelled to be furnished with plants by the promoting company. In a certain district in Bengal a well-known electric contracting firm was invited to design and carry out an electric installation for the palace of a big landlord. The lighting, fan and power load, as demonstrated afterwards, amounted to from 6 to 8 k.W. and the whole installation including the wiring could have been completed in those pre-War days for Rs. 12,000 at most, and the installation could have been run with a daily fuel cost not exceeding Rs. 5-0-0.

But that would, in the opinion of the contractors, have been a paltry scheme worthy neither of themselves nor of His Highness the Maharaja. Accordingly, they installed two *steam-driven sets*, one of 87 and the other of 90 kilowatts capacity, at a total cost of one and a quarter lacs apart from the cost of the transmission system. One or the other of these sets continued to run for the next decade on about one tenth full load and to consume fuel to the value of Rs. 30-0-0 per day during all that time, at the conclusion of which they were replaced by a 7 kilowatt oil-driven set!

We will not spoil the effect of this lovely example of the futility of appointing the wolf guardian of the sheepfold with any comment other than this: that it is only one of many similar ones to be found up and down India.

Further, it is a very common practice with the contractors, if they are asked to design and carry out the work, to supply different types and units of different makers. Sometimes one set has an oil engine, but the other set is a steam set; one a shunt dynamo, and the other a compound dynamo; one is a single cylinder engine, and the other a two-cylinder engine; and in most cases the reason is that the contractor has not two sets of the same type, and the matter is urgent. The contractor gets the agency from different firms at different times on different rates of commission and it is his business to push on the trade of the firm who offers the highest commission; and Janaki Ram would not lose an opportunity to earn when he can, he would not let go to others the chance to earn on any account!

## Power-Plant Economics and Tariff

The load to be carried is probably the most important factor to be considered in a power plant design.

**Load fluctuation:**—Lighting systems have steady loads except for peaks. Industrial loads are very steady except for certain applications to intermittent work using large units. Railway loads have considerable fluctuations.

**The load factor of a machine**:—Plant or system is the ratio of the average power to the maximum power during a certain period of time The average power is taken over a day or a year and the maximum is taken over a short interval of the maximum load within the period. The duration of the maximum load should be definitely specified, say half an hour per day, or for one month or per annum. The annual load factor of a central station=

$$\frac{\text{Total kilowatt-hours generated per annum}}{\text{Kilowatts of maximum demand} \times 8760} \times 100 \text{ per cent.}$$

$$= \frac{\text{Average load during the year}}{\text{Maximum load during the year}} \times 100 \text{ per cent.}$$

Under the same conditions, the average cost of generation and transmission per kilowatt-hour, will be lower, the higher the annual load factor.

The same ratio taken for a day gives the **daily load factor or for the period** and the maximum is taken over a short interval of the maximum load within that period. In each case the duration of the maximum load should be definitely specified. The proper interval depends upon the local conditions and upon the purpose for which the load factor is to be determined.

Example—A circuit carries a maximum load of 200 k.W. and delivers an amount of energy equivalent to a load of 180 k.W. during 3000 hrs. per year; determine the load factor for the year.

Solution—

The load factor for the year $= (180 \times 3000)/200 \times 24 \times 365 = 30\ 8$ per cent.

(b) **The station load factor** on which the standing charge is based—

$$= \frac{\text{Kilowatt-hours generated per day}}{\text{Kilowatts of plants installed} \times 24} \times 100 \text{ per cent.}$$

$$= \frac{\text{Average load}}{\text{Kilowatt installed}} \times 100 \text{ per cent.}$$

(c) **Plant load factor**

$$= \frac{\text{Average load}}{\text{Kilowatts of plants in use}} \times 100 \text{ per cent.}$$

The kilowatts are taken at rated full load. This is very nearly equal to the daily load factor.

### * Influence of load factor on cost of power

**(a) Fixed charges.**—It is obvious that this cost varies inversely as the load factor. It is important, however, that the proper factor be used, namely, the annual capacity factor of the total equipment installed.

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* George I Rhodes in Standard Hand Book for Electrical Engineer.

(b) **Operating labour.**—It is obvious that in small plants, or plants of very few units, a large amount of labour is unaffected by the load on the plant. As the number of units increases, this portion becomes relatively smaller. It is probable that the ratio of full-load labour costs per hour to no-load costs varies from 2 to 1 in plants of a single unit, to 5 to 1 in plants of a large number of units.

(c) **The coal.**—The coal required to maintain a plant ready for instant service with one unit running at no-load, consists of that required for its no-load steam, that of the auxiliaries and that for banked fires under sufficient boiler capacity to carry the peak load. This total no-load coal ranges from 25 per cent. of full-load coal in a plant of one unit to 8 per cent. in a plant of many units.

(d) **Operating repairs** and other expenses are very indefinite and uncertain except over a long period of time, but probably vary in direct proportion to the load, thus being independent of the load factor.

(e) **Total production cost** at no-load varies from 30 per cent. of that at full load in plants of a single unit to 10 per cent in plants having many units.

(f) **Period of load factor.**—Since the no-load costs in a station are determined largely by the peak load expected during the month or week, it is evident that load factors for a shorter period than a year are advisable. Possibly the average daily or weekly load factor will give the best method of comparing these costs.

**The plant capacity factor** is the ratio of the k.W. Hr. production to the total full load capacity of the equipment supplying the load × length of time, in hours, over which the capacity factor is to extend.

**Plant use factor** is the ratio of the k.W. Hr. production to kilowatt capacity × the actual number of hours of operation during the period over which the plant use factor is to extend.

**The demand of an installation** or system is the load which is drawn from the source of supply at the receiving terminals averaged over a suitable and specified interval of time.

**The demand factor** is the ratio of the maximum power demand over a specified time of any system to the total connected load of the system or of the part of the system under consideration producing that demand.

**Diversity factor.**—In the distribution of electricity, the maximum demands of consumers for general lighting and power purposes are made at different hours of the day, and vary from day to day during the week and from month to month during the year for various reasons. The demand for power purposes is greatest when the lighting load is smallest. The result is that the resultant maximum demand at the point of supply is less than it would have been if these maximum demands were coincident. Thus the sum of the maximum demands of individual consumers is greater than that on the distributing mains from which they are supplied. The sum of the maxima on distributing mains is greater than that of the feeder, the sum of the feeder maxima is greater than that of the substations, and the sum of the substation maxima is greater than the coincident maximum of the generating station. High load factor and low diversity factor are desirable qualities of a load.

**Diversity factor** is the ratio of the sum of the maximum simultaneous power demands of the subdivisions of any system or part of a system to the maximum demand of the whole system or of the part of the system under consideration, measured at the point of supply.

$$= \frac{\text{Sum of separate maximum demands.}}{\text{Maximum demand on the station.}}$$

**Example.**—The sum of the maxima of a group of feeders supplying a district is 5000 k.W. and the maximum demand upon the substation is 4000 k.W. Find the group diversity factor of these feeders.

Solution.—

$$5000/4000 = 1{\cdot}25.$$

The separate units approach their full out-put during the time they are allowed to be in service.

Note that the load and diversity factors do not convey any idea about the reserve capacity carried by the plant or system.

Hence, a knowledge of the plant capacity factor indicating the reserve capacity of the plant is very useful. If the plant does not work throughout the year, 8760 should be replaced by the number of hours of actual operation and the term *plant use factor* has been given to this modified form of plant capacity factor. The capacity factor illustrates the percentage of maximum plant out-put that the load curve allows the units to produce. The use factors show to what extent the separate units approach their full out-put during the time they are allowed to be in service.

*Typical Demand and Diversity Factors are :—*

| Service. | Demand factor per cent. | Part of the system. | Diversity factor per cent. |
|---|---|---|---|
| | *Residence Lighting.* | | |
| $\frac{1}{4}$ k.W. ... | 100 | Between consumers | 30 |
| $\frac{1}{2}$ k.W. ... | 60 | Between transformers. | 75 |
| Over 1 k.W. | 50 | Between feeders ... | 85 |
| | | Between substations | 90 |
| | *Commercial Lighting.* | | |
| General commercial lighting. | 60 | Between consumers ... | 70 |
| Restaurants, stores, and offices. | 70 | Between transformers | 75 |
| Theatres and small industrial establishment. | 60 | Between feeders ... | 85 |
| Schools and churches... | 55 | Between substations ... | 90 |
| Hotels ... | 50 | | |

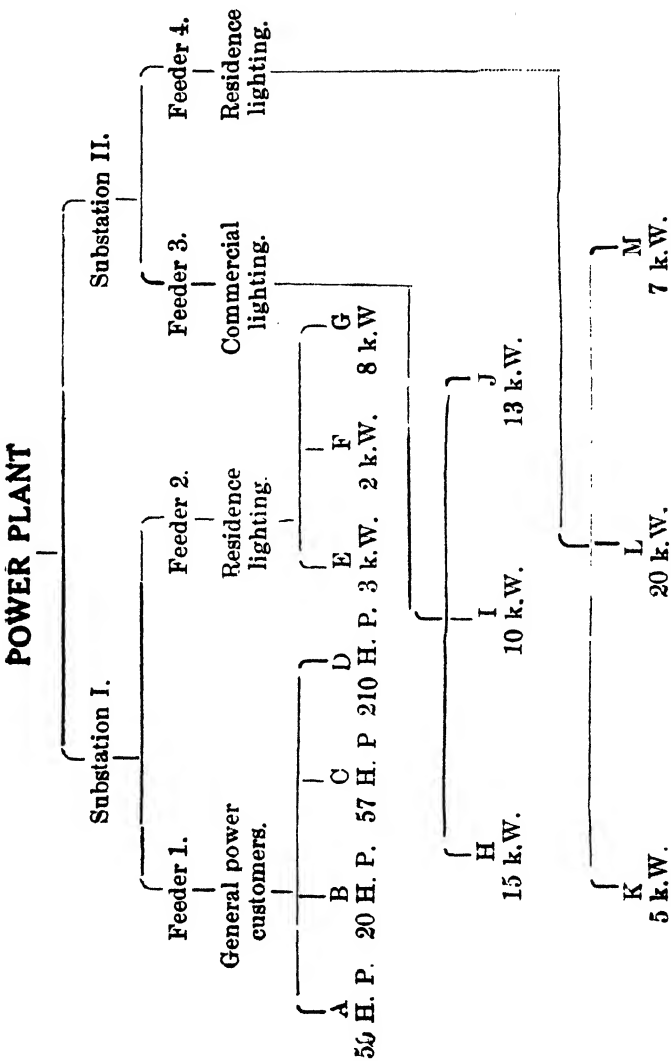
*General Power Service.*

| | | | |
|---|---|---|---|
| Less than 10 H. P. ... | 75 | Between consumers ... | 70 |
| 10-20 H. P. ... | 65 | Between transformers | 75 |
| 20-100 H. P. ... | 55 | Between feeders ... | 85 |
| Over 100 H. P. ... | 50 | Between substation ... | 90 |

P. 31, M. F. T. Morse Power Plant Engineering and Design.

**Example:—**

Suppose the power-plant at Mirzapur has 2 sub-stations Nos. I and II. and two pairs of feeders 1, 2 and 3, 4, respectively, come from the two substations. The connected load of the customers are given in the chart.—


POWER PLANT
Substation I.
Substation II.
Feeder 1.
General power customers.
Feeder 2.
Residence lighting.
Feeder 3.
Commercial lighting.
Feeder 4.
Residence lighting.
A
50 H. P.
B
20 H. P.
C
57 H. P
D
210 H. P.
E
3 k.W.
F
2 k.W.
G
8 k.W.
H
15 k.W.
I
10 k.W.
J
13 k.W.
K
5 k.W.
L
20 k.W.
M
7 k.W.

Individual maximum demand of customers connected to feeder No. 1.

| | |
|---|---|
| $50 \times \cdot 55 = 27 \cdot 5$ | Assuming average motor efficiency to be 75 % and reducing to Kilowatts, the sum of the maximum individual demands = $180 \cdot 4 \times \cdot 746 / \cdot 75 = 169$ k.W. |
| $30 \times \cdot 55 = 16 \cdot 5$ | |
| $57 \times \cdot 55 = 31 \cdot 4$ | |
| $210 \times \cdot 50 = 105$ | |
| Total ... $180 \cdot 4$ H. P. approximately. | |

The maximum simultaneous demand = sum of the individual demands × the diversity factor. Therefore, the maximum demand on feeder No. $1 = 169 \times \cdot 70$ = say 118 k.W (see table)

Similarly for the connected load on feeder No. 2 sum of individual demands = $(3+2+8) \times \cdot 50 = 6 \cdot 5$ k.W.

Maximum demand on feeder No. $2 = 6 \cdot 5 \times \cdot 30 =$ say 2 k.W.

Feeder No. 3.

Sum of individual demands $= (15+10+13) \times \cdot 60 = 22 \cdot 8$ k.W.

Maximum demand on Feeder No. $3 = 22 \cdot 8 \times \cdot 70 =$ say $1 \cdot 6$ k W.

Feeder No. 4.

Sum of individual demands $= (5+20+7) \times \cdot 50 = 16$ k.W.

Maximum demand on Feeder No. $4 = 16 \times \cdot 30 =$ say 5 k.W.

Maximum demand on substation $I = (118+2) \times \cdot 85 = 102$ k.W.

Maximum demand on substation $II = (16+5) \cdot 85 = 18$ k.W.

Maximum demand on plant $(102+18) \times \cdot 90 = 108$ k.W.

This is the plant demand with 100 % efficiency of transmission line. For 90 % efficient transmission, maximum demand on plant $= 108/90$ k.W. $= 120$ k.W.

## Improvement of Plant Economy

To effect an improvement in the economy of an existing power plant acquire an accurate knowledge of all the elements entering into the cost in that particular plant and then gradually eliminate the elements producing inefficiency. These elements are broadly to be found in :—(*a*) Boiler room practice, giving the greatest scope for improvement ; (*b*) Engine or Turbine room operation ; (*c*) Electrical operation ; (*d*) Labour shifts ; (*e*) Repairs, to be made as soon as their necessity is observed ; (*f*) Economy in supplies—choice of those adopted to the work, giving the lowest total cost for the object accomplished.

The other items of Power Plant Economics such as interests, profit, tax, insurance, depreciation and suitability of different types of Power Plant, have been already treated in different parts of this book.

**Rates** : –In most foreign countries there are Regulating Commissions who assume the guardianship of public interest, who demand that the rates should be *simple*. The rate in effect must be a fair apportionment of costs to one and all.

**The theory of rates demand** from the public stand-point of view that the rates should be uniform over large territorial areas. There should not be a preferential rate for some person in the same area.

The rates should be *fair*, *i.e.*, they should distribute the cost where they rightfully belong, taking full account of the customers' demand.

*Direct service from the producer to the consumer*— This requires the elimination of energy jobbers, subcontractor or middleman. The Calcutta Electric Supply Corporation and the Ganges Canal Hydro-Electric Scheme have violated this principle by getting middlemen or subcontractors at Bhatpara, Saharanpore and in other places.

The distribution of costs should be in such a way that persons creating a desirable and relatively inexpensive type of load may enjoy the full use and benefit of electrical appliances.

## Tariff

**Flat Rate.**—In this system a definite flat rate of so much per unit is charged to all consumers.

It is not satisfactory or fair as the charge per unit is made high and sometimes the profitable consumers, subscribing at times of low load, have to pay the losses on the unprofitable consumers.

**Maximum Demand System.**—Electrical energy is generally sold by meter, but this system of sale does not encourage the consumers who use energy at hours of small load or unusual hours. Hence *the maximum demand system* by which the consumer is charged *a certain sum per kilowatt of maximum demand and* a low charge per unit actually supplied to cover the consumer's share of standing costs and to pay his share of the running costs. It also does not seem to be fair, for all the consumers have not loads of the same diversity factor.

The maximum demand system discriminates to some extent between good and bad customers, *i.e.*, those taking power at times of no load and those taking it at maximum demand, respectively, and is much fairer than the flat rate system.

The object of maximum system is to (1) increase the profits of the undertaking, and (2) diminish the price per unit paid by the consumer.

The Maximum Demand System may be subdivided into two parts :—

(*a*) There is a fixed charge per k.W. of maximum demand. The consumer may use his full load constantly or only occasionally without affecting the amount he must pay. This system is applied in many hydro-electric installations, notably at Simla. The k.W. of maximum demand are estimated from the number and candle power of lamps installed, meters being dispensed with. The defect of this system is that it encourages waste.

(*b*) This makes, in addition to a charge per k.W. of maximum demand, a charge of so much per kilowatt hour actually consumed. Two meters are required, one for maximum rate of supply, and another for total quantity of supply.

Instances are found in Calcutta, Bombay and Madras where power is supplied for industrial purposes. This requires two meters, one to register the maximum amount of current in a given time and the other is an ordinary energy meter which registers the total number of B. O. T. units consumed during the same period.

The B O. T. units registered on the energy meter are divided and charged for at two different rates, the proportions of the total number to be charged at the high and low rates respectively depending on the reading on the maximum demand indicator.

Example.—An installation is supplied on the maximum demand system at 8 as. and 3 as At the end of a certain quarter the indicator registers a maximum demand of 3 k.W , the reading of the energy meter being 600 B. O. T. units. Find the charge for the quarter, the first 120 hours being taken at the maximum rate.

Solution :—

3 k.W. × 120 = 360 units at 8 as. = Rs. 180/-

600 − 360 = 240 units at 3 as. = Rs. 45/-

Total ... Rs. 225/-

**The Telephone System** is so called as it resembles the method of charging for Telephone Service. In this system also there is a fixed annual payment based on a certain percentage of the connected lighting load in advance and a small charge per unit actually utilized. Emergency or decoration lighting and wattage installed other than lighting are not connected, and the consumer is, in any event, made to pay the standing charges on the fraction of generating plant he requires to be placed at his disposal. It is better than maximum demand system in which the customer pays nothing at all if he uses no current although the generating plant has to be kept in readiness to supply him ; while he pays less, for working at times of heavy load, than he ought to do. Note that the standing charges in a modern station are much higher than the running charges.

Example.—Find the total charge per quarter for supply to the installation whose maximum demand is 100 k.W. and in which the consumption per quarter is 50,000 kelvins. The fixed rate is Rs. 100/- per annum per kilowatt demaned and the price per kelvin is 2 annas.

Solution :—

The fixed charge per quarter $= 100 \times 100/4 =$ Rs. 2,500.

Cost of energy $= 50,000 \times 2/16 =$ Rs. 6,250/-

Total cost = Rs. 8,750/-

To sum up : it is only the fact that society is individualistic rather than socialistic that prevents the immediate economic triumph of the large national power station. It is quite certain that within the next few decades the gradual exhaustion of fuel resources throughout the world will force this development upon the industrial nations in any case. It is possible by means of high-tension transmission to transmit power electrically over a distance of 300 miles with a loss of not more than 10 °/o. On the other hand, to transmit the fuel itself a similar distance from the pit head means at least doubling its cost. If it is consumed in small plants, the cost is redoubled. The concentration of power generation in, say, fifty power stations favourably placed as regards coal mines and hydraulic power would make available for use all over India at least four times as much power as could be obtained from the same resources used in small plants. Nor is that all The principle advantage is not the conservation of fuel ; it is the conservation of manhood. The great industrial centres of the West are like furnaces drawing and destroying the peasantry. It is not necessary to the industrialisation of India that this process should be repeated here. In our chapter on the choice of a site we have pointed out the necessity under existing conditions of selecting a site near a large centre of population. If, and when, India is covered with a network of high tension power transmission, it may yet be possible to avoid this and combine what is good in the existing conditions of the peasantry ; namely, their attachment to the soil, with as much of industrial development as is perhaps desirable. But this will be a task for the statesman rather than for the individual It is not a development likely to be encouraged by private enterprise. It may arise as a result of railway electrification.

## BIBLIOGRAPHY

Gillette and Dana's Mechanical and Electrical Cost Data.

J. W. Meares and R. E. Neale's Electrical Engineering Practice.

Von Schon's Hydro-Electric Practice.

F. Fowler's Standard Hand-Book for Electrical Engineers.

# CHAPTER XVIII

## DEPRECIATION AND VALUATION

DEPRECIATION is defined by Webster as follows:—"A falling off of value. When applied to money, it means a loss of exchange value or purchasing power. Applied to other things it means a lowering of worth." This is a good example of the kind of definition that leaves the sore place sorer than it was at first.

In this chapter we are going to assume that money does not depreciate. We will be concerned only with the loss in money value of things purchasable with money. We reserve the word 'depreciation' to mean that, and that only. Nearly all the components of a factory are perishable; some sooner, other later. We shall have to consider these components in detail, and indicate as accurately as we can how much of their value vanishes in each year. The vanishing value must, of course, be added to the operating expenses, and to the costs as indicated in hereafter. Usually a depreciation fund is initiated and a portion of the income of the business is paid into it each year. Repairs and renewals are paid for from this fund as they become necessary. In a well-conducted business the allocation for depreciation is sufficient to maintain the property at its original value or even to increase it.

There is another aspect of the depreciation of plant. When the perishable property is bought or sold in its life period, it is not, as a rule, considered worth its original value, because it has depreciated in the meantime. The valuation of its present worth is, therefore, its original worth less the accrued depreciation to such a date. Thus in a correct balance sheet it is the present value of plants, buildings, etc., that appears as an asset, the original value being diminished by the accrued depreciation up-to-date. The two kinds of depreciation usually recognised are physical depreciation and functional depreciation

**Physical depreciation** is the result of age, wear and tear, corrosion and decay. This kind of depreciation is constantly in progress; the rate of its progress depending upon the conditions of service or use, protection from ravaging elements, and the degree of care exercised in making prompt repairs when necessary. This rate, of course, varies greatly with different forms of machinery, apparatus, plant, etc.

**Functional depreciation** is the result of failure to function properly, in consequence of the lack of adaptation to the service demanded. This may be brought about by either *inadequacy* or *obsolescence.*

**The inadequacy** may be due to the fact that the demand for service exceeds the capacity of the plant, which necessitates the replacement of the present plant before the physical depreciation has run its full course. Of course, the plant is still of value to a locality or service suitable to its capacity. It is an important function of sound engineering to study the probable future demands on a plant and to so choose the capacity of the machines and arrange them, that the enchanced demand in course of time may be met without disturbing the units as we fore-shadowed in the chapter on Sites and Buildings for Factories. Thus, part of the economy in efficient engineering consists in securing, if possible, the maximum physical life from any piece of plant or apparatus, unless, of course, it appears conclusively that the total annual charges will be actually lessened by deviating to some other plan or policy. It is easy to realise that the maximum physical life is always greater than the economic life. Generally, the material assets of a business cease to be profitable assets some considerable time before their physical life comes to an end.

**Obsolescence** is that kind of functional depreciation which results when the plant or apparatus become obsolete. This may be due to new inventions or radical improvements in the art, causing a set-back of the present methods or machinery in relative efficiency, or to new demands which did not previously exist. The question whether all forms of obsolescence or allowances for their probable occurrence and effect should be included in depreciation is an open question. The advances in a certain art may be relatively infrequent, but if of a fundamental and revolutionary character they imperatively necessitate the discarding of the old plant. The other sort of obsolescence may be caused by mere improvements of things already old in the art. In the latter case, the main question is of efficiency and of reduction of the cost of production When comparing a new and improved machine of this class with an old one of obsolete type but not yet worn out in the physical sense, the question whether the new shall immediately supplant the old, is regulated by the consideration whether the saving in total annual charges resulting from the substitution will extinguish the remaining service value of the old machine within a reasonable period or much sooner than the expiration of the probable life period of the new machine. Thus there are certain cases in which obsolescence is not a proper charge against depreciation, but should be **amortized** through the application of those annual charges which represent the savings in operation secured by discarding obsolete machinery or plant.

It is easily realisable that provision for functional depreciation partakes of the nature of insurance to cover a risk. Such depreciation charges are rather insurance charges in the technical sense. Such provision, therefore, should depend upon the law of probability applied to the statistics of past occurrences with respect to the abandonment of plant or machinery strictly on account of inadequacy and obsolescence. This will give the monetary value of the risk and the annual insurance charge in terms of the percentage of the investment or cost of the plant. This insurance charge should be added to the annual charge for depreciation of a physical character to give the gross depreciation charge per annum.

Before we proceed to discuss the method of finding the annual contribution towards depreciation reserve we may define terms connected therewith.

**Original cost or investment** (I) the total actual outlay or expenditure for the physical plant, installed and in readiness for service; it is also known as the *physical cost.*

**Scrap value or salvage** (S) is the amount realized from the sale of the worn-out or abandoned plant for what it will bring as junk or second-hand materials.

**Cost of removal** (R) is the cost of labour and other expense incidental to the removal of the worn-out or abandoned plant, to make room for the new plant.

**Service or wearing value** $(W) = I + R - S$.

This is the net depreciable value of the plant, *i. e.*, the amount which is required to replace the discarded plant, provided the labour, material and other costs remain the same.

**Realized depreciation** (W) is another name for the wearing value.

**Accrued depreciation** (A) is the total or cumulative depreciation in the plant on any date expressed in monetary terms.

**Present worth** (P) is equal to $I - A$.

**The life of a plant** is the useful life of the plant. It is always expressed in years. In some cases, the estimated life includes allowances for probable inadequacy and obsolescence, and in such it is inevitably less than the physical life of the plant.

It now being admitted that the question of the depreciation of factories and of plant must be regarded as a matter of paramount importance in the determination of the lucrativeness or otherwise of a business, and in the valuation of properties, the point for consideration being the depreciation rate, *i e.*, the ratio of the number of rupees to be set aside each year towards the depreciation reserve (usually expressed as a percentage of some other sum to be dealt with later). There are various methods and practices followed by various concerns. But questions as to the particular practice to be followed in any individual case must, to a large extent, be left to the judgment of those most intimately acquainted with the conditions of the business, for as has been pointed out by Prof. Marshall in his

Principles of Economics "Almost every trade has its own difficulties and its own customs connected with the task of valuing the capital that has been invested in a business, and of allowing for the depreciation which that capital has undergone form wear and tear, from the influence of the elements, from new inventions, and from changes in the course of trade. These two last causes may temporarily raise the value of some kinds of fixed capital, at the same time that they are lowering that of others. And people whose minds are cast in different moulds, or whose interests in the matter point in different directions, will often differ widely on the question as to what part of the expenditure required for adapting buildings and plant to changing conditions of trade may be regarded as an investment of new capital, and what ought to be set down as charges incurred to balance depreciation, and treated as expenditure deducted from the current receipts, before determining the net profits or true income earned by the business".

Whatever may be the method for the determination of the rate, there are five main factors, as enumerated by Mr. R. N. Barber, A. C. A., (in a Lecture before the Manchester Chartered Accountants Students' Society), which enter into the determination of any rule for arriving at the deterioration which has taken place.

1st.—The original cost of the object—as defined above or in the case of a transfer of an established business, the estimated value of the object.

2nd.—Its estimated tenure of life, regard being had to its functions and the conditions under which they are fulfilled including therein volume, character and nature of work, the material on which it is employed, and the personal equation or care taken by the attendants or operators.

3rd.—The extent and value of the renovation or restoration received by it from time to time.

4th.—Its value in use or its present earning power, relatively and comparatively, to other instruments of production used for similar purposes.

5th.—Its residual or scrap value as defined above.

He also adds another factor :—" To these five I would frequently add a sixth, obsolescence, unless it is intended to be included in (2) or (4)".

**The problems of depreciation** arise in two different forms each having many aspects. The amount of depreciation is affected by the condition in which they are kept or used and by availability or otherwise of more suitable appliances, no matter whether they are in use or stored.

**I. Total depreciation,** which has—

(*a*) *Physical and economic aspect* which deals with what it is and what must be the total provision to be made.

(*b*) *Financial aspect*—dealing with what provision this may take.

**II. Annual or Interim depreciation** —which has—

(*c*) *Accounting aspect*—dealing with the method of alloting this total liability during the several years of the life of the article.

(*d*) *Legal aspect* which deals with income tax and valuation.

In considering depreciation the burden should be equitably distributed between the several years of the plants useful life in such a way as to correspond as nearly as possible to its annual wear or capital expiry or to its earning capacity for example.—

(1) In some cases no profits are expected in the first few years of its life—as in a tea plantation or in an electrical undertaking.

(2) In others the service rendered by the plant diminishes with time as in storage batteries. The depreciation burden is unequally loaded, a heavier burden is put on either the latter or earlier years. In the majority of cases, however, the advantage obtained in the use of the plant is tolerably equal in all the years of its useful life in which case the depreciation takes the form of **equal annual payments**. In the case of a plant, sometimes a number of items enter having a different length of useful life. In such cases we may have one depreciation fund

for each or we may make one fund serving the separate items. In this latter case, it is necessary to find the "*composite*" *or* "*equated life*" of the group of items By "**composite**" life we mean that life which when applied to the total cost would give the correct total provision. To find the composite life we must find the product of the wearing value (P—S) of each asset and the frequency of renewal and get the "cost of product where P is the capital cost and S is the salvage value. If we multiply the above product by the life, we will get the "**life cost**" **product**. Add the "life cost" products and divide by the sum of the cost of products, when we get the "**composite life**."

**Two methods of computing annual depreciation rates** which are invariably expressed in terms of percentage, are very commonly used.

1. A fixed percentage on original value.
2. A fixed percentage on diminished value.

**Annual Depreciation Formulae**:—In general use, there are three methods of computing the annual depreciation.

(1) **Straight Line Formula.**—This indicates equal fall in each year.

Here suppose P is the asset at the beginning of its economic life which falls to S, the value at the end of a period of time T years.

The amount of depreciation in any one year is $\frac{P-S}{T}$ and the rate of depreciation is $\frac{100}{T}$ o/o per annum and the rate is expressed as the per cent. of the wearing value P—S.

**The Straight Line Method** is based on the assumption that depreciation accrues according to a straight line law, in the simple ratio of age to life. The rate R may be expressed thus—

$R=100 \frac{W}{T\times P}$ (per cent.), where T is useful life in years. and P or I is the investment cost.

It has received the approval of several Public Utility Commissions and is more widely used in power plant cost accounting and is simple in application.

Buildings and fixed plants may, therefore, be conveniently grouped as follows and flat rates applied to each group :—

1. Buildings (Land does not usually depreciate). In all progressing cities there is more often appreciation or increase in value of land.
2. Motive power plant.
3. Mechanical Transmission.
4. Electrical Transmission.
5. Pipe Transmission.
6. Transportation plant.
7. Shop fixtures.
8. Special process plant.
9. Machines.

The above plant groupings are arranged in order to minimise any inaccuracy in the introduction of flat rate, arising out of the different condition and behaviour of different plants.

The *defect* is that the rate is too high at the beginning when there is practically no depreciation and too low at the close of the usual life. T.

Example 1.—A machine of original cost of Rs. 100/- is considered to have a life of 5 years after which the scrap value will be Rs. 10/-. Then the rate of depreciation will be—

$$\frac{90}{100 \times 5} \times 100 = 18\ \%\ \text{nearly.}$$

| | | | | |
|---|---|---|---|---|
| Therefore, at the end of the 1st year the contribution towards depreciation fund | | | = | Rs. 18/- |
| At the end of 2nd year | ... | ... | = | Rs. 18/- |
| „ „ 3rd „ | ... | ... | = | Rs. 18/- |
| „ „ 4th „ | ... | ... | = | Rs. 18/- |
| „ „ 5th „ | ... | ... | = | Rs. 18/- |
| Then the scrap value | ... | ... | = | Rs. 10/. |

(2) **Reducing balance** or compound interest formula which shows a greater fall in the earlier years.

This assumes that each year, the value falls by a certain percentage of the value at the beginning of the year.

If R is the rate per cent, P is the first cost, the value after T years is $P\left(1-\frac{R}{100}\right)^{T}$ which is the remainder value when T is the economic life.

$$\therefore \quad R = \left(1-\sqrt[T]{\left(\frac{S}{P}\right)}\right) 100 \text{ (per cent.)}$$

which is a bigger rate than that required under the Straight Line Law for the same length of life.

**Thus a fixed percentage on diminished value method** consists in writing off every year a fixed percentage of the residual of the preceding year. This rate—

$$R=\left\{1-\sqrt[T]{\frac{S}{P}}\right\} \times 100 \text{ (per cent.)}$$

The reason for the adoption of this method is that repairs on a plant tend to increase as time goes on until repairs become so great that it is no longer economical to operate the plant If a fixed proportion is written off every year to cover depreciation it is evident that the charges to overhead expense for depreciation and repairs will increase as times go on. Because of this, the plan of writing off a fixed percentage on diminished value is sometimes used.

Example 2.—For the same plant, the rate of depreciation will be—

$$100\left\{1-\sqrt[5]{\frac{10}{100}}\right\}=37\ \%$$

| | | |
|---|---|---|
| Thus at the end of 1st year the annual charge towards depreciation will be— | ... = | Rs. 37/- |
| Reduced value ... | .. = | Rs. 63/- |
| At the end of 2nd year, depreciation | ... = | Rs 39·5/- |
| Balance ... ... | ... = | Rs. 23·5/- |
| At the end of 3rd year, depreciation | ... = | Rs 14·5/- |
| Balance .. ... | ... = | Rs. 25/- |

| | |
|---|---|
| At the end of 4th year, depreciation | ... = Rs. 9·25/- |
| Balance ... ... | ... = Rs. 15·75/- |
| At the end of 5th year, depreciation | ... = Rs. 5·75/- |
| Balance or scrap value of the plant | ... = Rs. 10/- |

**Rate of depreciation :** — Usually this is expressed as a percentage of the original value of the plant or machinery or what is known as the diminishing value. It is based on the assured durability of the article, on its residual value and on whatever allowance should be made for its becoming obsolescent before it is worn out.

(3) **Sinking Fund Formula** falls less rapidly at first and represents in earlier years the usefulness to the owner. This method had the advantage that when depreciation is being provided for by equal annual deposits, it enables a balance sheet to be drawn up annually. It is an economically sound method of providing for total depreciation and such provision must naturally vary with the rate of interest.

For formulæ for calculating deposits, rate of depreciation, etc., refer to equations which follow

(4) **Besides the above, there is the depreciation provision:** — *Loan reduction method* : — When an undertaking, say, an electric installation, has been started and the capital has been borrowed, it is very prudent to pay off that loan in stages as the machine or equipment wears out or loses its value.

The life-expectancy of different kinds of machinery and plants is given as follows in Floy's "Engineering Valuation of Public Utilities and Factories."

**Estimated Life in Years of Plant Units.**

| *Kind of plant.* | *Estimated Life in years.* |
|---|---|
| Aerial Lines ... ... | 20 |
| Batteries, Storage ... ... | 10-15 |
| Belting ... ... | 20 |
| Boilers-fire tube ... ... | 10 |
| „ water tube ... ... | 20-25 |
| Buildings, brick ... .. | 25-50 |
| „ power plant ... .. | 33·3 |
| „ masonry ... ... | 40-50 |
| „ railroad transportation ... | 33·3 |

| *Kind of plant.* | *Estimated Life in year.* |
|---|---|
| Cables—high tension ... ... | 20 |
| ,, —lead covered ... ... | 20-25 |
| Cable feeders overhead .. ... | 33·3-60 |
| ,, underground ... ... | 25 |
| Chimney—steel ... ... | 10-14·3 |
| ,, —brick ... ... | 33·3 |
| Condensers—steam plant ... | 10-25 |
| ,, —gas plant ... ... | 30 |
| Cranes ... ... ... | 50 |
| Engines—steam high speed ... | 15-20 |
| Engines—general ... ... | 10-33·3 |
| ,, —gas ... ... | 15 |
| Furniture and fixtures ... ... | 20 |
| Gas services ... ... | 20 |
| Generators, belted ... ... | 10-20 |
| ,, direct coupled ... | 13·3-25 |
| Hydro-electric plant ... ... | 30 |
| Machinery—coal and ash handling ... | 10-20 |
| Motors, electric service ... | 12·5-20 |
| ,, gas ,, ... ... | 25-50 |
| ,, water ,, ... ... | 20-30 |
| Motors ... ... ... | 10-20 |
| Pipe—cast iron (small diameter), ... | 20-40 |
| ,, — ,, (large diameter) ... | 50-75 |
| Pipe—steel ... ... ... | 25-50 |
| Poles—iron ... ... ... | 20-50 |
| Poles—steel ... ... | 50 |
| ,, —wood . ... | 10-15 |
| Pumps ... ... | 15-25 |
| Rolling stock cars, bodies, open ... | 20-25 |
| ,, electric ... ... | 13·3-16·7 |
| Rotary converters ... ... | 20-25 |
| Stand-by plant ... ... | 20 |
| Stockers—fixed point ... ... | 20 |
| ,, —moving point ... ... | 5 |
| Switchgear and transformer plant ... | 20 |
| Switchboard and wiring ... | 20-33·3 |
| Transformers ... ... | 15-20 |
| Transmission lines ... ... | 50 |

| *Kind of plant.* | | | *Estimated Life in years.* |
|---|---|---|---|
| Turbo generators | ... | ... | 16·7 |
| Turbines, steam | ... | ... | 20-40 |
| „ water | .. | ... | 30 |
| Wires—copper | ... | ... | 20 |
| Wires—guard | ... | ... | 10-20 |
| „ —telephone (iron) | ... | ... | 6·5-15 |
| „ — „ copper | ... | ... | 30 |
| „ —trolley | ... | ... | 20-30 |

**In super-power-report** the following values were used :—

| | | | Per cent. |
|---|---|---|---|
| Hydro-electric plants | ... | ... | 3 |
| Hydraulic works | ... | ... | 1 |
| Steam electric power plants | | ... | 4 |
| Transmission lines | ... | ... | 2 |
| Sub-stations | ... | ... | 4 |

## Example.

* "GANGES CANAL HYDRO-ELECTRIC SCHEME."

SCHEDULE C (2) (Page 52).

*Maintenance and Repairs*

| Items | Cost. | Percentage. | Amount. |
|---|---|---|---|
| Buildings ... ... | 11,94,450 | 1 % | 11,945 |
| Plant— | | | |
| (*a*) Power generation .. | 21,37,987 | 2 % | 42,759 |
| (*b*) Transmisson lines ... | 51,29,628 | 0·25 % | 12,824 |
| (*c*) Step-down transformers and switchgear ... | 12,62,283 | 1 % | 12,623 |
| (*d*) Stand-by ... | 8,51,556 | 1 % | 8,516 |
| Telephone charges .. | ... | ... | 60,000 |
| Miscellaneous charges ... | ... | ... | 20,000 |
| Rural branch lines— | | | |
| (*a*) Transmission lines ... | 4,57,800 | 025 % | 1,145 |
| (*b*) Step-down transformers and switchgear ... | 4,55,700 | 1 % | 4,557 |
| Demonstration pumping sets ... ... | 30,050 | 2 % | 601 |
| Total ... | ... | ... | 1,74,970 |

* W. L. Stampe, Supdg. Engineer, Hydro-Electric Circle, U. P.

SCHEDULE D.

*Depreciation of Machinery.*

| Items. | Life in years. | Cost. | Percentage. | Amount. |
|---|---|---|---|---|
| Generating plant ... | 30 | 15,65,909 | 1·69 % | 26,464 |
| Step-up transformers ... | 20 | 5,72,078 | 3·7 % | 21,167 |
| Transmission lines ... | 50 | 51,29,628 | ·48 % | 24,622 |
| Step-down transformers and switchgear ... | 20 | 12,62,283 | 3·7 % | 46,704 |
| Stand-by plant ... | 20 | 8,51,556 | 3·7 % | 31,508 |
| Rural branch lines— (*a*) Transmission lines | 50 | 4,57,800 | ·48 % | 2,197 |
| (*b*) Transformers ... | 20 | 4,55,700 | 3·7 % | 16,861 |
| Demonstration pumping sets ... ... | 10 | 30,050 | 12·1 % | 3,636 |
| Total ... | ... | ... | ... | 1,73,159 |

" Note on the method of computing depreciation on machinery.

(*a*) The lives of the various types of plant are given in column 3 of the Schedule D, and have been assumed after consulting various experts. In this connection the following extract from the proceedings of the 58th session of the American Society of Engineers, *vide* Engineering News Record,' July 26,1928 pages 137 to 139, will be of interest Mr. Thomas Hogg, Chief Engineer of the Ontario Hydro-Electric Power Commission (one of the largest undertakings in America), remarked :—

'The expected life of power plants also is an all-important factor in power development costs Looking back over the history of power development as outlined by Mr Gibson (Chief Engineer, Niagara Falls Power Company), I notice the fact that some of the older power plants (generation) have become obsolete in less than 30 years. *Fifty years can be assumed to be the life of a modern plant.*'

(*b*) The capital cost of the plant in column 4 under the various sub-heads is taken from the statement of cost in the estimate.

(*c*) The annual percentage charge in column 5 has been calculated on the assumption that the amount contributed annually to the depreciation fund is compounded at the rate of $5\frac{1}{2}$ °/o for the period of the life of the plant and at the end of this period will equal the original cost It has been further assumed *that during the first three years of the life of the plant no depreciation charge shall be made* giving a slightly increased charge for the remaining years "

Sometimes from legal aspects, *e.g.*, for income-tax purposes, allowance of high rate of depreciation charge is beneficial to the company and share-holders. From the financial and accounting aspects, however, such high rates are highly detrimental to the interests of the share-holders a high depreciation leaves very little margin of profit. Further it increases the cost of production per unit and as such it is highly disadvantageous to the consumers, as well, say, of an electric company.

## Depreciation

By George W. Cravens, *Electrical Review*, April 23, 1910

### Table I.—Percentage Depreciation per Annum

| Items | Chicago Traction Commission. | Chicago Union Traction Co. | Milwaukee Electric Railway & Light Co. | Wisconsin railroad Commission. | Average English. | Average Scotch Practice. | Stone and Webster. | Industrial power plants. | Professor G. F. Gebhardt. | Miscellaneous sources. |
|---|---|---|---|---|---|---|---|---|---|---|
| Buildings ... ... ... | ... | 2 | 3 | 2 | 2·5 | 2·5 | 2 | 1-2 | 2 | 2 |
| Boilers ... .. ... | 3.5-10 | 6·6 | 7·5 | 6·6-8.5 | 5 | 5 | 5 | 2·5-3.3 | 4-6·6 | 7·5 |
| Steam piping ... ... ... | 3·5 | 6·6 | 7·5 | 5 | 5 | 5 | 5 | 2·5-3.3 | 5-8 | 5 |
| Auxiliaries ... ... ... | 5-10 | 6·6 | 5 | 6·6-8·5 | 5 | 5 | 5 | 4·6·6 | 3-5 | 7·5 |
| Steam engines ... ... ... | 3-10 | 6·6 | 5 | 5-6·6 | 5 | 5 | 5 | 2·5-5 | 4-6.6 | 5 |
| Steam turbines ... ... | ... | .. | 5 | ... | 5 | 5 | 5 | 2·5-5 | 4 | 4 |
| Belted generators ... ... | 5-10 | 6·6 | 7·5 | 5 | 5 | 5 | 5 | 6.6 | 3·3-4 | 7·5 |
| Direct connected generators ... | 5 | 6·6 | 7·5 | 5 | 5 | 5 | 5 | 4 | 3·3-4 | 5 |
| Wires and cables .. ... | 2 | 6·6 | 5 | 2 | 5 | 3 | 5 | 4-6.6 | 5 | 5 |
| Switchboards, etc. ... ... | 2 | 6·6 | 5 | 2 | 7.5 | 5 | 5 | 2-5 | ... | 5 |
| Rotary converters ... ... | ... | 6·6 | 5 | 5 | 5 | 5 | 5 | 4-5 | 4 | 5 |
| Transformers ... ... ... | ... | 6·6 | 5 | 5 | 5 | 5 | 5 | 3-5 | 4 | 5 |
| Motors ... ... ... | 5-10 | 6·6 | 5 | 5 | 5 | 5 | 5 | 4-6·6 | 5 | 5 |
| Storage batteries ... ... | ... | 6·6 | 10 | ... | 5 | 5 | 5 | 5-10 | 6.6 | 10 |
| Overhead systems .. . | ... | 10-14 | 7·5 | ... | ... | 3 | 10-14 | 5-10 | ... | 10 |
| Cars ... ... ... | ... | 5-8·5 | 6-7·5 | 5-6·6 | 10 | 7·5 | 5-8.5 | ... | ... | 7·5 |
| Trackwork ... ... ... | ... | 7·75 | 7.5-12 | 5 | 5 | 8 | 7·2 | ... | ... | 7·5 |
| Shop equipment ... ... | 3-10 | 5 | 7·5 | 3·3-10 | 7.5 | 7·5 | 5 | 4-10 | .. | 7·5 |
| Supplies and miscellaneous ... | 5 | ... | 5 | | 5 | 7·5 | .. | 5 | ... | 5 |

## Table II.—Percentage Depreciation for Given Service.

| Items of equipment | Light or intermittent service. | Heavy or continuous service. |
|---|---|---|
| Boilers, water tube ... | 4·6 6 | 5·8 3 |
| Boilers, fire tube ... | 5-6 6 | 6 6-10 |
| Piping, steam and water ... | 4·5 5 | 5.5-8·3 |
| Auxiliaries, steam ... | 3-5 | 4-6 6 |
| Engines, steam ... | 4.5 | 5-6 6 |
| Turbines, steam ... | 3-4 | 4 5 |
| Generators, belted ... | 4-6·6 | 5-8 3 |
| Generators, direct connected | 3-5 | 4-6 6 |
| Wires and cables ... | 3 5 | 4 6 6 |
| Switchboards and instruments | 2 5 | 5-8 3 |
| Rotary converters .. | 3-5 | 4-6 6 |
| Transformers ... | 3-5 | 4·6 6 |
| Motors, A. C. and D. C. ... | 4-6 6 | 5-8 3 |
| Storage batteries ... | 5 6 6 | 6 6-10 |
| Overhead systems ... | 4-10 | 8 3-12 5 |
| Cars and equipments ... | 5-8 3 | 6 6-10 |
| Trackwork, ballast, etc. ... | 5·8 3 | 7·5-12.5 |
| Shop equipment, tools, etc. | 5-10 | 7 5 15 |

## * Depreciation allowance under Sec. 10 (2 (VI) of the Income Tax Act. It follows the Straight Line Method.

| Class of buildings, machinery, plant or furniture. | Rate. | Remarks. |
|---|---|---|
| | Percentage on prime cost | |
| 1. *Buildings— ... | ... | * Double those rates may be allowed for building used in industries |
| (1) First class substantial buildings of selected materials | 2½ | |

* Pages 68 & 69, Income Tax Manual, 1931.

| Class of buildings, machinery, plant or furniture. | Rate. | Remarks. |
|---|---|---|
| (2) Buildings of less substantial construction. | 5 | which cause special deterioration, such as chemical works, soap and candle works, paper mills, and tanneries. |
| (3) Purely temporary erections such as wooden structures. | 10 | |
| 2. †Machinery, Plant or Furniture. | ... | † The special rates for electrical machinery given below may be adopted, at firm's option, for that portion of their machinery. |
| General rate ... | 5 | |
| Rates sanctioned for special industries— | | |
| Flour Mills, Rice Mills, Bone Mills, Sugar Works, Distilleries, Ice Factories, Aerating Gas Factories, Match Factories. | 6¼ | |

| Class of buildings, machinery, plant or furniture | Rate. | Remarks. |
|---|---|---|
| | Percentage on prime cost. | |
| Paper Mills, Ship Building and Engineering Works, Iron and Brass Foundries, Aluminium Factories, Electrical Engineering Works, Motor Car Repairing Works, Galvanizing Works, Patent Stone Works, Oil Extraction Factories, Chemical Works, Soap and Candle Works, Lime Works, Saw Mills, Dyeing and Bleaching Works, Furniture and Plant in hotels and boarding houses, Cement Works using rotary kilns. | $7\frac{1}{2}$ | |
| Plant used in connection with brick manufacture, tile-making machinery, optical machinery, glass factories, Telephone Companies, Mines and Quarries, Tubewell boring plant, concrete pile driving machines. | 10 | |
| Sewing machines for canvas or leather. | $12\frac{1}{2}$ | |
| Motor cars used solely for the purpose of business. | 15 | |
| Indigenous sugarcane crushers (*Kohlus* or *Belans*). | 15 | |
| Motor taxis, motor lorries and motor buses. | 20 | |

| Class of buildings, machinery, plant or furniture. | Rate. | Remarks. |
|---|---|---|
| | Percentage on prime cost. | |
| Ropeway ropes and trestle sheaves and connected parts. | 25 | |
| Ropeway structures— | | |
| (1) Trestle and station steel work. | 5 | |
| (2) Driving and tension gearing. | 7½ | |
| (3) Carriers ... | 10 | |
| 3. Electrical Machinery— | | |
| (a) Batteries ... ... | 15 | |
| (b) Other electrical machinery, including electrical generators, motors (other than tramway motors), switchgear and instruments, transformers and other stationary plant and wiring and fitting of electric light and fan installations. | 7½ | |
| (c) Underground cables and wires. | 6 | |
| (d) Overhead cables and wires. | 2½ | |
| 4. Hydro-electric concerns— | | |
| Hydraulic works, pipe lines, sluices and all other items not otherwise provided for in this statement. | 2½ | |

| Class of buildings, machinery, plant or furniture. | Rate. | Remarks. |
|---|---|---|
| | Percentage on prime cost. | |
| 5. Electric Tramways— | | |
| Permanent way— | | |
| (*a*) Not exceeding 50,000 car miles per mile of track per annum. | $6\frac{1}{4}$ | |
| (*b*) Exceeding 50,000 and not exceeding 75,000 car miles per mile of track per annum. | $7\frac{1}{7}$ | |
| (*c*) Exceeding 75,000 and not exceeding 1,25,000 car miles per mile of track per annum. | $8\frac{1}{3}$ | |
| Cars—car tracks, car bodies, electrical equipment and motors. | 7 | |
| General plant, machinery and tools... | 5 | |

Rates of depreciation authorized by the **Government of Australia** in connection with the **Federal income-tax** on industrial establishments: —

| | Per cent. | | Per cent. |
|---|---|---|---|
| Boilers ... | 5 | Machine tools ... | 5 |
| Boring machinery ... | 10 | Machinery used in ordinary manufacture | 5 |
| Cables ærial ... | 7·5 | Meters Switch Board | 7 5 |
| Cables underground | 2·5 | Motor trucks ... | 10 |
| Condensers ... | 5 | Patterns ... | 15 |
| Cranes ... | 5 | Pumps ... | 15 |
| Elevators, Electric... | 7·5 | Galvanized iron tanks for rain water ... | 5 |
| Elevators, Hydraulic | 10 | Galvanized iron tanks for other water... | 10 |
| Engines, Steam ... | 5 | | |
| Foundery Cupola ... | 15 | | |
| Furniture ... | 5 | | |
| Generators ... | 5 | | |

These figures are based on the *diminishing value of the assets* and not on their original cost.

The useful life of the plant or apparatus is purely a speculative matter of past experience, knowledge of the art and careful judgment are necessary in arriving at the probable life of the appliance

From what has been said it will be seen that considerable discrimination can be used as to the depreciation rates applicable to particular items, if due regard is paid to all the above considerations in each case. From the accounting point of view, however, there is no ready alternative to the use of *flat percentage rates*, differentiated according to the general character of plant involved.

These life tables are commonly said to give "average lives," but the authors have yet to see accompanying explanations of how these "averages" were determined. Usually such tables do not even indicate whether the life is natural or functional or composite Students should be on their guard, therefore, in the use of tables like the above, in practice.

The safest procedure will be for the works manager, after a valuation of the works and duly considering the duties and other conditions of work and configuration, of the plant, to furnish an estimate to the directors as to the life expectancy and therefore the depreciation rate for individual items of the plant, and from that basis the flat rate, appropriate to each group as a whole, may be deduced.

When the factory is built on leasehold land, the question of depreciation assumes a different aspect and calls for legal advice as to the sum to be provided over the period of the particular lease in question to counterbalance the expiration of values that legally pass on the determination of the lease, and to meet the cost of delapidations or making good after occupation.

In the case of municipal expenditure, however, in respect of which loans are raised under the sanction of the Local Government Board, the period laid down by the authority for the payment of the municipal loans must be observed. Generally these periods are much shorter than the actual life of the plant.

Since the problems of "**interest" and "discount,**" etc., were in most cases omitted, while learning Arithmetic, or are forgotten by the readers at this stage, we may begin with a recapitulation of the same and gradually lead to economic problems of engineering such as are required in calculating depreciation, valuation, etc., with examples.

Amount A = Principal P + total Interest I.

## Interest

**Interest**:—This is proportional to the original size of the loan or principal P and to the period of time T for which the principal has been borrowed.

Thus it is time rate and percentage rate and the interest is accumulated all the time the loan is outstanding.

**The elements of simple interest** problems are (1) The principal, (2) the interest, (3) the time, (4) the rate, (5) the amount.

From elementary arithmetic we know that if—

$P$ = principal,

$i$ = interest *per unit* of principal per annum.

$T$ = time in years during which the loan is outstanding.

$I$ = the total interest.

Then $I = PiT$ ....(1)

Then the total amount $A_1$ at the end of 1 year—

$A_1 = (P1 + i)$....... ...(2)

and at the end of T years—

$A_T = P\ (A + i\ T)$......(3)

The above is a case of what is called "**simple interest**." Since the interest is not stored inertly but is added every year to the principal, we have the case of "**compound interest.**"

The **elements of compound interest are**——

(1) The principal

(2) The nominal rate usually called simple rate.

(3) The effective rate

(4) The number of interest periods in one year.

(5) The time.

(6) The amount.

(7) The compound interest.

(8) The present worth.

In this case the amount A at the termination of the successive years is:—

$$A_1 = P\,(I+i), \qquad A_2 = P\,(I+i)^2,$$

$$A_3 = P\,(I+i)^3, \qquad \text{and } A_T = P\,(I+i)^T \;\ldots\ldots(4)$$

$$\text{Total interest earned} = P\left\{(I+i)^T - 1\right\} \;\ldots\ldots\ldots(5)$$

If the interest is compounded more often than once in an year, say $n$ times per year, $i_1$ the rate compounded $n$ times, and the interest for this period $= \frac{i_1}{n}$

Then at the end of T years, there will be $n$ T interest periods.

$$\therefore\; A = P\left(1+\frac{i_1}{n}\right)^{nT} \;\ldots\ldots(6)$$

And the effective rate of interest $i$ which compounded annually will give the same result as the actual rate $i_1$ with more frequent compounding is given by—

$$P\,(1+i)^T = P\left(1+\frac{i_1}{n}\right)^{nT}$$

$$(1+i) = \left(1+\frac{i_1}{n}\right)^n$$

$$i = \left(1+\frac{i_1}{n}\right)^n - 1 \;\ldots\ldots(7)$$

Where $i$ is the actual rate compounded $n$ times a year.

Thus if the actual rate is 6 % compounded quarterly, effective rate—

$$i = \left\{1+\frac{\cdot 06}{4}\right\}^4 - 1$$

$$= 1{\cdot}015^4 - 1 = 0609$$

$$= 6{\cdot}1\ \%$$

In calculation of depreciation by the **sinking fund** formula, we shall take this $i$ as the actual rate if compounded annually or as the effective rate, if compounded several times a year.

**Present worth** of a future sum of money or of service valued in money is the principal P which if lent will amount to that sum A at the end of the specified time T and with the specified rate $i$ and kind of interest.

**The future worth** of a present sum is the amount A which that sum will reach, so that the sum in this case forms the principal P in the formula.

**Sinking fund** :—We meet with this in problems on depreciation when valuing on the sinking fund basis.

Here we will have to find the *annual deposit* D, which will be necessary to realize a given amount A at the end of a certain term say T years with a given kind and rate of interest, when the interest actual or effective is compounded annually. The present worth now of this deposit which would amount to D in T years—

$$= \frac{D}{(1+i)^T} \;\ldots\ldots(8)$$

The future worth at the end of the period of this deposit to which D will amount in ( T−1 ) years—

$$= D\,(1+i)^{T-1} \ldots\ldots(9)$$

Hence, the total amount of the sinking fund

$$A = D\,\frac{(1+i)^T - 1}{i} \;\ldots\ldots(10)$$

$$\textit{or} \quad D = \frac{A\,i}{(1+i)^T - 1} \;\ldots\ldots(11)$$

If the interest is compounded more than once a year at the rate of $i_1$ compounded $n$ times per annum each deposit will amount to—

$$D\left(1+\frac{i_1}{n}\right)^{n \times \text{time}}$$

$$\text{and} \quad D = A\,\frac{\left(1+\frac{i_1}{n}\right)^n - 1}{\left(1+\frac{i_1}{n}\right)^{nT} - 1} \;\ldots\ldots(12)$$

The total present worth P of the series of payments is given by

$$P=D\frac{(1+i)^{T}-1}{i(1+i)^{T}} \text{......(13)}$$

If the deposits are made at the beginning of each year instead of at the end, they will have each a year longer to run and will each amount to $(1+i)$ times what they would have become.

The total amount of the series will be increased in this ratio or conversely the deposit will be correspondingly decreased if the amount is the same.

Thus $$D=\frac{A\,i}{(1+i)^{T}-1}\times\frac{1}{1+i} \text{......(14)}$$

$$P=D\frac{(1+i)^{T}-1}{i(1+i)^{T}-1} \text{......(15)}$$

In some cases in which the deposit interval is a multiple of the interest period, we proceed thus :

Let $K$ be the number of deposits made per annum, and $n$ is a multiple of $K$, and $i$ the rate of interest compounded $n$ times per annum.

The necessary end of interval deposit—

$$D = A\frac{\left(1+\frac{i_1}{n}\right)^{\frac{n}{k}}-1}{\left(1+\frac{i_1}{n}\right)^{nT}-1} \text{......(16)}$$

Necessary beginning-of-interval deposit—

$$D = A\frac{\left(1+\frac{i_1}{n}\right)^{\frac{n}{k}}-1}{\left(1+\frac{i_1}{n}\right)^{nT}}\times\frac{1}{\left(1+\frac{i_1}{n}\right)^{\frac{n}{k}}} \text{......(17)}$$

### Examples

(1) A patent expiring in 14 years' time is estimated to be worth Rs. 3,000. What is the present worth of the patent if interest is reckoned at 6 % compounded annually assuming that the gain resulting from the use of the patent accrues at the end of each year.

Solution :—From equation 13.

$$P = \frac{D\{(1+i)^T - 1\}}{i(1+i)^T}$$

$$3000 = \frac{D\{(1\cdot06)^{14} - 1\}}{\cdot06(1\cdot06)^{14}}$$

$$D = \frac{300}{\frac{2\cdot26-1}{\cdot66 \times 2\cdot26}} = \text{Rs. } 322$$

(2) A motor costs Rs. 800, and has a useful life of 20 years, after which its value is assumed to be zero. If interest is at 6 % compounded annually, how much must be set aside at the end of each year to replace the machine at the end of that period. What difference would it make if interest were compounded every 6 months.

Solution :—From equation (11)—

$$D = \frac{Ai}{(1+i)^T - 1} = \frac{800 \times \cdot06}{(1\cdot06)^{20} - 1}$$

$$= \text{Rs. } 21\cdot7$$

$$\text{Equivalent rate } i = \left(1+\frac{i}{n}\right)^r - 1$$

$$= (1\cdot03)^r - 1 = \cdot0609 \text{ or } 6\cdot1\ \%$$

$$D = \frac{800 \times \cdot061}{(1\cdot061)^{20} - 1}$$

$$= \text{Rs. } 21\cdot2$$

(3) A sewing machine can be bought for Rs. 160 cash or it can be purchased for a deposit of Rs. 20 and 36 end of monthly instalments. By how much will the total paid exceed the cash price ? Interest and other expenses are covered by one per cent. per month.

Solution :—From equation No. (13).

Value of the initial loan=160−20=Rs. 140.

$$D = \frac{Pi(1+i)^T}{(1+i)^T - 1}$$ when $i$ = interest per month.

$i$ = ·01 and T = No. of months.

$$D = \frac{140 \times \cdot 01\,(1\cdot 01)^{36}}{(1\cdot 01)^{36}-1} = 4\cdot 68$$

Total paid = 36 × D + 20 = 168·5 + 20 = 1885, which is Rs. 285 more.

(4) Find the annual expenses of owning a machine purchased for Rs. 800—salvage value Rs. 100 and life 20 years. If money is worth 6 % compounded annually, what will be the difference if money is compounded four times per annum ?

Solution :—From equation (11).

Interest charge = $Pi$ = 800 × ·06=Rs. 48.

Depreciation, *i.e.*, charge at the end of year deposit—

$$D = \frac{(P-S)\,i}{(1-i)^T - 1}$$ where S is the salvage value.

$$= \frac{700 \times \cdot 06}{(1\cdot 06)^{20} - 1} = 18\cdot 98.$$

Total = Rs. 66·98, say Rs. 67.

If money is compounded four times a year, the equivalent interest in the sinking fund formula becomes—

$$i = \left(1 + \frac{i}{4}\right)^4 - 1 = \left(1\cdot 015\right)^4 - 1$$

$$= \cdot 0638 \text{ or } 6\cdot 38\ \%$$

$$D = \frac{700 \times \cdot 0638}{(1\cdot 0638)^{20} - 1} = \text{Rs. } 17.$$

and in this case total expenses = Rs. 65.

(5) A machine (*a*) costs Rs. 800 and is estimated to last 20 years Another machine (*b*) costs Rs 1,200 and is estimated to last 25 years and to save Rs. 50 a year as compared with the former machine. Find which machine is worth purchasing taking interest at 6 % and assuming that both the machines have no salvage value.

Solution :—

| | | |
|---|---|---|
| **First machine :** | | Rs. per annum. |
| Interest | $= 800 \times \cdot 06$ | = 48 |
| Depreciation deposit | $= \dfrac{800 \times \cdot 06}{(1\cdot 06)^{15} - 1}$ | |
| | $= 8 \times 4\cdot 3 =$ | 34·4 |
| Extra maintenance | = | = 50 |
| | Total | ... 132·4 |
| **Second machine :** | | |
| Interest | ... $1200 \times \cdot 06$ | = 72 |
| Depreciation deposit | $= \dfrac{1200 \times \cdot 06}{(1\cdot 06)^{20} - 1}$ | = 32·6 |
| | Total | ... 104·6 |

Which is less than the first machine by nearly Rs. 38 per annum.

(6) The cost of two machines are Rs. 1,000 and Rs. 1,200, respectively, and are each capable of doing a certain amount of work. The former machine costs 6 pies per working hour, more in labour. If each machine has a life of 20 years, and a salvage value of 5 % of its cost, find how many hours per week must be worked for the two alternatives to balance ? Taking interest at 6 % on the original loan and at 4 % compounded quarterly on the sinking fund, and other items the same in both cases.

Solution—

Extra interest on the dearer machine — $200 \times 0\cdot 06$ = Rs. 12 per annum.

Extra wearing value of the same machine = (0·95 × 1200) − (0·95 × 1000) = (0·95 × 200) Rs. = Rs. 190.

To realise this in 20 years requires —

From equation (12), $D = A\left\{\dfrac{\left(1+\frac{i}{n}\right)^{n}-1}{\left(1+\frac{i}{n}\right)^{nt}-1}\right\} =$

$$\frac{190\left(1+\frac{\cdot 04}{4}\right)^{4}-1}{\left(1+\frac{\cdot 04}{4}\right)^{80}-1} = \frac{190\times\cdot 04}{1\ 208} = \frac{7\cdot 6}{1\ 208}$$

$$= \text{Rs. } 6\cdot 3$$

Total = 12+6·3 = Rs. 18 3 per annum.

And this represents 18·3 × 16 × 2 hours of working since each working hour costs 6 pies

(*i.e.*) 590 hours.

Or, 12 hours per week (nearly) for 50 weeks per annum.

(7) A plant was purchased for Rs. 30,000. What will be the valuation after 10 years and how soon will it be approximately one-tenth of its cost, if depreciation is assumed to follow the reducing balance or compound interest law, 10 % is written off each year from the value at the beginning of that year.

Solution :—

$$A = P(1-i)^{T} = \text{Rs. } 300{,}000 \times (1-0\cdot 1)^{10}$$
$$= \text{Rs. } 10{,}450$$

Also if $3000 = 30{,}000 \times (0\cdot 9)^{T}$

$$(0\ 9)^{T} = \frac{3000}{30000} = 0\ 1$$

Taking log, on both sides $T \times \log 0\cdot 9 = \log 0\cdot 1$

*i.e.*, $T(\bar{1}\cdot 9542) = \bar{1}\cdot 0000$

$$T = \frac{1}{0\cdot 0458} = 21\cdot 8 \text{ years.}$$

(8) A plant purchased for Rs. 30,000 has an estimated salvage value of Rs. 500 at the end of a useful life of 20 years. What would be the valuation half way through its life, (*a*) if depreciation is estimated on a straight line basis; (*b*) if depreciation is estimated on a reducing balance basis; (*c*) if depreciation is estimated on a sinking fund basis at 6 per cent. compounded annually.

Solution :—

Total depreciation, or wearing value.—
= Rs. (30,000−500) = Rs. 29,500 in 20 years.

(*a*) Valuation after 10 years—

$$= \text{Rs. } (30{,}000 - 29{,}500 \times \frac{10}{20}) = \text{Rs. } 15{,}250.$$

(*b*) Depreciation rate $i = 1 - \sqrt[T]{\frac{S}{P}} = 1 - \sqrt[20]{\frac{500}{30000}}$

$$i = 1 - \frac{1}{1{\cdot}227} = \frac{0{\cdot}227}{1{\cdot}227} \times 100 = 18{\cdot}5\,\%$$

Hence, the valuation after 10 years—
$= \text{Rs. } 30{,}000\,(1-x)^{10} = \text{Rs. } 30{,}000\,(1-0{\cdot}185)^{10}$
$= \text{Rs. } 30{,}000 \times (0{\cdot}815)^{10} = \text{Rs } 3{,}882.$

(*c*) Sinking fund deposit for 20 years fund—

$$= \text{Rs. } \frac{29500 \times 0{\cdot}06}{(1{\cdot}06)^{20} - 1} = \text{Rs. } \frac{295 \times 6}{2{\cdot}206} = \text{Rs. } 800 = \text{Y Rs.}$$

In T years, this would amount to—

$$A = \frac{D\,(1+i)^T - 1}{i}$$

Hence, in 10 years this would amount to—

$$A = \frac{(1{\cdot}06)^{10} - 1}{0{\cdot}06}$$

$$\therefore\ A = \frac{800 \times 0{\cdot}791}{0{\cdot}06} = \text{Rs. } 10{,}560.$$

So that valuation after 10 years = Rs. (30,000 − 10,560)
= Rs. 19,440.

(9) Selection of poles—given that :—

| | | (a) *For wooden poles.* | | *For reinforced concrete poles.* |
|---|---|---|---|---|
| First cost | ... | Rs. 1,000 | ... | Rs. 2000 |
| Salvage value | ... | Rs. 100 | ... | Nil. |
| Life | ... | 20 years | ... | Indefinitely long. |
| Annual maintenance | ... | Rs. 50 | ... | Rs. 10 |

Determine which of the two will be cheaper (*a*) if the service is required for 40 years—

∴ Wooden poles are cheaper.

(*b*) If it is required indefinitely long. Interest is to be reckoned at 6 % per annum.

Solution :—

**Basis of comparison—annual cost**

If the service is required for an indefinite time, the ferro-concrete poles will incur only two charges.

*Wooden poles.* Rs. per annum.

Interest on the first cost C $= 1000 \times {}^{\cdot}06 = 60$

Depreciation— $900 \times \dfrac{{}^{\cdot}06}{(1{\cdot}06)^{20} - 1} = 24{\cdot}4$

Maintenance ... ... ... 50

Total ... $134{\cdot}4$

*Ferro-concrete poles.*

Interest— $2000 \times {}^{\cdot}06$ ... 120

Maintenance ... .. ... 10

Total ... 130

But if it is only required for 40 years, the following depreciation charge must be added :—

$$\frac{2000 \times {}^{\cdot}06}{(1{\cdot}06)^{40} - 1} = 13$$

Total = Rs. 193, nearly.

(10) An engine costing Rs. 25,400 is 5 years old Its working life and salvage value have been assumed as 20 years and Rs. 1,500, respectively. The annual operating

costs for 5 years have been Rs. 8,000, 9,000, 11,000, 12,500, and 15,000. A new engine having a cost of Rs. 30,000, an estimated life of 20 years and a salvage value of Rs. 2,400, is estimated to have an annual operating expense of Rs. 10,600. The interest rate is 5 °/o and depreciation is by sinking fund. If the new engine is considered as a replacement of the old one, is the replacement advisable if Rs. 15,000 can be realised by its sale ?

**Solution** :—The present value of the first 5 years' operating cost (interest compounded annually at 5 °/o) is $8,000 \times 1{\cdot}05^4 + 9,000 \times 1{\cdot}05^3 + 11,000 \times 1{\cdot}05^2 + 12,500 \times 1{\cdot}05 + 15,000 =$ Rs 60,400.

The amount which annually placed at R compound interest, will amount to I in n years $= \dfrac{r}{(1+r)^n - 1}$

$$= \frac{05}{(1{\cdot}05)^5 - 1} = 0{\cdot}18.$$

Equalled annual operating cost of the old engine $= 0{\cdot}18 \times 60,400 =$ Rs. 10,872.

Annual sinking fund factor—

$$= \frac{{\cdot}05}{(1{\cdot}05)^{20} - 1} = 0{\cdot}0303$$

Sinking fund annuity of the old engine—

Rs. $(25,400 - 1,500)\ 0{\cdot}0303 =$ Rs. 724.

The present accumulation of an annuity of 1 is

$$\frac{(1+r)^n - 1}{r}$$

$$\frac{(1{\cdot}05)^5 - 1}{{\cdot}05} = 5{\cdot}52$$

Hence, the present values of the sinking fund set aside for engine depreciation is—

$724 \times 5{\cdot}52 =$ Rs. 3,996

Depreciated value of the engine—

= Rs. 25,400—Rs. 3,996

= Rs. 21,404.

Difference between this and sale price of engine $=$ Rs. 21,404 $-$ Rs. 15,000 $=$ Rs. 6,404.

$\therefore$ actual investment required when new engine is purchased $=$ Rs. 30,000 $+$ Rs. 6,404 $=$ Rs. 36,404.

Annual sinking fund deposit—
$=$ Rs. (36,404 $-$ 2,400) ·0303
$=$ Rs. 1,030.

Annual cost of old engine $= 724 + 25{,}400 \times {\cdot}05 + 10{,}872$
$=$ Rs. 12,866.

Annual cost of new engine $= 1{,}030 + (36{,}404) \times {\cdot}05 + 10{,}600 =$ Rs 13,450·2

Hence, the replacement is not at all advisable, the old engine costing about Rs. 584·2 less.

(11) A phase improvement plant is to be installed of a total corrective capacity of 1,500 K. V. A. and the choice lies between static plant costing Rs. 40 per K. V. A. and having a loss of 1 kW. per 100 K. V. A. and synchronous plant costing Rs. 20 per K. V. A. and having a loss of 4 kW. per 100 K. V. A. If the service averages 8 hours a day (and 300 days per year), what must be the price of energy in order to justify the static plant if the interest, depreciation, etc., of the two types are represented respectively by 12 % and 16 % per annum of the capital costs.

Solution :—

Capital charge on static plant—

$$= \frac{12}{100} \times 40 \times 1{,}500 = \text{Rs. } 7{,}200.$$

Capital charge on synchronous plant—

$$= \frac{16}{100} \times 20 \times 1{,}500 = \text{Rs. } 4{,}800.$$

Difference $=$ Rs. 2,400.

Losses charge on static plant—

$$= \frac{1}{100} \times 1{,}500 \times \text{service price} = \text{SP} \times 15.$$

Losses charge on synchronous plant—

$$= \frac{4}{100} \times 1500 \times \text{service price} = \text{S. P.} \times 60$$

$$\text{Difference} = \text{S. P.} \times 45$$

For the two alternatives to balance, the service price must be Rs. $\frac{2400}{45}$ —.

Which will correspond to an energy price of—

$$\frac{1}{4 \cdot 4} \times 16$$

$$= \frac{16}{45} \text{ anna}$$

or ·36 anna nearly.

(12) In a private generating station, the capital cost of the supply plant is represented by Rs. (150 W + 80 V). Where W is the k W. capacity and V is the K. V. A. capacity. Capital cost of the phase improvement plant is Rs. 25 per quadrature K V.A capacity. If the useful life of both types of plant is reckoned as 25 years with zero salvage value, and if maintenance, etc., be taken as 5 % per annum on the capital cost of supply plant or 4 % on the improvement plant, what is the most economical power factor reckoning interest at 6 % per annum.

Solution :—

Annual rate for interest and depreciation—

$$= 6 + 2{\cdot}72 = 8{\cdot}72 \ \%.$$

Hence, supply plant charge $= ({\cdot}0872 + {\cdot}05) \times 80$

$$= \text{Rs. } 10{\cdot}96.$$

Improvement plant charge—

$$= 25\ ({\cdot}0872 + {\cdot}04) = \text{Rs. } 3{\cdot}18.$$

Hence, $\sin\theta = \frac{3{\cdot}18}{10{\cdot}96}$ or $\theta = 16{\cdot}6$ $\cos\theta = 95{\cdot}0\ \%$

(13) Two types of lamps, each nominally rated to take 60 watts, give the same candle power. One type costs Rs. 2 and has a life of 1,000 hours and consume exactly 60 watts. The other type costs Re. 1, but is found to have a mean life of 800 hours and consume 65 watts. For what energy price the two will be economically equal.

Solution :—

| | Rs. | a. | p. |
|---|---|---|---|
| In 4,000 burning hours, 4 of the first type lamps would be required costing ... | 8 | 0 | 0 |
| In the same time 5 of the second type will be required costing ... ... | 5 | 0 | 0 |
| Difference in lamp cost ... | 3 | 0 | 0 |

In this period the second type of lamp will have consumed $5 \times 4 = 20$ k.W. more than the first.

Hence, energy price at which they will be economically equal is $\frac{3}{20}$ *or* $\frac{48}{20}$ *or* 2·4 anna and for any price higher than this, the first type of lamp will be preferable.

Expert opinion differs as to whether it is necessary to lay aside depreciation reserve for future use. In many manufacturing businesses the rough-and-ready method is adopted of charging to capital, in addition to the original cost, the cost of all renewals, alterations and extension of buildings and machinery; and the Profit and Loss A/C is debited in respect of depreciation with a percentage of the total amount in the Ledger under those heads. In some cases, however, proprietors are content to charge their P. and L. A/C with an estimated fixed sum yearly for depreciation, and they include under this term repairs and renewals. The amount so charged they credit to a depreciation fund and debit the a/c with the amount expended in repairs and renewals. In some undertakings, for example, most railways, the deterioration of the plant is taken to be adequately and fairly provided by the current expenditure upon repairs and renewals which is debited to revenue a/c and no cognisance is taken of the depreciation in the a/c. Such a system may possibly prove unobjectionable when an undertaking has been in operation for a number of years, and a permanent relation has been established between the initial cost and the cost of repairs required to maintain the plant at full value, but this system has nevertheless the risk of a/cs of particular years being very badly balanced. In the case of the water companies of Great Britain, there is no fund called the depreciation fund, but they are allowed by Act of Parliament to place to a reserve fund surplus profits to the extent of one-tenth of the capital, and as renewals are paid for out of profits, it follows that any abnormal charges in respect of deterioration are indirectly met out of this reserve fund. In general it may be said that unless considerable additions and extensions are constantly made, the system of charging all repairs and renewals to revenue, but making no allowance for depreciation, will not in the long run prove satisfactory. Unless proper care is taken, some years will be made to appear more lucrative than others when heavy renewals come up with inadequate funds to meet them. In certain cases only maintenance can therefore be said to balance depreciation. The cases are :—"Where the plant wears out so quickly as to need replacement at short intervals affording constant proof, by the mere continuance of working that not only the earning power of the factory is maintained, but also the capital value, or that of undertakings so large and permanent as to afford a wide average of deterioration and renewal over the whole plant." (Matheson—The Depreciation of Factories and Their valuation). It is worthy of note that even in the two cases referred to, Matheson speaks with some hesitancy and alludes to such a mode of procedure as a venture.

Where recourse is had to a fund for depreciation reserve, the proper deposition of this reserve pending its use for the purpose originally intended, is a subject which has received much discussion without evolving any hard and fast rule that meets with general approval. In particular if the property is one which earns more than 6 °/o or so, there will be some advantage in investing the depreciation reserve, or some portion of it, in the extension of the plant. This also possesses the advantage of reducing the requirements for fresh capital in extending the business; indeed in some cases it has become the policy to invest the whole depreciation reserve in this manner. The disadvantages of investing reserves in the business itself is the same as the disadvantage of carrying all ones eggs in one busket. If that busket is dropped.............. !

## Economic Considerations and Limitations

Generally, the expense of either the manufacture of an article or a service can be divided broadly into two portions—(1) the expenses which are periodic and which relate to the structure or machine and (2) others which depend upon the total amount of work turned out. This is only a general demarcation and no hard and fixed line can be drawn separating the two

So, if a certain portion called S of the structure or machine is regarded as fixed, next, we may determine how much of the work can be economically turned out with the help of the former structure or machine. Hence, we see the existence of a limit after which no more of the group of work can be done either from—

(*a*) *physical consideration*—which is absolutely compulsory, or

(*b*) *from an economical consideration*—which is only advisable to adopt.

(*c*) *Regulation* limitations. These are absolutely independent of each other and hence all of them must be considered to decide the limiting conditions.

Taking an example in electrical engineering we see that a very small wire may be capable of carrying the required current without excessive overheating (*i. e*) without exceeding the temperature limit. But it may not be suitable for overhead wiring for want of mechanical strength—*i.e.*, it may snap owing to the pressure of the wind or that due to birds sitting on it. This is why the Electricity Act provides that wires less than 6 S. W G. should not be used for overhead wiring. Here we see that the physical limit is reached before the economical one. But sometimes the other may be the limiting consideration as in the case of interior wiring where there is no questions of any bird or wind or frost causing the wire to snap off and we have only to look for the economical consideration.

Besides the above two, there are, as you have seen in dynamo motor, synchronous motor or transmission system, **regulation** is the determining factor.

The relative economy of any service may be stated like efficiency as—

$$\frac{\textbf{Value of output (product P or service)}}{\textit{Cost of output (cost of structure S or cost of work W).}}$$

It is always convenient to reduce P, S and W to some common denominator for the most useful comparison and usually the most convenient basis is either a time limit or a service limit

**Time limit** may be (*a*) annual cost, or (*b*) service limit.

(*a*) In this case, the service is supposed to continue indefinitely, the plant being replaced by a new one whenever the old one gets over its working life or becomes obsolete and each item is expressed proportionately every year.

(*b*) In this case the total capitalised cost taking into account the total expenses of the service is distributed over a fixed period of years which is either the life-time of the plant or the period for which the service is required.

**Service limit**:—Sometimes this is taken as the basis of comparison especially in cases where the interest is negligible in comparison with the depreciation; and where the structures employed have a relatively short life and are worn out in service rather than in time.

**Repairs and renewals**:—Instead of meeting this item when occasion arises out of income which leaves much to chance, we set up a separate provision for this Then there will not be much difficulty to 'even out' the replacements so that it represents a fairly uniform burden each financial year It is applicable only on short lined items, *e g.*, lamp renewals, and other smaller concerns or number of undertakings under one concern as in a municipality.

Under the head of repairs and renewals, there are so many partial replacements which are not actually repairs, but supply of new parts to the machine. If these are paid out of hand cash, these will unduly load the year in spite of the fact that the economic life of the machine or plant may be increased, beyond the original estimate. Thus though they reduce depreciation to some extent, they are dealt with separately. In the case of small articles nothing is allowed during its life, but when it gets out of service, the cost of the new article *minus* the money obtained by disposing off the old one or an amount estimated to be obtainable is allowed for income-tax assessment. In the case of items like dies and punches they may be regarded as current repairs and paid out of hand cash since they cannot overload any particular year. But repairs and renewals of major parts or machine which are done with a view to better the plant should be paid out of the depreciation reserve. Hence, we see that the cost as well as the frequency of renewal determines the choice of allocating the expense under one head or the other. However, an accurate forecast of repairs and renewals is required in the estimation of the total useful life as well as the salvage value.

**Deterioration** :—There are two kinds of deterioration, namely—

(1) The loss in value due to lapse of time and use of the article.

(2) The loss in value which occurs directly when the ownership of any thing has been transferred from the seller to the buyer. And it is to be noted that always "*second-hand*" value is less than the market value, unless in the case of rare exceptions like some musical instruments, fiddle, *volincet*—

Generally, the difference between the price of the new and second-hand article forms part of the deterioration loss.

In the case of a plant of general character, such as engines, boilers, shafting, pulleys, etc., it carries a high residual value in the event of displacement.

## Valuation

Whether in the ordinary course of his work or as a professional valuer, an engineer is often called upon to estimate. For income-tax purposes the value and prime cost of a factory or of a plant is often determined.

**Valuation** is the process of ascertaining by examination and survey the prime cost, the present and the prospective value of properties or the earning power of any asset.

Such a valuation is required within the works when the confirmation of the book values of the plant becomes necessary for works accounting purposes. With the post war necessity of reviewing capital values in the light of altered currency values, this work becomes increasingly important, in view of its essential bearing on depreciation rates Valuation of the plants is also necessary for the settlement of price when the property or the plant is undergoing a change of proprietorship—*Vide* auditing, p. 84.

When any such occasion arises, a professional valuer is called in and only his certificate is likely to be held valid in any financial transactions involving the plant values. But without suggesting any restrictions of the field of professional valuation, in any fully organised works, the works staff ought to be able to determine the value of the plant when it is required for account purposes. The usual difficulty in applying professional valuation in such cases is the lack of detail figures from which departmental figures can be obtained. The professional report will include probably an excellent description of the items included in the valuation, but no values, except as to totals under a few headings. In preparing for a works valuation, the works accounts should be previously organised on lines that will accord with those to be adopted in the inventory, and this will facilitate the adjustment of valuation afterwards, from year to year, with a minimum of further inventory.

**Interim Valuation :**—By this is meant how much of the total value ultimately expiring can be considered to have expired during any one year of its life.

Interim valuation is required to be done when a business is sold during the life of an asset or for annual accounting. But an accurate forecast of its active life and salvage value are necessary.

**Wasting assets :** —Income-tax distinction classifies as follows :—

(*a*) Inherently wasting assets meaning the capital invested in the purchase of temporary sources of profit.

(*b*) Assets in which the wasting is not inherent. In this case the capital is invested in the purchase of temporary interest in a permanent source of profit.

**The basis for valuation** recommended by the authors is the replacement value. The **replacement value** of any machinery is what a new machinery of the same capacity and quality would cost at the time of the valuation. The current inventory value is then obtained by deducting from the replacement value the money equivalent of depreciation according to the age of the plant.

The *reason for adopting this replacement value* instead of the original cost, is that the effects of currency inflation, or deflation, and other periodic fluctuations of value are thereby eliminated. The cost data information may be wrong, for the cost of alterations may have been added to the book value of the plant though such alterations were required rather to maintain than to increase the value. Thus the replacement value basis will correct the book-value so far as they may be wrong. There is, too, the insistent question of change in currency values making orignal pre-war costs quite misleading to-day ; the book values of the pre-war period being much less than the post-war period valuation. A yet further point is that the use of replacement values gives a common ground of reference in criticising the ultimate inventory values, often required for guidance in ascertaining the value to be covered under fire and other insurance policies. Another disadvantage of the cost data is that the classification adopted for a work's valuation is frequently different from that of the cost A/Cs. of a much earlier date. As a rule, a valuation includes value of trangible objects only, labour costs of installation are omitted. They must not, however, be forgotten by the purchaser.

The depreciation rate allowed in the case of these valuations, as recommended by the authors, should be a regular percentage deduction, each year of life, from the diminished value of the item. This is no simple job. Much labour will be saved by the use of the table given below:—

**Depreciation by percentage on diminished Values.**

Table of Remainder Values Expressed as percentage of Basis Value.

| No. of years. | Percentage Depreciation per Annum. | | | | | |
|---|---|---|---|---|---|---|
| | 10 % | 12½ % | 15 % | 20 % | 25 % | 30 % |
| 1 | 90·00 | 87·50 | 85·00 | 80·00 | 75·00 | 70·00 |
| 2 | 81·00 | 76·56 | 72·25 | 64·00 | 56·25 | 49·00 |
| 3 | 72·90 | 66·99 | 61·41 | 51·20 | 42·19 | 34·30 |
| 4 | 65·61 | 58·62 | 52·20 | 40·96 | 31·64 | 24·01 |
| 5 | 59·05 | 51·29 | 44·37 | 32·77 | 23·73 | 16·81 |
| 6 | 53·14 | 44·88 | 37·71 | 26·21 | 17·80 | 11·76 |
| 6·5 | ... | ... | ... | ... | ... | 10·00 |
| 7 | 47·83 | 39·27 | 32·06 | 20·97 | 13·35 | ... |
| 8 | 43·05 | 34·36 | 27·25 | 16·78 | 10·00 | ... |
| 9 | 38·74 | 30·07 | 23·16 | 13·42 | ... | ... |
| 10 | 34·87 | 26·31 | 19·69 | 10·74 | ... | ... |
| 10·3 | ... | ... | ... | 10·00 | .. | ... |
| 11 | 31·38 | 23·02 | 16·73 | ... | ... | ... |
| 12 | 28·24 | 20·14 | 14·22 | ... | ... | ... |
| 13 | 25·42 | 17·62 | 12·09 | ... | ... | ... |
| 14 | 22·88 | 15·42 | 10·28 | ... | ... | ... |
| 14·2 | ... | .. | 10·00 | ... | ... | ... |
| 15 | 20·59 | 13·49 | ... | ... | ... | ... |
| 16 | 18·53 | 11·81 | ... | ... | ... | ... |
| 17 | 16·68 | 10·33 | ... | ... | ... | ... |
| 17·3 | ... | 10·00 | ... | ... | ... | ... |
| 18 | 15·01 | ... | ... | ... | ... | ... |
| 19 | 13·51 | ... | ... | ... | ... | ... |
| 20 | 12·16 | ... | ... | ... | ... | ... |
| 21 | 10·94 | ... | ... | ... | ... | .. |
| 21·9 | 10·00 | ... | ... | | ... | ... |

N. B.—The Scrap-value in the above table is taken to be 10 % of the Basis value.

An illustration of the use of the table is given below :—

Suppose the basis value of an oil engine is Rs. 20,000. Its age is 10 years. The rate of depreciation is 15 %. Turning to the table it will be seen that its remainder value after 10 years is 19·69 % of the basis value. Thus its present worth is Rs. 3,938.

The work valuer must have a *full technical knowledge of all kinds of property, if he is accurately to determine the appropriate depreciation rate.* It will often be found that the rate allowed by the valuer is different from that allowed in financial a/cs. The best practice will be to settle the depreciation rate in consultation with the work manager who is well-acquainted with the workings, etc., of his own plant.

In the taking of a works inventory the acting works valuer must be very methodical, should possess sufficient technical knowledge, and should devote his whole time to it until the work is complete. An up-to-date works plan, containing the location of machinery, pipe service, lighting service systems, etc., if available, will be of distinct aid to the valuer in his work. The existing plant a/cs., if complete, should influence the holdings selected by the valuer and thus make his report of more use for the works a/cs. The valuation of the land and building form difficult items in the total valuation of factory or plant and it often happens that a land surveyer and an architect, over and above the works valuer are needed. For these particular items, the knowledge of an engineer may prove inadequate.

It will be of great convenience to the works valuer (in big affairs) to have a short-hand clerk going round with him as he proceeds in the factory taking down the necessary informations for his valuation. For such items as Mechanical Transmission, Pipe Transmission, Electrical Transmissian and Shop Fixture—it is convenient in the first instance that the value's clerk should go to the Millwright, Pipe Fitter, Electrician and Joiner, (*i. e.*, those people whose business it is to keep the particular plant in order) respectively, and take down from them the requisite information in good order. This can then be easily verified by the valuer himself. The usual practice in estimating the replacement values for the above items is to add a margin to the material cost for the installation and connections. This margin is better taken as so much per foot run graded to different sizes. The valuer should not be less careful in the valuation of these minor details, for they occur so frequently as to account for a considerable value in the bulk.

The best practice will be, in taking the inventory to note down the age of the plant, either from the plant records or from the shop staff, and to comment on the probable life of each item, more particularly in view of the likelihood of early obsolescence or supersession by more modern plant.

The inventory data should be finally entered as shown :--

| | Class of plant. | Plant No. |
|---|---|---|
| | ......... ............. | ...... ............... |

<table>
<tr><td rowspan="2">Maker......... ...............<br><br>Description....................<br><br>...... ... ··· ....... ................</td><td colspan="2">Location.</td></tr>
<tr><td>Date........</td><td>Dept............</td></tr>
</table>

| Date New. | Original Book Value. | Basis Value. | Depreciation Rate. | Age. | Investigated Value. | Probable Life. |
|---|---|---|---|---|---|---|
| | | | | | | |

Date........................ By...........................

The **valuation of loose plant** is largely influenced by the financial position of the concern. By loose plant is meant all attachments and accessories that are not integral part of the machines, but are really extras that theoretically could be used generally, although in practice such items as chucks may only be used on the machines to which they are fitted. In some cases, when the financial position is strong enough, no value whatever is put on the loose plant that has been put into use. In other cases all loose plant is valued *at cost*, the reason being that so long the items are good enough for use they are worth full value. But the most satisfactory and straightforward method is to value the loose plant on replacement basis and then to take a proportion of this value for inventory purposes. The argument in favour of this is that it gives an idea of the real values. The ready method of stock taking in this case will be by weight, although there may be some items which have not been bought by weight, and for which an average weight basis should be calculated.

The authors recommend the method laid down by Mr. Elbourne in "Factory Administration and Cost Accounts" for the groupings of loose plant and the definite proportions to be taken of the replacement value to arrive at the inventory value. The following table is quoted from that work :—

| Loose Plant Groupings. | Possible inventory Valuation Basis. | | |
|---|---|---|---|
| 1. Belting and Driving Ropes. | Replacement value less | | 50 % |
| 2. Gauges and Mechanical Appliances Standard. | Ditto | ditto | 50 % |
| 3. Hand tool—Engineers | Ditto | ditto | 25 % |
| 4. Holding Appliances for Cutting Tools. | Ditto | ditto | $33\frac{1}{3}$% |
| 5. Holding Appliances for Work. | Ditto | ditto | $33\frac{1}{3}$% |
| 6. Machining Tools ... | Ditto | ditto | $33\frac{1}{3}$% |
| 7. Ordinary Implements and Utensils. | Ditto | ditto | 50 % |
| 8. Portable Mechanical appliances. | Ditto | ditto | $33\frac{1}{3}$% |
| 9. Portable Shop Accessories. | Ditto | ditto | $33\frac{1}{3}$% |
| 10. Special Trade Tools and Accessories. | Ditto | ditto | 50 % |
| 11. Testing Gear ... | Ditto | ditto | $33\frac{1}{3}$% |
| 12. Transportation, Lifting and weighing apparatus. | Ditto | ditto | $33\frac{1}{3}$% |

N.B.—Subject to individual valuation of important items.

Consideration should also be given to the physical condition of the plant before any such rate as above is accepted ; for a firm is at liberty to write down its loose plant to a breaking up price, which would be considerably less than the suggested formulas given above. The table only serves as an illustration.

It should now be clear that it is possible to produce a very plausible valuation which is either greatly in excess or greatly less than the true value. It is not unusual for a firm, or the directors of a firm to conceal its prosperity from competitors by persistent undervaluation of plant added to firm revenue. On the other hand, overvaluation is, of course, an obvious device of persons trying to float an old established business as a Public Company.

# CHAPTER XIX

## JOBBING AND MASS PRODUCTION

SO far we have been considering business principles generally. We have now to proceed on a kind of tour of inspection through the workshop. We have to go into the details of workshop organisation, and it will be necessary, therefore, not only to know that it is an engineering workshop, but also what kind of an engineering workshop. The distinction we wish to make very clearly at the outset is the distinction between the *Jobbing shop* and the *Mass production shop* or factory. We do not remain in making this distinction, to suggest that a workshop must necessarily be wholly one or the other.

But we do most emphatically mean that the methods appropriate for jobbing production are nearly always quite unsuitable for mass production, and vice versa.

A jobbing shop accepts orders for any single job which its manager thinks likely to prove profitable. A mass production shop concentrates on the manufacture of a single speciality in large quantities. This is the prime distinction from which all the others arise.

**The jobbing shop** is always ready to quote a price for any article within the capacity of its plant It is, therefore, necessary that such prices should be estimated, that is to say, a cost calculated before the article is produced It is this prophetic character that principally *distinguishes* **estimating** from "**costing**" which is the determination of the cost of production from actual observation as the work proceeds. The basis of reliable estimating is experience, and costing, being recorded experience, is as necessary to the jobbing shop as it is to the mass production shop. But the latter does not use its costing system as the basis of an exact estimate of the cost of an unprecedented job.

Owing to the various nature of its work, the whole staff of a jobbing shop must be *pucca* engineers. The manager must be a resourceful man, fertile in expedients, and not afraid to tackle anything merely because he has never done it before; the draftsmen must have a sound knowledge of the scientific basis of engineering and of a wide range of machines, and the workmen must be good, and skilful mechanics who can be trusted to do a fair day's work for a fair day's pay. It will not be found practicable to offer the workmen a contract price depending on the amount of work he does (put him on piece work) because it is impossible where the work is so various to determine in advance what a fair price is. The workmen in addition to being good mechanics must be sufficiently well educated to work from drawings. Without drawing, the work of directing men, all on unprecedented jobs, would become impossible. Even with the drawings it will be necessary to have a good foreman in each department to superintend the work.

The draftsmen should be the kind of men who are interested in any ingenuity, not merely in some particular branch of engineering. They should know just how much is possible in the moulding shop, the machine shop or the smithy and how much is not, and bow and in what direction to modify a design in order to make its manufacture easier and cheaper without sacrificing efficiency. They should be able to imagine themselves in the position of the workmen who will operate the machine after it is made, and also in his who will have to dismantle, and repair it from time to time. They should work always in close consultation with the workshops. They should be familiar figures in all departments of the works exhibiting their half-completed drawings to the departmental foremen, and ever ready to welcome suggestions from the man "on the job".

With all they must be essentially brainworkers of the best type: the kind of brainworker that submits his speculations at every stage to the test of experiment.

The workmen must be skilled. The turner should be able to feel half a thousandth of an inch with his callipers. The pattern maker may be almost illiterate, but he must be able to visualize even the most complicated form with all its voids turned into solids, and all its solids into voids ; no mean feat of intellectual gymnastics in many cases.

The jobbing shop is now regarded in Western countries as somewhat old fashioned, but the jobbing shop doing a certain amount of new work and many miscellaneous repairs is the best place for a young engineer to get his practical training. He will get a far better training in some jungly place of that type than he would get in some world famous mass production shop such as for instance the celebrated Ford Works in America. He will find in the jobbing shop that every one from the mistries upward has something interesting and useful to teach him.

## The Mass Production Shop ✓

The principle which has led to the extraordinary financial success of the mass production shop is quite simple. It is the principle of sub-division and specialisation from top to bottom of the works.

The manager is an energetic business man rather than an engineer. If the speciality is, say, a motor car, he knows all about cars, not as an engineer knows Carnot's theory, or Bernoulli's Law (probably he never heard of either) but rather as the rider knows his horse ; from the outside. He has so soaked himself in car literature and car experience that his intellectual processes have become instinctive rather than intelligent.

Every new machine is first a theory in some engineer's brain ; then a clumsy experiment in some workshop; then a less clumsy experiment guided by the first and so on by a process of trial and error to the perfected machine it remains till a new theory results in the machine that displaces it altogether.

The responsible man at the beginning and end of this process is never the same man. He who designed the first clumsy machine was a thinker. He who designed the perfected article knew every detail of the earlier experiments but he could not have originated them. He is, however, the ideal mass production manager for that particular machine.

The philosophic reader may find amusement in the fact that the two men described above have, as a rule, very little respect for each other. The first despises the ignorance of the second. The second compares his machine with that produced by the pioneer, and thinks no more evidence of his own immense superiority is required.

The brains of a mass production shop are to be found in the drawing office, but strange to say the said brains know very little of the article being produced except its shape. They are engaged in devising Jigs, Fixtures, Gauges, Templates and other devices for its ever more speedy and economical production. A complete set of these for producing any particular article greatly exceeds in cost and complexity the article itself. An extreme example is to be found in a certain English Motor Car factory where the machine for finishing the cylinder monobloc cost £300,000, contains one hundred and eighty separate electric motors, and turns the casting out completely finished in four minutes from the time it was put on the machine.

The jigs often exhibit great ingenuity in the overcoming of difficult problems, but the problems are all of the same class. They are all puzzles in special relations. The good jig designer has the same relation to the good general designer that the chess player has to the physicist. If he is only a jig expert, he cannot be called an educated man.

As for the mass production workman, it can only be said that he is a coolie, and even that is an insult to the East which has never as yet succeeded in inventing such unintelligent labour as is the lot of the mass production workman. A typical job is boring six holes over and over again in the same part of the same object. He is not allowed nor expected to use any intelligence whatever. The drill is passed through six holes in a jig which prevents him boring them anywhere but in the right places. He never does any other job. So it is throughout the workshop. No workman ever does the work of another, and no workman has any conception of the completed machine to which he contributes his tiny part, any more than the coral insect has any conception of the island he is building.

This workman is, in no sense, an engineer. Usually he is taken from the street and taught his pitiful trick in a few hours. The only part of the shop where working drawings are to be found is in that part reserved for the construction of jigs. Even that is sometimes missing, and the jigs are supplied by another firm specializing in their design and manufacture.

In the above paragraph we have thought it right to stress the fact that there is a *serious drawback to mass production from the national point of view.* These workmen engaged in work no more intelligent than the work of the galley slave, usually earn better wages than do the skilled mechanics of the jobbing shop. For reasons which will be better understood later it pays to make that wage, which is invariably a piece work wage proportional to the amount of work done, a substantial one. The result is, a long day of furious physical labour, without interest, followed by exhaustion which is just as prohibitive of intellectual recreation as it is of physical recreation.

It is tempting to follow up this matter, but it would lead us beyond our brief. We leave it, therefore, with the remark that modern civilisation appears to be breeding a proletarian army ignorant and overfed, in many ways resembling the mercenary armies which did so much to overthrow the Roman, and other empires of the past.

As to the deadly efficiency of the mass production methods, there can be no doubt. The work turned out is of the highest accuracy, and is as cheap and abundant as it is accurate. How cheap and how good it is in comparison with the jobbing shop articles the reader may realize by a simple experiment. Let him buy one of these mass produced watches or motor cars, and let him smash some necessary part say the engine or the main spring, and let him entrust the nearest jobbing shop with the manufacture of a new one. He will certainly find that the repair costs as much as the whole machine did originally, and that it never works as well again.

For the next five chapters we will consider jobbing shop organisation only.

# CHAPTER XX

## INQUIRIES: PROGRESS CARDS

### Inquiries Department.

IN a large shop this is a separate department with its own head, own filing system, and an outside staff of travellers following up every inquiry as soon as it appears The ideal is, that on the day the inquiry reaches the office, an urbane gentleman representing the firm should call on the inquirer, full of enticing and helpful suggestions. In that case if the inquiry is genuine, and the traveller knows his business, he ought to come away with the order in his pocket, before the rival firms have had time to prepare and post their estimates. But to cover a whole country with a system of that kind is beyond the means of all but the largest firms.

As most of our readers are students, and as we hope that many of them will start their own business in quite a small way, we will assume that the manager attends to all inquiries himself and has no time to get away from his work. It would seem at first sight to that he has no chance against the urbane gentleman in the expensive clothes, but that is by no means the case. His great advantage is that he has not got to pay the travelling expenses, the salary, and the hotel bills of the U. G. and can, therefore, afford to quote a lower price. It must never be forgotten either by buyer or seller that the former pays for everything in the end. But the small man should also realize that there is not a post to lose if he want, the order.

Benares.
7-4-25.

| |
|---|
| Your Reference number.............. |
| Our Reference number.............. |

Gentlemen,

Your valued inquiry of the 5th instant is to hand. Our technical staff is going thoroughly into the matter, and the tender for the lowest price compatible with a sound job will reach you as soon as it can be prepared.

Yours faithfully.

Alternatively, if the matter is a very simple one:

" Dear Sir,

Referring to your inquiry for cast iron railings we can supply these to your sketches at Rs. 15/- (Rupees fifteen) per hundred-weight. We could, of course, quote a lower price, but the job would not be such as we would recommend. We do not think you would have any satisfaction in it.

Yours faithfully."

**Standard Forms :**—These letters are what are called " Standard Forms ". The manager should very carefully think out all such letters as above, once for all, and have them copied in a book of Standard Forms. If he does that, three quarters of his correspondence reduces to scribbling on the letters he receives " S. F. 7," " S. F. 3," and so on, as the case may be, and signing typed letters an hour or two later.

The above letters are designed to make the inquirer hesitate before placing his order with the U. G., at least till he has made further inquiries. They should be posted at once. It is a great folly to postpone writing an acknowledgment till the quotation is ready.

The letter should be filed. It should not be sent into the shop. If it is necessary to consult a departmental foreman, a copy should be sent. Particulars should be entered on a card.

| Firm's name and address. | | (1) Date of Inquiry. | (2) Date of acknowledgment. |
|---|---|---|---|
| Particulars of Inquiry. | | (3) Date of Quotation. | (4) Date of follow up letter. |
| Reference numbers. | | (5) Result. | (6) Job number. |
| Their's | Our's | | |
| | | | |

After (2) is filled up, the card should lie in an open box labelled "Inquiries A" on the manager's desk, until (3) can be filled up, when it should be transferred to "Inquiries B." A fortnight later if the quotation has not elicited any response, the "follow up" should be sent:—

"Gentlemen,

We trust that our quotation of—— reached you safely. If you will be so good as to state your difficulties in placing the order, we will be pleased to submit alternative proposals.

Yours faithfully,"

If this also fails to produce any answer, it probably means that the firm has been the victim of a rival firm anxious to know the tenderer's price and specification for a particular job. In that case "feeler" is entered in space (5) and the card is transferred to "Inquiries C". Any further inquiries from the same source should be ignored. On the other hand, if an order results, a job number is assigned to the work, entered in space (6) and a "progress card" is prepared. The letter stating a price which is sent in answer to an inquiry may be headed either "quotation" or "estimate". The former means that the letter is a definite undertaking to supply at the stated price, the latter that the price is only a guess to which the writer does not bind himself. Generally speaking, it is better to quote a price that provides for all reasonable probabilities, and even suffer an occasional loss than it is to offer estimates. No man in his senses places an order against an estimated price unless he is very well acquainted with the person that offers it,

**Progress cards** should be of two colours; one red to be used for urgent jobs, very sparingly, and the other white, to be used for work in no special hurry. It might be supposed that only the urgent jobs would get through the shop at all, but that is not so. It only means that when two jobs are ready to go on the same machine, the *lal wallah* must have the preference. Ample opportunity will arise for the ordinary job at time when that particular machine or that particular workman is not required for the urgent job.

These progress cards should lie on the manager's desk all morning, and should be sent into the works towards evening. It should be a standing order that only important movements should be entered on them, as otherwise the departmental foreman will fill them with records of unimportant operations in order to create an impression that they are getting through an immense amount of work. Here is a progress card after its progress is completed.

| Job No............... | Date | | Date |
|---|---|---|---|
| Date of Order........... | | Patterns complete. | |
| Promised } Date of | | Castings complete. | |
| Estimated } despatch. | | Forgings complete. | |
| General arrangement completed. | | Machining complete | |
| Detail drawings sent to pattern shop | | Erected. | |
| Detail drawings sent to smithy. | | Tested. | |
| Detail drawings sent to machine shop. | | Despatched. | |

This system helps to keep the manager in his office which, as a rule, is the best place for him It is, of course, essential that all departments should be subject to unexpected visits from the *Burra Sahib.* But he should never be long absent from the centre of his web.

## Appendix to Chapter XX.

"Factory Administration and Accounts." by E. T. Elbourne, contains specimen forms for every conceivable purpose.

"Engineering Economics," by J. C. L. Fish, contains a very sensible chapter on estimating.

"A First Course in Commercial Correspondence and Office Routine," by J. K. Grebby, contains a number of excellent examples of business letters.

# CHAPTER XXI

## WORKMEN'S TIME CARDS: GATE CONTROL

### Workmen's Time Cards

ARE intended to ensure that every hour the workman is paid for is charged to some job ; not in the ledger, of course, but in the job sheet, which is the central document of the costing system.

There is, at present, a movement in India, to substitute weekly for monthly payments. We are going to assume that it will be successful, and that all wages will be paid on Saturday. The reader should not have much difficulty in modifying the system for monthly payments, if that should turn out to be necessary.

Unless the workman is leaving for good, he is never paid all that is owing to him up to the date of payment. A part of his wage is retained by the firm, partly to give it time to prepare pay sheets and partly to ensure that the workman will not leave without due notice. The money paid on Saturday, will, therefore, be all that is due up to Thursday evening. The cards will be collected then, and new ones will be issued on Friday morning. During Friday they should be carefully examined for :—

(*a*) Cases where excessive time is being spent on one job or one operation.

(*b*) Cases where the total of hours reported by the workman does not correspond to the total, reported from the gate, by the time-keeper.

The cards should then be sent to the costing department to have the hours spent on each job entered on its job sheet, and then to the accountant for preparation of the pay sheet. All this must be completed before the office closes on Friday, no matter how long it takes. The pay-sheet duly certified by the accountant should be on the manager's desk when he arrives on Saturday morning. After he has satisfied himself that it contains nothing that ought to be investigated, he may write a cheque for the total, and have the money brought from the bank by a trustworthy messenger, who, if he goes on foot, should be followed at a short distance by a sturdy fellow capable of protecting him. But it is a false economy not to provide a conveyance for the bank messenger. Every one in the works knows when the pay money comes, and violent robbery of pay messengers is a not infreqnent occurrence.

By two O' clock, or whenever it is that the works close, for the week end, the pay of each workman should be ready in a little tin box bearing his number. The manager should occasionally make a raid on these at the last moment and check a box or two at random. Otherwise some clever fellow may try substituting a five rupee note for a ten, and trust that his word will be taken against that of the workman.

The pay of each workman should be handed to him as he passes out, over a high barrier, or better, through a small window as railway tickets are sold. The timekeeper, as the man whose business it is to know every workman by sight, should be present. Arguments about the amount due should not be tolerated at the time. If a workman has any complaint to make, he must reserve it till every one else has been paid. At least five hundred workmen per hour should be paid by this method. As they are paid in their own time, there should be enough windows and enough help to complete the whole process within half an hour.

| Hours. | Job No. | Remarks. | Workman's No. |
|---|---|---|---|
| | | | Friday.<br>Saturday.<br>Monday.<br>Tuesday.<br>Wednesday.<br>Thursday. |
| | Works | Total. | Gate. |

Foreman's Signature..............................

The completed card should bear two identical totals, one on the left obtained by adding the times reported for different jobs; the other on the right added in the office after the card has been surrendered, by abstraction from the gate-keeper's report for the week. The back of the card may be similarly ruled in red and reserved for overtime.

## Gate Control

If the time fixed for beginning work in the morning is seven O' clock, all the workmen will present themselves at the gates. between five minutes to seven and seven, and the hundred or so who arrive breathless in the last minute will consider themselves greatly injured if every one is not marked present at the hour. It is also quite fatal to credit a man with being in time if he arrives a second after the whistle stops blowing.

The humane and reasonable employer will order his whistle to begin sounding at the hour and to go on for say two minutes. but no further concession can be given without starting on a slippery slope that will find every one coming half an hour late after a very few weeks.

The usual system, by which the arrival of several hundred workmen within five minutes is registered, is the brass check system. As the workmen pass, the time-keeper (usually at the same place where they are paid on Saturday), a numbered check about the size of a rupee is handed to each of them by the time-keeper. This they drop through a small slot a few steps further on. The brass checks hang in order on a board immediately behind the time-keeper, but inaccessible to the workmen. As soon as the whistle stops blowing, the time-keeper, by means of the checks, makes a written record of all who have been in time. No one has to be recorded as two or three minutes late, because any one appearing late receives no pay for that half day.

Occasionally, a workman, for sickness or some other reason, leaves before the end of the day, but the record of this presents no difficulty. Neither does the general departure at the end of the day, nor the coming and going of the few overtime worker. The time-keeper must be at the gate all day. It is a job for a pensioner too old for hard work but still trustworthy.

The clerks, drawing office staff, and foremen enjoy the doubtful privilege of being free from the attention of the time-keeper. They are not fined for being late, but neither are they paid for overtime.

This class of employee should be paid monthly by crossed cheque, and not in currency. It should be a condition of their employment that they maintain a current account in the same bank as the firm.

# CHAPTER XXII

## DEPRECIATION: THE THEORY OF OVERTIME: MACHINE CARDS

We will presently resume our organising trip through the works but before doing so it is necessary to turn aside for a few pages in order to establish one or two principles of fundamental importance, without a knowledge of which our methods could not be appreciated.

### Depreciation

This means, of course, the loss of value of plant and machinery through the lapse of time. It should be considered as made up of two parts.

(*a*) Depreciation due to wear and tear caused by use.
(*b*) Depreciation of obsolescence.

It is the latter that is most often overlooked. In the old song it was said :—

"The minstrel boy to the war has gone.
In the foremost ranks you'll find him.
With his father's sword girt to his side,
And his wild harp slung behind him."

Note the curious "internal" rhyme. But that is not the point. The point is, that if the minstrel boy ventured into the ranks of modern war, armed with nothing better than his father's sword, he would have no chance of ever becoming a minstrel man. His father's sword might be quite intact, and made of a steel the like of which is not produced in these degenerate days, but all that would avail him nothing. The days of the sword are over. Obsolescence depreciation had reduced its value to zero.

It took a hundred generations to make the sword obsolete, but it is our destiny to be born in an age of rapid material progress, which for the last century has become faster and faster. There is unhappily no sign of a corresponding spiritual renaissance, but that is another story. It may be said that quite half the machines being made to-day will never be worn out. It is not true that our ancestors knew the secret of better steel than we can produce. As far as wear and tear are concerned, modern materials surpass those of previous ages. But long before a machine is worn out there is a far more efficient one on the market. This is a fact very difficult to bring home to the young reader. The middle-aged person, when his attention is directed to the machines of his youth realises the truth at once. He quite understands that it is not only because it is worn out that he would attach no value to the bicycle his father was so proud of when that ridiculous machine was the last word of fashion.

A very small invention occasionally reduces the value of a whole workshop full of machinery by fifty per cent. Such an invention was the so-called "High Speed Steel," which grew to a remarkable efficiency between 1900 and 1910. In order to take full advantage of it, all machine tools, lathes, planers, drills, shapers, and millers had to be made with wider pulleys, to take a broader belt, and with stronger stiffer parts throughout. A workshop full of such machinery made before 1900 though quite unworn would hardly be worth its scrap price to-day. The engineer who embarked in business with it hoping to compete with up-to-date firms would be in the same position as the minstrel boy. There would be no chance of success.

The time it takes to reduce the value of any appliance to nothing, in this way, varies, of course, with the appliance. Certain forms of material wealth, even appreciate in value with time. Whatever the period may be, the engineer who understands his business allows for the loss and computes the added cost as follows :—

He divides one hundred by the number of years he thinks' will elapse before the machine is hopelessly old-fashioned. This quotient is 'n'. He then assumes that whether his machines are running or not, they are costing him (on this account) n per cent. of their prime cost per annum. For example :—

If a motor car costs originally Rs 12,000-0-0, it is quite safe to say that it will be quite out of date in ten years, even if not used and worn out in five, as it would be if used continually. If it is only hired out say once a month for a day, the cost to its owner of that day will be :—

| | Rs | a. | p. |
|---|---|---|---|
| Petrol ... ... ... | 20 | 0 | 0 |
| Driver's wage ... ... | 5 | 0 | 0 |
| Obsolescence ... ... | 100 | 0 | 0 |
| Total ... | 125 | 0 | 0 |

It would be quite wrong in this case to add an allowance for wear. The car will be as good as new when the ten years have expired : but no one will want to hire it then. He will prefer, probably, to travel by aeroplane. It will be as good an new, but worthless as an agent of competition. On the other hand :—

Suppose the owner hires it out every day. In that case he may neglect obsolescence depreciation altogether as the car will be quite worn out before it is noticeably old-fashioned. The cost to the owner each day is now :—

| | Rs | a | p. |
|---|---|---|---|
| Petrol ... ... ... | 20 | 0 | 0 |
| Driver's wage ... ... | 5 | 0 | 0 |
| Depreciation due to wear at 300 days per year ... ... | 8 | 0 | 0 |
| Total ... | 33 | 0 | 0 |

These are extreme cases of course. An actual one would be intermediate between them. Some allowance would have to be made for both forms of depreciation not forgetting that each tends to cancel the other. If a machine is seldom used, wear and tear is very small, but obsolescence proceeds at its full value year by year. If it is used continuously wear and tear is in proportion to the amount of use, but obsolescence may never develop enough to be taken into consideration. We have been waiting for the reader to ask us what asset of an engineering business it is that has a negative depreciation. Of course he has not a ghost of an idea. It is the site, provided it is well-chosen.

The simple-minded reader has probably also failed to notice that in computing the daily cost of the car in the above examples we have omitted one of the largest items. We thought he would. When the car is done for at the end of five or ten years, it will be not only the cost of the petrol, plus the chaffeur's wages, plus the Rupees twelve thousand which the car cost originally, that will be missing from the cash box of its owner. There will also be missing the five per cent. on Rs. 12,000 for five or ten years which might have been obtained quite safely but for this ill advised adventure in cars. The complete statement in the first case should have been :—

| | | Cost of car per day. | | |
|---|---|---|---|---|
| | | Rs. | a. | p. |
| Petrol ... | ... | 20 | 0 | 0 |
| Driver's wage ... | ... | 5 | 0 | 0 |
| Depreciation ... | ... | 100 | 0 | 0 |
| Interest on prime oost ... | ... | 50 | 0 | 0 |
| Total | ... | 175 | 0 | 0 |

And in the second case :—

| | | Cost of car per day. | | |
|---|---|---|---|---|
| Petrol ... ... | ... | 20 | 0 | 0 |
| Wages ... ... | ... | 5 | 0 | 0 |
| Depreciation ... | ... | 8 | 0 | 0 |
| Interest ... ... | ... | 2 | 0 | 0 |
| Total | ... | 35 | 0 | 0 |

It is very important that the reader should digest, and thoroughly understand these two statements One of them embodies an essential element of success in engineering enterprise, and the other explains many failures. The items of cost fall into two classes; those which continue whether the car is used or not, and those which don't. Interest on prime cost, together with obsolescence are night and day charges. The manager who, in addition to this ordinary day shift, runs a night shift as well, escapes them altogether in his night factory. The increase of wages, which he must pay for night work, is always much less than he gains.

On the other hand, any machine or any factory standing idle, is like an open vein from which the financial life of the business ebbs away; slowly perhaps, but without pause, night or day.

### Machine Cards

Just as every workman has a card on which his work is recorded, so every important machine should have its own card.

| Hours | Job No— | Large Planer | Rate |
|---|---|---|---|
| | | | Friday |
| | | | Saturday |
| | | | Monday |
| | | | Tuesday |
| | | | Wednesday |
| | | | Thursday |
| Foreman's Signature— | | | |

It should be handed in together with the workmen's cards on Thursday evening whether there are any entries or not. The "rate" (hourly cost of the machine) should be computed as follows;—

The cost of power is annas six per horse-power hour. (It may be much less, but this is a not unusual cost in India). Depreciation and interest on prime cost may be roughly averaged out as being together equal to fifteen per cent. per annum. The rate is thus given by :—

$$\text{Rs} = \frac{6 \text{ Power}}{16} + \frac{15 \text{ Prime Cost.}}{100 \text{ Hours worked per year.}}$$

If the machine cost Rupees thirty thousand, requires ten horse-power to drive it, and runs continuously for forty-eight hours on each of fifty weeks per year the rate is Rupees five, annas ten.

But this is too good to be true. Such a large machine is more likely to run for five than for fifty weeks per year. In that case the rate is Rupees twenty-two. annas eight.

The installation of such a machine to run only five weeks a year would probably be a mistake. It would be extremely difficult, if not impossible, to recover the cost of using it from the customer, for whose benefit it was used. It would almost certainly be run at a loss. There is no mistake in our calculations, ( there never is ), but it would be useless to explain them to the customer. He will be sure to regard Rupees one hundred and eighty for one day's use of the machine as an outrage, and refuse to pay it.

Another man who would have no hesitation in characterising even Rupees five, annas ten per hour as a swindle is the workman who manipulates the machine for a wage of annas four per hour. "Here" he would say, "Here am I sweating all day at this work, and that idle fellow who sits all day in his office with his hands in his pockets, actually has the nerve to ask twenty times as much as he gives me ". Why ! I haven't even seen him this week !"

In this case, also, explanations would be futile. A great deal of unnecessary unpleasantness will be saved by either printing the rate on the card in some simple cypher or by omitting it altogether.

Just as there are a number of coolies about the shop whose wages cannot be conveniently charged to any job except by the method of "Overhead Charges" to be explained later, so there are a number of small coolie machines for which it is not practicable to use cards. The grindstone, for instance, is a coolie machine. But every important machine, like every skilled workman, should have its own card.

# CHAPTER XXIII

## STORES, TOOL ROOM, RAW MATERIALS

THE stores, where odments such as bolts, nuts, jointing material, and a thousand and one other small articles are kept, is very often the most mismanaged department of the works. Because no great ability seems to be required in a store-keeper, he is very frequently regarded as subject to the orders of the heads of other departments and under divided authority his affairs become hopelessly confused.

The remedy is to give him autocratic power within his own domain. The store should be a separate enclosure, barred absolutely against every one else in the works, except the manager. The foreman of other departments should be specifically forbidden to enter the stores on any pretext whatever. It is usually they who do the mischief.

Small articles should be handed out over a counter. Where heavy articles have to be brought in or taken out, it must be done by coolies under the orders of the store-keeper, and not for that job under anyone else's orders. It must be clearly understood by everyone that his is the sole authority, and the sole responsibility inside the store. It this is done, the only qualities required of a store-keeper are honesty and regularity. We do not mean to imply that these are qualities to be despised, or that they are unworthy of a decent remuneration, but only that no remarkable ability is required.

Nothing should be issued from the store, except in return for a store requisition properly filled up by a responsible person whom the store-keeper knows to have authority to make such requisitions. It must be on the standard-form numbered and lettered, so that the person making the requisition can be traced after any lapse of time.

| | |
|---|---|
| Store Requisition No E7 | Store Requisition No E7 |
| Date...................... | Date...................... |
| Job No.................... | Job No.................... |
| Foreman's Initials. | Foreman's Signature. |

These requisitions are the store-keeper's "Vouchers". He must carefully keep them till his books have been audited for the year, and he must be able to justify every issue by producing the corresponding voucher.

**The Store-keeper's Books:**—The store-keeper should not be expected to keep books in the ordinary sense. On no account should he be allowed to keep a self-contained system independent of the general system in the office. It will only be a muddle, always in arears, and a source of perpetual annoyance

**The Stores Day Book** is a journal in which is recorded, immediately they occur, every issue and every receipt of goods.

ISSUES.

| Date. | Goods. | Quantity. | Requisition Number. | Job Number. |
|---|---|---|---|---|
| | | | | |

The receipts should be similarly recorded in a separate volume of the day book.

RECEIPTS.

| Date. | Goods. | Quantity. | Invoice Number. | From whom received. |
|---|---|---|---|---|
| | | | | |

Rupees, annas and pies should have no place in the store-keeper's books, nor in his dealings.

**The Stores Journal** is a fair copy of the day book. It is a standing order, that it must be completed for the day before the store-keeper's day's work is finished. If he has no time to do it before the works close for the day, he must stay late and do it.

The store's day-book must never leave the store. It must always be available for the store-keeper to enter his issues and receipts as they occur. The journal, which is a kind of messenger between the store and the office, must be in the former department all afternoon, and in the latter, all morning. No excuse is to be accepted from either, for keeping it beyond the allotted time, nor for failing to transcribe the information to or from it.

**The Stock Book** is a rearrangement in ledger form of the stores journal. The accounts are like ledger accounts, but under headings descriptive of articles instead of firms. Here is the stock book open at the folio for polished hexagonal nuts for bolts screwed to Whitworth Standard thread five-eighths of an inch in diameter :—

Nuts 5—8 Whit. Bright Hex.

Minimum Stock—One Gross.

| Receipts. | | | | Issues. | | |
|---|---|---|---|---|---|---|
| Date. | Number, weight or quantity. | Page in day-book. | Stock. | Date. | Number, weight or quantity. | Page in day book. |
| | | | | | | |

This book like the journal must be posted every day. The store-keeper or his clerk should sit down to it towards the evening when the stores are usually slack, with the journal on one hand, the stock-book on the other, and the day-book in the middle. In the first column on the right-hand page should be entered every day, his balance, which should correspond to the quantity of the article in stock.

It is usual in many workshops to have an annual stock-taking. Everything is taken out of its box or other receptacle, counted, and the result compared with the records The store cannot be closed for this purpose without serious inconvenience to the works. Accordingly it is kept open and as many new mistakes are made during that time as during all the rest of the year.

Stock taking should be continuous throughout the year as described above. The manager, when he has nothing particular to do, (as we have suggested already, that should be his usual condition) should descend on the store once or twice a month without warning, and check over one or two items. If he should happen to open the stock book at the page described above, he should have the box turned out, and stock of the nuts counted in his presence. He should also compare the stock-book and the day-book for that particular item for a month past.

If the correspondence is not exact, he should get a new store-keeper. No impossibilities are required from that official. The little that is required should be exactly performed.

## Visible Stock

All stocks should be either on open shelves well-lighted from behind, or in glass fronted almirahs, so that they can be plainly seen. Glass is expensive, but expanded metal is cheap, strong and durable. It should be used extensively in making the furniture of the store. The roll top desk, and the closed wooden cupboard are always hives of disorder.

## The Tool Room

In small jobbing shops the tool room and the store are usually combined. In that case, there is not much to be said of the tool room that was not said of the store. The function of the tool room, under these circumstances, is the safe custody of the tools used only occasionally. In certain cases, such as files, the tools are issued as consumable stores, and are not returned to the store. The foreman, in requisitioning a new file, should write on his order "no return". If that is not done, the store-keeper should not issue the new file except in return for the old one which can be recut The foreman should not requisition a new file except for a big job Outsize spanners, taps, stocks and dies and the like are usually lent by the store-keeper to the workman who requires them. He may record the issue in a tool book, or the workmen may be given a few brass tokens stamped with their numbers which can be deposited as pledges for the tools they borrow. As soon as it becomes financially possible, the tool room should be separated, and combined with a tool and gauge-making workshop.

## Castings and Forgings

It is probably best to have a material charge of so much per hundredweight, including for the former, the cost of patterns. The cost of complex casting is much greater per hundredweight than the cost of simple one is, but the workmen's time cards will look after this difference. The weights of forgings and castings on any job may be reported directly to the casting department by the foremen. A periodic comparison of the total weight of castings with the total weight of pig iron, scrap, and wood used in the pattern shop, should be sufficient to prevent undue waste. It is not practicable to take these heavy and bulky articles through the store.

# CHAPTER XXIV

## STORE-KEEPING

THE following notes on store-keeping as actually followed in some of the best industrial organisations in India will be very instructive.

The Stores Department plays a very important part in the organisation of an industrial concern. *Its chief function* is to raise the general efficiency of production and therefore the factory by supplying all its material needs as demand occurs and at the minimum cost. In fact the stores is one of the main arteries of the factory feeding it as it were with its life-blood, namely, material.

The organisation of a modern factory may be illustrated as follows.

**Chart 1.**

STORES.

| | | | |
|---|---|---|---|
| Purchasing Section. | Receiving Section. | Storing and Issuing Section. | Accounting Section. |

The Purchasing Section is the most important of all as it is this section, which is primarily responsible for the existence of the stock in the stores and its value with its ultimate effect on the cost of the manufactured article in the factory.

**Purchasing.**

Purchasing is an art, the technique of which as in any other technique can be summed up in a few words as the ability to find sources and material so as to secure for the industry the greatest ultimate value

When one realises fully the significance of the fact that stores costs money but unlike money bears no interest and on the contrary is liable to certain risks, obsolence, fire, explosion, pilfering depreciation by rent hardening, deterioration, etc., it is so obvious that great care has to be devoted to the purchase of stores and to keeping the stock at a minimum compatible with safety.

In purchasing, **the main points** to note are :—

**1. Purchasing with due reference to stocks.**

Stocks of material on hand should always be considered before ordering fresh stocks

**2. Purchasing goods of new types and designs.**

When goods of new types or desings are placed on the market to replace existing types, the existing stocks should be exhausted first before ordering new goods.

**3. Surplus and obsolete stock.**

Wherever possible, surplus and obsolete stocks should be issued from stores as substitutes instead of purchasing the required stocks.

**4. Cheap material.**

The cheapest material is that which is the most economical The lowest price material is not the cheapest in the long run.

**5. Quantity buying.**

It is uneconomical to buy certain articles frequently in small quantities. It is therefore necessary to estimate the requirements carefully and to buy the same possibly in large quantities with the resultant benefit in price.

Examples : Carbon Brushes, Bolts and Nuts, etc.

**6. Seasonable purchasing.**

Such items as asphalt, timber, etc., can be bought more economically during certain seasons and therefore the purchase of such commodities should be made during the season as their prices naturally soar up out of season.

**7. Watching the market.**

Prices of materials such as copper, brass, tin, etc , fluctuate very often. It is, therefore, necessary to watch these fluctuations so as to buy when prices go down to a minimum.

*N. B.*—The stores should, however, not be over-stocked even though the prices may have fallen to a very considerable degree when the saving in price will not be sufficient to counterbalance the loss of interest on the money spent on the idle stock.

### 8. Minimum Stocks.

The stores should be stocked with minimum quantities just sufficient to provide for emergencies such as delay in deliveries of material to stores, rush of work in the factory, etc.

Normally the minimum stock will practically be at a stand-still, there being a constant flow of material into the stores in the same proportion as the flow of issues from the stores into the factory.

### 9. Direct Purchase.

Every effort should be made to purchase directly from the manufacturers or their agents. Dealing with middlemen always costs more and is unsatisfactory.

### 10. Maintaining the Firm's reputation.

This is a very important factor. The purchasing department of the firm must always create a good name for itself in the market by way of fair dealing, prompt payments, courtesy, etc , as it always results in good business relations.

## Method of Purchasing.

Purchases may be made in one of the following manners :—

1. Buying material from the local market either :—

(*a*) Directly from the merchant without reference to any other merchants, or

(*b*) On the *casual tender system*, namely, quotations for an article or a quantity of articles are obtained from a number of merchants. The lowest quotation or tender is usually accepted provided quality is up to standard.

(*c*) On the *Contract Tender System* which only differs from the previous system in as much as the tenders or quotations are invited at the beginning of the year for certain standard materials which are required during the course of the year. The merchant whose tender is accepted is under contract to supply the articles during the course in certain fixed quantities or as required at the price quoted in the tender at the beginning of the year.

2. Buying material from merchants outside the town of manufacture similarly as in 1 (*a*), (*b*) or (*c*).

3. Buying material from abroad similarly as in 1 (*a*), (*b*) or (*c*).

## Reasons for Purchasing.

The main reasons for making purchases of stores are :—

### 1. Standard material.

The factory may be manufacturing standard articles for which standard material is required to be stocked. The production in a factory of good organisation is usually uniform and the stores having a knowledge of the quantities required, arrange for a constant flow of such material in the stores.

This is most economically done on the *Contract Tender System* supplemented by Casual Tender System in case of rush of work.

### 2. Purchase Requisition.

For certain material not normally stocked in the stores, a purchase requisition is made on which is entered description and quantity of material required. This purchase requisition may be made by any of the following :—

1. Stores Issues Clerk in case of stock of certain standard material having fallen below the minimum requirements.
2. Factory Superintendent for special work.
3. A Foreman for special work
4. Heads of Departments for special work.

## Forms used by Purchasing Section.

### 1. Purchase Requisition.

This has already been referred to. It should be made in duplicate, original being sent to Purchasing

Department where it is filed after purchase order is made. Duplicate copy remains in the department in which it originated.

It should bear a number, be properly dated, show the department in which it originated, quantity and description of material required and a space for recording the purchase order number.

**2. Casual Tender Form.**

This is also prepared in duplicate, original being sent to the merchant, duplicate being kept in the Purchasing Section.

It should specify the kind of material, quantities required, date and period of such material, last date of submitting tender, bear a tender number and have columns for rates, period of delivery and remarks. On the reverse are set out conditions of tender and supply of stores. The tender forms with details filled in by the merchants are returned to the stores before the date of expiry.

**3. Contract Tender Schedule.**

This is a printed schedule drawn up of certain standard material with the quantities that are expected to be used during the course of the year. At the beginning of the year copies of this schedule are circulated to the merchants and their tenders are invited for all or part of the material. The conditions of tender and the quantities to be supplied at a time are also given in this schedule.

**4 Small Inquiries Form.**

This form is almost similar to the Casual Tender Form but smaller in size being used for inviting quotations from merchants for small supplies of material.

Like the Casual Tender Form 1 copy is kept by the Purchasing Section for record.

**5. Purchase Order Form.**

This is the form used to order goods. It specifies the quantities' description, rate and date of delivery and is given a number to be afterwards quoted in the merchants' Invoice and Challan and any correspondence that might occur. It is made out in triplicate. The original is sent to the merchant. The second and last copy being kept in the Purchasing Section. To the second copy is attached another form which is utilised by the Receiving Section to record the receipt of materials. giving details of date of receipt, quantity received, Bill number, Stock Ledger Folio and stock account chargeable, the form being forwarded with the Invoice to the accountant for payment.

The form in question is usually known MATERIAL RECEIVED REPORT FORM.

**6. Indent Form.**

This is utilised when goods are ordered from abroad and is addressed to the London Agent of the Company through whom the goods are ordered. It gives all the details as in the Purchase Order and in addition gives details of last Indent received for similar material.

**7.** Forms for recording date and information of past purchases for comparison of prices. In the Company's Stores there is a book where the details of all purchases are entered in a classified form for ready reference.

*N. B.*—It is after collecting and filing data and information of sources of supply. past purchases, prices and quotations, etc., in a well-organised manner that purchasing can be economically done on the lines already referred to.

## Main Divisions of Purchasing Section

There are really two main divisions of work connected with purchasing, these being .—

**1. Information.**

(*a*) Obtaining information as to sources of supply.

(*b*) Recording data of past purchases.

(*c*) Recording prices and quotations.

(*d*) Maximum and minimum quantities and future needs.

**2. Purchases.**

(*a*) Work connected with Purchase Requisition.
(*b*) Invitation of Tenders (Annual and Casual).
(*c*) Obtaining quotations for small purchases.
(*d*) Preparing Indents, placing orders and following up.

## Receiving Section.

The function of the Receiving Section starts on arrival of the goods which have been ordered.

The most important points which need the attention of this section are :—

(1) Quality of material received.

(2) Quantity, weight and size of material.

The work of this section falls under four main divisions :—

1. **Inspection** which includes——

(*a*) Inspection of material on arrival for ascertaining quantity, weight and size of material supplied.
(*b*) Making physical tests and chemical, if necessary, to ascertain the quality of material supplied.
(*c*) Rejection of excess quantities or those incorrect in weight or size or inferior in quality.
(*d*) Carrying out joint survey of goods with a representative of the Insurance firm for breakages, etc., during transit for goods that are insured.

*N. B.*--A technical person is usually deputed to report regarding the qualities of the goods, the rest of the inspection being carried out by non-technical persons.

(*e*) Sending acknowledgment or giving a receipt to the suppliers for the goods received.

2. **Invoices** which provides for—

(*a*) Recording and checking details of Invoice with those in the Purchase Order.

(*b*) Checking prices, classifying, etc.
(*c*) Approving and passing Invoices to Accountant for payment.

### 3. Posting in Stock Ledgers and Bin Cards.

Before the Invoice together with the material received Report Form is forwarded to the Accountant, the quantities of material received are posted on the Bin Cards and the quantities and prices on the Stock Ledgers. Both Bin Cards and Stock Ledgers are kept by the Accounts Section of the Stores.

### 4. Transportation.

As soon as the material is received and checked, it is forwarded to the various sub-stores where the material is required. The arrangement regarding the transport and delivery of the material to the sub-stores is done by the Receiving Department.

### Forms used by the Receiving Section

1. *Material Received Report Form.*

   This has already been referred to in connection with the Purchase Order Form.

2. *Material Arrival Report Form.*

   This is a form which is circularized to Heads of the different Departments informing them of the quantity of the material arrived, the cost delivered to stores (actual cost plus other charges such as Dock Dues, Duty paid, transportation, etc.) and the time taken for delivery. It ultimately comes back to the Chief Store-keeper to be filed.

3. *Receipt to be granted to the supplier.*

   This is merely a form used to give a receipt to the supplier on acceptance of the material. It furnishes the number, quantity and description of the material received and accepted. A carbon copy is kept for record.

4. *Material Despatch Form.*

This form accompanies the material which is forwarded to a department or a sub-stores. It is made out in triplicate. The original and the second copy being forwarded to the acceptor who signs the original and returns it to the Receiving Section. The third copy (carbon copy) remains in the Receiving Section for record.

*Correspondence with Insurance Company.*

If a joint survey of goods is required on account of breakages, the Surveyors are informed by letter.

Having obtained a certificate from the Surveyors giving details of the breakages that have occurred during transit, it is forwarded together with the claim to the Insurance Company.

It may be remarked here that it is usual to insure those goods that are ordered from aboard only.

## Storing and Issuing Section

After adequate provision has been made for purchasing material, receiving and examining them, there is the problem of storing them for varying periods.

The proper storage of materials deserves to receive as much attention as purchasing them, as a loosely kept store-room without a proper system is one of the most fruitful causes of losses.

In a well-organised and systematized stores system there are six main points to note :—

1. The receipt of materials and supplies into stores and their accurate recording.
2. The storing is convenient and safe places and receptacle and location of stores.
3. Protection of stores and tidyness.
4. The issuing of materials and receipt of materials taken in excess from the stores or old material returned to stores.

5. Physical Inventory.
6. Replacement of Depleted Stock.
1. *Receiving Materials and Supplies.*

The store-keeper in charge of the particular sub-stores or Central Stores in receiving the material forwarded to his stores (through the Receiving Section) should examine them in respect of the description, quantity and size as given in the Despatch Form, the original of which is signed and returned to the Receiving Section of the goods which are found in order. The duplicate copy of the Despatch Form is filed for reference.

Following this comes the work of posting the quantities in Bin Cards in respect of each material received.

2. *Storage.*

The proper storage of materials is of equal importance to receiving and delivering them. There are several things to be considered. Just as a thousand rupees would be securely locked up in a Cash Drawer, so also there may be a thousand rupees of material which should be secured from theft or a thousand rupees of rubber which must not be allowed to deteriorate.

It is not possible to give a description that would fit the needs of every industry but generally the stores should be equipped with racks, shelves, bins, drawers to suit the nature of the materials and should be like a modern city possessing :—

(*a*) Broad avenue for traffic.
(*b*) Numbered rack and bin.
(*c*) Aisle of convenient width.
(*d*) Well-lit and ventilated.
(*e*) Protected from fire
(*f*) One point of ingress.

3. (*a*) *Principle of storage.*

The work of storing is usually carried out on certain well-defined principles.

(*a*) One storage place, bin or rack for each item.

(*b*) Materials of a similar kind should be grouped together, such as bolts, nuts and screws or oil and greases or electrical meter and spares or tools, etc. This grouping is a source of help both in issuing and taking an inventory.

(*c*) Arrange items for maximum facility in taking inventory, namely, stack the materials, each stack representing a certain number of articles.

(*d*) Provide for turn-over of stock, namely, prevent an accumulation of old stock. The turn-over of stock can be secured by :—

(1) Single or Double Binning.

(2) Stacking or piling or double stacking similar to double binning, but in one compartment of bin.

(*e*) The articles should be stored and issued in standard lots as far as possible.

(*f*) Storage space should be utilized to its fullest extent.

2. (*b*) *Racks and Bins.*

The size of the racks or bins will depend upon the size of material and quantity to be stored. If a large stock of certain material is required to be maintained, it should be kept in two bins. The usual bin holding a small but known quantity and the balance in the other bin known as "*overflow bin*" from which material is transferred in standard lots to the usual bin. There should be no issues from the " Overflow Bin."

The overflow bin facilitates the taking of inventory and turn-over of stock.

*Double binning* is necessary for goods that are liable to deteriorate with age, and is the division of each bin into halves, one half for receipt and the other half for issue, reversing the process where issues are exhausted.

It enforces a turn-over of goods and aids physical inventory.

*2. (c) Location of Stores.*

The stores should be located as near to the site of the works or close to the Factory as possible. When an element of distance is inserted between the factory or works and the stores, to that extent fixed charges are piled up in the form of delay, uncertainty and loss of time and transport charges.

In large plants it will probably be necessary to have several store-rooms located near departments where material will be used. This may entail some duplication of stores, but will be fully compensated by the savings in men's time in obtaining stores.

*3. (a) Protection of Stores.*

The stores require protection from fire and explosion, rust, deterioration, dust and pilferring.

The usual aids to protection are :—

(1) Sprinkler system for fire and isolated position for inflammable stores such as oil, paint, petrol, kerosene oil, etc.

(2) To prevent rust and deterioration of material it should be vaselined and efficient turn-over by double binning should be adopted.

(3) Location of stores should be such that much dust should not have access to it.

(4) Pilferring should be avoided by locked bins, and keeping the small and costly material as near to the issuing clerk, as possible.

*3. (b) Tidyness.*

If there is a lack of orderliness and tidyness, there is a serious loss of time and material :—

(1) Keep in stock nothing that is required for the efficient working of the different departments.

(2) Obsolete and surplus stores that is not likely to be utilised in the near future should be disposed of as early as possible. If it deteriorates quickly all the more reason to dispose of it whilst it has a market value. Although such stores may have to be repurchased, yet there will be a gain for the extra

cost of storage and handling will be avoided, risks will be reduced and money will not be locked up unnecessarily.

(3) Such materials that are issued frequently should be stacked and kept as near to the issuing clerk, as possible.

*4. Delivery from Stores.*

Not less important than the receiving and storing is the delivery of stores.

Materials are drawn from the stores by means of Requisition Forms, which is a request on the store-keeper to issue certain material with description, size, quantity and the work-order number being specified.

Only certain authorized persons are empowered to sign Requisitions. They are the Foremen and the Heads of the Departments. In every case, however, the departmental head is required to sign every Requisition referring to his department.

The main points to note in issuing material is to see that:—

(1) The description and quantity, weight and order-number is clearly specified on the Requisition.

(2) The date and the initial of the foreman is given.

After delivering the material the bin cards should be posted with the quantities delivered on the issue-side.

When material is taken in excess for a work or old material is recovered from a work, it is returned to the stores with a *Credit Note*, which is similar to a *Requisition*, but differentiated by a Red Line across it to facilitate sorting.

After such materials are received, the bin cards are posted with the quantities received on the receipt side. The points referring to a Requisition is also necessary of application to a Credit Note, also in the accounts section of the stores.

In addition the following points should be noted:—

(1) No credit should be given for such material for which there can be no possibility of use for several years.

(2) If the material can, however, be reconditioned at a probably lower cost than the new article, then it is advisable to give a credit.

(3) All material, whether non-serviceable, scrap, etc., should be accepted, although no credits are given and placed in separate scrap bin or places.

The main aim should be to avoid loading the stores with obsolete and non-serviceable material and thereby incurring unnecessary expenses in storing and handl-ng it.

5. *Physical Inventory.*

Just as a cashier's accounts of actual money in his cash-box should balance with that shown in his books, so also should the store-keeper's actual stock balance with that shown in his bin cards or the stock ledgers in the accounts section.

An annual or half-yearly stock-taking is quite unsatisfactory, as the losses due to various causes cannot be easily traced.

Certain losses in the stores are unavoidable and others are preventable. They are :—

(1) Losses due to breakages—preventable.
(2) Losses due to deterioration or evaporation—unavoidable.
(3) Losses due to pilferage—preventable.
(4) Losses due to the breaking up of bulk materials for issue in small lots—unavoidable but to a certain extent preventable.
(5) Losses due to obsolence—unavoidable.

It is with the preventable losses that the store-keeper is most concerned with and the necessity of a proper control cannot, therefore, be over-estimated.

This is effected by :—

(*a*) *Perpetual inventory*, namely, a number of items are checked each day by the store-keeper and the actual quantities compared with the bin cards. The information is also forwarded to the accounts section usually on a standard form where the results are compared with the stock shown in the stock ledgers. By this means in three months a physical inventory is taken of all items. This system is continuous or perpetual, so that each item is checked four times in a year.

(*b*) *Annual inventory*. by which an actual inventory is taken of all the items at one time usually at the end of the financial year by the accounts section.

6. *Replacement of Depleted Stocks.*

From the bin cards and stock ledgers the maximum and minimum quantities required to be stocked can be known. These quantities are usually fixed in consumption with the purchasing section and posted in the bin cards.

When the stock of an item falls below the minimum, the store-keeper makes out a purchase requisition already referred to. The purchasing section arrange to supply the required material to replace the depleted stock.

## Forms used in connection with storing and issuing of material.

1. *Purchase requisition* to replace depleted stock or order some material required for some special works. This form has been described under purchasing.

2. *Bin card* is a record card used by the store-keeper of all items of materials and goods kept in the stores and in addition provides him with ready information as to the nature of the contents of any particular bin.

The essential features of the card are columns suitably ruled to admit the following details :—

(*a*) Description of the article.
(*b*) Bin number.
(*c*) Maximum and minimum quantities and the date of the last consignment received.
(*d*) Date, requisition number and the quantities issued.
(*e*) Date, credit note number and the quantities received,
(*f*) Balance of stock

The bin cards are usually filed in drawers in order of bin number or material near the place where the store-keeper or issuing clerk sits to avoid the necessity of walking a distance to each bin to find out whether the material required is in stock.

3. *Requisition.*

This is a form issued by the foreman in triplicate, the third (carbon) copy remarking with himself for record and original and second copy forwarded to the stores.

It gives the following details :—

(1) Number and date of requisition.
(2) Description, quantity, size and weight of material required.
(3) Columns for the rates and the total money value of each item delivered.
(4) Order number of work to which the material is to be charged.
(5) Initials of the foreman and the head of the department.
(6) Columnar spaces for the initials of the clerks who work out the rates and the amounts in the account section.

After the material is delivered, bin cards posted, the original requisition is forwarded usually at the end of the day to the accounts section. The second copy is kept in the stores for record.

## Material Credit Note

This form is similar to the requisition giving identical details but having an additional column for remarks as to whether material returned is serviceable or non-serviceable. It has also a red line across it to readily distinguish it from the requisition. It is also made out in triplicate, the distribution of the copies being similar to the requisition.

## Perpetual Inventory Forms

These would be quite simple in character showing date when inventory taken, bin number and description of material, quantity found as compared to that in the bin card and initials of the store-keeper.

## Scrap Material Forms

Some sort of form would be necessary to inform the purchasing section regarding the quantities of scrap material in stock. The purchasing section would then arrange regarding the sale of scrap material as well as obsolete and non-serviceable material.

## Accounts Section

The three main functions of this section are :—

1. To record and keep the accounts of the issues and deliveries of stores both in respect of quantities and prices in an efficient and accurate manner.

2. To submit to the financial accountant the total balance of stock in money every month, the total receipts and total issues.

3. To submit to the costing department the material cost, both direct and indirect.

1. The actual working of this section starts with the receipt of materials which may be due to one of the following sources :—

(*a*) Material arriving from abroad in compliance with the indents sent by the purchasing section.

(*b*) Material purchased from the local market by means of purchase orders.

(*c*) Manufactured articles from the factory made sale or to be re-used on other works. These articles are manufactured through the medium of work orders.

(*d*) Material taken in excess and returned or old material recovered from a work and returned.

The procedure and the forms used in purchasing and receiving material has already been described.

When the material is received, information of which is received in the accounts section through the medium of the invoice in the case of an indent, challan in the case of a purchase order work completion report in the case of a manufactured article and credit note (original copy) in the case of return of material, the quantities received together with the prices are recorded on a *Stock Ledger* (*Form*), which is the most important record in the accounts section as well as in the whole of the stores.

## Stock Ledger

The ruling of a stock ledger form is such that it is divided up into 2 parts, receipts and issues.

(1) On the receipt side is recorded the date of receipt, indent or purchase order number, receipt number, quantity received, rate and amount.

(2) On the issues side is recorded the date of issue, account chargeable (capital or revenue), total issues, rate and amount.

It is absolutely essential that the entries of articles, both in and out of stores, be correctly and accurately recorded as the stock ledger serves the same purpose and is as important as the cash-book with the cashier.

It should be mentioned that the stock ledger should be posted daily with the daily total issues and receipts. An abstract of quantities only is usually made by the store-keeper or stores issue clerk regarding the material issued and received in the stores This together with the requisitions and credit notes (original copies) is forwarded to the accounts section at the end of the day or the following morning.

This abstract is checked with the requisitions and credit notes, the prices and amounts extended after obtaining the rates from the stock ledgers, and then finally, entries of total (daily) quantities, rate and amounts are made in the stock ledgers.

The accounts section also compares the balances in their stock ledger with the actual balances in the bins taken by the store-keeper for the 'perpetual inventory'.

**2.** In all undertakings the accounts are closed at the end of the month to ascertain the financial position. Since the stores is a part of the undertaking, the cost of the stores received and issued during the month, and the balance remaining must be submitted to the financial accountant. *This is second function which the accounts section has to perform.*

This is accomplished by preparing a summary called the 'Material Issue Summary' showing the cost of issues during the month under each group of materials and under each item of article.

A similar summary '*Material Credit Summary*' is prepared for the materials returned into stores.

As for the materials that are purchased and come into the stores, the accountant enters the cost of such material in his books at the time of passing the invoices for payment.

The balance of the cost of stores in the financial accountant's books should, therefore, be the same as the total balance of stores in the stock ledgers at the end of the month.

3. *The third function of the accounts section* is to assist the costing department in the collection of one element of cost, namely, material (direct and indirect).

This part of the work has already been referred in the Notes on Costing and the procedure of collecting the material cost of a Word Order or a Standing Order may be summarized as follows :—

(1) Material is drawn from the stores by means of a requisition in duplicate, the original being forwarded to the accounts section. The accounts section extends the rates and the amounts. On each of these requisitions the Word Order or Standing Order number being mentioned.

(2) At the end of the month after the Stock Ledgers are closed and the *Material Issue and Credit Summaries* are drawn up, the requisitions are sorted under each Word Order or Standing Order Number.

The total of material cost of each requisition is then entered on a *Material Ledger Sheet,* which is a summary of the cost of the materials delivered against each Work Order or Standing Order Number.

This collects one element of cost, namely, the material cost (direct or indirect).

(3) The totals of the cost of material of each Material Ledger Sheet referring to a Work Order or Standing Order are then entered in another summary called '*Material Ledger Summary.*'

If the store-keeping and accounting has been correct, the grand total of the Material Ledger Summary should be equal to the grand total shown in the Material Issue Summary.

Similarly, a separate summary similar to the '*Material Credit Summary*' but showing the cost of the material credited to each work or standing is prepared. The grand total of this summary should be equal to the material credit summary.

(4) We thus have on one side the procedure of collecting the total cost of stores issued and credited and on the other side the cost of the material delivered or credited to each work or standing order.

The summaries together with the material ledger sheets, requisitions and credit notes are then forwarded to the cost department where this element of cost is posted in the cost ledger together with the other elements of cost, namely, wages and overhead charges.

The cost department after making entries in the cost ledger accumulate the totals of material cost under each account and furnish them to the accountant who posts them in his books, thus closing the financial accounts.

## Conclusion

As every department requires a directing agent usually known as superintendent of the department so also the four sections of the stores must be directed and guided by one authority. This authority is usually vested in one person called the "chief store-keeper."

In the organisation of the stores it will have been noticed that the work of each section is intimately interlinked with that of the other and a harmonious relation between the sections is absolutely necessary to ensure efficient working of the stores. This can always be successfully brought about by all the four sections working under one authority

Before closing the subject a word or two about maximum and minimum quantities to be kept in the stores will not be out of place.

**The maximum stock** is dependent upon the rate of use of the article, and also upon the economical quantity to buy at one time. On account of the latter consideration it is generally as " **Re-order quantity** ".

The maximum quantity depends upon the quantity required to meet the normal demand of the factory and the longest period in which the re-order quantity is being obtained.

Too much consideration cannot be paid to the re-order and minimum quantities as the one case over-stocking will entail loss of interest charges on unnecessary idle stock and the other stores charges and risks. In the other case stock having fallen below the minimum and ultimately exhausted will entail stoppage of work in the factory with all its attendant charges of idle men, machines and overhead charges.

It is, therefore, primarily the responsibility of the chief store-keeper to fill these quantities in consultation with the purchasing and store section and the factory superintendent or departmental heads.

The whole procedure of store-keeping may be illustrated by Chart I, where the administration is seen to be controlled by the chief store-keeper, the rest of the work being apportioned to the different sections under him.

*Diagram showing details of work of each section of the Stores Department.*

Chart I.

| | | |
|---|---|---|
| Purchasing. | Information. | Obtaining information regarding markets.<br>Tabulate records of prices and quotations.<br>Have correct specifications and keep data of all maerials. |

| | | | |
|---|---|---|---|
| Chief Store-keeper. Administration.<br>1. Operate the Department economically.<br>2. Render efficient service.<br>3. Perfect the organisation and system.<br>4. Attend personally to the fixing of the minimum and maximum stocks to be carried.<br>5. See that tidyness prevails.<br>6. See that obsolete and unserviceable stock is disposed off.<br>7. See that there is harmonious working between different sections. | Purchasing. | Purchases. | Regulate the purchasing.<br>Buy at lowest prices.<br>Obtain highest quality for prices paid.<br>Order economical quantities. |
| | Receiving. | Inspection. | Articles delivered are ones actually ordered.<br>Quantities and quality are correct.<br>Specifications are complied with. |
| | | Invoices. | Have invoices properly and quickly checked.<br>Insure security against over-payments<br>See that cash discounts are not lost by delay. |
| | | Posting. | Post correctly in Stock Ledgers & Bin Cards. |
| | | Transporting. | Transport material to the required sub-stores as early as possible. |
| | Storage. | Storage. | Keep investment in stores at a minimum.<br>Keep the material properly stores in bins, racks, etc.<br>Arrange stores systematically. |

| | | |
|---|---|---|
| Stores. | Protection. | Keep material secure from pilfering, deterioration, fire, etc. |
| | Issues & Receipts | Issue material and receive material on proper authorised forms.<br>Post Bin Cards. |
| | Perpetual Inventory. | Should be maintained. |
| Accounts. | Replacement of depleted stock. | Maintain active stocks, at the minimum consistent with safety.<br>Do not over-stock.<br>Do not allow stocks to fall below minimum. |

Requisitions and Credit Notes should be priced, and totals extended daily. Do not allow such work to accumulate to the end of the month. Stock Ledgers should be posted correctly. Balances should be compared with figures obtained by perpetual inventory. Cost Material Ledger sheets and summaries should be completed as early as possible and all possible assistance should be given to cost department.

# CHAPTER XXV

## OVERHEAD CHARGES, COST SUMMARY, SELLING PRICE.

OVERHEAD **charges** are all those expenses of running a shop which cannot reasonably be charged to any particular job. They include :—

(*a*) Rent, or interest on capital cost of site, buildings, and machinery, cost of repairs, and depreciation, excluding the allowances already made on the machine cards.

(*b*) Salaries of managing staff, clerical staff, and drawing office staff. Wages of general labourers (coolies).

(*c*) Cost of power, light, water, and insurance.

The list is not given as exhaustive, but to indicate the nature of an overhead charge.

Having partly calculated, and partly estimated the overhead charge for any period (say a year), our problem is to divide it fairly, and record a share of it as an addition to the cost of every job done during that period. We may as well admit at once that no very satisfactory system of doing this has been invented so far. We will notice and comment on two plans.

A fixed percentage may be added to the costs already noticed. That is to say, the overhead cost of any job is assumed to be the same percentage of other costs of that job, as overhead charges for a whole year are of all other costs for a whole year.

The alternative plan is to calculate 'q,' which is the annual overhead total divided by the total number of workman hours per annum. The overhead charge on any particular job is then made equal to the product of 'q' and the number of workman hours on that job.

Both these plans achieve what of course any reasonable plan must do, the charging of all overhead costs to the firm's customers, but both can be shown to be ridiculous in certain extreme cases. On the whole, we condemn the first plan reasonable though it may seem at first sight. If the reader will consider again the short list of overhead charges given above, he will perceive that most of them are functions of time. They would not be greatly changed if every job was made of gold, brass, or even of wood. It is not often that an engineer has to work in gold, but there are great differences in the costs of his materials, and also in the time taken to work them up. Now, if we assume the overhead cost to be a function of time only, which if not exactly true is nearly so, then we must also conclude that the overhead charge on any job should be proportional to the time spent on it, and not at all to the cost of its materials. This is the second plan, which is accordingly recommended.

The quantity 'q' must be carefully worked out in each case, but for the sake of the example immediately following we will assume that the total annual overhead costs divided by the total number of hours worked for a whole year by all the workmen comes to the same as the wage earned by the average workman in one hour; that is to say, we will assume that 'q' is four annas. It is quite usual to assume an average workman and his wage for the purpose of calculating costs which remains the same for years regardless of temporary market fluctuations.

## Cost Sheet

| Job No............ Completed......Date | | Pumpuplex 4" diameter 6" stroke 1000 gallons per hour |
|---|---|---|
| Workman hours ... | 400 ... | 100 0 0 |
| Castings (Iron) ... | 3 Cwt. ... | 36 0 0 |
| Castings (Brass) ... | 5 lbs. ... | 5 0 0 |
| Forgings ... | 0·5 Cwt. ... | 12 0 0 |
| Jointings and Packings... | ... | 10 0 0 |
| Bolts, nuts, and washers | ... | 20 0 0 |
| Planer ... ... | 5 hours ... | 15 0 0 |
| Lathe ... ... | 8 hours ... | 24 0 0 |
| Packing for despatch ... | ... | 15 0 0 |
| Overhead charge ... | 400 hours ... | 100 0 0 |
| Total exclusive of freight | | Rs. 337-0-0 |

Few details are given, as we wish to illustrate a principle, rather than to give a typical cost sheet which might obscure it in a multiplicity of items. Every job passing through the shop should leave such a record behind it. Until many such exist, accurate estimates will be impossible. With them the task of estimating will be increasingly simple as time goes on.

## Selling Price.

We come now to a very difficult passage. It is our duty as teachers to give a clear lead to our students, and unhappily, in this crisis, whatever lead we do give is bound to scandalize a large body of respectable opinion. We will not shirk on duty in the end, but we will first hear what the opposition has to say. It will please them to be allowed in the body of the text for one instead of being kept in the appendix, and it will do no harm as we will take care to expose their fallacies before we dismiss them.

(A) "You have very carefully taken account of everything this pump has cost you. You have included a fair recompense in wages for everyone that has helped to make it. You have allowed a fair interest to the capitalist who provided the money for your site, buildings and machinery. By your allowance for depreciation you have even taken care that the capital itself shall not diminish. All these charges together come to rupees three hundred and thirty seven. If you take a pie more than that you are a thief. The fact that the market price of exactly similar pumps is rupees one thousand is irrelevant. Unearned money is stolen money."

It is impossible not to respect our friend 'A.' He may not be a business man or a man of the world, but he has a clear idea of the difference between right and wrong, and he asserts it like a man.

(B) "If the authors know anything about economics, they would recognize the difference between rupees three hundred and thirty-seven and the market price of rupees one thousand for what it is. It is "**Economic Rent,**" which is the difference between the lowest cost at which men can produce and live, under the circumstances most favourable to low cost, and the market price which was determined as they themselves described quite correctly (for once) in Chapter one. Economic rent is a natural gift like life itself. 'A' is quite right in saying it is unearned, but that is no reason why one should refuse it. If 'A' was the logical person he evidently thinks he is, he should refuse to live. What did he do to earn his life? You should accept your economic rent of rupees six hundred and sixty-three in this case, and be thankful just as you accept and enjoy the sun and the air."

A clever fellow this, and we should think, a *pukka* economist. You can always recognize them by their habit of assuming for their speculations, the validity of natural law. We shouldn't wonder if this man 'B' could do things with curves, and even with the calculus that would surprise you.

(C) "It's all very well trying to dispose of economic rent with a laborious alleged witticism, but it is a reality for all that. That rupees six hundred and sixty-three appears as a mere accident of trade. If you sell your pump for rupees three hundred and thirty-seven, you are allowing your customer to get away with it, and he has no more right to it than you have. The right course is to sell your pump for a thousand and give the surplus to the state. It is a result of the way in which the state is organized, and the state has the best claim to it. If everyone did that, all other taxes would be unnecessary and no one's legitimate earnings would be taken from him as they are at present."

A great deal more easily said than done Mr. 'C'. Besides, we very much doubt if the state would make a better use of the money than we would ourselves. After all, what is the modern democratic state? Only a lot of politicians who have gained for a moment the fiscale favour of the ignorant multitude.

(D) "Away with all these theories. The only practicable plan is for everyone in the world to seize what he can, and let the weaklings perish. By this means it is ordained that the world shall progress. It always has been so and it always will be so. It is a law of nature and cannot be evaded."

Because each of these gentlemen has a following in the world, we have thought it fair to give expression to their opinions as impartially and fully as we could in a single paragraph. Our own are the following:—

The managing director of an engineering business, and indeed of any business should regard himself as the captain of passenger ship. 'D' would make him the captain of a pirate ship. The prime concern of the captain is the safety and comfort of the passengers (shareholders), and of the crew (workmen). We consider, that in his capacity of captain, he would be false to his trust in following blindly the principles of any of the four men whom we have unfortunately allowed to spoil the free flow of this chapter. He has to bring his ship, passengers, and crew safely home, and had better not make any original experiments with them.

If he can get a thousand rupees for an article which only costs him three or four hundred to make, he should take it. That state of affairs never lasts very long. He will need it all when the day comes, as it always does sooner or later, when no one wants pumps at any price. In these days of prosperity he should be carefully gathering a reserve for the days of adversity. He should ignore the clamour of the shareholders for excessive dividends, and see that his plant is brought up-to-date, and extended wherever it can be profitably extended. He should insist that his subordinates are properly paid. Then when the storm comes he will face it with a sound ship and a loyal crew.

It may be true—it is true—that the ship really belongs to the shareholders but every good engineer will agree that shareholders, should not be pampered. He will say that the first claim on the proceeds of industrial work is the claim of the industry itself, and that the shareholders are entitled to the balance, if any. It is for him, not the passengers to say what can be spared with safety. They will thank him, when on his retirement he hands over to them a ship worth perhaps twice as much as it was when he assumed command.

The captain of the ship should not, we think, be allowed in times of crises to throw any of his crew overboard until it is absolutely necessary. We consider it justifiable to undersell the market right down to absolute cost price if by so doing he can avoid discharging workmen. Such a course has the incidental advantage of keeping 'q' lower than it would be if the shops were half empty. The reader has, of course, forgotten what 'q' is. He should now read the important parts of this chapter (the parts we wrote ourselves), and more carefully note how it was estimated.

## Appendix to Chapter XXVI.

"It is important that the student should carefully avoid the error of believing that the prices and values are controlled by what things have cost to produce in the past. It is the cost which is expected to continue in the future, rather than which has been experienced in the past, that determines the price at which the market will be supplied"—

From "Elementary Principles of Economics," by Professor Irving Fisher.

# CHAPTER XXVI

## COSTING

COST accountancy or costing, as it is termed, is a comparatively new science. In fact 15 years ago there was very little attention paid to this subject.

**Definition:**—Costing may be described as a science which helps to correctly record the cost of labour employed, material used and the various expenses incurred in manufacturing, distributing and selling of goods.

It must be emphasized that in every department of engineering life, from the workman upwards, all work done is ultimately judged or valued on the question of costs. The management of a firm in these days of keen competition and high efficiency is not merely satisfied with knowing the total costs at the end of the year. They wish to know every element of cost All costs are brought out on unit basis, namely, what it costs to produce a yard of cloth, a machine, to lay a yard of cable in the ground, etc., etc. Further, what are the different costs which go to make up the total cost of the unit, such as a yard of cloth, a machine, etc. Further, what are these costs at the end of a month, a fortnight or even a week. It is costing only which makes these close analysis possible.

In its simplest form a manufactured article consists of raw material that has been changed in some respect by the application of labour. The direct charges, raw materials and labour can easily be ascertained, but not so the indirect charges such as salaries of engineers and foremen, clerical staff, cost of running machines, such as lathes, drilling machines, etc., and other general expenses that cannot be directly charged to any one article of manufacture. Unless these expenses, generally known as "*overhead expenses*," were apportioned on a scientific and equitable basis over types of articles produced, it would be very difficult to tell exactly whether a particular type was entailing a profit or a loss.

With competition increasing rapidly, the necessity of analysing and recording the cost of the various items of material, labour and overhead expenses and hence of curtailing costs was severely felt, and the new *science of* **cost accountancy** came gradually to be evolved. Although cost accounting is a branch of general accounting, the knowledge of accounts in the books is of least consideration. In **costing,** which is generally the term applied to this subject, a knowledge of manufacturing and engineering operations is absolutely necessarily combined with a knowledge of accounts, so that the analysis of costs can be carried out so as to show up every item of expenditure in a clear manner.

Costing having been primarily introduced in manufacturing has now been successfully employed to all undertakings, such as railways, gas and electric companies, textiles, etc.

**The principal object of costing** is to ascertain the actual cost of an article, process or service rendered.

**The main advantages of costing** are :—

1. Data is provided for estimating purposes.
2. Effective principal control can be exercised, as the detailed costs of running the various sections are easily known.

In addition—

3. It is known which departments or branches of the business are most profitable.
4. Losses due to inefficiency either in the factory or selling department can be traced.

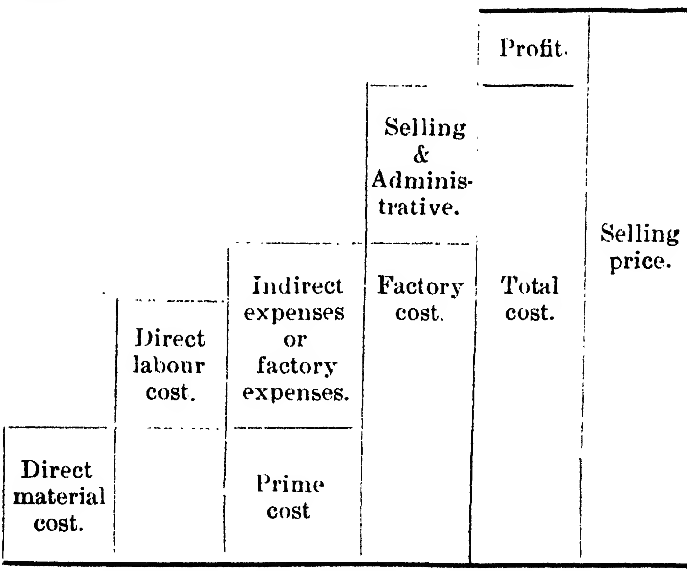
We will now pass on to the study of the principles by which the total cost of an article, a ton of chemicals, a yard of cloth, etc., can be ascertained. It must be remembered that the principles are the same for any industry or undertaking. It is only in details certain modifications that the cost systems in different undertakings differ.

For our purpose we will take up the costing system applicable to a modern factory as far as the general principles are concerned. As mentioned previously, the manufactured article in its simplest form consists of raw material that has been changed in some respect by application of labour.

*The main divisions under which the* "**element of cost**" can be divided are :—

1. Material (Direct).
2. Labour (Direct).
3. Overhead expenses, sometimes known as establishment expenses.

The following chart illustrates the relations of cost elements to selling price.




The selling and administrative expenses have been segregated from the factory expenses, since the latter bear some relation to the work done, whereas the former bear no relation and hence the apportioning of the factory expenses is invariably done on a different basis to that of the selling and administrative expenses. Every sort of work has the elements of cost just referred to with the exception of selling cost which does not exist in certain undertakings.

The next question arises as to what are the principles by which the cost can be arrived at in practice, namely, what are the methods employed in gathering together the different elements of cost.

## Definition of costing terms

**Direct materials** are such materials which enter into finished product and which being ascertainable can be directly charged to the cost of that product, order or process.

**Indirect materials** are such materials as cannot be easily measured, and hence cannot be directly charged to a product, process or order, and can only be apportioned according to some logical method and are a part of indirect or factory expenses.

**Direct labour** is the labour which is directly applied, can be measured, and hence can be directly charged to the product, process or order.

**Indirect labour** is labour which cannot be directly measured and can only be charged to an article, process or order according to some logical method.

**Indirect expenses or factory expenses** are all expenses incurred in running the factory, such as indirect material and labour just referred to, cost of maintenance of building, cost of heating, lighting, salaries of production engineer, foreman, planning engineer and staff, timekeepers, stores staff and works manager These expenses cannot be directly charged to any specific product, process or order, as in factory there are so many different kinds of articles produced These expenses can only be apportioned over the cost of each article by some equitable method.

The investigation of fixing such a method is one of the difficult problems in costing science.

**Prime cost** is the sum of direct material and labour.

**Factory cost** is the sum of prime cost and factory expenses.

**Selling expenses** include those items of expenditure which do not enter into the cost of manufacture, but which are incurred in marketing, the product such as sales manager, staff and other incidental expenses.

**Administrative expenses** include those items of expenditure which do not enter into the cost of manufacture or of marketing, but which are only incurred in the general administration of manufacturing and selling the product.

**Total cost** is the sum of factory cost, selling and administrative expenses.

**Selling cost** is the sum of the total cost and the profit to be levied.

**Overhead or establishment expenses** include indirect material and labour, factory expenses, and selling and administrative expenses.

## Methods of cost finding

The general principles of costing are the same for all undertakings. The work in manufacturing industries may be grouped in two general classes and the **methods of cost finding applicable** to these two classes are :—

1. Order of job method of cost finding.
2. Process method of cost finding.

Chart I.—Chart showing analysis of Cost Elements.

1. Factory cost.
- 1. Prime Cost.
  - 1. Direct Material.
  - 2. Direct Labour.
- 1. Indirect Material.
  - Material which cannot be applied in a direct manner.
  - Supplies
  - Scrap material.
  - Small Tools and Dies.

- Total Cost.
  - 1. Factory Cost.
    - 2. Indirect Charges.
      - 2. Indirect Labour.
        - Indirect or Non-Productive Labour.
        - Supervision or Foremanship.
        - Superintendence.
        - Inspection.
        - Factory Clerks' salaries.
        - Defective work.
        - Experimental work.
      - 3. Indirect Expenses.
        - Rent.
        - Insurance, Fire and Liability.
        - Taxes.
        - Maintenance, Repairs.
        - Power.
        - Light.
        - Heat.
        - Transportation.
        - Miscellaneous Factory Expenses.
  - 3. Selling Expenses.
    - Advertising; Sample Expenses; Commissions; Salemen's Salaries; Salemen's Expenses; Travelling Expenses; Sales Office Expenses; Rent; Clerks' Salaries; Telephone and Telegraph; Printing and Stationery; Postage; Miscellaneous Expenses; Shipping Department Expenses; Finished Stock Warehouse Expenses.
  - 2. Administrative Expenses.
    - Officers' Salaries; Office Salaries; Executives' Expenses; Auditing Expenses; Legal Expenses; Administrative Office Expenses; Salaries; Rent; Light and Heat; Telephone and Telegraph; Printing and Stationery; Postage; Office Supplies; Miscellaneous Expenses

Total Cost + Profit = Selling Price.

The former costs are those in which items of **prime cost** are traceable to definite job or factory orders. In other words, the actual material and labour costs and a pro rata share of factory and administrative expenses are all charged to definite factory orders usually designated by distinct work order numbers. Definite factory orders may be issued for the manufacture of a number of units, for a single unit or for certain parts of a unit.

**Process costs** are those employed in industries or undertakings where given products are being continuously produced, so that the definite factory orders and jobs lose their identity and become part of a large volume of production. The costs of material, labour and overhead costs are all charged to definite processes or operations which may be the production of 10,000 yds. of cloth, 1,000 castings of similar kind, 100 tons of chemicals, etc. Ultimately in process costing the costs are always brought out in terms of definite units, such as a ton, a pound, a yard, etc.

The accompanying chart shows methods of cost finding employed in various industries.

It must be borne in mind that although certain industries always indicate that one of the two methods of cost finding should be applied, there are other industries especially engineering firms where it is not unusual to find both methods of cost finding being used. For instance, an engineering firm may be partly producing standardized goods, namely, such work being done continuously, and hence the process method is applied and at the same certian business orders have to be completed for which the order method can only be applied. In an electric supply company **order method** of costing will be applied in the Mains Dept. where definite works such as laying of district services, mains extensions are carried out. But in the Meter Department where meters are tested continuously, the process method would be applicable.

**Chart II.**

General Methods of Cost Finding.

Use for the purpose of :

1. Ascertaining by reports the material, labour, and overhead costs.
2. Compiling and summarising these costs elements.
3. Determining the total cost of the Job, Order or Article.

- 1. Order Method of Cost Finding.
  Also known as :
  Special Order Method.
  Specific Order Method.
  Job Method.
    1. Building Construction Industries.
    2. Repair Shop. (Including Garages and Machine Shops).
    3. Plating Shops.
    4. Cabinet Shops.
    5. Garment Manufacturing Plants.
    6. Straw and Felt Hat Plants.
    7. Boot and Shoe Plant.
    8. Departments in Wood-working Plants.
    9. Departments in Metal Manufacturing Plants.
    10. Assembling Department.
- 2. Process Method of Cost Finding.
  Also known as :
  Product Method.
  Machine Process Method.
    1. Foundries
    2. Paper Mill.
    3. Plant and Varnish Manufacturing Plants.
    4. Chemical Manufacturing Plants.
    5. Rubber & Celluloid Manufacturing Plants.
    6. Manufacturing of Food-Stuffs.
    7. Coal-Mining.
    8. Ice Manufacturing Plants.
    9. Treating Departments.
    10. Cutting & Machining Departments, Wood-working Plants.

**Chart showing methods of cost-finding applied to various industries.**

## Factory Departments

The manufacturing departments must be classified as certain departments will require the order method of cost finding and the others the process method. In a factory, in addition to the manufacturing or productive departments, there are certain non-productive or service departments such as the power plants or stores-room which have only an indirect relation to the product manufactured.

Over and above these two classifications, we have the administrative departments such as—

1. Correspondence department.
2. Accountant's Office.
3. Cost department, etc.

And selling departments possibly consisting of—

1. Advertising department.
2. Shipping department, etc.

The classification of the departments corresponds to the classification of disbursements.

(1) Manufacturing departments corresponding to direct labour or material or prime cost.

(2) Service department to factory expenses.

(3) Administrative department to administrative expenses.

(4) Selling department to selling expenses.

*Economy and efficiency are the keynotes of every industry.* These cannot be attained unless one begins to analyse the various phases of work in a perfectly logical manner. There could not be a more logical manner than to separate the departments so that each department or group of departments represents the different elements of cost, namely, prime cost, factory expenses, etc. Further, the classification is necessary since each department or even a section of it will require different methods of cost finding.

## Factory Orders

After the departments and products are classified and the particular method of cost finding is settled upon, there must be found some means of accumulating the cost of an article as it passes through different departments. For this purpose all items of product or jobs must be distinctly designated. This is done by means of order numbers.

In all kinds of factories, whether big or small, *orders should be in writing and never verbal.* Written factory orders serve dual purpose, in as much as they provide for those qualities of permanency, accuracy and reliability of records which are absolutely essential for the efficiency of a factory as well as costing and statistical information.

*Written orders must contain the following* :—

(1) Date, order number to which time worked and material taken can be charged and description of work to be carried out together with a drawing to scale, if necessary.

(2) Complete instructions as to the method of doing the work.

(3 Required date of completion and the time to be taken for each operation to provide continuous flow of work.

(4) Provision for recording information as to progress and completion of order in each department.

The orders should be classified under several headings since this facilitates the collection of the elements of costs in a logical manner.

## Work orders

In its simplest form a work order gives the following informations.

1. Order number and date of issue.

2. Department of the factory where the work is to be carried out and the date by which it is to be completed.

3. Description of work and the quantity of articles used.

4. Signature of the Head of the department usually the workshop superintendent.

X. Y. Co., Ltd. Work Order
—— —— No. XXXX.

Please put the undermentioned work in hand. Delivery to be given by..............193 .
———193 . ———Dept. head.

| Quantity. | Description of work. |
|---|---|
| | |

Charge to——— Deliver to——— For———
Requ. No—— By—— Date—— W. O. prepared by
—— For———— Work order completed——193 ,
and located———

All material requisitions and credit notes have been passed to Stores Dept.

——193 . Sd. —— ——

These work orders are printed in triplicate. The original copy is forwarded to the foreman in whose department the work is to be carried out. The foreman in question may forward it with a chit after the work is completed to another foreman, in whose department further work on the article is to be carried out. Finally the original copy goes to the cost department. The circulating copy in the meanwhile goes to store-keeper, time-keeper and ultimately to the cost department. By this means the store-keeper and time-keeper are notified of the account chargeable.

On completion of work, the workshop department issues a work order completion report informing the time-keeper and store-keeper that work is completed. These two attach the respective requisitions for material and labour sheets and forward the same to cost department where the elements of costs are accumulated and the total cost brought out on a ledger called the cost ledger which gives the following information :—

1. Order number, date started and completed.
2. Description of work.
3 Total cost and its analysis into elements of costs material, labour and overhead charges.

One copy of the Work Order remains in the Superintendent's office as a record.

## Store-keeping and Material Cost

The first element of cost to be considered in cost calculation is material cost. 'Store-keeping' is the subject of another chapter and hence here mention will be made as to how the direct and indirect material cost should be computed.

All purchases should be done by means of an official order called purchase order which is an order form giving details and quantities of material required and forwarded to the merchant. When purchasing, it must be borne in mind that the cheapest material is that which is the most economical. The lowest price material is not the cheapest in the long run.

**Issue of material**—The issue of material from store rooms usually involve the following forms and records.

(*a*) **Material requisition** which is an order upon the stores to supply a certain quantity of material both direct and indirect. It is usually prepared and signed by some responsible official as foreman, etc.

The stores, after issuing, enter the quantities on the Bin Cards, and the Accounts section on the Stock Ledger after working out the costs.

(*b*) **Material Credit Note**—When material taken is in excess or through any other reason is returned to stores, it is necessary to provide some sort of record.

All material Requisitions or Debit notes and Material Credit Notes should always bear the order number to which the material refers, so that the requisitions and credit notes may be sorted under each number on completion of work.

**Accounting**—On completion of work, the storekeeper is informed by means of the completion report form which bears the particular order number. The material requisitions and credit notes are collected together under the particular number and the total cost entered on a summary sheet called Material Ledger Sheet giving particulars of Requisition numbers, dates, individual amounts and total cost of material issued and credited.

The Material Ledger sheets at the end of the month are posted to the Material Ledger Summary and this together with requisitions and credit notes are forwarded to the Cost department. This completes the collection of one element of cost, namely, Material (Direct and Indirect).

## Labour Cost

The next element of cost to be considered is the Labour Cost, in the collection of which it is necessary to consider the various forms used for recording the cost of labour It is also necessary to have some knowledge of the various methods of paying wages although in India only three of the methods are employed.

The various methods of paying wages are :-

### 1. Day-Rate system.

This provides each workman being paid at a daily rate, the day consisting of a certain number of hours of work ; usually 8 to 9 hours.

The disadvantages of this system are :--

(1) Lack of incentive on the part of the workman as he has nothing to gain to make his maximum effort.

(2) Difficulty of finding labour costs as a workman never works at a standard rate and hence the time taken for the same kind of job differs considerably.

### 2. Monthly-Rate system.

The disadvantages are the same as in the previous method. This system as also the previous one are widely applied in India.

### 3. Piece-Work system.

This is a system of paying wages on the basis of work done. A rate is established for the various operations incidental to production, either as a result of past experience or by means of a special test. The workman is then paid a fixed amount, say Re 1, or Rs. 8, which is the calculated cost of this time for doing the particular job regardless of the actual time taken. If the workman does the job in less time, he profits; if more, he loses. Such a system invariably creates friction and dissatisfaction between workman and employer.

The above 3 systems are the only ones in general practice in India. There are other systems such as (4) Differential Piece Rate system, (5) Premium Bonus system, (6) Contract system, and lastly (7) Profit sharing system.

As already mentioned, the collection of elements of cost, namely, direct material and labour, indirect material and labour and the overhead expenses, is carried out by means of work orders and standing orders.

## Time-keeping

It must be remembered that labour constitutes the most important element of cost, and small variations in the methods of collecting the time spent by workmen on the different jobs, lead to great differences in the result. The particular branch of costing under which the cost of labour, both direct and indirect, is collected, is called "*Time-keeping.*"

In time-keeping two operations are to be carried out:

**1. Firstly, recording the time spent in the factory only**, namely, the number of days worked and thereby calculating the total wages to be paid during the month or work according to pay period.

This can be done by means of attendance registers as in small concerns, checks in case of bigger concerns, or mechanical time clock recorders as in the case of big factories. The last is the best, since it avoids disputes as to time.

**2. Secondly, recording of time spent on jobs or processes**, *i e*, to analyse the actual time spent by a workman upon a specific job or process or indirect work. This can be carried out by two methods.

(*a*) The foreman records the actual time taken.

(*b*) By means of mechanical clock recorder, the workman clocking the time of starting a work and completing the work on a card called *job card.*

At the end of the pay period, usually a month, the total number of days as obtained from the gate cards for each workman are totalled up and the amount of wages calculated after deducting contributions to provident fund, etc. The particulars are transferred to the pay-roll or pay-sheet. Similarly, at the end of the pay period, usually a month, the total time taken for each job is collected from the job cards on a work order labour ledger and the cost of labour worked out per each job.

We have now studied the methods by which the cost of material (direct and indirect) and labour (direct and indirect) can be collected.

## Collection of Establishment Expenses

We shall now study the method of collecting the cost of the last element of cost, *i.e.*, Overhead Expenses, or Establishment Expenses, as they are termed. Establishment expenses have been classified into three main divisions :—

(1) Factory expenses.
(2) Selling expenses.
(3) Administrative expenses.

**Factory expenses.**—These consist of three principal subdivisions :—

(1) Indirect material.
(2) Indirect expenses.
(3) Indirect labour.

Collection of **cost of indirect material :**—This is done by means of miscellaneous factory orders or standing orders similar in principle to collection of cost of direct material. There may be as many standing orders as there are kinds of indirect materials The indirect material is drawn from the stores by means of requisitions as already described, the standing order number being mentioned on the respective requisition.

The cost of indirect material is accumulated by means of the material ledger sheets for all the standing orders for miscellaneous factory orders in question.

## Indirect and Non-productive Labour

The above includes the following :—

(1) (*a*) Lost time and idle time of productive workers.

(b) Time of helpers, sweepers and truckers.

(2) Supervisors and foremen.
(3) Superintendence.
(4) Inspection (when not considered as a direct labour charge to a job).
(5) Factory clerks.
(6) Employees on experimental works.
(7) Employees on defective works.
(8) Leave pay, holidays and Sundays' pay.
(9) Stores clerks.

Now we shall consider these one by one.

1. (a) This time lost is accumulated by means of a job card similarly as a direct labour to a job. A standing order is usually engaged to record such time.

(b) This is also recorded on job cards, a standing order being engaged for each kind of work.

2. This is more or less a fixed item. This charge is very readily determined when each department has its own foreman or supervisor, but where a foreman supervises more than one department, his time should be arbitrarily apportioned to each department, and included in the overhead expenses of the department concerned.

3. As this includes salaries of works manager, production superintendent, etc., their salaries are absorbed in the general operating expenses and then distributed to the operating departments upon some arbitrary basis.

4. This is usually charged to the overhead expenses and apportioned as above

5. Part of this expense is charged to the factory expenses and the remaining to administrative expenses, the ratio depending on how much the volume of products turned out is related to this expense.

6 & 7. Their time is collected by means of standing orders and job cards and charged to factory expenses.

8. Such pay should be included in the factory expenses, usually the cost of such pay is charged to standing orders and collected.

## Indirect Expenses

This may be classified as follows :—

(1) **Rent.**—Building and ground. The most practical method of apportioning this expense is on the basis of floor space occupied by each department. In the cost of owned building, the interest on the cost of the building must be divided in the same way.

**Rent**—This item is more or less fixed and is apportioned on the basis of the floor space occupied by each department. When the building is owned, only the interest on the capital cost of the building is concerned.

2. **Insurance** is the amount paid for the fire insurance and is apportioned to all the machinery *plus* a proportionate value of the building which they occupy.

3. **Tax** is only the Municipal property tax and is apportioned on the basis of floor space occupied.

4. & 5. **Power, Light and Heat** are, if generated, evaluated separately, and the cost is apportioned on the basis of floor space. But if they are purchased, the actual meter readings are considered.

6. **Transport** is an indirect expense and is to be charged under Factory cost

7. Miscellaneous Factory expenses, such as that of investigation work, etc., should be considered under indirect expense.

8. **Depreciation** is the gradual decrease in value to wear and tear or obsolescence, and is charged to the various items

9. **Maintenance and repairs to machines and buildings.**—This expense is totalled and is put under Factory expense or apportioned to the individual departments, where possible.

**Administrative expenses :**—These may include (1) salaries to managers, accountants, etc., and charged under Factory expense.

(2) Sundry expense, such as stationery.
(3) Director's travelling expenses.
(4) Legal and audit fees, etc.
(5) Postage, telephone, etc.

**Selling expenses.**—This includes all the expenditure incurred for the manufacture, sale and distribution of the article.

This includes salaries of sales manager, travelling expenses, advertising, etc

## Expense Allocation

Fundamentally all items are divided into two parts—(1) fixed items, (2) variable items.

## Methods of Distributing Overhead Expense

The most usual methods are :—

(1) Prime cost method.
(2) Productive-labour cost method.
(3) Productive-labour hours method
(4) Machine-rate method.
(5) Miscellaneous method.

(1) **Prime cost method**.—The overhead expenses are in this method calculated as percentage of prime cost, *i.e.*, direct material and direct labour. The disadvantage is that this method gives only inaccurate results.

(2) **Productive-labour cost method.**—In this method, the overhead expenses involved are apportioned in proportion to the cost of labour involved.

For such a method to work satisfactorily there must be uniformity as to product wages paid and time of operation on the article manufactured These conditions rarely exist in an entire plant but do in a single department.

(3) **Productive-labour hours method.**—This differs from the previous method in that the amount of labour is measured by the time and not by the cost. In other words, the overhead expenses are considered as a proportion of the number of employees engaged and the hours that they work. The limitation of this method is

that labour should be the dominant factor and the product should be uniform. But this gives more accurate results than the previous methods and has got a wider field of application.

(4) **Machine-rate method.**—The principle of this method is that overhead expenses are in proportion to the number of hours the machine works.

This has got two advantages:—

(1) This provides for the difference of overhead expenses that occur due to the operation of different machine.

(2) It also provides for the other indirect expense connected with the machine to be absorbed by the machine rate. The machine rate is calculated for the several types and sizes of the machine and the charges that are to be considered are:—

(1) Cost of power.
(2) Cost of repairs and maintenance.
(3) Depreciation.
(4) Lubricating and cutting, oils, cotton waste, etc.
(5) Rent, insurance, taxes, etc.

The machine rate cannot be employed as the only basis of apportioning overhead expense, because in addition to the expense of a number of machines, there are expenses such as light, heat, power, salaries, etc. Hence, the best of way, or rather the only accurate way of apportioning overhead expense, is to have a machine-rate for each machine and to have Direct Labour hour rate to cover the other expenses.

## Selling Expense

The selling expense is either an "advalorem" charge on the factory cost by means of a percentage

| | | Rs. | a. | p. |
|---|---|---|---|---|
| Direct material ... | ... | 10 | 0 | 0 |
| Direct labour (6 hrs.) | ... | 5 | 0 | 0 |
| Factory expenses ... | ... | 5 | 0 | 0 |
| Factory cost ... | ... | 20 | 0 | 0 |
| Selling expense (10 °/o) | ... | 2 | 0 | 0 |
| Selling cost ... | ... | 22 | 0 | 0 |

or may be an absolute charge per unit as Re. 1/- per dozen or Rs. 0/4/0 per yard, provided the production is uniform.

The "advalorem" charge is, however, the best practical method. The total selling expenses are divided by the total of the factory cost of all articles produced and the required percentage obtained.

## Cost Sheet or Ledger.

This should give at least :—

(1) Order number of work and date started and completed.

(2) Description of work.

(3) Name and address of customer, if necessary.

(4) Total cost, and its analysis into elements of cost, material, labour, overhead expenses and selling expenses. The cost sheet should show analysis, as far as practically possible, of each element of cost, namely, material labour and overhead cost should each be analysed.

# CHAPTER XXVII

## ESTIMATING

AN estimate is a scientific forecast of expenditure involved by way of material, wages and other expenses in the production of any given item. It is intended to provide a basis on which the selling prices can be fixed, and catalogues prepared or inquiries answered. For an estimate to be reliable it must be the result of careful thought and analysis, and of careful understanding of what is required. For difference between costing and estimating *vide* p. 267.

### Qualifications and Functions of an Estimator

An estimator must possess (1) a thorough practical training, (2) an appropriate technical training, and (3) familiarity with charts and graphs. On the one hand an estimator is devoted to, obtaining orders for his employers, and on the other hand, to safeguard them as to the expenditure involved on any order obtained on the result of his quotations. He may be asked to assist in the fixing of delivery dates or the completion of a job or to assess the value of work either finished or that as in progress for annual stock-taking. Not only has the estimator to prepare tenders, but in the event of an order maturing, he is called on to lay down the processes of manufacture and to fix the piece work or other prices at which the work shall be carried out. This, of course, presupposes a sound practical knowledge and experience.

### General Organization of an Estimating Department: Mechanical

Assuming an enquiry for a quotation has been received, the first step before the actual work is commenced is to give it a *reference number* to build it with the order in the event of the tender being successful. Having done this, the customer's requirements are examined with any condition, guarantees or specifications that may be attached; and assuming the company's own products will not suit, the estimator proceeds to take out the quantities and weights. If the drawings are not supplied by the customer, they are requisitioned from the drawing office. From these he obtains details of the kind of material and the specification from which each item is to be produced. Then the estimator has to decide by what means the various components shall be manufactured—whether from castings or forgings, etc. This requires consultation with both the designing staff and works. Then the estimator will have to decide the necessary allowances for machining. Care should be taken to credit scrap recoverable in the process of manufacture.

If an analysis of the items shows certain specialised items like steam fittings, etc., inquiries will have to be sent for these and tenders invited. Then consultation should be made with the planning department, whose particular function is to lay out both the processes and the precise sequence.

Then comes the question of *wages costs*. The drawings and processes should be handed over to the rate fixing department, if there is any, or the estimator himself has to do it, as mentioned in the following pages. Probably one of the most difficult processes to gauge is the *assembly figure* so far as labour costs are concerned. Also the cost of fitting up is influenced by several factors such as variation in sizes, drawing office errors, etc., which cannot always be foreseen.

Then the overhead charges are to be considered. These rates are supplied by the accountant and may be either a certain percentage of wages or they may be allocated in an hourly cost basis relative to the type of machine or plant considered.

The addition of establishment costs, which are usually expressed as a percentage of the factory costs, completes the estimate, and the whole then forms a reliable basis on which the price may be quoted to the customer. The cost of patterns also should not be lost sight of in giving a quotation.

The question of tests and guarantees, tests and packing should not be overlooked. Then account for an appreciable sum, and a careful estimate of such expenditure should be made. Lastly an allowance will be included for unforeseen contingencies, such as spoiled work, defective material, increase in market rates, inaccurate drawing and acts of God. It should be noted here that a record of the current market rates and a knowledge of the fluctuation in prices that occur periodically are necessary to some extent to forecast the prices.

If an early delivery date has been promised, it may entail the working of overtime and the installation or night shift, and in that case the estimate should include this extra expense also.

One of the greatest assets contributing to the success of any estimating department is its ability to work in complete harmony with the remaining departments of a work. Without this, it is impossible for it to function satisfactorily, and any young engineer aspiring to a position of this nature will be well-advised to have primarily in his mind, the importance of a tactful disposition.

Where a large number of special fittings are called for, it is necessary to make abstracts from the specification and send out inquiries to sub-contractors so as to obtain reliable prices to include in our estimate.

When an order has been secured, the estimator sends along to the works extracts from his estimate as to the weights of material and wages costs Similarly, the calculations made by the draughtsman who has dealt with it, are sent along to those responsible for getting out the detail drawings

**Ratio of Profit**:—It is an axiom of estimating to avoid quoting either an unduly high price or an inordinately low price, unless the latter be done with sole object of keeping the works engaged.

**Planning** :—(1) Specify the size, length, weight, and kind of material for the various items

(2) Decide the particular methods and sequence of processes by which the components shall be manufactured.

(3) Decide whether any jig, fixtures, or special tools shall be made.

**Classification of Estimates** :—(1) Estimates for work similar to the standard product of the Company.

(2) Estimates for work of an entirely new nature.

## Main Headings of Estimating

(1) **Cost of materials** :—The cost of material may include both raw material and also that of special items brought outside in a finished state.

(2) **The cost of labour** will entail consideration as to the means of estimating the time in which the various parts can be manufactured and assembled together.

(3) **Cost of overhead charges** :—These consist of all expenditure pertaining to the running of works other than that which can be directly charged to orders for which the firm expect to receive payment. It includes, for instance, expenses relative to advertising, royalties, and possibly maintenance of show rooms, etc.

**Mechanical:**—When estimating, first the quantities and weights of materials should be considered and then the following items should be estimated. The need for crediting scrap should not be lost sight of.

(1) Rough and finished sizes of material—allowances for machining.—It must be remembered that the sizes or dimensions given on the drawings are always the finished sizes of the particular items to which they refer.

**Foundry Costs** :—(1) Cost of metal up to the stage of pouring; (2) direct wages spent or moulding, core-making and dressing. Also it is to be decided whether any jig fixtures or special tools shall be made.

As regards the calculation of production times on a feed and speed basis and scraping, etc., can be obtained by referring to any book on machine shop practice.

## Wage Systems, Their Effects on Estimating

This affects our labour charges in the estimate An elaborate description of the several systems was given in the chapter on costing. Here we shall consider some of the features relating to the estimates *in brief*.

The day work and piece work are quite simple in that in a day pay system, the job can be changed for the number of hours spent on it at the hourly rate of the workmen employed on it. And under the piece rate, the special labour charges for that piece can be charged for that job. These are quite simple and offer little trouble. Now let us consider the more complicated bonus systems.

(1) **Halsey system** :—Under this system, the time the employee saves is allocated as to one-third to himself and $\frac{2}{3}$ to the employer. If a workman does a job in 50 hours and if 100 hours is the standard time, he receives a bonus of $\frac{1}{3}$ (100-50) = $16\frac{2}{3}$ hours.

(2) **Halsey weir system** :—This method differs from the Halsey system only in the fact that the time saved is allocated as to 50 % to the man and 50 % to the employer. If as in (1) the workman finishes the job in 50 hours, which is marked 100 hours, the bonus which he will receive is $\frac{1}{2}$ (100-50) = 25 hours.

(3) **Rowan system** :—For any time saving that a man makes on a job, he receives the same percentage increase in his pay as the time saved bears to the time allowance. In the above example time saved (50 hrs.) is 50 % of time allowance and he would receive a bonus in this case of 50 % of 50 hrs.' or 25 hrs.' extra pay.

In the three premium bonus systems thus outlined, the time allowance given for any specific task will vary for each system. Thus, to fix a time allowance so that the employee can earn $33\frac{1}{3}$ per cent. bonus, the following additions must be made to the estimated actual time :—

| | | | |
|---|---|---|---|
| Halsey system ... | ... | 100 | per cent. |
| Halsey weir system | ... | $66\frac{2}{3}$ | „ |
| Rowan system ... | ... | 50 | „ |

To emphasize the influence of the various wage systems have on the costs, let us consider an example. We will assume a task estimated to actually take 30 hrs. for a man whose wage rate was Re. 1 per hour. An appropriate piece work price, based on the man earning time *plus* one-third would be 40 rupees and as stated; this would represent the wage cost irrespective of the time taken. The respective time allowance for the premium bonus systems would be—

| | | | |
|---|---|---|---|
| *Halsey system* ... | 30 hours + | 100 % | = 60 hours. |
| Halsey weir system | 30 hours + | $66\frac{2}{3}$ % | = 50 hours. |
| *Rowan system* | 30 hours + | 50 % | = 45 hours. |

Referring to the table given on the next page and remembering that Rs. 40 represents the standard wages cost under the piece work system, we observe that this cost can indeed vary within wide limits.

*Wages cost for a given task under various previous bonus system.*

| | *Halsey system.* | | | *Halsey weir system* | | | *Rowan system* | | |
|---|---|---|---|---|---|---|---|---|---|
| | Hours. | | | Hours | | | Hours. | | |
| Time allowance ... | 60 | 60 | 60 | 50 | 50 | 50 | 45 | 45 | 45 |
| Time taken ... | 25 | 35 | 45 | 25 | 35 | 45 | 25 | 35 | 45 |
| Time saved ... | 35 | 25 | 15 | 25 | 15 | 5 | 20 | 10 | 0 |
| Bonus payable in hours | $11\frac{2}{3}$ | $8\frac{1}{3}$ | 5 | $12\frac{1}{2}$ | $7\frac{1}{2}$ | $2\frac{1}{2}$ | 11·1 | 7 7 | 0 |
| Total wages cost ... | Rs. a. | Rs. a. | Rs. a. | Rs. a. | Rs. a. | Rs. a. | Rs a | Rs a. | Rs a. |
| Standard earnings ... | 25 0 | 35 0 | 45 0 | 25 0 | 35 0 | 45 0 | 25 0 | 35 0 | 45 0 |
| Bonus earnings ... | 11 $10\frac{2}{3}$ | 8 $5\frac{1}{3}$ | 5 0 | 12 8 | 7 8 | 2 8 | 11 1·5 | 7 11 | 0 0 |
| Total ... | 36 $10\frac{2}{3}$ | 43 $5\frac{1}{3}$ | 50 0 | 37 8 | 42 8 | 47 8 | 36 1 5 | 42 11 | 45 0 |

## Collective or Output Bonus

The underlying principle of this system is that assuming the whole of the employees increase their output in a given period beyond a previously determined standard, without augmenting the number of men engaged for the hours worked, a percentage increase in their wages is made corresponding to the increase in production. A development of this idea includes the participation of the whole of the staff in the bonus sharing.

(3) **Overhead charges :**—Let us consider now the third and last item mentioned before—that of estimating This consists of every other item of expense pertaining to the running of a business, other than the wages and material directly chargeable to productive work. By productive work is meant all labour and material debited to specific orders for which the Company should ultimately receive cash or credit. It is usual to divide this into two classes

1. Workshop expenses ; 2 Establishment charges.

**Workshop expenses** consist of the items given below :—

(1) **Provision of power :**—This may be supplied either from outside or may be generated from one's own plant. In the latter case this would include depreciation of the plant and the building which contains it, repair and up-keep of shafting, belting, etc., fuel, stocking, etc.

(2) **Building expenses :**—This would include rent, lighting, heating, insurance, repairs, etc.

(3) **Supervision :**—Under this heading would be debited salaries of foremen, charge hands, inspectors, shop clerks, wages, staff, etc.

(4) **Maintenance and depreciation of plant :**—This will include the provision necessary for the tools, repair, up-keep of the production units as well as annual charge of sufficient magnitude as will enable the purchase of a new machine when the working one completes its useful life.

(5) **Interest on capital :**—Bank rate is usually debited against the cost of production.

(6) **Unclassified labour :**—Including wages of labourers, cranesman, store-keepers, etc.

The first method we propose is to add to the prime costs ( direct wages and materials ) of an article a percentage estimated to cover the total workshop expenses of the factory.

**Percentage on wages method.**—This consists of totalling the whole of the workshop expenses for a given period, expressing this as a percentage of the direct wages and allocating them in strict proportion to the wages cost of the job.

**Man-hour method** consists of allocating the workshop expenses on the basis of the number of hours worked by each direct wage-earner.

**Machine-hour rate**—same as the last, but on the basis of the number of hours taken on a machine.

(2) **Establishment charges** :—

(1) **Sales expense**—being the cost of advertising, agency commissions, salaries, show-rooms, depots, etc.

(2) Delivery and packing charges.

(3) **General expenses**—representing the office salaries and supplies, director's fees, royalties, etc. The usual procedure adopted is to total them and add as a percentage to the factory cost ( in computing costs and wages ) generally the figure does not exceed 10 per cent.

**Extra cost of overtime** :—

The effect of overtime and night work are to be taken into account. Whether the institution of a regular night shift is economical, depends largely on the nature of the business. It is the general experience that continued night work is not truly economical in ordinary manufacture.

**Allowances for men working out**:—

When a company having men employed at a distance from the works, their allowances are not only the ordinary wage rates payable, but they must be paid in addition, for travelling time and for lodgings.

## Nature and Distribution of Expense

If we take any industrial system, the general processes of manufacture can be classified as collecting raw material, changing it into a finished product, distributing it among customers and supervising, safeguarding and conducting the whole of this business or seeing, safeguarding and promoting the whole cycle. Or it can be summed up in four words—purchase, production, distribution or selling, and administration. When translated into the language of the manufacturer, these become *labour material* and *expenses*.

The various components of the selling price of a finished product can be, as shown in page 327, represented as follows.

Selling price Rs. 600.

Inclusive or Total cost Rs. 500.

Shop cost Rs. 400.

Rs. 300.
Prime or flat cost.

| Rs. a. p. | Rs. a. p. | | | |
|---|---|---|---|---|
| 150 0 0 Labour | 150 0 0 Material | Factory expense. | General expense. | Profits. |

**Distribution of expense** :—There are a variety of methods in practice of arriving at the cost price of an article manufactured or cost of repairing an old article.

(1) The first method is the *distribution of expenses by material.* This can be applied fairly accurately only when the product is uniform and even then it is only of a limited applicability.

(2) The next is the *percentage on wage* method of allotting the factory expense and this is used fairly widely. In this we total up the wages paid for a definite

time for productive labour and the factory expenses during the same period and find what the percentage of the former to the latter is.

(3) The third method is *man-hour plan*. This is similar to the last method, but here we find what percentage of the total time spent by the workers, the factory expenses. It is to be noted that this method takes no cognizance of the machine element.

(4) Next and most widely adopted is the *machine-hour* plan of distribution expense and this is more accurate than those described already, for it takes into cognizance all the factors—the machines employed, the men turning them and the equipment surrounding both.

The first step in this method is to determine the expense of running a machine on an hourly basis. This includes the interest and depreciation on the cost of the machine, cost of power to run the machine, cost of cranage, transportation, etc., incidental, rental, lighting and heating and a fair proportion of *the general expenses incurred for* administration, superintendence and non-productive factory labour.

Having thus arrived at the total expense for a definite period, we can get the hourly rate of the machine by dividing the total estimated expense by the number of hours the machine is expected to run during that period. But this rate is subject to correction after actual observation, in case there is much variation.

This method works quite all right, but for the fact that it gives some trouble in cases where the working of the plant as a whole or of a particular machine varies much from the normal. The machine rates will become then either two much or too less according as the machine was run for abnormal or subnormal period. In such cases, the extra income may be allowed to go as a reserve to be drawn upon in a subnormal period in case too much expense is charged against jobs of an active period or in the other case, *i.e.*, when the machine lies partly idle, the extra expense of a previous period may be credited to this period.

There is another case to be considered—that of executing a small job on a higher machine—hour rated machine in case all the machines which are to be used for that job are fully occupied. This is known as the **problem of penalized job**.

The natural extension of the machine-hour rate method is the **distribution by production factors**. The principal of these factors are—land and buildings, lighting, heating, ventilation, transport, administration, management, etc.

To all these factors must be added *correspondence* and *advertisement*, which, in many cases, form no small percentage.

Tha last factor is *depreciation*, which may be either functional depreciation or depreciation due to obsolescence. The former is the case in which a machine or a plant becomes useless for good service owing to wear and tear after it has served for its useful life. The other is the case where it becomes out of date and it cannot be used, or it becomes inadvisable to use it owing to the advent of a cheaper or more economical machine and in such cases the machine will be quite in a working condition, but of all the methods described, the machine-hour rate method is the best, because it is a blending of practical workability and a reasonable mathematical accuracy and is within the comprehension of ordinary industrial managers and within the powers of ordinary accounting staff. It forms a good compromise between the more accurate *production-factor system* and the more practicable *percentage on wages system*.

## Estimate of Masonry Structure

To make an estimate first get (1) the specification of materials and structure or the article of which you are going to make the estimate.

(2) Next make a complete drawing of the finished article—giving plan, elevation and section, as may be necessary. Consider the waste and additional work to be done to complete the thing.

(3) Get the scheduled rate of items—this varies in each locality according to the cost of labour, raw materials, etc.

The contingencies and overhead charges must be duly added.

Then calculate the quantities from the plan, elevation and section, and put them in form A. From the schedule of rates determine the cost for each item.

Deduct for openings, etc. Then add up to get the total. Then make an abstract of costs.

The specimen estimate of a building has been given in all its details for careful study.

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## SCHEDULE A.

| Serial No. | Sub-heads of work. | Rate. | | | Per. |
|---|---|---|---|---|---|
| | | Rs | a. | p. | |
| 1 | Excavation of founds ... | 5 | 0 | 0 | c/oo c. ft. |
| 2 | Earth filling watered and rammed ... ... | 5 | 0 | 0 | °/oo ,, |
| 3 | Lime concrete in founds ... | 18 | 0 | 0 | °/o ,, |
| 4 | Ist class brickwork in lime in founds and plinth ... | 21 | 0 | 0 | °/o ,, |
| 5 | Ist class brickwork in lime in superstructure ... | 22 | 0 | 0 | °/o ,, |
| 6 | Ist class cut brickwork in Jambs, etc. ... ... | 25 | 0 | 0 | °/o ,, |
| 7 | R. B. lintel work ... | 68 | 0 | 0 | °/o ,, |
| 8 | R. B roof slab 3″ .. | 75 | 0 | 0 | °/o ,, |
| 9 | Ditto 5″ . | 72 | 0 | 0 | °/o ,, |
| 10 | Ditto 6″ ... | 80 | 0 | 0 | °/o ,, |
| 11 | Ceiling plaster 1 : 4 Cement sand mortar .. | 4 | 8 | 0 | °/o s. ft. |
| 12 | Wall plaster 1 : 6 Cement, sand mortar ... | 4 | 0 | 0 | °/o ,, |

SCHEDULE A.—(*Contd*).

| Serial No. | Sub-heads of work. | Rate. | | | Per. |
|---|---|---|---|---|---|
| | | Rs. | a. | p. | |
| 13 | Plinth plaster 1 : 4 Cement sand mortar ... | 5 | 0 | 0 | °/o s. ft. |
| 14 | 1½" P. S. floor over 3" lime concrete ... | 20 | 0 | 0 | °/o ,, |
| 15 | Roof girders hoisting only | 1 | 0 | 0 | cwt. |
| 16 | Boxing girders ... | 1 | 0 | 0 | r.ft. |
| 17 | Ironwork in gates | 10 | 0 | 0 | cwt. |
| 18 | Whitewash ... ... | 0 | 4 | 0 | °/o s. ft. |
| 19 | Outside colourwash ... | 0 | 6 | 0 | °/o ,, |
| 20 | Painting and varnishing door and window leaves .. | 3 | 0 | 0 | °/o ,, |
| 21 | Cornice 15" projection ... | 0 | 10 | 0 | R ft. |
| 22 | Cornice 9" projection .. | 0 | 6 | 0 | ,, |
| 23 | Roof concrete ... | 35 | 0 | 0 | °/o c. ft. |
| 24 | Bed stones for girders ... | 2 | 0 | 0 | c. ft. |
| 25 | R. C. columns . | 1 | 8 | 0 | ,, |

SCHEDULE B.

**Rate of stock materials.**

| Serial No | Sub-heads of work | Rate | | | Per. |
|---|---|---|---|---|---|
| | | Rs. | a. | p. | |
| 1 | Brick ballast for foundation ... | 8 | 0 | 0 | °/o c. ft. |
| 2 | Roof ballast ... ... | 9 | 0 | 0 | °/o ,, |
| 3 | IIIrd class bricks ... | 8 | 0 | 0 | °/oo |
| 4 | IInd class bricks ... | 10 | 0 | 0 | °/oo |
| 5 | Ist class bricks ... ... | 11 | 0 | 0 | °/oo |
| 6 | M. S. rods ... ... | 7 | 0 | 0 | cwt. |
| 7 | Cement bags ... ... | 2 | 12 | 0 | each |
| 8 | Stone line unslaked ... | 65 | 0 | 0 | °/o mds |
| 9 | Beri lime ... ... | 30 | 0 | 0 | °/o c.ft. |
| 10 | Cinder ... ... | 8 | 0 | 0 | °/o ,, |
| 11 | Sand ... ... | 6 | 0 | 0 | °/o ,, |

## SCHEDULE C.

The allowance of materials in the various sub-heads of work shall be on the following scale :—

1. *Bricks per 100 c. ft. of masonry...1050 bricks.*
   Size of bricks $10'' \times 4\frac{7}{8}'' \times 2\frac{7}{8}''$.

2. *Lime mortar for 100 c. ft. of pucca brick-work ... ... ... 33 c. ft.*

   The proportion of the ingredients shall be as follows :—

   Slaked and screened lime...1 part

   Screened cinder.............. 1 ,,

   Ganges river sand, free from dust ..1 part

3. *For $\frac{1}{2}''$ thick cement plaster per 100 s. ft. :—*

   Sand cement mortar measured dry ... 6 c. ft.

4. *Pointing per 100 s. ft. :—*

   Pointing material measured dry ... 2 c. ft.

5. *Reinforced brickwork slabs and lintels per 100 c. ft. :—*

   | | | |
   |---|---|---|
   | Cement bags | ... | .. 8 c. ft. |
   | Sand | ... | ... 25 ,, |
   | M. S. Road : | | |
   | For lintels | ... | ... $2\frac{1}{2}$ cwt. |
   | 3″ slab | ... | ... $2\frac{1}{2}$ ,, |
   | 5″ ,, | ... | ... $2\frac{1}{2}$ ,, |
   | 6″ ,, | ... | ... $3\frac{1}{2}$ ,, |

6. *Foundation concrete per 100 c. ft. :—*

   Brick ballast I & II $1\frac{1}{2}''$ gauge . 110 c. ft.

   Lime mortar measured dry ... 36 ,,

(Ratio 100 : 33)

7. *Roof concrete per 100 c. ft.* :—

| | | |
|---|---|---|
| Brick ballast I & II $\frac{1}{2}''$ to $1''$ gauge | ... | 110 c ft |
| Mortar measured dry ... | ... | 44 ,, |

(Ratio 100 : 40)

The mortar will consist of—

| | | |
|---|---|---|
| Bari lime | ... | 1 part |
| Cinders | ... | $1\frac{1}{2}$ parts |

| | | |
|---|---|---|
| Bari lime for rendering | ... | 10 c. ft. |

8. $1\frac{1}{2}''$ *P. S. floor per 100 s. ft.* :—

| | | |
|---|---|---|
| Cement bags ... | ... | 3 |
| Sand ... .. | ... | $5\frac{1}{2}$ c. ft |
| Fine stone ballast $\frac{1}{4}''$ to $\frac{3}{4}''$ gauge | ... | 11 ,, |

9. *1 : 2 : 4 reinforced cement concrete per 100 c. ft.* :—

| | | | |
|---|---|---|---|
| Cement bags | ... | ... ... | 20 bags. |
| Sand | ... | ... ... | 50 c. ft. |
| Stone ballast | ... | ... ... | 86 ,, |
| M. S. rods | ... | . ... | 3 cwt. |

10. *Whitewash per 1000 s. ft.* :—

| | | |
|---|---|---|
| Slaked and screened stone lime of the best quality ... | ... | 1 md. |

**ESTIMATE No. ————**

*Detail of measurements and calculations of quantities.*

Name of work—

| Serial number and name of sub-head and details of work. | Dimensions. | | | | Number contents or area | Total. | Grand total. |
|---|---|---|---|---|---|---|---|
| | Number. | Length. | Breadth. | Height or depth. | | | |
| (1) *Excavation of Founds.* | | | | | | | |
| Pillars ... ... | 15 × 2 | 5 | 4 | 3 | 1,800 | | |
| End pillars ... ... | 6 | 7 | 4 | 3 | 504 | | |
| Junction pillars ... | 2 | 7 | 4 | 3 | 168 | | |
| Junction pillars in front wall ... | 2 | $3\frac{1}{2}$ | 7 | 3 | 147 | | |
| Ditto ditto | 2 × 2 | 2 | 4 | 3 | 96 | | |
| Dwarf walls ... ... | 36 | $7\frac{1}{2}$ | 2 | 3 | 1,620 | | |
| Ditto ends ... ... | 3 | $21\frac{1}{6}$ | 3 | 3 | 572 | | |
| Partition walls ... .. | 2 | $22\frac{2}{3}$ | 2 | 3 | 272 | | |
| Common wall ... ... | 1 | $21\frac{1}{6}$ | $3\frac{1}{2}$ | 3 | 222 | | |
| Front projection wall .. | 1 | $18\frac{3}{4}$ | $3\frac{1}{2}$ | 3 | 197 | | |
| For steps .. ... | 8 | 6 | $2\frac{1}{2}$ | $\frac{1}{2}$ | 60 | | |
| | | | | | | 5,658 | 5,658 c. ft. |

| Serial number and name of sub-head and details of work. | Dimensions. Number. | Length. | Breadth | Height or depth. | Number contents or area. | Total. | Grand Total. |
|---|---|---|---|---|---|---|---|
| (2) *Foundation concrete.* | | | | | | | |
| $\frac{1}{2}$ of excavation of founds ... | ... | ... | ... | ... | 2,829 | | |
| Add for steps ... ... | 8 | 6 | $2\frac{1}{2}$ | $\frac{1}{4}$ | 30 | 2,859 | 2,859 c ft. |
| (3) *Earth filling.* | | | | | | | |
| Back portion ... ... | 1 | 150 | 25 | $1\frac{1}{2}$ | 5625 | | |
| Front portion ... sides | 2 | $38\frac{3}{4}$ | 25 | $1\frac{1}{2}$ | 2906 | | |
| Front portion .. central | 1 | 25 | 28 | $1\frac{1}{2}$ | 1050 | 9581 | 9,581 c. ft. |
| (4) *I. B. W. in line in foundations and plinth.* | | | | | | | |
| Pillars 1st. offset ... ... | 15×2 | $3\frac{5}{6}$ | $2\frac{1}{2}$ | $\frac{1}{2}$ | 144 | | |
| 2nd ,, ... | 15×2 | $3\frac{5}{12}$ | $2\frac{1}{12}$ | $2\frac{7}{12}$ | 552 | 696 | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| End pillars (length 4′ 7½″ + 1′ 8½″) | 8 | $6\frac{1}{3}$ | $2\frac{11}{12}$ | $\frac{1}{2}$ | 74 | | |
| And junction pillars ... | 8 | $5\frac{11}{12}$ | $2\frac{1}{2}$ | $\frac{1}{2}$ | 59 | | |
| | 8 | $5\frac{1}{2}$ | $2\frac{1}{12}$ | $2\frac{1}{12}$ | 191 | | |
| Junction pillars in front wall ... | 2 | 7 | $2\frac{11}{12}$ | $\frac{1}{2}$ | 20 | | |
| | 2 | $6\frac{7}{12}$ | $2\frac{1}{2}$ | $\frac{1}{2}$ | 16 | | |
| | 2 | $6\frac{1}{6}$ | $2\frac{1}{12}$ | $2\frac{1}{12}$ | 54 | | |
| Dwarf walls except end spans ... | 24 | $8\frac{2}{3}$ | $1\frac{2}{3}$ | $\frac{1}{2}$ | 173 | | |
| | 24 | $9\frac{1}{12}$ | $1\frac{2}{3}$ | $2\frac{7}{12}$ | 939 | | |
| Dwarf walls near corner pillars. | 10 | $9\frac{1}{12}$ | $1\frac{2}{3}$ | $\frac{1}{2}$ | 76 | | |
| | 10 | $9\frac{1}{2}$ | $1\frac{2}{3}$ | $\frac{1}{2}$ | 79 | | |
| | 10 | $9\frac{17}{24}$ | $1\frac{2}{3}$ | $2\frac{1}{12}$ | 337 | | |
| Dwarf walls near front junction pillars. | 2 | $9\frac{1}{8}$ | $1\frac{2}{3}$ | $\frac{1}{2}$ | 15 | | |
| | 2 | $9\frac{13}{24}$ | $1\frac{2}{3}$ | $\frac{1}{2}$ | 16 | | |
| | 2 | $9\frac{9}{24}$ | $1\frac{2}{3}$ | $2\frac{1}{12}$ | 65 | | |
| Partition walls ... ... | 2 | $24\frac{1}{6}$ | $1\frac{2}{3}$ | $\frac{1}{2}$ | 40 | | |
| | 2 | $24\frac{7}{12}$ | $1\frac{2}{3}$ | $2\frac{7}{12}$ | 212 | | |
| Common wall ... ... | 1 | $23\frac{9}{12}$ | $2\frac{1}{2}$ | $\frac{1}{2}$ | 29 | | |
| | 1 | $24\frac{1}{6}$ | $2\frac{1}{12}$ | $\frac{1}{2}$ | 25 | | |
| | 1 | $24\frac{7}{12}$ | $1\frac{2}{3}$ | $2\frac{1}{12}$ | 85 | 3,201 | 3,201 c. ft |
| Carried over ... | ... | ... | ... | ... | ... | 3,201 | |

| Serial number and name of sub-head and details of work. | Dimensions. Number. | Length. | Breadth. | Height or depth. | Number contents or area. | Total. | Grand total |
|---|---|---|---|---|---|---|---|
| Brought forward ... | ... | ... | . | ... | ... | 3,201 | |
| Wall in front project .. | 1 | 20 | $2\frac{1}{2}$ | $\frac{1}{2}$ | 25 | | |
| | 1 | $20\frac{5}{12}$ | $2\frac{1}{12}$ | $\frac{1}{2}$ | 21 | | |
| | 1 | $20\frac{5}{6}$ | $1\frac{2}{3}$ | $2\frac{1}{12}$ | 72 | | |
| Steps Masonry ... ... | 8 | $5\frac{1}{2}$ | 2 | $\frac{1}{2}$ | 44 | | |
| Steps Masonry ... ... | 8 | $5\frac{1}{2}$ | 1 | $\frac{2}{3}$ | 29 | | |
| | | | | | | 3,392 | 3,392 c. ft. |
| *(5) I. B. W. in cement mortars (1 : 6) in Plinth.* | | | | | | | |
| Pillars ... ... | $15\times 2$ | $3\frac{2}{3}$ | $2\frac{1}{12}$ | $\frac{5}{12}$ | 96 | | |
| End pillars including two junction pillars ... ... | 8 | $5\frac{1}{12}$ | $2\frac{1}{12}$ | $\frac{5}{12}$ | 41 | | |
| Junction pillars in front wall ... | 2 | 7 | $2\frac{1}{12}$ | $\frac{5}{12}$ | 12 | | |
| Dwarf walls ... ... | 36 | $8\frac{5}{6}$ | $1\frac{1}{3}$ | $\frac{5}{12}$ | 221 | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| End walls ... ... | 3 | $21\frac{1}{3}$ | $1\frac{2}{3}$ | $\frac{5}{12}$ | 44 | | |
| Wall in front projection ... | 1 | $20\frac{1}{2}$ | $1\frac{2}{3}$ | $\frac{5}{12}$ | 14 | | |
| Partition walls ... ... | 3 | $24\frac{7}{12}$ | $1\frac{2}{3}$ | $\frac{5}{12}$ | 51 | | |
| | | | | | | 479 | 479 c ft. |
| (6) *I. B. W. in lime in Superstructure.* | | | | | | | |
| Front walls long ... ... | 2 | 105 | $1\frac{1}{4}$ | 18 | 4725 | | |
| Front walls projection ... | 2 | 3 | $1\frac{1}{4}$ | 18 | 135 | | |
| Front short walls ... ... | 2 | 25 | $1\frac{1}{4}$ | 18 | 1125 | | |
| Back walls long ... ... | 2 | $151\frac{1}{4}$ | $1\frac{1}{4}$ | 18 | 6806 | | |
| Back walls end ... ... | 1 | 25 | $1\frac{1}{4}$ | 18 | 563 | | |
| Partition walls ... ... | 2 | 25 | $1\frac{1}{4}$ | $15\frac{1}{2}$ | 969 | | |
| Add for pillars ... ... | 30 | $2\frac{1}{2}$ | 5/12 | 18 | 563 | | |
| Add for corner pillars ... | 6 | $6\frac{1}{3}$ | 5/12 | 18 | 285 | | |
| Add for junction pillars ... | 2 × 2 | $1\frac{1}{4}$ | 5/12 | 18 | 38 | | |
| Add for junction pillars in front walls ... | 2 | $6\frac{1}{3}$ | 5/12 | 18 | 95 | | |
| Deduct | | | | | | 15,304 | |
| (a) *Openings*:— | | | | | | | |
| Doors 10′ × 12′ ... ... | 1 | 10 | $1\frac{1}{4}$ | 12 | 150 | | |
| Doors 8′ × 12′ ... ... | 4 | 8 | $1\frac{1}{4}$ | 12 | 480 | | |
| Doors 5′ × 10′ ... ... | 10 | 5 | $1\frac{1}{4}$ | 10 | 625 | | |
| | | | | | | 1,255 | |
| Carried over ... | ... | ... | ... | ... | ... | 1,255 | |

| Serial number and name of sub-head and details of work. | *Dimensions.* Number. | Length. | Breadth. | Height or depth. | Number contents or area. | Total. | Grand total. |
|---|---|---|---|---|---|---|---|
| Brought forward ... | ... | ... | | .. | ... | 1,255 | |
| Windows 4′×7′ ... ... | 34 | 4 | $1\frac{1}{4}$ | 7 | 1190 | | |
| Windows 3′×7′ ... ... | 2 | 3 | $1\frac{1}{4}$ | 7 | 53 | | |
| Clerestories ... ... | 1 | 10 | $1\frac{1}{4}$ | $2\frac{1}{2}$ | 31 | | |
| Ditto ... ... | 1 | 8 | $1\frac{1}{4}$ | $2\frac{1}{2}$ | 25 | | |
| Ditto .. .. | 10 | 5 | $1\frac{1}{4}$ | $2\frac{1}{2}$ | 156 | | |
| Ditto ... ... | 34 | 4 | $1\frac{1}{4}$ | $2\frac{1}{2}$ | 425 | | |
| Ditto ... ... | 2 | 3 | $1\frac{1}{4}$ | $2\frac{1}{2}$ | 19 | | |
| For less height of common wall 6″ for R. B. slab and 6″ for concrete ... .. | 1 | 25 | $1\frac{1}{4}$ | 1 | 31 | 1930 | |
| *For bearing of slab on external walls.* | | | | | | | |
| Front wall long ... ... | 1 | $103\frac{3}{4}$ | 5/8 | $\frac{1}{2}$ | | | |
| Front wall project ... ... | 2 | 3 | 5/8 | $\frac{1}{2}$ | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Back walls long ... ... | 1 | $78\frac{3}{4}$ | 5/8 | $\frac{1}{2}$ | | |
| Back walls ... ... | 2 | $151\frac{1}{4}$ | 5/8 | $\frac{1}{2}$ | | |
| End walls ... ... | 3 | 25 | 5/8 | $\frac{1}{2}$ | 177 | 3,362 |
| *(b) R. B. Lintel.* | | | | | | |
| Overdoors $16' \times 12'$ ... | 1 | 12 (with bearing 1′ one each side) | $1\frac{1}{4}$ | 1 | 15 | |
| Overdoors $8' \times 12'$ ... | 4 | 10 | $1\frac{1}{4}$ | 1 | 50 | |
| Overdoors $5' \times 10'$ ... | 10 | $6\frac{1}{4}$ | $1\frac{1}{4}$ | 5/12 | 33 | |
| Windows $4' \times 7'$ ... ... | 34 | $5\frac{1}{4}$ | $1\frac{1}{4}$ | 5/12 | 93 | |
| Windows $3' \times 7'$ ... ... | 2 | $4\frac{1}{4}$ | $1\frac{1}{4}$ | 5/12 | 4 | |
| Clerestories $10' \times 2\frac{1}{2}'$ ... | 1 | 12 | $1\frac{1}{4}$ | 1 | 15 | |
| Ditto $8' \times 3\frac{1}{2}'$ ... | 4 | 10 | $1\frac{1}{4}$ | 1 | 50 | |
| Ditto $5' \times 2\frac{1}{2}'$ ... | 10 | $6\frac{1}{4}$ | $1\frac{1}{4}$ | 5/12 | 33 | |
| Ditto $4' \times 2\frac{1}{2}'$ ... | 34 | $5\frac{1}{4}$ | $1\frac{1}{4}$ | 5/12 | 93 | |
| Ditto $3' \times 2\frac{1}{2}'$ ... | 2 | $4\frac{1}{4}$ | $1\frac{1}{4}$ | 5/12 | 4 | 390 |

| Serial number and name of sub-head and details of work. | Dimensions: Number. | Length. | Breadth. | Height or depth | Number contents or area. | Total. | Grand total. |
|---|---|---|---|---|---|---|---|
| (c) *Bed stones under joists.* | | | | | | | |
| Same as subhead 16 ... | ... | ... | ... | ... | 36 | 36 c.ft. | |
| (d) *Masonry in Jambs of doors and windows.* | | | | | | | |
| Doors 10′ × 12′ ... ... | 1 × 2 | $\frac{5}{6}$ | $1\frac{1}{4}$ | 12 | 25 | | |
| 8′ × 12′ ... ... | 2 × 4 | $\frac{5}{6}$ | $1\frac{1}{4}$ | 12 | 100 | | |
| 5′ × 10′ ... ... | 2 × 10 | $\frac{5}{6}$ | $1\frac{1}{4}$ | 10 | 208 | | |
| Windows 4′ × 7′ ... ... | 34 × 2 | $\frac{5}{6}$ | $1\frac{1}{4}$ | 7 | 496 | | |
| 3′ × 7′ ... ... | 2 × 2 | $\frac{5}{6}$ | $1\frac{1}{4}$ | 7 | 29 | | |
| Clerestories sills ... | 1 | 10 | $1\frac{1}{4}$ | $\frac{3}{4}$ | 9 | | |
| Ditto | 1 | 8 | $1\frac{1}{4}$ | $\frac{3}{4}$ | 8 | | |
| Ditto | 10 | 5 | $1\frac{1}{4}$ | $\frac{3}{4}$ | 47 | | |
| | 34 | 4 | $1\frac{1}{4}$ | $\frac{3}{4}$ | 128 | | |
| | 2 | 3 | $1\frac{1}{4}$ | $\frac{3}{4}$ | 6 | 1,056 | |
| | | | | | | 4,844 | 10,460 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 7. *Jambs masonry* | | | | | | | | | |
| Same as subhead 6 (d) | | ... | ... | . | ... | ... | 1,056 | 1,056 | 1,056 c. ft. |
| 8. *R. B Lintel work* | | | | | | | | | |
| Same as subhead 6 (b) | | ... | ... | ... | ... | ... | 390 | 390 | 390 c. ft. |
| 9. *Salwood work in Chowkhats* | | | | | | | | | |
| Doors | $10' \times 12'$ | ... | 1 | 34 | $\frac{5}{12}$ | $\frac{5}{12}$ | 5·9 [1] | | |
| Doors | $8' \times 12'$ | ... | 4 | 32 | $\frac{5}{12}$ | $\frac{5}{12}$ | 22·2 | | |
| Doors | $5' \times 10'$ | ... | 10 | 30 | $\frac{1}{3}$ | $\frac{5}{12}$ | 41·7 [2] | | |
| Windows | $4' \times 7'$ | ... | 34 | 26 | $\frac{1}{3}$ | $\frac{5}{12}$ | 122·8 } [3] | | |
| Ditto | $3' \times 7'$ | ... | 2 | 23 | $\frac{1}{3}$ | $\frac{5}{12}$ | 6·4 } | | |
| Clerestories | $10' \times 2\frac{1}{2}'$ | ... | 1 | 25 | $\frac{1}{4}$ | $\frac{1}{3}$ | 2·1 | | |
| Ditto | $8' \times 2\frac{1}{2}'$ | ... | 1 | 21 | $\frac{1}{4}$ | $\frac{1}{3}$ | 1·8 | | |
| Ditto | $5' \times 2\frac{1}{2}'$ | ... | 10 | 15 | $\frac{1}{4}$ | $\frac{1}{3}$ | 12·5 | | |
| Ditto | $4' \times 2\frac{1}{2}'$ | ... | 34 | 13 | $\frac{1}{4}$ | $\frac{1}{3}$ | 36·8 | | |
| Ditto | $3' \times 2\frac{1}{2}'$ | .. | 2 | 11 | $\frac{1}{4}$ | $\frac{1}{3}$ | 1·8 | | |
| | | | | | | | | 254 | 254 c. ft. |

(1) Door Chowkhats are of three pieces only, there being no sill.
(2) Doors Chowkhats are of four pieces, there being no sill but a fanlight.
(3) Window Chowkhats are of five pieces, there being a fanlight also.

| Serial number and name of sub-head and details of work. | Dimensions | | | | Number contents or area. | Total. | Grand total |
|---|---|---|---|---|---|---|---|
| | Number. | Length. | Breadth. | Height or depth. | | | |
| *(10) Holdfasts.* | | | | | | | |
| Doors 10′×12′ ... ... | 1×8 | ... | ... | ... | 8 | | |
| Ditto 8′×12′ ... ... | 4×8 | ... | ... | ... | 32 | | |
| Ditto 5′×10′ ... ... | 10×6 | ... | .. | ... | 60 | | |
| Windows 4′×7′ ... ... | 34×6 | ... | ... | ... | 204 | | |
| Ditto 3′×7′ ... ... | 2×6 | ... | ... | ... | 12 | | |
| Clerestories 10′×2½′ ... | 1×2 | ... | ... | .. | 2 | | |
| Ditto 8′×2½′ ... | 1×2 | ... | ... | ... | 2 | | |
| Ditto 5′×2½′ .. | 10×2 | ... | ... | ... | 20 | | |
| Ditto 4′×2½′ ... | 34×2 | ... | ... | ... | 68 | | |
| Ditto 3′×2½′ ... | 2×2 | ... | ... | ... | 4 | | |
| | | | | | | 412 | 412 No. |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| *(11) 2" thick Teakwood doors $\frac{2}{3}$ glazed with $\frac{1}{4}$" thick plate-glass and $\frac{1}{3}$ panelled $\frac{1}{2}$" thick.* | | | | | | | |
| Doors $10' \times 12'$ ... ... | 1 | $9\frac{1}{4}$ | $11\frac{1}{4}$ | | 104·0 | | |
| Ditto $8' \times 12'$ ... .. | 4 | $7\frac{1}{4}$ | $11\frac{1}{4}$ | | 326·3 | | |
| Ditto $5' \times 10'$ ... ... | 10 | $4\frac{5}{12}$ | $9\frac{5}{12}$ | (a) | 415·9 | | |
| Windows $4' \times 7'$ ... ... | 34 | $3\frac{5}{12}$ | $6\frac{5}{12}$ | (b) | 745·4 | | |
| Ditto $3' \times 7'$ ... ... | 2 | $2\frac{5}{12}$ | $6\frac{6}{12}$ | (b) | 31·0 | | |
| Clerestories $10' \times 2\frac{1}{2}'$ ... | 1 | $9\frac{7}{12}$ | $2\frac{1}{12}$ | (b) | 20·0 | | |
| Ditto $8' \times 2\frac{1}{2}'$ ... | 1 | $7\frac{7}{12}$ | $2\frac{1}{12}$ | (b) | 15·8 | | |
| Ditto $5' \times 2\frac{1}{2}'$ ... | 10 | $4\frac{7}{12}$ | $2\frac{1}{12}$ | (b) | 95·4 | | |
| Ditto $4' \times 2\frac{1}{2}'$ ... | 34 | $3\frac{7}{12}$ | $2\frac{1}{12}$ | (b) | 253·8 | | |
| Ditto $3' \times 2\frac{1}{2}'$ ... | 2 | $2\frac{7}{12}$ | $2\frac{1}{12}$ | (b) | 10·8 | 2018 4 | |
| Deduct items marked (a) and (b) above. | ... | ... | ... | ... | ... | 1588 1 | 430 3 sq. ft. |
| *(12) 1½" thick teak framed doors $\frac{2}{3}$ glazed and $\frac{1}{3}$ panelled.* | | | | | | | |
| Items marked (a) in subhead (11) | ... | ... | ... | .. | 415·9 | 415·9 | 415·9 sq. ft. |

| Serial number and name of sub-head and details of work. | Dimensions. Number. | Length. | Breadth. | Height or depth. | Number contents or area. | Total. | Grand total. |
|---|---|---|---|---|---|---|---|
| (*13*) $1\frac{1}{2}''$ *thick glazed windows and clerestories.* | | | | | | | |
| Items marked (*b*) in subhead (*11*) | ... | .. | .. | ... | 1,172·2 | 1,172·2 | 1,172·2 sq. ft. |
| (*14*) *R. S. joists for roof.* | | | | | | | |
| $18'' \times 6'' \times 55$ lb. girders $17 \times 27 \times 55$. | ... | ... | ... | ... | 25,245 | | |
| $18'' \times 6'' \times 55$ lb. girders $2 \times 30 \times 55$. | | | | | 3,300 | 28,545 | = 254·9 cwt. |
| Note.—Length of girders also includes 11' bearing on both ends. | | | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| (15) *Boxing roof girders.* | | | | | | | |
| | 17 | 25 | ... | ... | 425 | | |
| | 2 | 28 | ... | ... | 56 | 481 | 481 ft. |
| (16) *Bed stones for girders.* | 19 × 2 | $1\frac{1}{2}$ | $1\frac{1}{4}$ | $\frac{1}{2}$ | 36 c. ft | 36 | 36 c. ft. |
| (17) *Reinforced brickwork slab 6" thick.* | | | | | | | |
| Front portion ... | 1 | $103\frac{3}{4}$ | $26\frac{1}{4}$ | $\frac{1}{2}$ | 1,362 | | |
| Front portion proj. ... | 1 | $26\frac{1}{4}$ | 3 | $\frac{1}{2}$ | 39 | | |
| Back portion ... | 1 | $151\frac{1}{4}$ | $26\frac{1}{4}$ | $\frac{1}{2}$ | 1,985 | 3,386 | 3,386 c. ft. |
| (18) *Roof concrete $4\frac{1}{2}$" mean thickness* $\left(\frac{6''+3''}{2}\right)$ | | | | | | | |
| $\frac{3}{4}$ of subhead No. 16 | | $\frac{3}{4}$ × | 3,386 | ... | 2,540 | 2,540 | 2,540 c. ft. |
| (19) *Ceiling plaster of (1 : 4) cement mortar.* | | | | | | | |
| Front portion ... | 1 | $102\frac{1}{2}$ | 25 | ... | 2,563 | | |
| Front portion project ... | 1 | 25 | 3 | ... | 75 | | |
| Back portion ... | 1 | 150 | 25 | ... | 3,750 | 6,388 sq. ft. | |
| Deduct:— | | | | | | | |
| For boxing joists ... | 17 | 25 | 1 | ... | 425 | | |
| For boxing joists ... | 2 | 28 | 1 | ... | 56 | 481 | 5,907 sq. ft. |

| Serial number and name of sub-head and details of work. | Dimensions. | | | | Number contents or area. | Total. | Grand total. |
|---|---|---|---|---|---|---|---|
| | Number. | Length. | Breadth. | Height or depth. | | | |
| (20) *Inside plaster of walls : 5 cement mortar.* | | | | | | | |
| Front portion all round (Length $=102\frac{1}{2}'+102\frac{1}{2}'+25'+25'+3'+3''=261'$) ... | 1 | 261 | 17 | ... | 4,437 | | |
| Back portion long walls ... | 2 | 150 | 17 | ... | 5,100 | | |
| Short walls ... ... | 4 | 25 | $15\frac{1}{2}$ | ... | 1,550 | | |
| End walls ... ... | 2 | 25 | 17 | ... | 850 | 11,937 | |
| Deduct (i) :— | | | | | | | |
| For ends of partition walls in back portion ... | $2\times2$ | $1\frac{1}{4}$ | $15\frac{1}{2}$ | ... | 78 | | |
| For internal door-openings | 3 | 8 | 12 | ... | 288 | 366 | 11,571 sq. ft. |
| (i) The door-openings have been deducted once only; one side being allowed for plastering on jambs and lintels. | | | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| (21) *Outside plaster of walls (1 : 5) cement mortar.* | | | | | | |
| Front wall ... ... | 1 | $106\frac{1}{4}$ | $16\frac{3}{4}$ | ... | 1,780 | |
| Front wall projection ... | 2 | 3 | $16\frac{3}{4}$ | .. | 101 | |
| Front wall pillar projetion ... | 2 × 6 | $\frac{5}{12}$ | $16\frac{3}{4}$ | | 84 | |
| Front portion end walls ... | 2 | $28\frac{3}{4}$ | $16\frac{3}{4}$ | .. | 963 | |
| Front portion end walls pillar projection ... | 2 × 2 | $\frac{5}{12}$ | $16\frac{3}{4}$ | ... | 28 | |
| Front portion back wall ... | 2 | $39\frac{3}{8}$ | $16\frac{3}{4}$ | ... | 1,319 | |
| Front portion pillar projection .. | 2 × 6 | $\frac{5}{12}$ | $16\frac{3}{4}$ | .. | 84 | |
| Back portion long wall ... | 2 | $151\frac{7}{8}$ | $16\frac{3}{4}$ | . . | 5,088 | |
| Back portion wall pillar projection. | 2 × 24 | $\frac{5}{12}$ | $16\frac{3}{4}$ | ... | 335 | |
| Back portion end wall ... | 1 | $28\frac{3}{4}$ | $16\frac{3}{4}$ | ... | 482 | |
| Back portion end wall pillar projeciion ... | 2 | $\frac{5}{12}$ | $16\frac{3}{4}$ | ... | 14 | |
| | | | | | | 10,278 |
| Deduct :— | | | | | | |
| *External doors and windows.* | | | | | | |
| Doors 10′ × 12′ ... ... | 1 | 10 | 12 | ... | 120 | |
| Doors 8′ × 12′ ... ... | 1 | 8 | 12 | ... | 96 | |
| Doors 5′ × 10′ ... ... | 10 | 5 | 10 | ... | 500 | |
| Carried over ... | ... | ... | ... | ... | 716 | |

| Serial number and name of sub-head and details of work. | Dimensions. Number. | Length. | Breadth. | Height or depth. | Number contents or area | Total. | Grand total. |
|---|---|---|---|---|---|---|---|
| Brought forward ... | .. | ... | ... | ... | 716 | | |
| Windows $4' \times 7'$ ... ... | 34 | 4 | 7 | ... | 952 | | |
| Ditto $3' \times 7'$ ... ... | 2 | 3 | 7 | ... | 42 | | |
| Clerestories $10' \times 2\frac{1}{2}'$ ... | 1 | 10 | $2\frac{1}{2}$ | ... | 25 | | |
| Ditto $8' \times 2\frac{1}{2}'$ ... | 1 | 8 | $2\frac{1}{2}$ | ... | 20 | | |
| Ditto $5' \times 2\frac{1}{2}'$ .. | 10 | 5 | $2\frac{1}{2}$ | .. | 125 | | |
| Ditto $4' \times 2\frac{1}{2}'$ ... | 34 | 4 | $2\frac{1}{2}$ | ... | 340 | | |
| Ditto $3' \times 2\frac{1}{2}'$ ... | 2 | 3 | $2\frac{1}{2}$ | .. | 15 | | |
| | | | | | | 2,235 | 8,043 |
| (22) *Plinth plaster up to 6" below ground level (1 : 4) cement plaster rendered with neat cement* .. | | | | | | | |
| | 1 | $106\frac{2}{3}$ | 2 | ... | 213 | | |
| | 2 | 3 | 2 | ... | 12 | | |
| | $2 \times 6$ | $\frac{5}{6}$ | 2 | ... | 20 | | |
| | 2 | $29\frac{1}{6}$ | 2 | ... | 117 | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | 2×2 | $\frac{5}{6}$ | 2 | | 7 | | |
| | 2 | $39\frac{7}{12}$ | 2 | | 158 | | |
| | 2×6 | $\frac{5}{6}$ | 2 | | 20 | | |
| | 2 | $151\frac{7}{24}$ | 2 | | 605 | | |
| | 2×24 | $\frac{5}{6}$ | 2 | | 80 | | |
| Note—No deduction has been made in plinth plaster for steps, this being allowed for their ends. | 1 | $29\frac{1}{6}$ | 2 | | 58 | | |
| | 2 | $\frac{5}{6}$ | 2 | | 3 | | |
| | | | | | | 1,293 | 1,293 sq ft. |
| (23) *Patta projection at plinth plaster only with (1 : 3) cement plaster rendered with neat cement.* | 1 | $106\frac{2}{3}$ | ... | ... | 10. | | |
| | 2 | 3 | ... | ... | 6 | | |
| | 2×6 | $\frac{5}{6}$ | ... | ... | 10 | | |
| | 2 | $29\frac{1}{6}$ | ... | ... | 58 | | |
| | 2×2 | $\frac{5}{6}$ | ... | ... | 3 | | |
| | 2 | $39\frac{7}{12}$ | ... | ... | 79 | | |
| | 2×6 | $\frac{5}{6}$ | ... | ... | 10 | | |
| | 2 | $151\frac{7}{24}$ | ... | ... | 303 | | |
| | 2×24 | $\frac{5}{6}$ | ... | ... | 40 | | |
| | 1 | $29\frac{1}{6}$ | ... | ... | 29 | | |
| | 2 | $\frac{5}{6}$ | ... | ... | 2 | | |
| | | | | | | 647 | 647 ft. |

| Serial number and name of subhead and details of work. | *Dimensions.* Number. | Length. | Breadth. | Height or depth. | Number contents or area. | Total. | Grand total. |
|---|---|---|---|---|---|---|---|
| (24) $1\frac{1}{2}''$ *(1 : 2 : 4) cement concrete Patent stone floor over $4\frac{1}{2}''$ lime concrete.* | | | | | | | |
| Front portion ... | 1 | $102\frac{1}{2}$ | 25 | ... | 2,563 | | |
| Front portion projection ... | 1 | 25 | 3 | | 75 | | |
| Back portion ... | 1 | 150 | 25 | .. | 3,750 | 6,388 | |
| Deduct :— | | | | | | | |
| For two partition walls ... | 2 | $1\frac{1}{4}$ | 25 | ... | 63 | 63 | 6,325 sq. ft. |
| (25) *Cornice 15″ projection.* | | | | | | | |
| Bring over subhead (23) patta at plinth ... | ... | ... | ... | ... | 647 | | |
| Add for projections at four corners ... ... | 4 | 1 | .. | ... | 4 | 651 | 651 ft. |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| NOTE :--Projections at the remaining four corners have been cancelled with deducting at the four re-entrant points. | | | | | | | |
| (26) *Bases of windows.* | | | | | | | |
| Windows $4' \times 7'$ ... | 34 | ... | ... | ... | 34 | | |
| Windows $3' \times 7'$ ... | 2 | ... | ... | .. | 2 | 36 | 36 No. |
| (27) *Mouldings at bases and caps of pillars.* | | | | | | | |
| Front wall ... ... | 12 | ... | ... | ... | 12 | | |
| Front portion end wall .. | $2 \times 2$ | ... | ... | ... | 4 | | |
| Front portion back wall ... | $4 \times 2$ | ... | ... | ... | 8 | | |
| Back portion long ... | $13 \times 2$ | ... | ... | ... | 26 | | |
| Back portion end ... | 2 | ... | ... | ... | 2 | 52 | 52 No. |
| (28) *$1\frac{1}{2}''$ dressed stone-work in steps.* | | | | | | | |
| Including risers & treads ($6''+15''=1'\ 9''$) | $8 \times 2$ | $5\frac{3}{4}$ | $1\frac{3}{4}$ | ... | 161 | 161 | 161 sq. ft. |

| Serial number and name of sub-head and details of work. | Dimensions. Number. | Length | Breadth. | Height or depth. | Number contents or area. | Total. | Grand total. |
|---|---|---|---|---|---|---|---|
| 29. *Parapet wall on top 1' high & 10" thick with 15" pillars.* | | | | | | | |
| Front wall | 1 | 105 | ... | ... | 105 | | |
| ,, ,, projects . | 2 | 3 | ... | ... | 6 | | |
| ,, ,, portion short... | 2 | $25\frac{5}{6}$ | ... | ... | 52 | | |
| ,, ,, back .. | 1 | $79\frac{1}{6}$ | 105' – 25' 10" = 79'2" | ... | 79 | | |
| Back portion long ... | 2 | $151\frac{1}{4}$ | | ... | 303 | | |
| ,, ,, end ... | 1 | $25\frac{5}{6}$ | | ... | 26 | 571 | 571 ft. |
| 30. *Whitewash.* | | | | | | | |
| Same as inside plaster of walls *plus* ceiling plaster subheads 18 and 19 | ... | ... | . | ... | 5,907 | | |
| | | | ... | .. | 11,571 | 17,478 | 17,478 s. ft. |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| *31. Outside colourwash* Same as outside plaster of walls subhead 21 ... | | ... | ... | ... | ... | 8,043 | 8,043 | 8,043 s. ft. |
| *32. Painting & varnishing doors and windows* *Note*:—Two and a half times the face area of opening is allowed. | | | | | | | | |
| Doors | 10′×12′ | $1\times2\frac{1}{2}$ | 10 | 12 | ... | 300 | | |
| | 8′×12′ | $4\times2\frac{1}{2}$ | 8 | 12 | ... | 960 | | |
| | 5′×10′ | $10\times2\frac{1}{2}$ | 5 | 10 | .. | 1,250 | | |
| Windows | 4′×7′ | $34\times2\frac{1}{2}$ | 4 | 7 | ... | 2.380 | | |
| | 3′×7′ | $2\times2\frac{1}{2}$ | 3 | 7 | ... | 105 | | |
| Clerestories | 10′×$2\frac{1}{2}$′ | $1\times2\frac{1}{2}$ | 10 | $2\frac{1}{2}$ | ... | 63 | | |
| | 8′×$2\frac{1}{2}$′ | $1\times2\frac{1}{2}$ | 8 | $2\frac{1}{2}$ | ... | 50 | | |
| | 5′×$2\frac{1}{2}$′ | $10\times2\frac{1}{2}$ | 5 | $2\frac{1}{2}$ | .. | 313 | | |
| | 4′×$2\frac{1}{2}$′ | $34\times2\frac{1}{2}$ | 4 | $2\frac{1}{2}$ | ... | 850 | | |
| | 3′×$2\frac{1}{2}$′ | $2\times2\frac{1}{2}$ | 3 | $2\frac{1}{2}$ | ... | 38 | | |
| | | | | | | | 6,309 | 6,309 s. ft. |

## Abstract of Estimated Cost

| Serial subhead number. | Quantity. | Denomination. | Subheads of works. | Rate. Rs. | as. | p. | Per. | Estimated cost. Rs. | Remarks. |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 5,658 | c. ft. | Excavation of foundations ... | 5 | 0 | 0 | °/oo c. ft. | 28 | |
| 2 | 2,859 | ,, | Foundation concrete ... | 18 | 0 | 0 | °/o c. ft. | 515 | |
| 3 | 9,581 | ,, | Earth filling watered and rammed ... ... | 5 | 0 | 0 | /oo c. ft | 48 | |
| 4 | 3,392 | ,, | First brickwork in lime in foundations and plinth ... | 21 | 0 | 0 | °/o c. ft. | 712 | |
| 5 | 479 | ,, | First brickwork in cement mortar (1 : 6) in plinth ... | 26 | 0 | 0 | °/o c ft. | 139 | |
| 6 | 10,460 | ,, | First brickwork in lime in superstructure ... | 22 | 0 | 0 | °/o c. ft | 2,301 | |
| 7 | 1,056 | ,, | Cut brickwork in jambs, etc. ... | 25 | 0 | 0 | °/o c ft. | 264 | |
| 8 | 390 | ,, | Reinforced brickwork in lintels | 68 | 0 | 0 | °/o c. ft. | 265 | |
| 9 | 254 | ,, | Salwood work in chowkhats ... | 3 | 0 | 0 | c. ft | 762 | |
| 10 | 412 | No. | Holdfasts ... ... | 3 | 0 | 0 | each | 77 | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 11 | 430·3 | s ft. | 2″ thick teakwood doors $\frac{2}{3}$ glazed with $\frac{1}{4}$″ thick plate glass and $\frac{1}{3}$ panelled in $1\frac{1}{2}$″ thick teakwood ... ... | 2 | 0 | 0 | sq ft | 861 |
| 12 | 415·9 | s. ft. | $1\frac{1}{2}$″ thick teak-framed doors, $\frac{2}{3}$ glazed and $\frac{1}{3}$ panelled ... | 1 | 8 | 0 | sq ft | 624 |
| 13 | 1,172·2 | s. ft. | $1\frac{1}{2}$″ thick glazed windows and clerestories ... | 1 | 6 | 0 | sq. ft. | 1,612 |
| 14 | 254·9 | cwt. | R. S. joists for roof including hoisting ... ... | 10 | 0 | 0 | cwt. | 2,549 |
| 15 | 481 | ft. | Boxing roof girders ... | 1 | 8 | 0 | r. ft | 481 |
| 16 | 36 | c ft. | Bed stones for girders ... | 2 | 0 | 0 | c ft. | 72 |
| 17 | 3,386 | c. ft. | Reinforced brickwork slab 6″ thick ... .. | 80 | 0 | 0 | °/o c. ft | 2,709 |
| 18 | 2,540 | c. ft. | Roof concrete ... .. | 35 | 0 | 0 | °/o c. ft | 889 |
| 19 | 5,907 | s. ft | Ceiling plaster of (1 : 4) cement mortar ... ... | 4 | 8 | 0 | °/o sq. ft. | 266 |
| 20 | 11,571 | s. ft. | Inside plaster of wall of (1 : 5) cement mortar ... | 4 | 1 | 0 | °/o sq. ft. | 492 |
| | | | | | | | | 15,566 |
| | | | Carried over ... ... ... | | | | | 15,666 |

| Serial subhead number. | Quantity | Denomination. | Subheads of works. | Rate. Rs. a. p. | Per. | Estimated cost. Rs. | Remarks. |
|---|---|---|---|---|---|---|---|
| | | | Brought forward ... | ... | | 15,666 | |
| 21 | 8,043 | s. ft. | Outside plaster of walls (1 : 5) Cement mortar ... ... | 4 4 0 | % s. ft | 342 | |
| 22 | 1,293 | s ft. | Plinth plaster ... .. | 5 0 0 | % s. ft. | 65 | |
| 23 | 647 | r. ft. | Patta projection at plinth : Plaster only in (1 : 3) Cement mortar rendered with neat Cement ... ... | 0 2 0 | ft. | 81 | |
| 24 | 6,325 | s. ft | $1\frac{1}{2}''$ (1 : 2 : 4) cement concrete Patent stone floor over $4\frac{1}{2}''$ lime concrete. | | | | |
| 25 | 651 | ft. | Cornice 15' projection ... | 1 0 0 | r.ft. | 651 | |
| 26 | 36 | No. | Bases of windows ... | 1 0 0 | each | 36 | |
| 27 | 52 | No. | Mouldings at bases and caps of pillars ... ... | 4 0 0 | each pillar | 208 | |
| 28 | 161 | s.ft. | $1\frac{1}{2}''$ thick-dressed stonework in steps ... ... | 0 8 0 | s. ft. | 81 | |

| Serial sub-head number. | Quantity. | Denomination. | Sub-heads of works. | Rate. | Per. | Estimated cost. | Remarks. |
|---|---|---|---|---|---|---|---|
| | | | | Rs. a. p. | | Rs. | |
| | | | Brought forward ... | ... | ... | 17,130 | |
| 29 | 571 | ft. | Parapet wall on top ... | 0 8 0 | r. ft. | 286 | |
| 30 | 17,478 | s. ft. | Whitewash ... ... | 0 4 0 | °/o s ft. | 44 | |
| 31 | 8,043 | s. ft. | Outside colourwash ... | 0 6 0 | °/o s ft. | 31 | |
| 32 | 6,309 | s ft. | Painting and varnishing doors and windows. | 3 0 0 | °/o s.ft. | 89 | |
| | | | Total of the above .. | | | 17,580 | |
| | | | Contingencies 5 per cent. ... | | | 879 | |
| | | | Total of estimated cost ... | | | 18,459 | |

| | | |
|---|---|---|
| | Add charges for Establishment ,, ,, Tools and Plants — per cent. ,, — Total 5 ,, | 18,459<br>923 |
| | GRAND TOTAL, ESTIMATED COST FOR SANCTION ... | 19,382 |
| | Rupees nineteen thousand, three hundred and eighty-two only. | |

| Examined, checked and approved by | | Framed by |
|---|---|---|
| *Superintending Engineer,* | *Executive Engineer,* | *Signature*—— |
| *Dated*—— | *Dated*—— | *Departmental rank*—— |

*Statement of materials required*

| Serial number of estimate. | Quantity. | Sub-heads of works. | Bricks 1st class. | Brick ballast for founds. | Brick ballast fine for roof. | White stone lime. |
|---|---|---|---|---|---|---|
| 2 | 2,859 c. ft. | Foundation concrete. | ... | 3,145 c. ft. | .. | 314·5 c. ft. |
| 4 | 3,392 c. ft. | First brick-work in lime in founds and plinth. | 35,616 | ... | ... | 373 c. ft. |
| 5 | 479 c. ft. | First brick-work in cement. | 5,030 | ... | ... | ... |
| | | Mortar (1:6) in plinth. | | | | |
| 6 | 10,460 c. ft. | First b. w. end line in superstructure. | 1,09,841 | ... | ... | 1150·7 c. ft. |
| 7 | 1,056 c. ft. | Cut b. w. in jambs, etc. | 11,088 | ... | ... | 116·2 |
| | | Carried over | 1,61,575 | 3,145 | ... | 19,54·4 |

*for the Ceramic shed.*

| Beri lime. | Cement. | M.s. rods. | Sand. | Cinder | Fine stone ballast. | Remarks. |
|---|---|---|---|---|---|---|
| ... | ... | ... | 315 | 315 | ... | Per 100 c. ft. of rammed concrete ballast 110 c. ft. (lime 11 c. ft., sand 11, cinder 11), mortar 33 c. ft. |
| ... | ... | ... | 373 | 373 | ... | Per 100 c. ft. of b. w. bricks 1050 : Lime 11 c. ft., sand 11 c. ft., cinder 11 c. ft., mortar 33 c. ft. |
| ... | 22·6 | ... | 135 | ... | ... | Per 100 c. ft. of b. w. bricks 1050: cement $4\frac{5}{7}$ c ft, sand 28 c. ft, mortar 33 c ft. |
| ... | ... | ... | 1,151 | 1,151 | ... | Same as item No. 4. |
| ... | ... | ... | 116 | 116 | ... | Same as item No. 4. |
| | 22·6 | | 2090 | 1955 | 1955 | |

| Serial number of estimate. | Quantity. | Sub-heads of works. | Bricks 1st class. | Brick ballast for founds. | Rrick ballast fine for roof. | White stone lime. |
|---|---|---|---|---|---|---|
| | | Bt. forward .. | 1,61,575 | 3,145 | ... | 1954·4 |
| 8 | 390 c. ft. | Reinforced b. w. in lintels. | 3,900 | ... | ... | ... |
| 17 | 3,386 c. ft. | Reinforced brickwork slab. | 33,860 | ... | ... | ... |
| 18 | 2,540 c. ft. | Roof concrete | ... | ... | 2,794 c. ft. | ... |
| 19 | 5,907 s. ft. | Ceiling plaster (1 : 4) cement mortar. | ... | ... | ... | ... |
| 20 | 11,571 s. ft. | Inside plaster (1 : 5) cement mortar. | ... | ... | ... | ... |
| 21 | 8,043 s. ft. | Outside plaster of walls (1:5) cement mortar. | ... | ... | ... | ... |
| | | Carried over | 1,99,335 | 3,145 | 2,794 | 1,954·4 |

| Beri line. | Cement. | M. s. rods. | Sand. | Cinder. | Fine stone ballast. | Remarks. |
|---|---|---|---|---|---|---|
| ... | 22·6 | ... | 2,090 | 1,955 | ... | |
| ... | 39·0 c. ft. | 9·75 cwt. | 98 c. ft. | ... | ... | Per 100 c. ft.:— Bricks 1000, cement 10 c. ft., sand 25 c. ft., m. s. rods $2\frac{1}{2}$ cwt. |
| ... | 338·6 c. ft. | 118·51 cwt. | 847 c. ft. | ... | ... | Per 100 c. ft.:— Bricks 1000, cement 10 c. ft., sand 25 c. ft., m. s. rods $3\frac{1}{2}$ cwt. |
| 701 c. ft. | ... | ... | ... | 671 c. ft. | ... | Ballast 110 c. ft. cinders $13\frac{2}{5}$ c. ft., lime $\frac{88}{5}$ c. ft. + 10 c. ft. for rendering. |
| ... | 59·1 c. ft. | ... | 236 c. ft. | ... | ... | 5 c. ft. of dry mortar per 100 s. ft., *i.e.*, 1 c. ft. cement, 4 c. ft. sand. |
| ... | 115 7 c. ft. | ... | 579 c. ft. | ... | ... | 6 c. ft. dry mortar per 100 s. ft., *i.e.*, 1 c. ft. cement, 5 c. ft. sand. |
| ... | 80·4 c. ft. | ... | 402 c. ft. | ... | ... | Same as above. |
| 701 | 655.4 | 128 26 | 4252 | 2626 | | |

| Serial number of estimate. | Quantity. | Sub-heads of works. | Bricks 1st class. | Brick ballast for founds. | Brick ballast fine for roof. | White stone lime. |
|---|---|---|---|---|---|---|
| | | Bt. forward ... | 1,99,335 | 3,145 | 2,794 | 1,954·4 |
| 22 | 1,293 s. ft. | Plinth plaster (1 : 4) | ... | ... | ... | ... |
| 23 | 643 s. ft. | Patta projection at plinth (1 : 3) cement mortar plaster. | ... | ... | . | ... |
| 24 | 6,325 s. ft. | $1\frac{1}{2}''$ (1 : 2 : 4) cement concrete patent stone floor over $4\frac{1}{2}''$ lime concrete. | ... | 2,601 | ... | 260·1 |
| 25 | 651 ft. | Cornice 15" projection. | 10,932 | ... | ... | 114·5 |
| 26 | 36 No. | Bases of windows. | ... | ... | ... | ... |
| | | Carried over ... | 2,10,267 | 5,746 | 2794 | 2,329·0 |

| Beri lime. | Cement. | M. s. rods. | Sand. | Cinder. | Fine stone ballast. | Remarks. |
|---|---|---|---|---|---|---|
| 701 | 655·4 | 128·26 | 4,252 | 2,626 | ... | |
| ... | 15·5 c. ft. | ... | 62 c. ft. | ... | ... | 6 c. ft. of dry mortar per 100 s. ft., *i.e.*, 1·2 c. ft. cement 4·8 c. ft. sand. |
| . | 7·3 c. ft. | ... | 22 c. ft. | ... | ... | Plaster per ft. length=$\frac{3}{4}$ sq. ft. Allow six c. ft. of dry mortar of given ratio per 100 s. ft. |
| ... | 237·2 c. ft. | . | 348 (For P. stones). 260 (For lime concrete). | 260 (For lime concrete). | 696 c. ft. | For lime concrete allow as per found concrete. For patent stone allow 11 c. ft. of fine stone ballast, $5\frac{1}{2}$ c. ft. sand, $3\frac{3}{4}$ c. ft. of cement per 100 s. ft. of patent stone floor. |
| ... | 39·1 c. ft. | .. | 115 (For b. w.) 156 (For plaster) | 115 | ... | Lime masonry per ft. run $1 \times \frac{5}{4} \times \frac{5}{4} = 1·6$ c. ft. (1:4) Plaster per ft run=2 $\frac{5}{4} \times \frac{5}{4}$ =5 s. ft. |
| ... | 1·7 c. ft. | ... | 7 c. ft. | | | |
| 701 | 956·2 | 128·26 | 5222 | 3001 | 696 | |

| Serial number of estimate | Quantity. | Sub-heads of works. | Bricks 1st class | Brick ballast for founds. | Brick ballast fine for roof. | White stone lime. |
|---|---|---|---|---|---|---|
| | | Bt. forward ... | 2,10,267 | 5,746 | 2,794 | 23,290 |
| 29 | 571 ft. | Parapet wall on top. | 5,250 | ... | ... | 55 c ft. |
| 30 | 17,478 s. ft | Whitewash inside. | ... | ... | ... | 26·2 c. ft. |
| 31 | 8,043 s. ft. | Outside colourwash. | ... | ... | ... | 12·1 c. ft. |
| | | Total ... | 2,15,517 | 5,746 | 2,794 | 2,422·3 or 807 mds. |
| | | Rate ... | 11/-°/oo | 8/-°/o c. ft. | 9/-°/o c. ft. | 65/-°/o mds. |
| | | Cost ... | Rs. 2,370 | Rs. 460 | Rs. 251 | Rs. 525 |

Total cost of materials. Rs. 7,127

| Beri lime. | Cement. | M. s. rods. | Sand. | Cinder. | Fine stone ballast | Remarks |
|---|---|---|---|---|---|---|
| 701 | 956·2 | 128,26 | 5,222 | 3,001 | 696 | |
| ... | 17·5 | ... | 55 (For b. w.) 88 (For plaster). | 55 | ... | Total masonry No. $571 \times \frac{5}{6} \times 1$ $=476$ c ft. Add for pillars 46 No. $46 \times \frac{5}{12} \times \frac{5}{4} \times 1 = 25$ c. ft. Total (1:4) Plaster $=571 \times 3 = 1,713$ s. ft. Add for pillars$=46 \times \frac{5}{6} \times 1 = 40$ s. ft. $=$ 1,753 s. ft. |
| ... | ... | ... | ... | ... | ... | Allow per 1,000 s. ft. 1½ c. ft. of white lime. Allow 1½ c. ft. of white lime per 1000 s. ft |
| 701 | 973·7 or 779 bags. | 128·26 cwt. | 5,365 c. ft. | 3,056 | 696 | |
| 30/- °/o c. ft | 2/12/- boy | 7 cub | 6/-°/o c. ft. | 8/-°/o c. ft. | 20/-°/o c. ft. | |
| Rs. 210 | Rs. 2,142 | Rs. 898 | Rs 322 | Rs. 244 | Rs 139 | |

Total cost of materials Rs. 7,561 apart from the cost of timber, etc.

## On Estimate of Interior Wiring.

When the building is finished, we come to interior wiring. Note that if the plan of wiring is done beforehand during the construction of the building, then all holes in the wall for passing the wire and all hooks for suspending the fan, etc., and all plugs or slots for taking wiring in or through the wall, may be made more conveniently and economically.

I. Determine the purpose for which the area is to be used.

II. Find the intensity of illumination required from Table I, pages 56-60.*

Consult chart of important factors, page 54, and efficiency of utilization, pages 63, 64, and 72, 73.

Rating of lamps and fan points, page 199.

Note for artificial illumination :—

(1) Intensity of illumination.

(2) Sufficiency of illumination of unvarying intensity on all principal surfaces and to each person if working in a factory.

(3) The uniformity of illumination without regard to the location or the work.

(4) Reduction of glare :—Glaring reflections or blinding effect, to be minimised by—

(*i*) suitable arrangement of lamps,
(*ii*) using the proper size,
(*iii*) using a suitable reflector.

(5) Diffusion of illumination, and direction of light, avoiding objectionable shadows or contrasts of intensity.

(6) Steadiness of the light secured by using constant voltage of supply.

(7) Colour value of the light and colour balance. Violet produces the maximum chemical effect, yellow the maximum light effect. Red produces the maximum heat effect. The most luminous part of the spectrum is yellowish green.

(8) Appearance

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* All references are from the second Edition of "Illumination Engineering Practice," by B. C. Chatterjee.

(9) Efficiency.

(10) The type of lamp must be suitable to—

(*i*) the class of work requiring light,

(*ii*) the mounting height,

(*iii*) the physical surroundings.

(11) The lighting effect appropriate for the location and lighting units which must be in harmony with their surroundings, whether lighted or unlighted.

(12) Simplicity, reliability, ease of maintenance, initial and operating condition and cost not out of proportion to the results attained.

Heads of illumination consideration :—

(*i*) Intensity of brilliancy.

(*ii*) Distribution of light.

(*iii*) Diffusion of light.

(*iv*) Quality of light..

III. **The cost of illumination** :—The operating costs consist of three parts :—

(1) Fixed Charges—Interest on the initial capital outlay insurance, taxes, depreciation of permanent parts, regular attendance and other charges which are independent of the hours of use. Note that obsolescence rather than the wearing out of parts determines the life of a lighting system.

(2) Maintenance charges such as renewal of parts, labour and all costs except the cost of the energy supplied.

(3) The cost of energy—This depends upon the hours of burning and the rate of charge.

Cost of installation—

If A = area square feet to be illuminated.

n = number of lamps.

W = wattage of each lamp.

w = watts per square foot.

n = Aw/W number of lamps.

•The cost per point (lamp or fan) is determined from estimate. If the cost of installation is too high, the designer may reduce the watts per square foot to keep the cost within the amount available for the purpose.

Remember that "Generally speaking cleaning and renewals cost more than current"—Theory and Design of Illumination Engineering Equipment, by Jolly, Weldram and Wilson.

IV. Determine the size of the wire from calculation, and tables affixed, pages 233 and 235.

Determine fuse wire from table, page 236.

V. Determine the cost per unit.

Cost of installation :—

(1) Cost of mason for drilling holes in the wall for receiving the plugs or taking the wire through walls—this depends upon the nature of the wall—approximate cost Rs. 3 to Rs. 5 per hundred plug holes, and Rs. 25 to Rs. 40 per 100 holes in the wall.

(2) Labour for putting the plug—Cement, labour. Plugs must be put with the wider head buried in the wall and gap filled with cement.

(3) Wireman's labour--This depends upon the length of the circuit. For a complete point : Casing and Henley—Rs. 1-2 per point ; bare wire and cleat As. -/8/- to Re. 1/- per point.

(4) Cleats—Circular or clips screwed to the plugs.

(5) Screws—$\frac{1}{2}''$, $1''$, $\frac{3}{4}''$, $1\frac{1}{4}''$, $1\frac{1}{2}''$, $2\frac{1}{2}''$, and $3''$ to fix the cleats to the plugs or casing or battens, as the case may be, and for putting capings over casing.

(6) Casing and varnish—at least two coatings of varnish.

(7) Wires—Double the length of the distance from the cut-out connection or the mains.

(8) Flexible wire for pendants.

(9) Black tape, rubber tape and solution.

(10) Lampholder.

(11) Shade.

(12) Bulb.

(13) Ceiling rose.

(14) Bracket.

(15) Round block $4''$ diameter.

(16) Boards—$7'' \times 4''$ or $8'' \times 10''$ ;

Distribution board—$10'' \times 14''$, $12'' \times 20''$, $16'' \times 20''$

(17) Switch, with each lamp.
(18) In plug points, a plug.

Note that if 2 points are in one place, only 3 wires may be run from the mains.

(19) Cut out.
(20) Distribution board.
(21) Sub-distribution board.
(22) Fuse box and fuse.
(23) Mains, double the length from the metre board.
(24) Earthing wire and plate.

The price is fluctuating. Consult current price list.

## Wireman's Instruments and Tools

General :—

(1) Pliers—6" and 8".
(2) Screw driver—6", 12".
(3) Knife.
(4) Bradawl—6".
(5) Megger for testing when the installation is complete.

Casing :—

(1) Saw 12".
(2) Chisel—

| (flat and | round) |
|---|---|
| 1" | 1" |
| $\frac{3}{4}$" | $\frac{3}{4}$" |
| $\frac{1}{2}$" | $\frac{1}{2}$" |

(3) Trisquare.
(4) Gimlet.
(5) Drill.
(6) Hammer.
(7) Fitter's chisel.
(8) File.

VI. Determine the price of things from the price list as given in pages 243-260. Remember that the price is fluctuating.

## Calculation of the Size of Wire

(1) Find the number of lamps in a circuit and the power taken in the circuit—Table III, p. 69. (Table IX, p. 84; Tables, pp. 89 and 93).

(2) The voltage of supply is known; divide the power by the voltage and get the current that passes through the circuit.

(3) Find the size of the wire from the drop allowed from the following, drop allowed $= I \Sigma \rho \, l/A$.

(4) See in the table the size of the wire, and check whether it can be safely used.

*Note* :—Good practice shows the drop in potential to be within the following limits from feeding points (points where sub-feeders or mains are attached) to lamp 5 %.

Loss in sub-feeders 3 %.
Loss in mains 1.5 %.
Loss in service-wire 0.5 %
The actual voltage variation should not exceed 3 %.

## Limits of Current and Temperature in Cables

Mr. Kennelly has given the following formulæ for electric light cables for interiors of buildings where the conductor is enclosed in a wooden casing.

$I = 560 \cdot d^{3/2}$, d being in inches.

$I = 138 . d^{3/2}$, d being in centimetres.

I being the current in amperes which will raise the temperature of the conductor 10° C. from 24° C.

d=diameter of copper core of conductor.

**For Bare Overhead Wires** :—Prof. G. Forbes has given the current which can be carried without over-heating, as—

$$I^2 = D \frac{\pi^2 h}{4 \rho \cdot 24} = \frac{D^3 . t}{320 \cdot \rho}$$

Where :—

$I$=current in amperes.

$D$=diameter of wire in centimetres.

$t$=excess of temperature of wire over air in deg. C.

$h$=coefficient of radiation and convection=·0003.

$\rho$ =specific resistance of material at limiting temperature in ohms per cm. cub.

·24 = calories in a joule.

The usual limit of current density is 1000 amperes per square inch for house wiring, but higher densities may be used in small cables.

**General formula** for determining the sectional area of conductor :—

*For feeders and transmission lines.*

If kW. = kilowatts delivered at end of line.

$l$ = route in yards in length of line, not lead and return.

$E_r$ = voltage at the point of use.

$p$ = percentage loss of $E_r$,

$c$ = a constant as follows :—

(*i*) In continuous current or single-phase 2-wire system $c$ = 4·9, say 5.

(*ii*) In continuous current or single-phase 3-wire, outer conductors, pressure being given across outers $c$ = 4·9, say 5.

The neutral or middle were used in practice=0·625.

*N B.*—The neutral is generally taken as half the size of the outers in 3-phase star.

(*iii*) In continuous current or single-phase 3-wire, volts being given between outer and neutral ; outer conductors $c$ = 1·25.

(*iv*) In three-phase mesh or star system, pressure being given between any two phase wires $c$ = 2·5 each outer.

(*v*) In three-phase star system pressure being given between outer and neutral $c$ = 0·833.

PF = Power factor which is for lighting only = 0·95.

PF Mixed load, 2/3 light, 1/3 motor = 0·9.

PF Mixed load, 2/3 light, 1/3 motor = 0·9

PF Mixed load, 1/3 light, 2/3 motor = 0·85.

PF Motor load only = 0·8.

In single phase = 0 7.

$$\text{Area} = (\text{kW} \times l \times c)/(E_r^2 \times p \times \text{PF}).$$

(1) Current = watts delivered / $E_r$ , continuous current.

(2) For single-phase system, Current = watts delivered / $E_r$ × PF.

(3) Current = watts delivered/($E_r$ × $\sqrt{3}$ × PF) for three-phase system.

Note :—In practice it is seldom advisable to use a smaller wire than No. 6 S.W.G.

*** The estimating of a Railway will be studied from the following :**

*Abstract of Cost of Railway.*

| Heads of Account. | Total cost in Rupees. | | | |
|---|---|---|---|---|
| | Sub-heads. | | Main heads. | |
| | Total cost. | Rate per mile. | Total cost. | Rate per mile. |
| I. Preliminary expenses :— | | | | |
| (*a*) Survey expenses. | | | | |
| (*b*) Plant. | | | | |
| (*c*) Establishment. | | | | |
| II. Land : | | | | |
| III. Formation : | | | | |
| (*a*) Earthwork. | | | | |
| (*b*) Tunnels. | | | | |
| IV. Bridgework :— | | | | |
| (*a*) Major bridges | | | | |
| (*b*) Minor bridges. | | | | |
| V. Fencing. | | | | |
| (*a*) Fencing. | | | | |
| (*b*) Road crossing. | | | | |
| (*c*) Mile and gradient posts. | | | | |

Adopted from the "Report on final Location Survey and Estimates of Lucknow-Sultanpur-Zafarabad Railway Project," 1930.

| Heads of Account. | *Total cost of Rupees.* | | | |
|---|---|---|---|---|
| | Sub-heads. | | Main heads. | |
| | Total cost. | Rate per mile. | Total cost. | Rate per mile. |
| VI. Electric telegraph. | | | | |
| VII. Ballast and permanent way :— | | | | |
| (*a*) Ballast. | | | | |
| (*b*) Permanent way. | | | | |
| VIII. Stations and buildings :— | | | | |
| (*a*) Stations and offices. | | | | |
| (*b*) Workshops, store building, etc. | | | | |
| (*c*) Staff quarters. | | | | |
| (*d*) Station machinery. | | | | |
| IX. Plant :— | | | | |
| (*a*) Engineering. | | | | |
| (*b*) Construction. | | | | |
| (*c*) Locomotive. | | | | |
| (*d*) Carriage and wagon. | | | | |
| (*e*) Station and office furniture. | | | | |

| Heads of Account. | Total cost of Rupees. | | | |
|---|---|---|---|---|
| | Sub-heads. | | Main heads. | |
| | Total cost. | Rate per mile. | Total cost. | Rate per mile. |
| (*f*) Steamers or boats required for the general purposes of the railway, but not for public traffic. | | | | |
| *Heads of Account.* | | | | |
| X. Ferries, etc. :— | | | | |
| (*a*) Ferries. | | | | |
| (*b*) Floating | | | | |
| XI. Rolling stock bridge :— | | | | |
| (*a*) Locomotive. | | | | |
| (*b*) Carriage and wagon. | | | | |
| XII. General charges :— | | | | |
| (*a*) Direction. | | | | |
| (*b*) Engineering. | | | | |
| (*c*) Stores. | | | | |
| (*d*) Audit and account. | | | | |
| (*e*) Medical and sanitation. | | | | |
| (*f*) Locomotive. | | | | |
| (*g*) Traffic. | | | | |

Total expenditure......

Total rate per mile......

*General details of...ft...ins Gauge.*

## Standard of Construction.

| | | |
|---|---|---|
| Standard of construction | ... | C |
| Ruling grade ... | ... | 1 in 400 |
| Ruling curvature ... | ... | 4° |
| Ruling grade in station yard | ... | 1 in 1,000 |

Land.—Based on Railway Board's revised rules 1926. This must be obtained from the Civil Authorities concerned.

Formation.—Banks—18 ft with slopes 2 to 1. Turfing provided, and cutting 24 ft. including side drains—slopes 1 to 1 Catch water drains as necessary.

Bridgework.—Major bridges.—M. L. type. Small spans—LL.B. of 1903 *plus* 25 °/o.

Foundations.—Wells provided where considered necessary.

Masonry.—For single line only, formation width 20 ft.

Pipe culverts and siphons and R. C. slabs—Provided for irrigation drains and small openings.

Fencing.—At first and second class level crossings. through (Benares), and where line passes close to villages, as required by the Civil Authorities. Gate lodges and gates provided at first and second class level crossings.

Electric telegraphs.—A thorough rate of Rs. 525 per mile has been provided to cover requirements.

Ballast, permanent way and fittings.—Rails and fish plates.—85 lbs. B. H. 2nd hand. New fish bolts and spikes.

There are various **classes of materials** which are used in connection with permanent way of rails, such as noted below :—

| | |
|---|---|
| 1. Rails of 90 lb. section flat-footed<br>2. Rails of 88 lb. section double-headed.<br>3. Rails of 75 lb. section flat-footed<br>4. Rails of 60 lb. section flat-footed | These are used according to importance of the track. |

5. Patent and steel sleepers.
6. Fowlers patent pots, C. I.
7. K K. type sleepers – C F.
8 Wooden deodar sleepers.
9. Wooden sal sleepers.
10. Fish plate of 6 holes.
11. Fish plate of 4 holes.
12. Fish plate bolts with nuts.
13. Steel bearing plates.
14. Coach screws for wooden sleepers.
15. Spikes for wooden sleepers.
16. Wooden blocks for double-headed rails.
17. Cotters for steel sleepers.
18. C. I. blocks for double-headed rails.
19. Anti creepers—to stop creeping of the rails.
20. Check rails—used for level crossings and curves.
21. Check blocks—used as a washer between two tracks.
22. Points and crossings, for diverting trains from one line to other.
23. Ballast stone—size $1\frac{1}{2}'' \times 1\frac{1}{2}''$. Shanbergarh ballast standard size.
24. Kankar ballast—$2'' \times 2''$.
25. Brick ballast—$2\frac{1}{2} \times 2\frac{1}{2}$.

The following materials are required for laying out the tracks on plain ground without cutting and fillings.

| | | |
|---|---|---|
| 90 lb. section 36 ft. long ... | $146\frac{1}{2}$ pairs | One mile linking. |
| Wooden sal sleepers ...... | 2194 | |
| Spikes ... .. | 10970 | |
| Fish plate of 4 holes B. S. ... | 588 | |
| Fish bolts with nuts B. S. ... | 1176 | |
| Ballast ... ... | 12800 c. ft. | |

Culverts @ $6' \times 4'$ high 400/- each. According to site.

Drainage included in P. way According to position.

Crossing points at station—according to position 500/- approximately.

Level crossing gate according to position 1000/- approximately.

• Sleepers —New standard size ; deodar and softwood sleepers have been provided for at the rate of 1,911 per mile.

Ballast.—At the rate of 14 c. ft. per foot run of track, 14 c. ft. of this quantity being sand or earth from borrow pits on near banks and all kankar ballast in cutting.

Points and crossings.—90 lbs. R. B. S. points and crossings 1 in 12 and 1 in $8\frac{1}{2}$ have been provided.

Station and station buildings.—As per C. E.'s drawing No. (......) and wagon body on Halt Stations.

For Halt Stations one wagon body only is provided.

For Flag Stations, Station Master's office, and Record Rooms only.

For other stations, Station Master's office, Record Room and Waiting Hall.

Rail level platform throughout.

At all the crossing and watering stations 100 ft. long goods platform has been provided.

Number of bays goods shed as per C. E.'s plant No.......at...............and 1 bay goods shed at.............. and..................stations have been provided.

Number of crossing and watering station. 10 crossing stations, one Flag Station and 3 Halt Stations have been provided.

1,800 ft. C. S. R. have been allowed on Loops.

Staff quarters —Standard types of staff quarters have been provided as follows :—

Halt stations—*nil.*

Flag station—1 S. M., 1 Traffic menial.

Crossing station— • S. M., 1 A S M, 6 Traffic menials.

Crossing and watering station—1 S. M., 1 A. S. M., and 6 Traffic menials.

1 Loco pumpman, 1 Loco menial.

P. W. I.'s quarters with office, workshop, godown and out-houses, Time Keepers' and Trollyman's quarters have been provided at.................and..................... and S. P. W. I.'s quarters with Trollymen's quarters at .........and...............

No gang huts have to be allowed along the line.

Station machinery :—Water supply at ................ and....................is from a well using.................... pump and 6 H. P. Marshalls vertical boiler with 4" suction and 3" delivery pipes. Platform weighing machines should be provided for at watering and crossing stations, but not at Flag and Halt stations.

56 mds. weighing machines are to be provided in goods sheds. Buffer stops on all stations have to be provided.

Signalling – Outer and Home signals only provided at watering and crossing stations. Indicators and padlocks provided for loops.

## Notes on Railway Construction

The method of packing of track sleepers is now being done by means of shovel instead of crowbar packing, and the stone dust are spread over the ground upon which the sleepers are placed.

General :—

To lay out the line it is essential to see that the ground (where the sleepers are to be placed) is perfectly dressed, then the sleepers should be placed 21/2 ft. apart and rails may be lined up over them joining with fishplate affixing the coach screws against them sleepers according to standard gauge Having done so, the level of the track should be corrected by means of spirit box. Level is taken between the rails, so that they are in the same level.

In curves, the surveyor first surveys the ground and determines what will be the difference in level between the rails, then a permanent structure such as a piece of rail is firmly fixed to the ground ; in this the difference of level between the rails are marked permanent. At the time of placing the rails, this mark in the permanent structure and the bedding on the other rails must be in the same level. It may be noted that the determination of the difference of level is a matter of survey and calculation

## Level Crossing

At level crossing the rails are placed flush with the ground. Parallel to each rail a piece of check rail is placed, at a distance of 2½" to allow the flange of the wheels to pass through. To hold in position the check rails are bolted with permanent or main rails having a check block in center as a spacer. The ground of the rail line is made level with the cross road, so that any vehicle may pass unobstructed. A pair of gates are placed on both sides which are utilized in controlling the traffic at times when the trains pass For the gateman a small pacca hut is provided—at each gate the cost of the hut and other accessories at level crossing is Rs. 1,000/- according to schedule rate.

## Embankment

In plain fields the embankment is generally made 10 ft. × 4 ft. after consolidation. During construction layers of earth 10″ high are rammed down to $7\frac{1}{2}''$. After the earth work, it is left for further consolidation by receiving the water by next monsoon, when the surface is dressed finally to receive the sleeper and rails as already stated.

* The sides are sloped according to the natural angle of the repose of soil and turfed with grass technically called "band" with the grass.

Note —In case of single track of B. S. the difference between the inner flanges of two rails is 5′—6″.

In the case of two tracks distance between the two tracks must be 7′ according to standard dimensions The total breadth of the embankment should be 20 ft.

## Cuttings

In cutting the depth is adjusted according to survey the level being determined by calculation and nature of the soil, so that too much cutting being expensive is avoided. The line is given a gradual slope along the side. The breadth of the cutting should be 10 ft. as stated. The side slopes are adjusted according to the natural angle of the repose of the soil, excepting in stone cutting when the rules of tunnelling are adopted.

## Tunnelling

Tunnelling is done in two ways.

Firstly, with dynamite for which the Standard rate is Rs. 500 per cu. ft.

Secondly, boring in which the small holes are made on the side of rocks and blasted.

## Station and Station Yard

Station yard consists of the following—

Loop line is provided for the purpose of crossing of trains.

Main line is for the through passing of the trains.

Siding for keeping the wagon or passenger train. This is small in size to accommodate only a few wagons.

## Signalling

In an ordinary station there should be 8 signals, *viz.*, up and down 2, outer, 2 up and down warners, two up and down main Homes, 2 up and down loop Homes.

The function of these signals is at the time of receiving a train from any direction either from up or down the home signal is lowered after having the correct road set The outer signal is provided at a distance of 600 yards from the facing point to allow a sufficient distance for stopping train if road is not clear. Warner signals are lowered when trains run through that station.

## 1 Curve Abstract

| Degree of curvature and radius. | Length of the line. | | |
|---|---|---|---|
| | Number of each. | Length in miles. | Total curvature degrees. |
| $\frac{1}{2}^\circ$ R= ... | | | |
| $1^\circ$ R= ... | | | |
| Etc., etc. .. | | | |

Total ... ... ...

Ratio of curve to total length of line ... per cent.

Average amount of curvature per mile ... degrees.

## 2. Gradient Abstract.

| Gradient. | Length of the line. | | |
|---|---|---|---|
| | Number of each. | Length in miles | °/o of total length of line. |
| 1 in °/o ... | | | |
| 1 in °/o ... | | | |
| 1 in °/o ... | | | |
| Etc., etc. ... | | | |
| Level ... | | | |
| Total ... | | | |
| Steepest grade ... | 1 in | | |
| Longest continuous length of steepest grade. | mile. | | |
| Followed by ... | level. | | |
| For .. ... | mile. | | |

## 3. Bridge Abstract.

| Class of Bridges | Spans. | Length of the line. | |
|---|---|---|---|
| | | Total number of spans. | Water-way lin. ft. |
| | | | |

## 4. Important Bridges.

(Water-way...sq. ft. or more).

| Name of river. | Mileage. Spans. | *Height of under side of girders.* | | Average depth of foundation. | Section of Ry. |
|---|---|---|---|---|---|
| | | Above low water. | Above flood water. | | |
| | | | | | |

## 1. Structural Engineering Works.

### (5) FENCING.

### (*a*) Fencing.

| Description. | Unit. | Rate. | *Length of Line* | |
|---|---|---|---|---|
| | | | Quantity. | Cost. |
| Fencing 5 wire ... | Mile. | | | |
| Cattle-guards at stations and level crossings | Set. | | | |
| Boundary marks | Mile. | | | |
| Total ... | ... | | ... | ... |
| Add for contingencies | % | | ... | ... |
| Grand Total ... | ... | | ... | ... |
| Mean rate per mile | Rs. | | ... | ... |

*Note.*—The unit of one mile is to be taken as one mile in length of single fence, not fencing sufficient for both sides of a mile of railway.

## (b) Road Crossings.

| Description. | Unit. | Rate. | Length of Line. | |
|---|---|---|---|---|
| | | | Quantity. | Cost. |
| Earthwork at level crossings ... | c. ft. | | | |
| Gates, huts and guard rails at second class level crossings ... | each. | | | |
| Posts and guard rails at 3rd class level crossings .. | each. | | | |
| Metalling second class crossings and Public Works Department road diversions ... | Lin ft. | | | |
| Bridges in road diversions ... | Lin. ft. | | | |
| Total ... | | | | |
| Add for contingencies. | % | | | |
| Grand Total ... | | | | |
| Mean rate per mile | Rs. | | | |

## FIXED STATION MACHINERY.

| *Section of Railways.* | *Name of Station.* | *Loco well.* | | *Boiler.* | | *Pumps and Boiler.* | | *Water Tanks.* | | *Water columns.* | | *Piping.* | | *Hydrant.* | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | No. | Dia. ft. | No. | Sq. ft. | Hand No. | Power No | No. | Capacity Galls. | No. | Dia. inch. | L. ft | L. ft. | L. ft | L. ft. |
| | | | | | | | | | | | | | | | |

| *Ashpit.* | | *3 ft. Valve.* | | *Weighing Machine.* | | *Sluice and Ball Valve sizes.* | *Ticket dating Machine.* | *Weighing Machine for Goods shed* | *Signals.* | | *Buffer Stops.* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| No. | Length ft. | No. | Dia. ft. | No. | Capacity Cwt. | No. | No. | | Home. | Outer. | |
| | | | | | | | | | | | |

## 1. Structural Engineering Works.

### (i) PRELIMINARY EXPENSES.

| Detailed Heads. | Length of Line. | |
|---|---|---|
| | Rate per mile. | Total cost. |
| (a) Survey Expenses ... | | |
| (b) Plant ... ... | | |
| (c) Establishment ... | | |
| Total ... | | |

## 2. Land.

## 1. Structural Engineering Works.

### (3) FORMATION.

#### (a) Earthwork.

| Description. | Unit. | Rate. | Length of Line. | |
|---|---|---|---|---|
| | | | Quantity. | Cost. |
| Earth work in banks and cuttings. | | Through rate. | | |
| Nallah diversion and catch water drain. | | | | |
| Maintenance, etc., at per cent. | | | | |
| Turfing slopes ... | | | | |
| Service road .. | | | | |
| Jungle clearing .. | | | | |
| Lock spitting and C. I. pillars. | | | | |
| Pitching ... | | | | |
| Dressing formation | | | | |
| Work establishment at per cent. .. | | | | |
| Etc . | | | | |
| Total ... ... | | | | |
| Add for contingencies, per cent. .. | | | | |
| Grand Total ... | | | | |
| Mean rate per mile .. .. | | | | |

(b) Tunnels. (c) Walling. (d) Side Drains.

| Description. | Unit. | Rate. | Length of Line. | |
|---|---|---|---|---|
| | | | Quantity. | Cost. |
| Side drains in earth | Chain. | | | |
| ,, muram | | | | |
| ,, rock | | | | |
| Total ... | | ... | | |
| Add for contingencies per cent. | | ... | | |
| Grand Total ... | | ... | | |
| Mean rate per mile | | ... | | |

## (4) BRIDGE WORK.

### (a) Major Bridges.

| Description of work. | Unit. | Rate. |
|---|---|---|
| (i) STEEL WORK. | | |
| Total ... ... | | |
| (ii) MASONRY. | | |
| Total ... ... | | |
| (iii) MISCELLANEOUS. | | |
| Pitching ... ... ... | | |
| Service works and diversions ... | | |
| Work Establishment ... ... | % | |
| Total ... ... | | |
| Grand Total ... ... | | |
| Add for contingencies .. ... | % | |
| Total cost of Bridge ... | | |
| Cost per lineal foot of Waterway ... | | |

## 1. STRUCTURAL ENGINEERING WORKS

### (4) Bridge works.

(*b*) Minor bridges costing less than Rs 5,000 each.

## 1. STRUCTURAL ENGINEERING WORKS

### (3) Formation and (4) Bridgework.

Cost mile by mile.

| Mile. | BANKS. | | CUTTINGS. | | 3. | | 1. | 2. | 3. | 4. | 4. | 4 BRIDGE WORKS. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *Up to ft. height at Rs. per...... C. ft. ex.* | | *Up to ft. deep at Rs. per...... C. ft.* | | *Maintenance sundries, etc.* | *Total.* | *Tunnels.* | *Wallings.* | *Drains.* | *Total formation.* | *Major Bridges* | *Minor Bridges.* | *Total .. Bridges works.* | *Total.. formation and ... Bridges.* |
| | Quantity. | Cost. | Quantity. | Cost. | Cost. | Cost | Cost. | Cost. | Cost. | Cost. | Cost. | Cost. | Cost. | Total. |
| | | | | | | | | | | | | | | |

## 1. Structural Engineering Works.

### (5) *Fencing.*

#### (c) Mile and Gradient Posts.

| Description. | Unit. | Rate. | Length of Line. | |
|---|---|---|---|---|
| | | | Quantity. | Cost. |
| Mile post ... | Each. | | | |
| Gradient posts. ... | ,, | | | |
| Telegraph—post number plates ... | ,, | | | |
| Total ... | | | | |
| Add for contingencies, % | | | | |
| Grand Total | | | | |
| Mean rate per mile, Rs. | | | | |

### (6) *Electric Telegraph.*

(Length......miles).

| Description | Unit. | Rate. | | |
|---|---|---|---|---|
| Electric Instruments ... | Mile. | | | |
| Telephones ... | | | | |
| Train Control Equipment ... | | | | |
| Total ... | | | | |
| Add % for contingencies ... | | | | |
| Grand Total Rs. ... | | | | |
| Rate per mile Rs. ... | | | | |

## 1. Structural Engineering Works

### (7) *Ballast and Permanent way.*

| Description. | Unit. | Rate. | *Length of Line.* | | |
|---|---|---|---|---|---|
| | | | Quantity. | Cost. | Rate per mile. |
| MAIN LINE :— | | | | | |
| ( i ) Rails and Fastenings ... | Mile. | | | | |
| Add for contingencies, °/o ... | | | | | |
| Total ... | | | | | |
| ( ii ) Sleepers and Fastenings— | | | | | |
| (a) Sleepers— | | | | | |
| (1) Wood ... | Mile. | | | | |
| (2) Cast-iron and ferro-concrete Bridge sleepers ... | C. ft. | | | | |
| (3) Steel trough ... | | | | | |
| Add for contingencies, °/o ... | | | | | |
| Total. | | | | | |

| Description. | Unit. | Rate. | Length of Line. | | |
|---|---|---|---|---|---|
| | | | Quantity. | Cost. | Rate per mile. |
| (iii) Ballast (sand and kankar) ... | Mile. | | | | |
| Add for contingencies, °/o ... | | | | | |
| Total | | | | | |
| Total 1 (7) (a) ... | | | | | |
| SIDINGS :— | | | | | |
| (i) Rails and Fastenings ... | | | | | |
| Add for contingencies, °/o ... | | | | | |
| Total ... | | | | | |
| (ii) Sleepers and Fastenings— | | | | | |
| (a) Sleepers— | | | | | |
| (1) Wood ... | | | | | |
| Add for contingencies, °/o ... | | | | | |
| Total ... | | | | | |
| (iii) Ballast (Sand and Kankar) ... | | | | | |
| Add for contingencies °/o ... | | | | | |
| Total ... | | | | | |
| Total 1 (7) (b) | | | | | |

| | Unit. | Rate. | Length of Line. | | |
|---|---|---|---|---|---|
| | | | Quantity. | Cost | Rate per mile. |
| POINTS AND CROSSINGS LBS. F.F. | | | | | |
| ( *i* ) Points & crossings | | | | | |
| in ... ... | Set. | | | | |
| in ... ... | .. | | | | |
| Add for contingencies, ...°/o ... ... | | | | | |
| Total ... | | | | | |
| ( *ii* ) Crossing sleepers and Fastenings— | | | | | |
| (*a*) Sleepers—for | | | | | |
| in ... ... | Set. | | | | |
| (1) Wood in ... ... | ,, | | | | |
| Add for contingencies, ...5 °/o ... ... | | | | | |
| Total ... | | | | | |
| (*iii*) Maintenance during construction ... ... | Set. | | | | |
| Total ... | | | | | |
| Total 1 (7) (c) ... | | | | | |
| Total 1 (7) ... | | | | | |

## 1. Structural Engineering Works.

### (7) BALLAST AND PERMANENT WAY.

Detailed Estimate of one mile of Track
(Ballast and Permanent Way).

Standard of Track—85 lbs. B. H. 2nd hand rails on wooden sleepers (with C. I. chairs) Main Line.

Sidings.—Rails 85 lbs. per yard.
Sleepers 1,911 per mile.
Ballast 14 cubic feet per foot run.

| Details | Quantity. | Unit. | Rate. | Amount. |
|---|---|---|---|---|
| MAIN LINE | | | | |
| Rails and fastenings.— | | | | |
| (1) Rails 36′-0″ long ... | . | L. ft. ... | Re. 0-13-4 | |
| (2) Fish plates ... | ... | Ton. ... | Rs. 90-0-0 | |
| (3) Sishbolis and nuts | ... | Cwt. ... | Re. 9·9 | |
| (4) Freight ... | ... | Ton mile ... | Re. 0·0247 | |
| (5) Loading, unloading, stacking and other depot charges ... | ... | Ton. ... | Re. 2-0 0 | |
| (6) Local carriage from depot to lead ... | ... | Ton mile .. | Re. 0-1-6 | |
| (7) Laying ... | ... | Mile ... | Rs. 650-0-0 | |
| (8) Maintenance ... | ... | Mile-month | Rs. 200-0-0 | |
| Total ... | ... | ... | | |
| Sleepers and fastenings— | ... | | | |
| (1) B. G. Sleepers ... | ... | Each ... | Re. 6-8-0 | |
| (2) C. I. Chairs ... | ... | Ton ... | Rs. 68-0-0 | |
| (3) Standard spikes (2nd hand) ... | ... | Each ... | Re. 0·04 | |
| (4) Keys wooden (new) | ... | Per cent. ... | Rs. 52-0-0 | |
| (5) Freight (on sleepers) | ... | Ton mile ... | Re. 0·0247 | |

| Details. | Quantity. | Unit. | Rate. | Amount. |
|---|---|---|---|---|
| (5A) Freight on charis, etc. ... | .. | Ton mile ... | Rs. 0·0247 | |
| (6) Loading, unloading, stacking and other depot charges ... | ... | Ton ... | Rs. 2-0-0 | |
| (7) Local freight from depot to lead ... | . | Ton mile .. | Re 0-1-6 | |
| (8) Laying | .. | Mile ... | Rs. 350-0-0 | |
| Total ... | ... | | | |
| Ballast— | | | | |
| (1) Sand ballast (14 c. ft per foot run in bank) ... | ... | 100 c. ft. | Rs. 3-0-0 | |
| (2) Kankar ballast (14 c. ft. foot run in cutting) ... | .. | 100 c. ft. | Rs. 15-0-0 | |
| (3) Lifting and spreading. ... | .. | 100 c. ft. | Re. 0-8-0 | |
| Total ... | .. | ... | | |

Total cost of one mile of Track Line (Sidings) Rs. ...

*Note.*—This estimate should be made out for one mile of complete track, inclading ballast and all charges for handling, linking and maintenance during construction.

## 1. Structural Engineering Works.

(8) Stations and Buildings.

(*b*) Workshops, Store Buildings, etc.

(9) Shore Connections for Ferry Steamers.

(10) Plant—Construction.

# CEMENT CONCRETE ROADS

## * General Specification

*Sub-grade*—Definition. All constructions between country level and the base of the concrete slab.

The sub-grade shall not be less than 12″ above the just anticipated water level in the side drains or the surrounding country level and shall consist of properly compacted material. It shall be efficiently drained so that no storm water or other drainage can possibly remain in the drains for a longer period than 12 hours. For the full width of the slab the surface of the sub-grade shall be given a coat of at least 3″ thick clean material such as stone metal, cleaned ashes or cinders which shall be rolled into the sub-grade sufficiently to give an even bearing for the slab. Extreme hardness of this coat of meterial is not a desideratum, but care should be taken to see that it is evenly compacted all over the surface. Any loose spots found should at once be repaired by rolling good material.

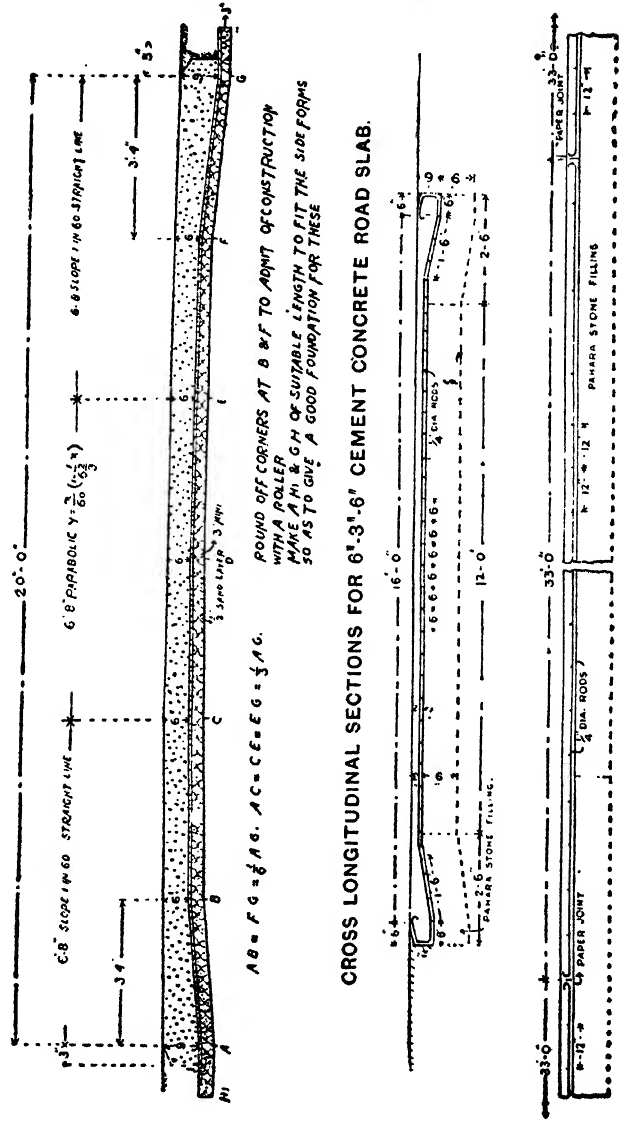
*Insulating layer.*—The surface of the sub-grade shall be insulated from the base of the slab as provided in the detailed specification.

*The slab.*—The slab shall be designed as in plate No. 1 attached to this specification and shall be laid in the alternate bay system. For widths other than the widths given in plate No 1 the central thickness of the slab may be larger or smaller as circumstances indicate, but the edge thickening shall always be 50 per cent. more than the designed central thickness; thus if, for a 16′ width, a slab with a 4″ central depth is necessary, then the thickness of the edges shall not be less than 6″. The length of a bay is determined by the nature of the joints and the method of tamping If joints are at an angle of 60 degrees to the longitudinal axis of the road, tamping should generally be done from the cross forms and the length of the bay be limited to 20′; tamping can be done from the side forms also, but with the 60 degree joint great care is necessary in tamping the acute angle portions

* P. W. D. Specification, U. P.

Plate No. 1.

TYPE SECTION FOR A 9"-6"-9" CEMENT CONCRETE ROAD



of the bay. In this case the bay may be made as long as 33′ Greater lengths of bay are undesirable.

*Concrete.*—The concrete shall be laid in two courses in accordance with the provision of the detailed specifications, the idea being to arrive at a mosaic surface in which the aggregate appears as the wearing coat of the road. Too much of the cement mortar should not be allowed to come to the top and tamping should be regulated to give just sufficient consolidation to expel all trapped air and render the concrete as dense as possible.

*Cement.*—Cement shall conform in all respects to the British Standard Specification for a slow-setting Portland cement All cement shall be tested before issue to work and shall invariably be issued by weight, 94 lbs. being equivalent to 1 c. ft. Test in accordance with a standard should be carried out as far as the apparatus in stock will permit, but cement should be invariably tested for tensile strength.

*Water.*—The cement water ratio once fixed shall be adhered to throughout the work. As little variation as possible shall be permitted. If the quantity of cement and the cement water ratio is variable, cracks will be unavoidable.

*Forms,*—Forms shall be of the stiffest nature possible. Where a vertical surface is required measures should be taken to ensure that such surface is truly vertical. Flexibility in the forms is detrimental to good work, and it is possible to avoid waviness of the surface where forms are flexible.

*Joints.*—Joints shall be plain butt joints laid at an angle of 60 degrees to longitudinal axis of the road. The alternate bay method of laying permits of full allowance for expansion and contraction of the slab under temperature and humidity. The contraction during setting is designed to take care of alteration in length due to temperature and humidity, and no material should therefore be introduced in the joints. The length of the bay should be regulated to permit of as fine a joint as possible. Joints square to the longitudinal axis of the road should only be permitted under directions of the

Deputy Chief Engineer, as such joints will usually be of a special nature and not the plain butt joints The length between joints will vary from 20′ to 33′.

*Workmanship.*—Cleanliness in all stages of the work is a *sine qua non* Materials shall be kept as clean and as free from dust and other deleterious matter as possible. Sand specially should be stored in bins, cement in bags, and hydrated lime in bags. The water must be clean and potable when used. Aggregate should be kept free from dust, if possible.

*Curing and hardening*—The slab should be hardened as provided in the detailed specifications and should be kept wet to moist for at least three weeks after laying. For the first week it should be kept very wet; for the second week it should be kept wet by regulating the amount of water sprinkled over; for the third week the material on the top of the slab may be allowed to dry out gradually, but not too rapidly. In the fourth week the slab should be allowed to dry out completely so that at the end of the fourth week traffic may be allowed on it.

*Finishing.*—Before opening to traffic the edge of the slab should be carefully puddled with clay puddling mixed with sufficient sand to prevent cracking and the whole formation of the road should be dressed neatly, the pattris being allowed a slightly greater slope than the slab.

*The camber.*—The camber of the concrete slab should be as flat as is consistent with a quick run-off of the rain-water. A camber of 1 in 100 is by no means too flat, but for the present the standard is fixed at 1 in 60 or 1 in 50 with a parabolic central width as shown in plate No. 1. The pattris should be given a somewhat greater slope, say, 1 in 40 or 1 in 36, so as to assist in run-off of the rain-water well away from the concrete slab

*Diversion of traffic.*—Since a concrete road cannot be opened for traffic for nearly two months, care must be taken to divert traffic to ensure as little dislocation and discomfort as possble. If a long length of road is to be concreted, a careful programme must be made so that progressive opening of completed portions of the road is possible and only such length of a road as is consistent with continuous working should be taken up at one time. Diversions shall be suitable to the amount and duration of the traffic over them, and should, if possible, be located on the leeward side of the slab so that any dust from the traffic is blown away from the work and not on to it. If possible, traffic should be diverted on to roads which are not under operation.

*Temperature*—Concrete shall, if possible, be laid at temperatures between 40 degrees F. and 90 degrees F. If it is necessary to lay concrete when the day temperature is likely to exceed 90 degrees F. or hot drying winds are experienced, care must be taken to protect the concrete against drying out too rapidly, but in no case shall the cement water ratio be altered beyond the maximum of 6 gallons per 94 lbs. equal to 1 c. ft. of cement. Alterations of the cement water ratio should not be regarded as one of the measures to be taken to prevent too rapid drying out of cement concrete. Protection should be afforded by means of bags or mats laid on the surface of the slab. Similarly, if the day temperature falls below 40 degrees F., precautions must be taken against freezing during the night, and before the work is left for the night, a layer of dry bags spread over the wet ones will afford adequate protection in all stations in the plains. Special measures will, of course, be required in hill tracts or where severe frosts are experienced.

*Tests.*—The importance of making tests during construction cannot be exaggerated. Careful record should be kept of all tests made, and tests should, if possible, be made and recorded for each bay. A careful record of all costs should be carefully kept.

*Crossings*—All crossings shall carefully be designed so that no joint is parallel to the line of traffic. Slabs should not be wider than 24′ or longer than 33′. If greater lengths or widths are permitted, a greater thickness of concrete or reinforcement shall be provided as may be found most economical. When it is impossible to avoid a joint running parallel to the direction of traffic, it should be saw tooth in plan with angles not less than 99 degrees and length of edge of tooth not less than 9 inches.

## Cement Concrete Roads

* *Detail specification.*

*Sub-grade.*—If the sub-grade is a road already in existence, it shall be carefully examined for cracks and fissures under variations of temperature and humidity; and if these are discovered, suitable steps as hereinafter described shall be taken to prevent such cracks extending to the concrete slab. The sub-grade shall be further examined for soft spots, pot holes, etc., and these shall be carefully filled with good soil, watered and rammed.

2. If the sub-grade has to be constructed, it shall be worked up to full section in layers not exceeding 6". All clods shall be pulverised and the earth carefully rammed and watered.

3. In all cases drains shall be made and graded carefully so that no water can effect a lodgment, and they shall be of sufficient size to clear the road of all water within twelve hours as an absolute maximum.

4. The sub-grade shall be finished off with a coat not less than 3" thick of some clean material such as stone ballast, engine cinders, etc., which shall be rolled into the sub-grade with a roller not less than 10 tons in weight. If cracks and fissures have been observed in the sub-grade, and intermediate coat of waste material or sand shall first be rolled into the surface. The thickness of this coat shall be regulated by the nature of the soil. The finishing 3" coat of rolled material shall be carefully examined to ensure an even bearing bed for the concrete slab, and must be free from waviness.

*Insulating layer.*—The surface of the sub-grade shall be carefully insulated from the base of the concrete slab by a thin layer, not exceeding $\frac{1}{2}$" of pure clean fine micaceous sand free from earth. As the object of this layer is to act as a lubricant between the concrete and the sub-grade, only sufficient sand should be used to ensure this. Just before the concrete is laid it shall be moistened to prevent it absorbing the water from the concrete, but care must be taken to prevent any puddling due to excess of water. It is essential that this sand should be free from

* P. W. D. Specification, U. P.

clay or other deleterious matter. If there is any clay, the sand will not act as a lubricant. The sub-grade shall be passed by the Executive Engineer or his assistant before the sand insulating layer is laid.

*The concrete slab. The mix—*

The mix shall be as follows :—

94 lbs. = 1 c. ft. cement.
5 to 5½ gallons water.
2 c. ft. clean sharp sand 0 to ¼″.
4 c. ft. dry coarse aggregate from ½″ to 2½″ gauge.
1/20 c. ft. = 1½ lbs. hydrated lime.

This quantity of material should produce 4·1 c. ft. of concrete laid and finished.

All materials shall be dry before the water is added and the quantity of water for each 94 lbs. = 1 c. ft. of cement shall not be allowed to exceed 6 gallons without the consent, in writing, of the Deputy Chief Engineer.

*Materials.*—The aggregate shall be of the best stone available. No stone which has not passed the attrition and toughness tests of the Government Test House at Alipore should be used. All aggregate shall be cubical. Flat pieces shall be rejected from the coarser aggregate and broken up for finer. Subject to the percentage of voids not exceeding 42 per cent., the Executive Engineer may vary the percentage of coarse and finer aggregate. The following mixture will be found to be economical :—

Coarser aggregate or hand-broken cubical ballast 1″ to 2½″ gauge 75 per cent.

Finer aggregate all sizes between ½″ and 1″ 25 per cent.

If the aggregate is cubical, the percentage of voids should be as low as 40 per cent. Frequent voids tests at least one for each bay shall be made.

*Sand.*—This shall be clean sharp sand with grains varying from 0 to ¼″. The sieve test should show at least 33 per cent. retained on an ⅛″ screen and 66 per cent. on a 1/16″ screen and not more than 10 per cent. shall pass through a 1/50″ screen. All sand shall be tested for organic matter from which it should be freed before use.

*Water.*—All water used for mixing shall be clean and pure and free from alkaline matter and acids. A good test is that it should be potable.

*Cement.*—All cement shall be very frequently tested for tensile strength and cement should be ordered fresh in quantities that can be utilized in one month. It should be stored in a dry place, and if stored longer than a month it should be carefully tested for deterioration. No cement that has not been thoroughly tested should be issued to the work.

*Hydrated lime.*—Freshly burnt unslaked white lime shall be purchased and thoroughly slaked till it falls into an impalpable powder, if properly slaked it will be found to be a powder finer than cement. The process of slaking shall be carefully performed by sprinkling and spreading small quantities at a time. Slaking in bulk snould not be permitted. When the lime is thoroughly hydrated into an impalpable powder, it should be bagged in suitable bags by weight ready for use.

*Preliminary arrangements.*—The Engineer shall carefully ascertain the capacity of his mixer or mixing tray and shall specify in terms of cement and cement water ratio the batch he will employ, for example :—

| | | |
|---|---|---|
| ½ bag 5 to 5½ gallons 94 lbs. cement | ... | 1 bag 10 to 11 gallons 188 lbs. cement. |
| 5 to 5½ gallons water | ... | 10 to 11 gallons water. |
| 2 c.ft. sand | ... | 4 c.ft. sand. |
| 4 c.ft. aggregate | ... | 8 c.ft. aggregate. |
| 1½ lbs. hydrated lime | ... | 3 lbs hydrated lime. |

Having fixed the batch, he will have all the cement and hydrated lime bagged in accordance with the weight of the batch he intends to employ. 3 gallon, 2½ gallon and 2 gallon water measures painted in different colours should be prepared in sufficient numbers to ensure the issue of the quantity of water to the batch. No refilling of measure shall be permitted till the batch is laid. Sand and aggregate boxes, either of one or two cubic feet capacity, should be made and painted of different colours for sand, coarse and fine aggregate. All sand should be stored in bins. A sufficient number of measures should be prepared to permit of all material for a batch being arranged in orderly array and checked over before mixing of that batch is commenced. Executive Engineers should insist on methodical working in this respect and should adopt stringent precautions against the temptation to use more water than that allowed.

*Mixing.*—If hand-mixing is employed, the cement, sand and hydrated lime shall be first placed in the mixing tray of steel plates ($8' \times 4' \times 9''$). These shall be turned over and over till a uniform colour throughout the mass is attained. The coarse and fine aggregate shall then be introduced and turned over dry till the mass appears to be uniformly mixed. Finally, water is gradually poured on till the whole tray-full is again of a uniform colour. Each cut of the spade or phaorah shall scrape the bottom of the tray and turn the contents over. If it takes too long to mix a whole tray-full, a half or a third of the tray should be mixed with water at a time using a half or a third of the quantity of water, but the whole tray-full of material must invariably be mixed dry before any water is added. If a batch mixer is employed, the materials to be shot into the mixer must be ready in suitable measures in accordance with its capacity and grouped in batches so that there may be no mistakes and confusion.

*Placing.*—All concrete, when mixed, shall be placed in two layers. The lower layer should be $3''$ thick at the centre and the surface should be approximately to camber. This layer should never be more than $1'$ to $1\frac{1}{2}'$ in advance of the upper layer. The upper layer shall be laid true to the camber and from $\frac{3}{8}''$ to $\frac{1}{2}''$ higher than the finished section to allow for ramming down by the camber-tamper. The concrete shall be lowered to the layer and not shot on to it from a height. Each layer should not require any spreading with a trowel. If masons are allowed to do this, they move the aggregate only, leaving the mortar. Each layer should be rodded and punned freely to remove all trapped air, but this rodding and punning should be carefully done, as coolies are liable to work aimlessly. The punning rods are $\frac{5}{8}''$ steel rods shod with a weighted end about 2″ square. The tendency is to use the rod end too freely and force the rod through to the sub-grade ; this should be checked by making the coolies use the punning end. When the concrete has been brought approximately to camber, it should be brought to true camber by means of the tamper.

*Note.*—It is important that all processes from the time the mixing water is added to the comple.ion of the tamping should be completed within the setting time of the cement The setting time is the time from the adding of water to the time when the setting commences, and should be ascertained for the particular brand of cement used.

*Completing the bay.*—When the concrete has been tamped in position, the surplus water shall be carefully dried off. The best method is to mop up the surplus water with bags Laitance shall not be permitted and trowelling dear to the heart of masons shall, on no account, be allowed, but there is no objection to the us. of a hard wood float. If a great thickness of mortar appears at the surface, too much ramming with the tampers is the fault; and this should be rectified immediately. If the surface is wavy or the concrete piles up in front of the tamper, the quantity of water is either in excess or too much tamping is being done. The remedy lies in examining the tamping, and, if not in excess, reduce the water content.

*Curing and hardening.*—When the bay has been completed and has hardened sufficiently, wet bags shall be gently spread over the surface. These shall be kept moist by frequent sprinkling. After 24 hours the bags shall be removed and the first application of silicate of soda solution 3:3 ratio shall be spread over the surface from the rose of a watering can. The spray mixture is made from one gallon of the soda silicate solution to five gallons of water, but before the application the surface must be broomed free of any laitance that may have formed. When the spraying has been completed, the wet bags shall be replaced and left for another 24 hours. They shall then be removed again and another application of the soda silicate mixture shall be spread over the surface in the same manner, as before ; but this time the surface is not broomed before spraying. The bags are then replaced for another 24 hours when the hardening process is completed by a third application of silicate of soda. The bags shall not be replaced, but a 3″ layer of earth shall be spread so as to completely cover the concrete. This layer of earth should be well watered till it is wet through and the watering continued for 14 days. The layer of earth is then allowed to dry slowly by decreasing the amount of watering gradually for seven days, and finally allowed to dry completely till the road can be opened for traffic on the 28th day.

*Alternate bays.*—The Executive Engineer should lay down the number of odd bays, *i.e.*, 1st, 3rd, 5th, etc., that should be put in hand before commencing on the even bays, *i.e.*, 2nd, 4th, 6th, etc. In this he will be guided by the conditions of traffic and the length of road he can keep closed. The concreting of the even bays should not be commenced till seven days after the first of the odd bays have been hardened. If longitudinal tamping is done, it will be advisable to postpone concreting of the even bays till the adjacent odd bays are strong enough to stand the hammering of the tamper. This will be the fourth day after hardening of the adjacent bays.

*Test.*—Careful tests should be made during the progress of the work. The list of tests are :—

(*a*) Cement tests in accordance with the apparatus available. } Standard specification.

(*b*) Void tests for the aggregate.

(*c*) Slump tests.

(*d*) Field tests.

*Joints.*—All joints, unless otherwise directed by the Deputy Chief Engineer, shall make an angle of 60 degrees with the longitudinal axis of the road. They shall be plain butt joints, but care must be taken to ensure that the face of the joints is truly vertical. In laying even bays no material shall be introduced into the joint, but the face of the odd bays may be cleaned and brushed free from dust or adhering earth. Unless specially ordered by the Deputy Chief Engineer, no attempt shall be made to join one bay to another by means of neat cement or any other method. Joint forms must be constructed to the camber necessary for the 60 degree angle. Tamping should be done from these forms, and joints shall not be at greater distances apart than 20′. If longer bays are required, the joints shall be as prescribed by the Deputy Chief Engineer.

*Forms.*—For a small work the best type of form is either the masonry wall 9′ thick of brickwork in clay plastered with 1 : 3 : 5 mix Portland cement plaster or wooden form with stiff brackets for pegging down to the sub-grade. It is important that any form should be of the stiffest type possible at reasonable cost.

For large work "Blaw Knox" patent steel forms are very good, but their use is limited to side forms

All cross-forms shall be constructed to true camber if tamping is done from them, and they should be armoured with a thin steel plate to resist damage from blows of the tamper.

Forms may be removed after 24 hours and shall be at once washed clean of all adhering cement. Before use they may either be rubbed over with soft soap or with a mixture of oil and water.

Report accompanying and forming part of Estimate No.—of probable cost of reconstruction of roads in Benares Division, Programme No. ..., amounting to Rs. ... ....

| Space for subsequent comments. | Report. |
|---|---|
| | *Note*—Total cost Rs. ........... for G. T. Road and Benares Sarnath Road Detailed cost is given for G. T Road only. Instructions for the preparation of this estimate were issued in letter No —, dated ......... from the Chief Engineer. |

| Space for subsequent comments. | Report. |
| --- | --- |
| | This estimate provides for the following work :— (*i*) G. T. Road. Concreting of miles 1 (remaining length about ... furlongs, as about three furlongs will be done from the estimate already sanctioned), 2 and 3. The width will be 12′ and thickness 4″ in the middle and 6″ at the edges. |

**General specification** of the work in estimate No. – of 19—29.

| Space for remarks. | General specifications. |
| --- | --- |
| | G. T. Road—miles 1, 2, 3 and Benares-Sarnath Road. Cement concrete :—The coarse aggregate will consist of Gaya stone and the fine aggregate of Gaya sand. The slab will be 4″ thick in the middle and 6″ in the sides on the G. T. Road, and 6″ in the middle and 9″ at sides on the Benares-Sarnath Road. Width of concrete slab shall be 12′ on the G. T. Road and 20′ on the Benares-Sarnath Road, except on the Burna Bridge where it will be 22′. Where the latter road is widened, a solid coat of 3″ thick Chunar metal will be given. The concrete slab shall be separated from the road crust by an insulation layer of sand. |

*Benares*

## ANALYSIS OF THE COST OF CEMENT

*Materials*

| Mile number. | C. C Slab | | | | | | |
|---|---|---|---|---|---|---|---|
| | *Coarse Aggregate.* | | | | | | *Gaya* |
| | Gaya Large Metal. | | | Gaya Small Metal | | | |
| | Quantity. | Rate. | Amount. | Quantity | Rate. | Amount. | Quantity |
| 1 | 18,400 | 26/6/- | 4,853 | 6,800 | 44/3/- | 3,005 | 12,000 |
| 2 | 18,400 | 27/4/- | 5,014 | 6,800 | 45/1/- | 3,064 | 12,000 |
| 3 | 18,400 | 28/2/- | 5,175 | 6,800 | 45/15/- | 3,124 | 12,000 |

*Materials*

| Miles number | *Cement.* | | | *Bricks.* | | | *Gaya Sand.* | | |
|---|---|---|---|---|---|---|---|---|---|
| | Quantity | Rate. | Amount. | Quantity. | Rate. | Amount | Quantity. | Rate. | Amount. |
| 1 | 2 Tons | 57/- | 114 | 3,000 | 18/- | 54/- | 200 | 25/10/- | 51 |
| 2 | 2 Tons | 58/- | 116 | 3,000 | 18/- | 54/- | 200 | 26/8/- | 53 |
| 3 | 2 Tons | 59/- | 118 | 3,000 | 18/- | 54/- | 200 | 27/6/- | 55 |

*Division.*

## CONCRETE ROAD (SLAB 6″–4″–6″).

*and cost.*

| Sand. | | Cement. | | | Stone Lime. | | | Total for C. C. Slab. |
|---|---|---|---|---|---|---|---|---|
| Rate. | Amount. | Quantity. | Rate. | Amount. | Quantity. | Rate. | Amount | |
| 25/10/- | 3,075 | 234 | 57/- | 13,338 | 80/- | 1/- | 80/- | 24,351 |
| 26/8/- | 3.180 | 234 | 58/- | 13,572 | 80/- | 1/1/- | 85/- | 24,915 |
| 27/6/- | 3,285 | 234 | 59/- | 13.806 | 80/- | 1/2/- | 90/- | 25,480 |

*and Cost.*

| White Lime. | | | Total for side form. | Hardening. | | | Total for Hardening. |
|---|---|---|---|---|---|---|---|
| | | | | Sodium Silicate. | | | |
| Quantity. | Rate. | Amount. | | Quantity | Rate. | Amount. | |
| ... | ... | ... | 219 | 24 Cwt. | 12/- | 288 | 288 |
| ... | ... | ... | 223 | 24 Cwt. | 12/1/- | 290 | 290 |
| ... | ... | ... | 227 | 24 Cwt. | 12/2/- | 291 | 291 |

| Miles number. | *Materials (cost.)* Water charges. | Share of T. and P. | Total of materials | C. C. SLAB. *Laying.* Quantity. | Rate. | Amount. | *Curing.* Quantity. | Rate. |
|---|---|---|---|---|---|---|---|---|
| 1 | 7,333 at -/1/6 687/- | 7,333 at -/-/6 229/- | 25,774 | 7,333 | /3/- | 1,375 | 7,333 | -/-/6 |
| 2 | 7,333 at -/1/6 687/- | 7,333 at -/-/6 2··9/- | 26,344 | 7,333 | -/3/- | 1,375 | 7,333 | -/-/6 |
| 3 | 7,333 at -/1/6 687/- | 7,333 at -/-/6 229/- | 26,914 | 7,333 | -/3/- | 1,375 | 7,333 | -/-/6 |

| LABOUR | | | | | | | | Total for Labour for each mile. | Total Cost for one mile. | Total Cost per sq yard. |
|---|---|---|---|---|---|---|---|---|---|---|
| Amount. | Total for C. C. Slab. | Side form. | | | Hardening. | | | | | |
| 229 | 1,604 | 160 bays | 3/- per bay | 480 | 7,333 | -/-/3 | 115 | 2,199 | 27,973 | 3/13 |
| 229 | 1,604 | 160 | 3/- | 480 | 7,333 | -/-/3 | 115 | 2,199 | 28,543 | 3/14/4 |
| 229 | 1,604 | 160 | 3/- | 480 | 7,333 | -/-/3 | 115 | 2,199 | 29,113 | 3/15/6 |

SIGNED
BY
Executive Engineer.

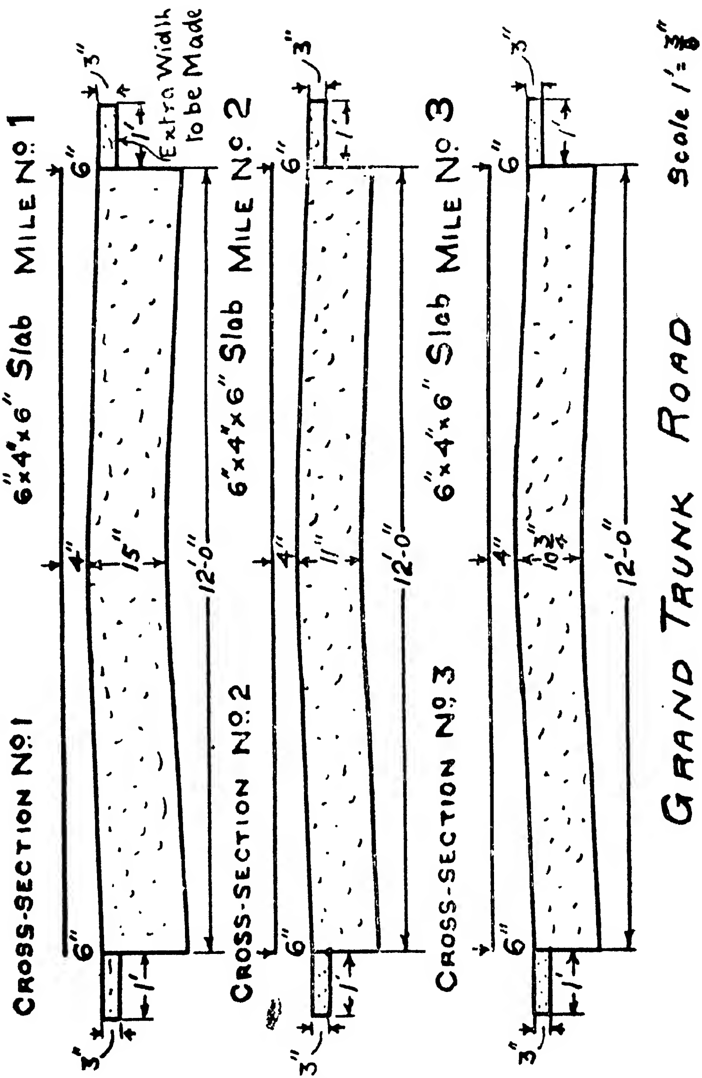

Cross-Section No. 1
6"×4"×6" Slab Mile No. 1
Extra Width to be Made
Cross-Section No. 2
6"×4"×6" Slab Mile No. 2
Cross-Section No. 3
6"×4"×6" Slab Mile No. 3
Grand Trunk Road
Scale 1' = 3/8"
6"
4"
3"
1'
15"
11"
$10\frac{3}{4}$"
12'-0"

Plate 2.

## Specification for Bituminous Grouted Macadam.

1. The following instructions apply to all cases where it is proposed to lay a bituminous grouted macadam wearing coat :—

(*i*) A bituminous grouted macadam wearing coat shall not be placed on an existing road surface unless the latter is 9″ thick. If the thickness of the existing road surface is less than the above, an intermediate coat of $4\frac{1}{2}''$ of water bound macadam, $1\frac{1}{2}''$-$2''$ gauge shall be laid prior to laying the bituminous grouted macadam wearing coat. It is essential that the intermediate coat shall be laid at least three months prior to the wearing coat.

(*ii*) A bituminous grouted macadam wearing coat shall not be laid on an existing road, the camber of which differs greatly from that required for such wearing coats, namely, 1 in 48, nor shall it be laid on an existing surface, that is loose or badly-pot-holed. In such cases an intermediate coat of water bound macadam shall be given.

2. The camber of the surface upon which the bituminous grouted wearing coat is to be given shall be 1 in 48 and it shall be laid as in the diagrammatic sketch, Fig. 1.

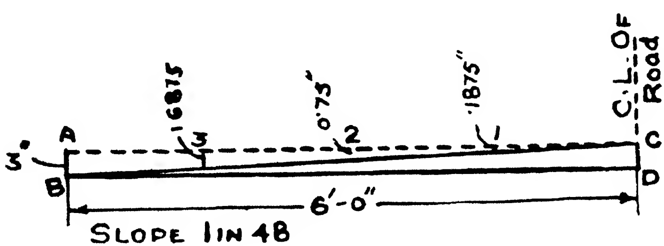



Fig. 1.

Let $C$ be the centre line of the road and $CD = AB$ =rise at the crown. To find the distance from the line

$AC$ down to the curved line $CB$, divide the half width of roadway $AC$ into any number of equal parts, say $n$, and designate the distance from the point 1 on $AC$ vertically down to $BC$ by $x$, then by the principles of parabola $x=\frac{AB}{x^2}$. and distance from point 2 down to the road surface is $2^2 x$ or $4x$, and the distance from 3 in $3^2 x$ or $9x$, and so on.

3. By sub-grade is meant the natural soil on which is placed the artificial foundation.

The sub-grade shall be brought to a firm unyielding surface by rolling with a steam roller, weighing not less than 10 tons, and all portions of the surface of the sub-grade inaccessible to the roller shall be tamped thoroughly with a rammer. All soft and yielding spots and all vegetable substances or other unsuitable material, shall be removed and the space refilled with approved material

The camber of the sub-grade shall be parallel to the camber of the finished wearing coat.

The crown of the sub-grade should be at least 6″ above the general level of the adjacent land.

When rolling the sub-grade, the steam roller shall be driven at its low speed

4. **Foundation.**—The foundation shall consist of a 9″ layer to stone blocks covered with a 3″ coat of water bound macadam metal of 2½″ gauge. The stone blocks shall be as large as possible, providing one dimension is not greater than 9″. The blocks shall, in no case, consist of surface stone, and all shall have sharp arises. Any stone having rounded surface shall be rigorously rejected. Small pieces of stone, that is those which will pass through a 4″ diameter ring, shall be used for wedging into the interstices of the larger blocks, but shall not be used for bringing up the thickness of the 9″ foundation coat to the correct thickness.

The stone blocks shall not be dumped into position, but every stone be placed in position by hand with its length at right angles to the axis of the roadway and carefully packed with pieces of smaller stone in the interstices, hammered into a position, if necessary. The surface of the foundation coat shall be kept as true to the correct finished camber of the wearing coat, as possible, and shall be rolled until thoroughly compacted with a roller weighing not less than 10 tons.

The Deputy Chief Engineer may, at his discretion, specify smaller stone blocks than the above, but the laying and rolling of the same shall be similar to that already specified.

In districts where only river boulders are available, the same may be used with the Deputy Chief Engineer's permission, but every boulder shall be split and the laying and rolling of same shall be similar to that specified above.

After the 9″ foundation coat of stone blocks has been consolidated, a 3″ coat of water bound macadam metal of $2\frac{1}{2}$″ gauge shall be laid on same, and consolidated with a roller, weighing not less than 10 tons. This 3″ cost shall be carefully consolidated to the camber of the finished wearing coat.

5. **Intermediate Coat** —In all cases where the wearing coat is to be either—

(*a*) asphaltic concrete,
(*b*) asphaltic macadam,
(*c*) bituminous grouted macadam,

a $4\frac{1}{2}$″ coat of $1\frac{1}{2}$″ gauge, which shall be termed the intermediate coat, shall be given, consisting of water bound grade metal, laid to the correct camber of the finished wearing coat and consolidated with a roller weighing not less than 10 tons. No clay should be used as blinding when consolidating this coat.

In miles that are widened the $4\frac{1}{2}$″ intermediate coat shall be given over the entire width (existing and new).

*N.B.*—Under no circumstances shall the 3″ water bound macadam coat of the foundations form a wearing coat. If the wearing coat is to be a water bound macadam either surface-treated or not, then a $4\frac{1}{2}$″ coat of the water bound grade metal shall be laid over the foundations, as specified in paragraph 4.

6. **Wearing coat.**—No wearing coat of bituminous grouted macadam shall be laid in any mile until the road surface shall have been given an intermediate coat, as specified above, unless the Deputy Chief Engineer shall consider that the existing surface is fit enough and has a camber of approximately 1 in 48.

7. **Material.**—The material to be used shall be as follows :—

(*a*) Large aggregate, which shall pass a $2\frac{1}{2}''$ diameter ring but be retained by a $1''$ diameter ring.

(*b*) Intermediate aggregate which shall all pass a $1''$ diameter ring but be retained by a $\frac{1}{2}''$ diameter ring.

(*c*) Grit which shall all pass a $\frac{1}{2}''$ diameter ring but shall be screened to exclude all fine stuff which will pass a 16 mesh screen. All the above aggregate shall be free from clay or other deleterious matters.

(*d*) The asphalting cement material shall consist of :—

(*i*) Trinidad refined asphalt and flux oil mixed by weight 100 parts T. R. A. and 23 parts flux oil for the grout mixture and 100 T. R. A. and 50 part flux oil for the seal coat mixture ; each quantity shall be accurately weighed being put into the boiler.

*Or*, (*ii*) Mexphalt, 30-40 penetration grade for grout mixture, and spray mixture, 80-100 penetration grade for seal coat mixture.

*Or*, (*iii*) Other kinds of materials which may be used for the asphaltic cement matrix ; but whenever such are used, the Deputy Chief Engineer is to be consulted and asked for instructions.

The asphaltic cement consisting of mixture of T. R. A. and flux, both for grout and seal mixture, shall be brought to and maintained at temperature ranging between 325° F. and 375° F. before and while being used. Preferably the T. R. A. cement shall be used with a temperature nearer 325° F. than 375° F., as the higher the temperature the greater the loss by evaporation. It shall be kept continuously stirred while being heated and being drawn-out from the boiler and open half drums ; unless this is done, it will be found that only flux oil is being drawn off. The mexphalt and spraymax shall be brought to and maintained at temperatures ranging between 325° F. and 350° F. before and while being used.

A thermometer shall be provided with each boiler to see that the matrix is being used at the correct temperature. All heating of the asphaltic cement shall be done in specially constructed boilers or in open half drums.

8. **Laying.**—Before the large aggregate is laid, the surface of the road shall be thoroughly well swept clean of all dust, dirt and manure. For this purpose stiff bars and wire brushes shall be used to loosen the dirt and remove a portion of the binding material of the water bound coat in order to form a key for the new wearing coat, but in no case shall the surface be picked up, after which soft housemaid's brushes shall be used for removing all fine particles of dust. If any dust still remains on the surface, it can be removed by blowers, either hand or mechanical. The dirt and dust removed shall be deposited away from the cleaned surface, so that there may be no chance of its being blown down on to the surface. No more surface shall be cleaned than can be laid with the large aggregate so as to ensure continuous working. No work shall be taken in hand unless the road surface is absolutely dry as also all materials of the aggregate and in the event of rain falling during progress of the work, the work shall be stopped and not resumed until all is thoroughly dry again.

The large aggregate which shall be clean and free from all dirt, shall be brought from the stock to the road and damped a few feet away from the workmen laying the same. It shall be hard packed true to template, 3" thick.

Template shall be used freely to ensure the correct camber and thickness of metal being spread.

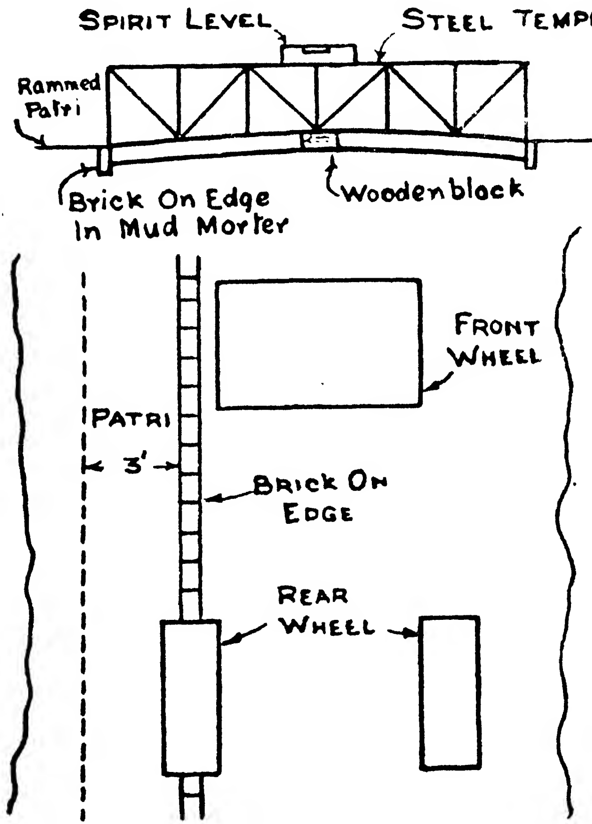



Plate 3.

The large aggregate shall not be dry rolled when T. R. A. is used, but when mexphalte is used, dry rolling may be done to a limited extent ; any rolling shall be done as specified hereafter for grouting.

9. **Edging.**—The edges of the dry metalling of the large aggregate of the wearing coat shall be kept in position by means of 1st class bricks on edge laid in and on a $1\frac{1}{2}''$ bed of clay mortar.

When the surface of the road has been prepared for and before the laying of the large aggregate of the wearing coat, the brick edging shall be constructed.

To ensure the brick edges being laid true to the alignment of the road and level with the top of the wearing coat, the following method should be employed.

At intervals of every 10 ft. the subordinate in charge of the work shall, by means of the road template, spirit level and a block of wood, $3''$ deep, have fixed in position one brick on edge on each side of the travelling surface, as shown in the Fig. 3. The bricks at 10 ft. intervals having been fixed, the mason will then lay on edge the intervening bricks. It is essential to see that the edging is laid on at least a $1\frac{1}{2}''$ bed of clay mortar to ensure of the bricks being evenly bedded, otherwise breakages will occur when rolling takes place.

Immediately the edging has been placed in position, the "pateries" either side for a width of $3'$ are to be made up with clay flush with the brick edging and well watered and rammed. The surface of the road, after cleaning, is then ready to receive the large aggregate, which is spread $3''$ thick as specified, flush with the top of the brickedging and after having received the grout and intermediate aggregate may be rolled, all as specified before, care being taken to see that one wheel of the roller upon first rolling passes half over the metalling and half over the edging and "pateries," as in the Fig. 3. This ensures consolidation of the brick edging upon first rolling and prevents subsequent spreading.

10. **Pouring.**—After large aggregate has been spread, the surface shall be marked off by means of chalk lines or strings into areas of a known quantity, each area being of such size as to take the known quantity of asphaltic cement required. The asphaltic cement will then be poured on to the surface by means of pouring cans 1·5 gallons being used per sq. yard in the case of T. R. A. and 1·25 in the case of mexphalte, care being taken to see that it is at the correct temperature. As soon as the asphaltic cement has been poured on to the surface and while it is still hot, a thin layer of intermediate aggregate shall be broadcasted over the treated surface in such a quantity as to fill the surface voids and just cover the treatment, after which the surface shall be rolled with a roller weighing not less than 10 tons until thoroughly well-consolidated. The rolling shall start longitudinally at the sides and proceed towards the centre, overlapping successive strips by at least half the width of the roller. The pouring of the bitumen shall be so regulated, that it is regular and the spout of the pouring can shall be kept within 6″ of the surface. The directions of the successive pourings shall be reversed.

*N.B.*—The best results will be obtained by doing the initial roll with a 10 ton Tandem-roller and finishing of with a 15 ton roller, but it is realised that it is not always possible

11. **Seal Coat.**—After the grouted surface has been well-consolidated, it shall be swept clean of all loose stones and dust and the seal coat applied, not more than 3/10ths gallon per sq. yard being applied, care being taken to see that the asphaltic cement for the seal coat is of the correct temperature. The seal coat may be either applied by means of mechanical sprayers or pouring cans. The quantity required per sq. yard being small, it will be necessary to either sweep or squeeze the asphaltic cement to ensure its even distribution. As soon as the seal coat has been applied and while it is still hot, grit to a depth of at least ½″ shall be broadcasted over the surface and the whole rolled with a roller weighing not less than 10 tons;

the rolling to continue until all the grit has been well-compacted Upon completion of the rolling there should remain on the road a light uniform covering of the grit so that the maximum quantity, which the asphaltic cement will absorb, has been applied, the fine screening from the grit may be used as a top dressing after rolling. To light a covering of grit will mean, that the surface will attain a polished surface. but will probably bleed during the hot weather.

12. **Pateries.**—During grouting operations the "pateries" shall be watered for a length at least equal to that under operation.

Too much attention cannot be paid to cleaning of the road surface and of the grout surface before the laying of the large aggregate coat and application of the seal coat, respectively.

The rolling of the grout coat and seal coat shall be done with a tandem roller if the same is available.

13 **Protection of Road Surface.**—During the period between the spreading of the large aggregate and completion of the seal coat the surface of the road shall be protected from all traffic other than that which is absolutely essential to its construction.

14. **Protection of Workmen.**—Men employed in handling the asphaltic cement shall be supplied with boots of approved pattern and thick gloves or other protection for the hands.

## Report.

Report accompanying and forming part of Estimate No.—of the probable cost of reconstructing miles 181 to 196 of the Lucknow-Benares Provincial road in the Benares Division :—

Amounting to Rs. 4,47,164

| Space for subsequent comment. | Report. |
| --- | --- |
| | In the programme for these miles it was proposed to lay a foundation of 9″ stone blocks and one coat of metal rolled into the intersections, from a return of the depth of metal in these miles sent in by the Executive Engineer, Benares, it has been ascertained that there are depths of metal existing on these miles which vary from 13″ to 21″ except in isolated furlong where the depth is less. It has, therefore, been decided in accordance with the decision arrived at by the Chief Engineer to omit this stone block foundation and to provide it only in portions where the road has to be widened on in isolated bits where the depth of metal is less than 9″. From the savings created in the work of providing new foundations it has been possible to realise a sufficient sum to provide for bitumenising the first 6 miles, that is, miles 191 to 196 of the Lucknow-Benares road These miles will be grouted with bitumen from the |

| Space for subsequent comment. | Report. |
|---|---|
| | Trinidad Lake flux, with a suitable flux, and rolled with Gaya stone chippings. The programme provides, exclusive contingencies, a sum of Rs. 4,69,228 for this work, but the total estimated expenditure will be Rs 4,47,164. There will, therefore, be a balance of Rs. 22,064 available for such items as tools and plant or small excess in the other parts of the programme, the total amount of the estimate is Rs. 4,47, 164, but under the programme for this year the sum available for expenditure amounts to Rs. 2,75,000, the balance of this estimate may be provided in the next year. |
| | It has been considered advisable to deal with the whole of the proposals of the Jaunpur-Benares section of the Lucknow-Benares road as one unit although in the programme only ten miles were provided this year. The reason for this is that should there be any difficulty in carrying the work in any particular mile, another mile can be substituted by the Executive Engineer who will be carrying out the work. |

**General specification** of the work contemplated in the estimate No. of 19 .

| Space for remarks. | General specification for the particular work. |
|---|---|
| | 1. The old kankar or stone surface existing on the road will not be dug up completely, but it will be dug up only sufficiently to provide an even surface constructed to the proper camber with a crossfall of 1 in 50. Template will be constructed to create profile in accordance with the instructions given in the specification for cement concrete road The Engineer shall work out the template for the particular width of the road in accordance with those instructions. |
| | 2. Where there is any depth of metal less than 9″ the whole of this metal shall be dug out and the foundation laid with 9″ stone blocks from *pahara* of Chunar, as may be found to be the cheapest. All the interstices between the 9″ stone should be filled with round stone ballast of the same stone as the 9″ blocks and the stone shall then be rolled with a steam roller of not less than 10 tons weight. Should sufficient old metal be available from the excavation of the present metalling, this should be used to fill up all interstices in the stone blocks, similarly ; any metal dug from the road should be used in filling up the interstices of the stone blocks where the road had to be widened. |

| Space for remarks. | General specification for the particular work. |
|---|---|
| | 3. The widening of the road is to be done by putting down 9″ stone blocks whose interstices are filled with the surplus old metal from the road and rolled with a roller of not less than 10 tons weight. This stone foundation is to be provided in equal width on either side of the existing metalling. For the portion in the Shiopur bazar whole width will be metalled between the side drains, as shown in the drawing attached to the estimate. The eastern portion of the bazar, where the road widens out considerably, only 24′ width will be provided. The remainder of the road will form earthen pateries graded in a uniform slope of 1 in 50 and care should be taken that the earth for this pateri is good clay and from not light vegetable earth or refuse of the bazar. |
| | 4. In miles 191-196 should be given a bitumen grouted surface coat. On the soling coat of the existing metal, which should be thoroughly cleaned. $4\frac{1}{2}$ of best Gaya metal should be rolled without any binding of any nature whatsoever. This preliminary rolling shall only be a light rolling intended to partially consolidate the metal sufficient to ensure penetration of asphalt without its being allowed to waste apparently in the foundation. The Engineer |

| Space for remarks. | General specification for the particular work. |
|---|---|
| | should watch this preliminary rolling carefully because if he rolls too hard he will get defective penetration. On the other hand, if he does not roll it sufficiently he will spoil valuable asphalt. Greatest care should, therefore, be taken to roll first sufficiently and not too little or too much. A few experiments should be tried on such miles as are not to be provided for bitumen. The extent of rolling should be gradually watched on these miles to ascertain how many movements of the rolling are sufficient to consolidate the metal so as to give the penetration required. |
| | 5. The asphalt shall be heated in an approved bitumen heater and shall be applied either under pressure sprayer or by means of a bucket, as may be finally decided, but great care shall be taken in each case to ensure an absolutely even distribution of bitumen, *i.e.*, a fixed number of gallons per square yards as approved of in the special specication provided for this type of work. The Engineer shall mark out regular spread and divide up his road into area representing the capacity of the spread of bitumen |

| Space for remarks. | General specification for the particular work. |
|---|---|
| | from bitumen cans If he uses the pressure sprayer, he shall ascertain its rate of delivery and mark out his range of surface in accordance with the discharge of the sprayer which he has ascertained. |
| | 6 When the bitumen has been applied and before it has time to cool, hard stone chippings shall be spread on the surface and thoroughly rolled in and consolidated. This final rolling shall be completely done so that there is no movement of the road surface under the roller and rolling shall not be stopped until this is attained. The stone chippings to be used is graded from $\frac{1}{2}''$ down to sand. It is essential that absolute even distribution both of chippings and of bitumen be ensured by constant supervision. Finally, a seal coat with the amount of bitumen as specified in the specification shall be applied and for this, the hard stone chippings rolled in before the bitumen has had time to cool. This means that laying the hard stone chippings should follow the nozzle of sprayer or the spraying can. |

| Space for remarks. | General specification for the particular work. |
| --- | --- |
| | For rolling not less than a ten ton roller shall be used without the consent of the Executive Engineer. |
| | 7. From mile 181 to 190 the road shall be 12′ wide and shall be provided with a surface of Gaya or Mander stone metal laid $4\frac{1}{2}''$ deep and rolled to a uniform camber used as the binding material. When the initial rolling has been completed, good moorum binding shall b applied in a $\frac{1}{2}$ layer all over the surface and thoroughly rolled in and consolidated with a 12 ton roller. A good rate has been provided for this moorum and the Executive Engineer should see that the very best moorum available is obtained. |

# ABSTRACT OF ESTIMATED COST.

## Benares District, Benares Division.

Estimate No.——framed by Mr. ——— Engineer, of the probable cost of Reconstruction, miles 180 to 196, of the Lucknow-Benares Provincial Road in the Benares District.

| Serial number | Quantity. | Denomination | Subhead of works. | Rate. | Per. | Estimated cost. Rupees | Rate per mile. |
|---|---|---|---|---|---|---|---|
| 1 (*a*) | 255915 | c. ft. | Excavation of metal. | 10/- | °/oo | 2,559 | |
| 1 (*b*) | 243540 | ,, | Excavation of ordinary earth (extra width of miles 181 to 190). | 4/- | °/oo | 974 | |
| 2 | 499455 | ,, | Grading, levelling, subgrading, watering and ramming and rolling to cross fall. | 10/- | °/oo | 4,995 | |
| 3(*a*) | 21780 | ,, | Stone block foundation from Pahara, miles 181. | 25/4/- | °/o | 5,499 | |
| (*b*) | 21780 | ,, | Stone block foundation from Pahara, miles 182. | 24/6/- | °/o | 5,309 | |
| | | | Carried over ... | | ... | 19,336 | |

| Serial number | Quantity. | Denomination. | Subhead of works | Rate. | Per. | Estimated cost. Rupees | Rate per mile. |
|---|---|---|---|---|---|---|---|
| | | | Bt. forward ... | | | 19,336 | |
| (c) | 11880 | c. ft. | Stone block foundation from Pahara, miles 183. | 23/8/- | °/o | 2,792 | |
| (d) | 11880 | ,, | Stone block foundation from Pahara, miles 184. | 23/8/- | °/o | 2,792 | |
| (e) | 11880 | ,, | Stone block foundation from Pahara, miles 185 | 24/6/- | °/o | 2,896 | |
| (f) | 11880 | ,, | Stone block foundation from Pahara miles 186. | 25/4/- | °/o | 3,000 | |
| (g) | 11880 | ,, | Stone block foundation from Pahara, miles 187. | 25/4/- | °/o | 3,074 | |
| (h) | 11880 | ,, | Stone block foundation from Pahara, miles 188. | 25/- | °/o | 2,970 | |
| (i) | 11880 | ,, | Stone block foundation from Pahara, miles 189. | 24/2/- | °/o | 2,866 | |
| (j) | 11880 | ,, | Stone block foundation from Pahara, miles 190. | 23/4/- | °/o | 2,762 | |
| | | | Carried over ... | | ... | 42,488 | |

| Serial number. | Quantity. | Denomination. | Subhead of works. | Rate. | Per. | Estimated cost. Rupees. | Rate per mile. |
|---|---|---|---|---|---|---|---|
| | | | Bt forward ... | ... | ... | 42,488 | |
| (*k*) | 22275 | c.ft. | Stone block foundation from Pahara, miles 191. | 22/6/- | °/o | 4,984 | |
| (*l*) | 22275 | ,, | Stone block foundation from Pahara, miles 192. | 21/8/- | °/o | 4,789 | |
| (*m*) | 15840 | ,, | Stone block foundation from Pahara, miles 193. | 20/10/- | °/o | 3,267 | |
| (*n*) | 49500 | ,, | Stone block foundation from Pahara, miles 194. | 19/12/- | °/o | 9,776 | |
| (*o*) | 22275 | ,, | Stone block foundation from Pahara, miles 195. | 20/10/- | °/o | 4,596 | |
| (*p*) | 22275 | ,, | Stone block foundation from Pahara, miles 196. | 19/12/- | °/o | 4,399 | |
| 4 | 293040 | ,, | Laying and consolidating foundation after filling interstices with old metal. | 2/- | °/o | 5,861 | |
| | | | Carried over | | | 80,160 | |

| Serial number. | Quantity. | Denomination | Subhead of works. | Rate. | Per | Estimated cost. Rupees. | Rate per mile. |
|---|---|---|---|---|---|---|---|
| | | | Bt. forward | ... | ... | 80,160 | |
| 5 (a | 23760 | c. ft | Gaya stonemetal collection, mile 181. | 34/4/- | °/o | 8,138 | |
| (b) | 23760 | ,, | Gaya stonemetal collection, mile 182. | 33/6/- | °/o | 7,930 | |
| (c) | 23760 | ,, | Gaya stonemetal collection, mile 183 | 32/8/- | °/o | 7,722 | |
| (d) | 23760 | ,, | Gaya stonemetal collection, mile 184. | 32/8/- | °/o | 7,722 | |
| (e) | 23760 | ,, | Gaya stonemetal collection, mile 185. | 33/6/- | °/o | 7,930 | |
| (f) | 23760 | ,, | Gaya stonemetal collection, mile 186. | 34/4 | °/o | 8,138 | |
| (g) | 23760 | ,, | Gaya stonemetal collection, mile 187. | 34/4/- | °/o | 8,286 | |
| (h) | 23760 | ,, | Gaya stonemetal collection, mile 188. | 34/- | °/o | 8,078 | |
| (i) | 23760 | ,, | Gaya stonemetal collection, mile 189. | 33/2/- | °/o | 7,871 | |
| (j) | 23760 | ,, | Gaya stonemetal collection, mile 190 | 32/4/- | °/o | 7,663 | |
| (k) | 31680 | ,, | Gaya stonemetal collection, mile 191. | 31/6/- | °/o | 9,940 | |
| | | | Carried over | | ... | 1,69,578 | |

| Serial number. | Quantity. | Denomination | Subhead of works. | Rate. | Per. | Estimated cost. Rupees. | Rate per mile. |
|---|---|---|---|---|---|---|---|
| | | | Bt forward | ... | . | 1,69,578 | |
| (*l*) | 31680 | c. ft. | Gaya stonemetal collection, mile 192 | 30/8/- | °/o | 9,662 | |
| (*m*) | 31680 | ,, | Gaya stonemetal collection, mile 193. | 29/10/ | °/o | 9,385 | |
| (*n*) | 46530 | ,, | Gaya stonemetal collection, mile 194. | 28/12/- | °/o | 1,337 | |
| (*o*) | 31680 | ,, | Gaya stonemetal collection, mile 195. | 29/10/- | °/o | 9,385 | |
| (*p*) | 31680 | ,, | Gaya stonemetal collection, mile 196 | 28/12/- | °/o | 9,108 | |
| 6 | 442530 | ,, | Consolidation with steam roller. | 4/- | °/o | 17,701 | |
| 7 | 26400 | ,, | Moorum for binding. | 40/- | °/o | 10560 | |
| 8 | 60720 | s. yd | Bitumen fronting with Trinidad lake asphalt including cost of hard stone grit rolling laying and final dressing. | 3/1/- | per s.yd. | 1,85,955 | |
| 9 | 16 | mile | Pateries. | 200/- | Per mile | 3,200 | |
| | | | Total of the above | | | 4,25,871 | |
| | | | Contigencies 5 per cent | | | 21,293 | |
| | | | Total of the Estimated Cost | | | 4,47,164 | |

## Cost of Concrete Road

The cost of cement concrete road in U. K. as compared to the local estimate is instructive. *

The cost of a concrete road varies in different localities according to the nature of the site, the cost of materials, rates of wages, etc., but the following figures, giving estimates of the cost of laying a 6-in. one-course road and an 8-in. two-course road, will serve as a guide to the cost of concrete roads generally. The prices and and wages can be varied to suit local conditions.

*Typical Costs for a one-course Concrete Carriageway, 6 inch thick with single reinforcement.*

| | Cost per sq. yd. of Surface. s | d. | s. | d. |
|---|---|---|---|---|
| Excavation and grading ... ... | 0 | 8 | 1 | 0 |
| Rolling formation ... ... | 0 | 4 | | |
| Clinker bed, 3 in. consolidated thickness (Clinker at 4 s. per cu. yd ) ... | 0 | 6 | 0 | 6 |
| Concrete 4 : 2 : 1 mix. | | | | |
| Cement at 50s. per ton ... ... | 1 | 11 | 6 | 8½ |
| Fine aggregate at 10s. per cu. yd. ... | 0 | 9 | | |
| Coarse aggregate at 8s. per cu. yd. ... | 1 | 2½ | | |
| Water ... ... ... | 0 | 1 | | |
| Labour (based on 1s. per hour) ... | 1 | 2 | | |
| Forms, carpentry, and waste ... | 0 | 3 | | |
| Expansion joints ... ... | 0 | 2 | | |
| Curing (canvas and damp earth) ... | 0 | 2 | | |
| Reinforcement supplied and laid ... | 1 | 0 | | |
| Total ... ... | | | 8 | 2½ |

* The concrete year book, 1933.

*Typical costs for a Two-course concrete Carriageway 8 in. thick, with single Reinforcement.*

| | Cost per sq. yd. of Surface. | | | |
|---|---|---|---|---|
| | s. | d. | s. | d. |
| Excavation and grading ... | 1 | 6 | 1 | 6 |
| Clinker, 3 in. consolidated thickness (Clinker at 4s. per cu. yd.) ... .. | 0 | 6 | 0 | 6 |
| Concrete, bottom course, 6 in. 4 : 2 : 1 mix. | | | | |
| Cement at 50s per ton ... | 1 | 11 | | |
| Sand at 10s. per cu yd. ... | 0 | 9 | | |
| Ballast ($1\frac{1}{2}$ in. to $\frac{1}{8}$ in.) @ 8s per cu. yd. ... | 1 | $2\frac{1}{2}$ | | |
| Top course, 2 in. 3 : $1\frac{1}{2}$ : 1 mix. | | | | |
| Cement @ 50s. per ton ... | 0 | 10 | | |
| Sand @ 10s. per cu. yd. ... | 0 | 3 | 9 | $8\frac{1}{2}$ |
| Granite chipping @ 30s. per cu. yd. ... ... | 1 | 6 | | |
| Water ... ... ... | 0 | 1 | | |
| Labour @ 1s. an hour ... | 1 | 6 | | |
| Forms, carpentry, and waste ... | 0 | 4 | | |
| Expansion joints ... ... | 0 | 2 | | |
| Curing (canvas and damp earth) | 0 | 2 | | |
| Reinforcement supplied and laid | 1 | 0 | | |
| Total ... | | | 11 | $8\frac{1}{2}$ |

*Typical costs on large contracts.*

LABOUR.

| Men employed: | | | £. | s. | d. |
|---|---|---|---|---|---|
| 1 Ganger ... | 10 hrs. | at 1s. 6d. | 0 | 15 | 0 |
| 2 Mixer drivers ... | 20 „ | at 1s. 4d. | 1 | 6 | 8 |

| | | | £. | s. | d. |
|---|---|---|---|---|---|
| 1 Tipping bucket ... | 10 hrs. | 280 hrs. at 1s. | 14 | 0 | 0 |
| 3 Spreaders, bottom and top ... | 30 ,, | | | | |
| 4 Tamping bottom and top ... ... | 40 ,, | | | | |
| 1 Wheeling top ... | 10 ,, | | | | |
| 1 Jointer ... | 10 ,, | | | | |
| 4 Levelling and fixing forms ... ... | 40 ,, | | | | |
| 8 Loading mixers ... | 80 ,, | | | | |
| 6 Loading skips ... | 60 ,, | | | | |
| 1 Loco. driver ... | | ... | 0 | 15 | 0 |
| 1 Fireman ... | | ... | 0 | 12 | 6 |
| | | | 17 | 9 | 2 |

= 10½d. per sq. yard.

Add cost of laying temporary railway track = 1½d. ,, ,, ,,

Total labour = 1s. ,, ,, ,,

## Materials

For 1 bay, 30 ft. by 15 ft. by 8 in. thick.

| | £. | s. | d. |
|---|---|---|---|
| Bottom course, 6½ in. thick, 4 : 2 : 1 mix | | | |
| 7 cu. yd. gravel ... @ 7s. = | 2 | 9 | 0 |
| 3½ cu. yd. sand ... @ 12s. = | 2 | 2 | 0 |
| 33 bags rapid-hardening Portland cement ... @ 57s. = | 4 | 14 | 0 |
| Top course, 1½ in. thick, 3 : 1½ : 1 mix. | | | |
| 2 tons 6 cwt. granite chippings ... @ 25s. = | 2 | 17 | 6 |
| 1 cu. yd sand ... @ 12s. = | 0 | 12 | 0 |
| 13 bags rapid-hardening Portland cement ... @ 57s. = | 1 | 17 | 1 |
| | 14 | 11 | 7 |

| | | £. | s. | d. |
|---|---|---|---|---|
| Add petrol, oil, etc., for mixers | ... | 0 | 2 | 0 |
| Fuel for loco. | ... | 0 | 1 | 0 |
| Water supply | . | 0 | 1 | 0 |
| | | 14 | 15 | 7 |

= 5s. 11d. per square yard.

## Summary of Cost

| | | | s. | d. |
|---|---|---|---|---|
| Formation treatment as detailed, including labour and materials | ... | = | 1 | 4 |
| Labour, concreting slab | ... | = | 1 | 0 |
| Materials for slab | ... | = | 5 | 11 |
| Expansion and longitudinal joints | ... | = | 0 | 1 |
| Curing with canvas and damp earth | ... | = | 0 | 1 |
| Total | ... | | 8 | 5 |
| | | | per sq. | yd. |

The foregoing table is an extract of costs recently taken out over an area of 400 sq. yds. of road, and indicates the cost of laying a concrete carriageway on an extension scale where full scope is given for utilisation of extensive plant to simplify the handling of materials. In this case the carriageway was 8 in. thick without reinforcement and was laid in two courses. The treatment of the foundation consisted of a 6-in. consolidated layer of destructor clinker, followed by 3-in. of water-bound hoggin. This was allowed to stand for 14 days before the concrete raft was laid.

——:o:——

The following will give a fairly good idea about **Irrigation Engineering Estimates.** The estimates under all the headings will give the total cost.

*List of Major Heads Appertaining to the Public Works Department, Irrigation Branch.*

## Expenditure

Capital expenditure not charged to revenue—

(1) Construction of Irrigation, Navigation, Embankment and Drainage works.

A. Irrigation works—

(1) Productive.

(2) Unproductive.

Expenditure charged to revenue—

14. Interest on works for which Capital Accounts are kept—

15. Other revenue expenditure financed from ordinary revenues

A. Irrigation works.

(1) Works for which only Revenue Accounts are kept.

(2) Works for which neither Capital nor Revenue Accounts are kept.

(3) Miscellaneous expenditure.

B. Navigation, Embankment and Drainage works.

(1), (2), and (3) as under A above.

15. (1) Other revenue expenditure financed from Famine Insurance grants.

## Revenue

XIII. Irrigation, Navigation, Embankment and Drainage works, for which Capital Accounts are kept.

A. Irrigation works.
(1) Productive
(2) Unproductive
} Gross receipts. Deduct working expenses. Net receipt.

B. Navigation, Embankment and Drainage works.
(1) Productive
(2) Unproductive
} Gross receipts. Deduct working expenses. Net receipts.

XIV. Irrigation, Navigation, Embankment and Drainage works for which no Capital Accounts are kept

A. Irrigation works.

(1) Works for which only Revenue Accounts are kept.

(2) Works for which neither Capital nor Revenue Accounts are kept.

B Navigation, Embankment and Drainage works

(1) and (2) as under A.

*Note:*—There are no navigation, embankment or drainage works under U. P., P. W. D. Irrigation Branch.

**Minor Heads**—under Irrigation.

Under Gross receipts.
Direct receipts.

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Water rates.
Owners' rates.
Water supply of towns.
Sale of water.
Plantations.
Other canal produce.
Water power.
Navigation.
Rents of buildings
Fines
Miscellaneous.
Deduct refunds.
Portion of land revenue due to works.

**Under Working Expense**

Extensions and Improvements.
Maintenance and repairs.
Establishments.
Tools and Plants.
Suspense.
Deduct recoveries on revenue account.
Deduct English cost of stores.
Loss or gain by exchange.
Expenditure in England.

*Main Heads under* 15-A (1) or 15-A (2)—(Revenue Expenditure).

Works.
Extensions and Improvements.
Maintenance and repairs.
Establishment.
Tools and Plant.
Suspense
Deduct English cost of stores.
Loss or gain by exchange.
Expenditure in England.

*Minor Heads under* 55-A (1) or 55-A (2).

Works.

Establishment.
Tools and Plant.
Suspense.
Deduct receipts and recoveries on Capital Account.
Deduct English cost of stores.
Loss or gain by exchange.
Expenditure in England.

**Irrigation Project Estimate,** *Original Capital Works.*

I. *Head Works :—*

A. Preliminary :—
Surveying.
Levelling.
Contingencies.

B. Land :—
Permanent.
Temporary.
Contingencies.

C. Works :—
Masonry works.
Steel gates.
Wooden beams.
Pitching.
Etc., etc.
(*e.g.*, Concrete, brickwork, archwork, etc.)
Contingencies.

K. Buildings (Offices, Residences, Inspection House, etc.).
Concrete.
Brickwork.
Archwork.
Wooden doors and windows.
Joist, etc.
Contingencies

L. Earthwork :—
Excavation
Embankment
Puddling
Etc., etc.
Contingencies

O. Miscellaneous.
Bed forms.
Milage posts, etc.
Contingencies.

P. Maintenance.

II. *Main Canal and Branches* :—

A. Preliminary as before.
B. Land as before.
D. Regulators
Foundation—earthwork.
Concrete.
Brickwork or masonry.
Archwork.
Steel gates.
Grooves.
Woodwork.
Pitching.
Etc , etc.
Contingencies.

E. Falls.
Foundation—earthwork.
Concrete.
Brickwork or masonry.
Pitching,
Woodwork.
Etc , etc.
Contingencies.

F. River and hill-cutting work.
Super passage.
Level-crossing
Aqueducts.

L. Earthwork (channel) :—
Excavation.
Embankment.
Puddling
Contingencies.

M. Plantations.
Sawing.
Restocking.

Nurseries.
Etc., etc.
Tending.
Contingencies
N. Tanks and reservoirs
Earthwork.
Excavation.
Puddling.
Contingencies.
O. Miscellaneous.
Mile and furlong stones.
Bed profiles.
Gauges.
Outlets.
P. Maintenance.
Rate per mile.
Contingency.
Establishment

III. *Distributaries* :—
Heads :—A, B, C, K, L, O, P, as above.

IV. *Drainage and protective works.*
Heads :—A, B, C, K, L, O, P, as above.

(x) Earthwork.
Concrete.
Brickwork or masonry.
Archwork.
Pitching.
Etc., etc.
Contingencies.

F. Other cross drainages, such as—
Siphons, inlets, etc.
Earthwork :—
As above marked (*x*).
G. Bridges.
As above marked (*x*).
H. Escapes.
Grooves
As above marked (*x*).
I. Navigation works.
Lock gates.

Lock channels
Steel and wood gates.
As above marked ($x$).

J. Mills houses, stone mills, etc.
As above marked ($x$).

K. Buildings.
Inspection houses.
Staff quarters.
Offices.
Petrol huts.
Etc., etc.
As above marked ($x$).

V. *Water Courses*
A, B, C, L, O, P, as above.

VI. *Special tools and plants such as*—
Excavators, navvy, engines and tracks, etc., etc.

VII. *Losses on stock.*
As local conditions and circumstances may require.
Establishment charges.
General.
Leave and pension charges.
Tools and plants.
Indirect charges:—
Audit and accounts.
Capitalised value of abatement of land revenue.

### Extensions and Improvements

I. Head works.
II. Main canal and branches.
III Distributaries.
IV. Drainage.
V. Losses on stock.

Details as for capital works with the exception:—

A. Preliminary, and
P. Maintenance
Maintenance and repairs.
Heads and sub-heads as for extensions and improvements.

# CHAPTER XXVIII

## TRADE CYCLE, AND ECONOMICS OF MASS PRODUCTION

BEFORE proceeding to a more careful consideration of the problems of mass production, it is desirable that the reader should apprehend the phenomena of the Trade Cycle. It has been observed during the last century or so, that industrial prosperity, though on the whole a rising tide, has been subject to more or less regular resting periods. They are times of acute depression, and anxiety for business men, and of bitter poverty and hardship for the employed class. Alternating with the **trade depression** is the **trade "boom,"** during which credit expands, prices rise, everyone is in employment at a good wage, and it seems almost impossible to pay so much for anything, that it will not presently be possible to sell it for a still higher price.

The period between two trade booms or between two trade depressions varies from three to ten years. It is usually about six or seven. No conclusive explanation has ever been advanced. By some economists, and those not the least eminent, the trade cycle is regarded as a natural phenomenon, quite beyond the control of mankind. They say that the immediate cause is the success or failure of the world's crops and the prime cause, a fluctuation in the amount of heat coming from the sun. But this theory would lead to the conclusion, that a great deal of human misery is the act of God, and not due to human ignorance and folly. No matter how well-attested they appear to be, such theories must not be accepted as they lead to paralysis of endeavour. The classic example is that acclaimed by Yudhisthira at the mystic lake. Though all the evidence shows man, that all his efforts are vain, and that his life must end in an irretrievable disaster, he always has refused and always will refuse to believe it. We ourselves regard trade booms and trade depressions as essentially failures to control credit. We do not think that the problem of controlling it will defeat mankind for ever, no matter what may be the initiating cause of its variations. It is the bright side of mass production, as contrasted with the dark one which we have already noticed that it may be made a powerful agent of credit control.

The jobbing shop lives from hand to mouth. It is the obedient humble follower of the trade cycle During the slow ascent from a depression it gathers more and more confidence. It employs more and more men. and being as its directors think, certain of orders in the future, buys more raw material on longer and longer credit. Its employees being, as working men nearly always are, quite improvident, spend their wages as fast as they get them. Even if they were not improvident, they would, as poor men have to spend most of them to live. This accelerated spending is an increase in the velocity of circulation, which is the equivalent of inflation, and tends, therefore, to raise prices and intensify the boom.

This ascent is the slow part of the trade cycle. Whatever it may be that starts it, possibly it is a pure accident, such as the failure of a large bank. dishonestly conducted, (or the outbreak of war) the whole descent into the depths of depression commonly only lasts a month or so. We have said that the manager of the jobbing shop, confronted with a trade depression, should rather cut prices to the bone than discharge good workmen. Unhappily he will have to cut prices first, and discharge workmen sooner or later anyhow, and the collective result of all shops doing this, will be to hurl the whole community into the depths. To cut prices where the medium of exchange has become three-fourth credits, is to deflate, and only makes things worse. Nevertheless the jobbing shop must do it. It must realise even at a loss where half or all its liabilities are bills due for payment in one or two months. These are the times when it seems impossible to pay so little for any thing that it will not have to be sold at a still lower price.

The discharge of employees has the same disastrous effect that cutting price has. The merchant prince may not recognise the fact that the swarms of workmen coming and going through the gates of his works are his own ultimate customers, but the fact is none the less a fact for all that.

Fortunes have been made in providing for the wants of the rich, but not many, and none very large. The rich man pays a good price allowing a handsome profit to his provider, sometimes. But he is not numerous enough to support the industry of a nation. The richman, if he is an industrialist, is a middleman between one set of unrich consumers and another of unrich producers, and the consumers in one case are the producers in another. To discharge workmen universally is to ruin customers universally. The merchant community that does this is like a number of drowning men grasping at each other. Its behaviour is futile and suicidal, but inevitable in the present unorganised state of society.

No moral or class judgment is implied in all these. The unrich man nearly always thinks that the rich man makes proverty by the seizure of an unfair share of the produce of industry.

We cannot support him in this theory. The root cause of these troubles is simply ignorance, and the defective organisation which arises from it The unrich man with his obvious ethics, whichhe wrongly imagines to be the monopoly of his class, and his complete ignorance of economic principles, would, if given the opportunity, make an even more complete mess of things than does the class he condemns. History provides a number of examples of the under dog seizing the supreme power by force, and as many of his return after an interregnum bloody misrule, to the system he overthrew. Such examples, as history does provide of permanent uplift, are examples of a whole people co-operating to the same end. Our present situation is original only in its minor details

Expansion and restriction of credit, like the hope and panic from which they usually spring, are difficult, but not altogether impossible to control. There is, to take the most conspicuous example, one power which can manufacture and destroy credit to an almost unlimited extent, regardless of the phases of the trade cycle, and at any time. It is a great nation with a long record of probity and prosperity The popular faith in a future, corresponding to its past, provides a foundation for the manufacture of credit more stable than a mountain of gold The same power to a much smaller degree is possessed by local governments and municipalities, and to a still lesser degree by persons or firms of established reputation.

These can create credit even in times of depression. It is to their advantage to do so, because it is then that everything, including capital, is cheapest (Capital is cheap when it is possible to borrow it at a low rate of interest. It is cheap, during a depression, to the man who can offer safe investments, because there is always a certain amount of surplus income, seeking safe investment, and in these times safe investments are scarce).

The buying and manufacturing of a mass production shop should be done for the greater part during depression, because :—

(*a*) It can be most cheaply done then.

(*b*) By so doing depression is relieved

It should not buy or manufacture, or at least it should not buy more than it can help during a boom, because :—

(*a*) Then materials are most expensive.

(*b*) By so doing it adds to the general inflation and the height of the inevitable drop.

Self-interest and the public interest point in the same direction for once, but unhappily it is not possible to follow them all the way. The time required fully to realise the profits of such a policy is too long. Nothing short of a nation could last out the depression. Credit would be exhausted before the boom materialised. Nevertheless it should be the ideal of the mass producer to guide his enterprise generally in the direction indicated above. He will not be able to do it, except on a very large capital, and even then only very imperfectly. Perhaps, the best compromise is to run generally on jobbing shop lines during the boom, and fall back on a mass production specially when orders are not forthcoming.

At this stage Chapter II is to be read once more.

# CHAPTER XXIX

# ORGANISATION FOR MASS PRODUCTION

## Choice of the Article to be Manufactured

IT is said that Mr. Ford, the American who now produces motor cars in millions, hesitated between the car and a watch which could be sold for a rupee, and was afterwards unable to explain why he did not choose the latter. The watch is indeed an ideal article possessing all the essential qualities for mass production. They are :—

(*a*) Stability of form.
(*b*) A wide market.
(*c*) An elastic demand.

*By stability of form* we mean that the article should be one that, having been invented long since, has lost what Well calls " the adventurous quality of youth " It has settled down for life, and the best solutions of its mechanical problems having been discovered is unlikely suddenly to be subjected to the competition of an improved and patented article.

The very worst thing to select for mass production is some new invention. It is of prime importance where expensive machinery has to be installed, that it should not have to be altered or scrapped till it has earned the cost of installing it

There have been no inventions of any importance in the watch since the middle of the eighteenth century, and therefore as regards stability of form, no other machine can compete with it. On the other hand, consider the motor car.

The first successful cars appeared on the world's roads between 1890 and 1900, and it is by no means certain, in fact it is most improbable, that it has reached anything like its final form. The change speed gear, for instance, is most unsatisfactory. So is the self-starter where that exists, the best of self-starters being a very crude affair. The tyre is, at the present moment, in a state of transition to a new type, the baloon tyre. Front wheel brakes are being attempted successfully for the first time. It is very unlikely that petrol, a most dangerous and increasingly expensive fluid, will be the final form of fuel. A change of fuel is bound to bring in its train great changes in the engine. The differential serves its purpose only on a smooth dry road. We also are unable to understand why Mr. Ford chose the car. We strongly suspect him of the engineer's itch for invention, which is a most dangerous disease in the mass production shop. It should be eradicated everywhere except in the Jig and Fixture department.

*The wide market* goes almost without saying. We have already remarked that there is not much to be made in catering for the rich The correct policy is to provide the poor with a luxury article, because the demand for poor men's luxuries is highly elastic. The demand for necessities is considerable, but it has no elasticity ; that is to say, a reduction in price will not attract a great number of new buyers, since everyone is already supplied.

✓ The demand for power-driven pumps or even for hand pumps in India is probably very elastic. The pump is perhaps the most likely article in this country. It is an old and stable machine. It is not a necessity, or every *ryot* would have one.

At the same time it is a very desirable article in an agricultural country, and there can be little doubt that a twenty-five per cent. reduction in any class of pump would tempt a vast number of people.

When the mass production article has thus been chosen, it should be redesigned from top to bottom with a view to eliminating

(*a*) All fitting work.

(*b*) As many as possible of the parts adjustable for wear.

(*c*) As much as possible of the machining that must be done on intermittently cutting machines, such as the planer, slotter, and shaper.

As for (*a*) all that need be said, is that it is a desirable consummation in all design, and especially so in work produced in large quantities by unskilled labour. The second principle is not so obvious, and must be applied with discretion. Experience does show, however, that when adjustment for wear becomes necessary, it is usually better to scrap the worn part, or even the whole machine, and get a new one from the makers. We may again refer to the typical machine, the three-rupee watch. There is no doubt that as soon as it begins to go wrong it had better be thrown away and a new one purchased in its stead.

The reciprocating machine is unsatisfactory because it wastes time and power—time because there is a back stroke, and power because of the friction resulting from inertia forces. Plane surfaces, where they cannot be avoided, should be arranged for the milling machine.

The redesigned machine should, of course, be exhaustively tested before it is finally adopted. There must be no change after production has commenced. A dozen machines, at least, should be made and driven to death to find out the weak points. This testing is an indispensable part of all design. No very satisfactory machine ever comes straight off the drawing board, no matter how clever and experienced its designer may be. Many possible improvements become obvious as soon as it begins to work, and have to be incorporated in the next one. It is quite necessary that the lesson of experiences should be learned, as far as possible, before, not after mass production begins.

**Limits** :—For every hole that is to be bored, the workman is given two plug gauges—one the 'GO' GAUGE, which must go in easily, and the other the 'NOT GO' GAUGE, which must not go in at all. The sizes of these two gauges are the limits in that case. There are similar, but as a rule lower, limits for the shaft which must fit in to the hole. The technical aspects of limits are beyond the scope of this work. On economic grounds, however, it is necessary to warn the reader, that there is only one system of limits which he ought to consider. He is advised to commit to memory the formulæ of the British Engineering Standards Association, which he will find in its 'Publication No. 164, 1924.'

It is a task that will prove quite easy to an Indian student. It would be a serious error to adopt any of the numerous other limit systems, which are to be found in various books, and that are advised by numerous firms of gauge makers.

The formulæ permit the choice of any one of a number of grades of workmanship. It would take us too far aside from our present thesis to consider in any detail the choice of a grade. Naturally the nature of the article to be produced is a prime factor. If it is a cane-crushing machine, wider limits may be tolerated than are permissible for a watch. The usual mistake made is to select a finer grade of workmanship than is necessary or desirable. The variation in the work is shown by experience to be much less than the variation in the gauges. Many text-books assume that the gauges should be of steel. That would be very nice, but it is better to have a large supply of cast iron gauges constantly renewed and checked, than a miserly supply of steel ones, many of them worn far beyond their proper sizes. The gauges for use in the workshop are made in the tool room, which, in the mass production shop, must be a separate department. All the skill of the establishment is concentrated in the hands of the comparatively few workmen to be found there.

**Jigs** :—These are frames made to envelop the part to be manufactured. Their object is to guide the operator in his work, and to save his time in fixing the parts in the machine tools. As in the case of gauges, we must refrain from a more exact description for fear the reader should think he has learned all about jigs. The design and making of jigs and fixtures has a highly developed technique of its own.

The design of the article, and the thorough testing of that design, must be preliminary work. So must the decision, as to limits, and the making of gauges and templates. Jigs and fixtures will continue to be modified and improved as long as production lasts. The decision as to :—

**Piece-work rates** should be postponed for some considerable time till it is known with certainty, how long every operation should last. Any alteration of rates once announced has very evil effects upon the workmen. If the rate is lowered, the workmen naturally conclude that it is a mistake to work too hard, as it only leaves him in the end working twice as hard for the old wage. On the other hand, if the rate is raised, he sees the rise as a result of not working too hard before, and perseveres in that policy, in the hope that it will produce yet a further increase. When it is known how long every job requires of a workman, working with the normal vigour, of a time paid man, the wage for that time or the time itself is the "Standard Rate," and should be announced to the workmen as such, and never altered again unless there is a great change in the methods of manufacture. So far all methods of payment by results are the same.

There are three ways of dividing the profits arising from any saving of time.

**Piece-work.**—The workman, provided his work passes the inspector, obtains for each operation, the full rate, no matter how quickly he does it. He does not receive any payment for work which fails to pass, but suffers no penalty except the loss of his own time. If he can do twice as much work as he formerly did, his wages are doubled, and so on. The employer's share is the saving of overhead charges, which is normally about the same as the increase of wages. On the whole this is the best system. The workmen understand it, and regard it as just. They are not so sure about :—

## Collective Piece-work

**Bonus systems** which allot in addition to the saving of overhead charges, a certain proportion of the extra wages also to the employer ; in some cases a fixed proportion, and in others a proportion which is larger for large savings than for small ones.

The third system of **payment by results** has never obtained any vogue in the West, but it might well be considered in the East, as having the potentiality of largely mitigating the poisonous social effects of intensive piece-work, and as being congenial to the temperament of the people.

**The Task System**:—A certain number of the worker's operation is daily task. When it is completed, he is allowed to go, another workman of course taking his place at the machine. It is found in the West that the most powerful inducement that can be offered to a workman to work as quickly as he can is the prospect of quadrupled wages. But the Western worker has the stimulus of an invigorating climate, and is not, as a rule, originally an agricultural worker. A mass production shop set up in the midst of an agricultural district in India, and working on the task system might solve many problems.

## Appendix to Chapter XXIX

A. "Self-Government and the Bread Problem," "Man and Machine Power," —both by Captain J. W. Petavel, contain some interesting discussions of Indian Industrial problems.

B. Extracted from a leading article in "Engineering," dated 13-2-25.

"It is by no means certain, however, that mass production methods, when intelligently employed, have the soul destroying effect with which they are generally credited, nor do we believe that they could have been employed so successfully in the United States (of America), if that were the case.

That, it is possible for these methods to be successfully utilised in the British Isles, was amply demonstrated during the war, as it was only by adopting mass production that we were able to attain an output of munitions far in excess of that of any other nation. It might be said, however, that this was a period during which we were content to sink our individuality, and for this reason special interest attaches to a paper on 'Some

Notes on British Methods of Continuous Production.' read by Mr. Frank G. Woolard, before the Institution of Automobile Engineers, on Tuesday last. The paper describes the very successful application of methods of continuous production—or mass production, as it is generally called in America—in the engine works of Messrs. Morris Motors, Limited, and reading between the lines of this paper it is evident that in this case, at any rate, the individualism of the worker—to whatever extent it may actually exist—has not been found incompatible with the successful working of the system.

The extent to which continuous production methods can be applied successfully in the case of any given firm is dependent entirely on the market to a particular product and mistakes in the past have generally taken the form of excessive capital sunk in plant without sufficient assurance that the products would have a ready sale. In other words, it is essential that a potential demand should exist before laying down plant for continuous production, and although it is doubtless possible to create a demand in certain classes of goods simply by lowering the price of an article, it must be remembered that the requisite plant is, of necessity, extremely expensive, and that on this account no lowering of the price can result until the sales have reached a high figure. It will generally be found that where continuous production methods are being most successfully applied, as in the United States, improvements in the productive plant have taken place gradually, and have only been effected when the increasing sales have shown that such improvements were warranted.

It will be evident from what we have said, that the first essential of production on such lines is that the article manufactured shall have achieved a firm position in popular favour, and that it shall have been tried out by the actual user to such an extent, that no reasonable doubt can exist as to essential soundness of its design. From this point of view the policy of so many of out automobile firms of introducing entirely new models at frequent intervals, is little short of suicidal, as it means, in essence, that the older models on which the only judgment that counts—that of the purchasing public—have been passed are withdrawn, and that for some time to come, sales will be effected on the basis of the reputation of the firm rather than on the quality of the article sold. It may appear from this that the adoption of continuous production stultifies improvements in design, but although this danger undoubtedly exists, its importance can easily be overestimated. That, it is quite possible to introduce improvements in design under these conditions of manufacture is amply borne out by an examination of the products in successive years of one or two of the best known firms manufacturing along these lines, but in making such an examination it is necessary to bear in mind that the original product was essentially sound, and that in consequence any additional improvements have been in the nature of refinements."

# CHAPTER XXX

## CONTRACT AND SPECIFICATION

**Contract and Specification :**—Although a competent legal counsel is necessary in all matters connected with a contract, a fairly good knowledge of the law is useful in assisting the manager or engineer of a firm to avoid serious mistakes and difficulties.

**Policy to be followed :**—(1) Determine how far the contractors are to be made responsible for the final results.

(2) The principal purpose of a specification is to convey clearly the ideas and intentions of the designer of a plant. An engineering specification is almost always a part of a contract, either directly or by reference. It is meant to describe labour, materials or results desired by a purchaser, with the object of enabling competitive bidders to estimate with equal facility upon the amount of a contract.

(3) Do not burden the specification with restrictions of the contractor's complete latitude in utilising his own experience and ingenuity for the purpose of securing the best, speediest and most economical realisation whereever practicable. Remember that every unnecessary or unfair clause in a specification has its part in limiting competition and lowering the standard of honesty among contractors. Avoid specifying proprietary articles or material as far as possible in order not to restrict competition.

(4) The art of drawing specification is acquired by practice and it presupposes a thorough knowledge of the subject-matter in hand. In drawing up a specification, however, it is very desirable that many specifications, covering similar or identical subject-matter, should be available for consultation. Thus standards of recognised engineering societies should be followed unless

local conditions prohibit them, and manufacturers' standards should be followed if low bids are to be expected.

(5) All high quality materials are costly. Hence, unless the best materials and workmanship are necessary, in spite of their higher cost, adopt some fair commercial standard to avoid waste.

(6) Avoid unduly long description of minor items by demanding "reasonably" good articles for the purpose.

**Specification** :—A specification is a written description of works to be done.

**Form of Specification** :—(1) All specifications should be clear, concise, direct, definite, conclusive and legally sound, and should be in convenient form for reference purposes.

(2) Number the paragraphs or clauses of all specifications for convenience of reference and allot a separate clause for every item of the work.

(3) The magnitude and importance of the work determine the degree of the details of the specification. After describing the object of the specification and stating the general conditions, amplify the form so far as may be necessary in particular cases under the following heads.—

I. Summarised description of principal characteristics and conditions of service.
II. Style and description of apparatus, details of construction.
III. Dimensions, weights, drawings and schedules.
IV. Work to be done by other contractors
V. Performance and tests.
   (*a*) Performance which may be checked by mere observation.
   (*b*) Factory tests.
   (*c*) Performance and tests after erection.
VI. Workmanship and finish.
VII. Packings, marking, shipping and delivery.
VIII. Inspection and rejection.
IX. Guarantees.

X. Conditional payments. (The details of conditional payments depending upon results of inspection and tests).

When the capacity of the machines, as described beforehand, is known, the capacity, type and number of machines are determined, and a complete schedule of the machines required should be made out. Following this, a brief specification for each class of machine required should be drawn up. The SPECIFICATION amongst other things should make clear :—

(*i*) The class of machine and number of machines required and at times the name of the manufacturer

(*ii*) The productive capacity of the machine.

(*iii*) The r. p. m. and size of driving shaft proposed or other means of power-drive for the machine.

(*iv*) Whether driving pulley, counter shafting or other driving accessories are to be provided with the machine.

(*v*) A list of all accessories and spare parts, if necessary, required.

(*vi*) The number of working drawings (not fewer than 3 copies) of the machine and copies or working instruction required.

(*vii*) Full instruction for the packing and delivery of the machine and its equipment.

**Points to be covered in specification :**—The specification should, so far as possible, cover the following points :

**In preliminary specification :**—

(1) These specifications are intended to furnish such information to the bidders as will enable them to prepare detailed plans upon which to give prices. Should any bidder consider the requirement of these specifications prohibitive to the free exercise of his skill, any suggestions made by him will be duly considered.

(2) In comparing proposal, due consideration will be given by the company to availability, reliability, simplicity, cost of maintenance and quickness of delivery.

Before a contract is awarded, prepare the **final specifications** in the light of the information obtained from the contractors in response to queries (1) and (2) above.

(3) The tenders are to be in sealed covers and the engineer should agree to treat all drawings submitted by the bidders as confidential and that he will not show such drawings to other manufacturers whether they are tendering under this specification or not.

(4) There should be definition of titles, describing the parties to the contract such as 'engineer,' etc.

(5) The names of the persons concerned and their respective powers should be stated.

(6) The name of the place where the work is to be done or the materials are to be delivered, should be stated.

(7) The contractor shall be responsible for the correctness of all drawings even after they are approved by the engineer.

(8) Materials ordered or work commenced prior to the approval of the drawings will be at the contractor's risk.

(9) No approved drawing may be changed without the approval of the engineer.

(10) The contractor shall inspect the work of other contractors whose work affects his, and shall notify the engineer of anything which injuriously affects his work. The contractor shall give these other contractors the privilege of inspecting his work in so far as it affects the acceptance of their work

(11) Contractor shall not drill or in any way impair the strength of buildings or structures except with the written consent of the engineer.

(12) All work shall conform to the requirements of the Insurance Company and to all Government regulations

(13) The Standardisation Rules of the I. E. E. and other similar documents should be followed wherever possible.

(14) The provisions of the preliminary specification and those subsequently agreed upon between company and bidder should be incorporated as part of the final or contract specification

Questions of import duty, freight and carriage to site should not be left to chance, and shipping weights and dimensions should also be asked for, especially where transport over mountains or rough country is involved. Foundation plans should always be asked for. Also terms of payment should be specified. It is usual to pay 10 % on setting to work and the remainder after a period of 3 or 6 months' working ; in large foreign contracts a proportion is often paid on receipt of bill of lading.

## Points to be Covered in Contract

(1) The actual contract in all important cases should be prepared by a competent lawyer in consultation with the engineer.

(2) The work must be performed in such a way as not to interfere with safety and continuity of service.

(3) The contractor shall not transfer the contract to others without permission.

(4) Time of commencement of work, rate of progress and date of completion.

(5) The character of the method and appliances to be used and grade of workmen to be employed.

(6) Arbitration and settlement of disputes.

The following specimen may be taken as a fair model :—

## FORM OF MODEL, GENERAL CONDITIONS OF CONTRACT FOR ELECTRICAL WORKS.

(Adapted from the form of the Chartered Institution of Electrical Engineers, London)

Definition of Terms.

1. In construing these general conditions and the annexed specification, the following words shall have the meanings herein assigned to them unless there is something in the subject or context inconsistent with such construction :—

The "purchaser" shall mean The Honourable Maharaja Sir Krishna Narayan Chatterjee, K. C. S. I., and shall include his legal personal representatives, successors and assigns.

The "contractor" shall mean the tenderer whose tender shall be accepted by the purchaser, and shall include the tenderer's legal personal representatives, successors and assigns.

The "sub-contractor" shall mean the person named in the contract for any part of the work or any person to whom any part of the contract has been sub-let with the consent in writing of the engineer and legal representatives, successors and assigns of such person.

The "engineer" shall mean Prof. Bhim Chandra Chatterjee, B. Sc., M. I. E. E., or any other engineer for the time being, or from time to time duly authorised and appointed in writing by the purchaser to supervise the carrying out of the contract.

"Plant," "work" or "works" shall mean and include plant and materials to be provided and work to be done by the contractor under the contract.

The "contract" shall mean and include the general conditions, specification, schedules, drawings, form of tender, covering letters, schedule of prices, and the agreement to be entered into.

The "specification" shall mean the specification annexed to these general conditions.

The "site" shall mean Rangpur, Nawabganj in Bengal, India, and any other place in the said territory where work is to be executed under the contract.

"Tests on completion" shall mean such tests as are prescribed by the specification to be made by the contractor before the plant is taken over by the purchaser.

"Commercial use" shall mean that use of the work which the contract contemplates or of which it is to be commercially capable.

"Month" shall mean calendar month.

"Writing" shall include any manuscript, type-written or printed statement, under or over signature or seal, as the case may be.

Words importing persons shall include firms and corporation.

Words importing the singular only shall also include the plural and vice versa where the context requires.

Contractor to inform himself fully.

2. The contractor shall be deemed to have carefully examined the general conditions, specifications, schedules and drawings and in cases of doubt, submit the doubtful points in writing to the engineer, and have his doubt removed. The purchaser shall pay for any alteration of the work necessitated by reason of inaccurate information supplied by the engineer to the contractor.

Contract and Bond.

3. The contractor and the purchaser shall enter into a sealed agreement for the proper fulfilment of the contract and the contractor shall duly provide necessary securities. All expenses for completing and stamping the agreement shall be paid by the purchaser.

Contract Drawings.

4. The contractor shall submit, to the engineer for his approval, on or before the dates mentioned in the specification, a set of blue prints of the drawings of the general arrangement as set out therein, and of such detail drawings as may be reasonably necessary.

Within fourteen days of the receipt of such blue prints, the engineer shall signify his approval or otherwise of the same.

Within fourteen days of the notification by the engineer to the contractor of his approval of such blue prints, two sets, in ink on tracing cloth or ferro-gallic prints mounted on cloth, of the drawings, as approved, shall be supplied to him by the contractor and be signed by him and by the contractor, respectively, and be thereafter deemed to be the "Contract Drawings".

These drawings, when so signed, shall become the property of the purchaser, and be deposited with the engineer, and shall not be departed from, in any way whatsoever, except by the written permission of the engineer as herein provided. During the execution of the works, one of the sets of drawings shall be available for reference on the site

In the event of the contractor desiring to possess a signed set of drawings he shall supply three sets instead of two sets, and in this case the engineer shall sign the third set and return the same to the contractor.

The contractor shall supply from time to time at schedule rates, single copies of additional drawings for the purposes of the contract.

The engineer, or his duly authorised representative, whose name shall have previously been communicated in writing to the contractor, shall have the right, at all reasonable times, to inspect drawings of any portion of the work.

If the contractor shall not submit the blue prints, referred to in the first paragraph of this Clause, within the time specified, or subsequently within seven days after, the purchaser or the engineer shall, in writing, have required him so to do; and if the delay shall not have been occasioned by the purchaser or the engineer, or any other contractor, or other reasonable cause, the purchaser shall be entitled by notice in writing within seven days from the expiry of the said seven days aforesaid, to avoid the contract and the purchaser upon the giving by him of such notice shall not be liable to or for any claim or demand from the contractor in respect of work then already done, or material furnished, or in respect of any other matter or thing whatsoever in connection with the contract, but nothing contained in this Clause shall deprive either party of any rights or claims, he may have or have had against the other, by reason of the non-compliance by such other, with any of the provisions of this Clause.

Sub-letting of Contract.

5. The contractor shall not, without the consent, in writing, of the engineer, assign or sublet his contract or any substantial part thereof, nor make any sub-contract with any persons for execution of any portion of the work other than for raw materials or for minor details.

Manner of Execution, Quality of Material, etc.

6. The plant shall be manufactured, constructed, provided, put in position, and maintained in the best and most substantial and workmanlike manner, and with materials of the best or of approved qualities for their respective uses

Power to vary or omit work.

7. The contractor shall not alter, in any way, any of the work accepted as directed in writing by the engineer. The engineer shall have full power, from time to time, during the execution of the contract, by notice in writing, to instruct the contractor to alter, amend, omit, add to or otherwise vary any of the work without prejudice to the contract, to the extent of an increase or decrease of not more than 10 °/ₒ of the total price payable under the contract, unless consented in writing, and the contractor shall carry out such alterations, amendments, omissions, additions or variations, and be borne by the same conditions as originally agreed upon. The necessary difference of price should be made in the contract price.

Engineer's Supervision.

8. All the works shall be carried out under the direction and to the reasonable satisfaction of the engineer. The contractor shall be responsible for the correctness of the positions, levels, and dimensions of the works according to the drawings, notwithstanding that he may have been assisted by the engineer in setting out the same.

Engineer's Decisions.

9. In respect of all matters which are left to the decision of the engineer, including the granting or withholding of certificates, the engineer shall, if required so to do by the contractor, give in writing a decision thereon, and his reasons for such decision. All decisions of the engineer shall be subject to the right of arbitration reserved by these general conditions.

Contractor's Representative and Workmen.

10 The contractor shall employ at least one competent representative, whose name or names shall have previously been communicated in writing to the engineer by the contractor, to superintend the erection of

the plant and the carrying out of works. The said representative, or if more than one shall be employed, then one of such repesentatives, shall be present on the site during working hours, and any written order or instruction which the engineer or his duly authorised representative, whose name shall have been previously communicated in writing to the contractor, may give to the said representative of the contractor, shall be deemed to have been given to the contractor.

The engineer shall be at liberty to object to any representative or person employed by the contractor in the execution of or otherwise about the works, who shall misconduct himself or be incompetent or negligent, and the contractor shall remove the person, so objected to, upon receipt, from the engineer, of notice in writing requiring him so to do.

Liability for Damage.

11. Until the plant shall be or be deemed to be taken over, the contractor shall be liable for and shall be deemed to have indemnified the purchaser in respect of all damage or injury to any person or to any property of the purchaser or of others occasioned by the negligence of the contractor or his workmen or sub-contractors or by defective design, or work, or material, but not otherwise.

Provided that the contractor shall not be liable under the contract for any loss of profit or loss of contracts or any claims made against the purchaser not already provided for in the contract, nor for any damage or injury caused by or arising from the acts of the purchaser or of others, or (save as to damage by fire as hereinafter provided) due to circumstances over which the contractor has no control.

The contractor shall be deemed to have indemnified and saved the harmless purchaser against all actions, suits, claims, demands, costs, or expenses arising in connection with injuries suffered prior to the date when the plant shall have been taken over under Clause 19 herein by persons employed by the contractor on the works whether at common law or any other statue in force at the date of the contract dealing with the question of the liability of employers for injuries suffered by employees.

In the event of any claim being made, or action brought against the purchaser involving the contractor and arising out of the matters referred to and in respect of which the contractor is liable under this Clause, the contractor shall be immediately notified thereof, and he shall, with the assistance, if he so require, of the purchaser, but at the sole expense of the contractor, conduct all negotiations for the settlement of the same, or of any litigation that may arise therefrom. In such case the purchaser shall, at the expense of the contractor, afford all available assistance for any such purpose.

Insurance.

12. The contractor shall ensure such plant and materials ordered for the plant as may, for the time being, be upon the site, and shall keep them insured against destruction or damage by fire for the full value of such plant and materials until the same be taken over under Clause 15.

Replacement of Defective Work or Materials.

13. If during the progress of the work the engineer shall decide and notify in writing to the contractor that the contractor has executed any unsound or imperfect work or has supplied any plant or materials inferior in quality or quantity to those specified, the contractor on receiving details of such defects or deficiency shall, at his own expense, within seven days of his receiving the notice, proceed to alter, reconstruct, or remove such work, or supply fresh materials up to the standard of the specification, and in case the contractor shall fail so to do, the purchaser may, on giving the contractor seven days' notice in writing of his intention so to do, proceed to remove the work or materials complained of, and, at the cost of the contractor, perform all such work, or supply all such materials, provided that nothing in this Clause shall be deemed to deprive the purchaser of, or affect, any rights under the contract which he may otherwise have in respect of such defects or deficiencies.

14. Subject to any deductions which the purchaser may be authorised to make under the contract, the contractor shall be entitled, upon the certificates of the engineer, to payments by the purchaser by instalments in accordance with the following provisions:—

Terms of Payment.

(i) As the works progress, instalments of 80 per cent. of the contract value, as certified by the engineer, of the plant from time to time delivered or work executed on the site.

(ii The remaining 20 per cent. referred to herein as "Retention Money," in respect of each distinct section or part of a section of the works, as follows:—

10 per cent. at the expiration of one month after the plant shall have been taken over by the purchaser; and the remaining 10 per cent. at the expiration of twelve months thereafter.

If at the time at which either of the said instalments of the Retention Money becomes payable under the contract, there are minor defects in the plant which are not of such importance as to affect the full commercial use of the plant, then the purchaser shall be entitled to retain only such part of the instalment then due, of the Retention Money, as represents the cost of making good such minor defects, and any sum so retained shall become due upon such minor defects being made good.

In cases where the contractor is prevented, for any period, from causes for which the purchaser is responsible either, first, from delivering the plant to the site, or, secondly, from proceeding with the erection of the plant which he has already delivered to the site, the purchaser shall bear the cost of storage and protection, including Fire Insurance, of the plant and materials during such period. In the first case, the purchaser shall make the payment of 80 per cent. thereof (as if the plant had been delivered) within one month from the date of notification, by the contractor to the purchaser, that the plant is ready for delivery, opportunity to be given to the purchaser within that time to satisfy himself that the plant is so ready and that all portions thereof are suitably and sufficiently marked as being his property; and the Retention Money shall be payable, as above specified, provided that if the aforesaid period of delay shall exceed two months, the first instalment of 10 per cent. of the Retention Money shall be payable at the expiry of the said two months from the date of notification aforesaid and the second instalment thereof within fifteen months from the date of such notification aforesaid, and such payments shall be reduced by an amount to be agreed upon to cover the cost of delivery, erection, and maintenance. In the second case, the Retention Money shall be payable, as above specified, provided that if the aforesaid period of delay shall exceed two months, the first instalment of 10 per cent. of the Retention Money shall be payable at the expiry of the said two months, and the second instalment thereof of the Retention Money within fifteen months from the date from which the instalment of 80 per cent. became payable, and such payments shall be reduced by an amount to be agreed upon to cover the cost of erection and maintenance.

Certificates of Engineer.

15. Every application to the engineer for a certificate must be accompanied by a detailed claim (in duplicate) setting forth in the order of the schedule of prices, particulars of the plant delivered and work executed to the date of claim, and the certificate as to such plant and work as is in the reasonable opinion of the engineer in accordance with the contract, shall be issued within 14 days of the application for the same.

The engineer may, by any certificate, make any correction or modification in any previous certificate which shall have been issued by him, and payments shall be regulated and adjusted accordingly.

Certificate not to Affect Rights of the Purchaser or Contractor.

16 No certificate of the engineer on account, nor any sum paid on account by the purchaser, nor any extension of time for the execution of the works by the contractor, shall affect or prejudice the rights of the purchaser against the contractor, or relieve the contractor of his obligations

for the due performance of the contract, or be interpreted as approval of the work done or of the materials supplied, and no certificate shall create liability in the purchaser to pay for alterations, amendments, or variations not ordered in writing by the engineer, or discharge the liability of the contractor for the payment of damages whether duly ascertained or certified or not or of any sum against the payment of which he is bound to indemnify the purchaser, nor shall any such certificate, nor the acceptance by him of any sum paid on account or otherwise affect or prejudice the rights of the contractor against the purchaser.

Test on Completion.

17. On the completion of the works on the site substantially in accordance with the contract, the contractor shall give the engineer notice in writing thereof, and before making the "tests on completion" shall give the engineer seven days' notice in writing of the date on which he will make the said tests of the work in accordance with, and in the manner prescribed by, the specification.

Unless otherwise agreed, the contractor shall commence such tests upon such date, and shall carry out the same; and if the engineer or his authorised representative, whose name shall previously have been communicated in writing to the contractor, shall attend such tests, shall be carried out in his presence.

If the engineer or his said representative shall fail to be present at the said tests, the contractor shall be entitled to proceed in his absence, and the said tests shall be deemed to have been made in his presence.

If any portion of the plant fail under the tests to fulfil the contracts, tests of the faulty portions shall, if required by the engineer, or by the contractor, be repeated within a reasonable time upon the same terms and conditions, and upon payment to the purchaser of all reasonable expenses to which he may be put by such tests.

If the "tests on completion" be not successfully made by the contractor within one month after the date fixed by the contract for the completion for commercial use or for testing of the plant, and if, in the opinion of the engineer, the tests are being unduly delayed, the engineer may, in writing, call upon the contractor under seven days' notice to make such tests, and on the expiry of such notice such tests shall forthwith be made by the contractor.

If, after the expiry of the said notice from the engineer, the contractor neglects to make such tests, the engineer may proceed to make such tests himself at the contractor's risk and expense.

Rights of Use before Tests.

18. If the contractor neglects to make the tests on completion by the dates stipulated by the contract, the purchaser shall nevertheless have the right of using the plant at his own expense until the "tests on completion" are successfully carried out, but such use shall, provided the plant is used in a proper and normal manner, be at the contractor's risk.

At any time after the completion of the works, or any portion thereof as the case may be on the site, the purchaser may, pending any arbitration under the contract, use any portion of the plant reasonably capable of being used, but in such case the contractor shall be entitled to be paid, in respect of any plant commercially used, a sum equal to five per cent. per annum (according to the period of the user) upon the amount withheld or deducted in respect of such plant.

Time of taking over.

19. The plant, when erected on the site, shall be deemed to have been taken over by the purchaser when the engineer shall have certified in writing that the plant has fulfilled the contract conditions and such certificate shall not be unreasonably withheld, nor shall the engineer delay the issuing of his taking over certificate on account of minor omissions or defects, which do not affect the commercial use of the plant, provided always that the contractor undertake to make good such omissions and defects at the earliest possible moment.

Interference with Tests.

If, by any act of the purchaser or of the engineer, or by the use of the plant, as provided in Clause 17, the contractor shall be prevented from carrying out the "tests on completion" within two months from the date of the notice of completion, specified in Clause 17, unless in the meantime the plant shall have been proved not to be substantially in accordance with the contract conditions, the plant shall be deemed to be taken over as on the last day of the said two months and payment to the contractor shall be made as if final satisfactory "tests on completion" had taken place, but nevertheless the contractor shall make the said tests during the period provided for maintenance as, and when, required by the engineer upon fourteen days' notice in writing; and the obligations and liabilities of the contractor in connection with such test shall be the same as his obligations and liabilities in connection with the tests specified in Clause 17, provided that the purchaser shall pay the extra expense of such tests.

Rejection of Defective Work.

20. If the complete plant, or any portion thereof, before it is taken over under Clause 19, be defective, or fail to fulfil the requirements of the contract, and the contractor receives from the engineer notice setting forth particulars of such defects or failure, the contractor shall forthwith make the defective plant good, or alter the same to make it comply with the requirements of the contract. Should he fail to do so within a reasonable time, the purchaser may reject and replace, within a reasonable time and at a reasonable price under competitive conditions, at the cost of the contractor, the whole or any portion of the plant, as the case may be, which is defective or fails to fulfil the requirements of the contract. The contractor's full and extreme liability under this Clause shall be satisfied by the payment to the purchaser of the extra cost, if any, of such replacement, such extra cost being the ascertained difference between the price paid by the purchaser, under competitive conditions, for such replacement and the contract price for the plant so replaced, and the repayment of

any sum paid by the purchaser to the contractor in respect of such defective plant. Should the purchaser not so replace the rejected plant within a reasonable time, the contractor's full and extreme liability under this Clause shall be satisfied by the repayment of all moneys paid by the purchaser to him in respect of such plant. If such supply of defective plant shall have caused delay in the completion of the contract, so as to give rise to a claim for damages on the part of the purchaser, nothing contained in this Clause shall interfere with, or prejudice, any right of the purchaser with respect to such claims, but such claims shall not, in the case of plant replaced by the purchaser, as herein provided, exceed 25 per cent. of the contract value of the plant so replaced.

Maintenance.

**21.** For a period of twelve calendar months after the plant has been taken over under Clause 19, the contractor shall be responsible for any defects that may develop under the conditions provided for by the contract, and under proper use, arising from faulty materials, design, or workmanship in the plant, but not otherwise, and shall remedy such defects when called upon so to do by the engineer, who shall state in writing in what respect any portion is faulty.

If it becomes necessary for the contractor to replace or renew any defective portions of the plant under this Clause, the provisions of this Clause shall apply to the portions of the plant so replaced or renewed until the expiration of six months from the date of such replacement or renewal or until the end of the above-mentioned period of twelve months, whichever may be the later. If any defects be not remedied within a reasonable time, the purchaser may proceed to do the work at the contractor's risk and expense, but without prejudice to any other rights which the purchaser may have against the contractor in respect of such defects.

If the replacement or renewals are of such a character as may affect the efficiency of the plant, the purchaser shall have the right to give to the contractor, within one month of such replacement or renewal, notice in writing that "tests on completion" be made, in which case such tests shall be carried out as provided in Clause 17 hereof. Should such tests show that the plant sustains the guarantees given in the contract, the cost of the tests shall be borne by the purchaser. Should the guarantees be not sustained, the cost of the tests shall be borne by the contractor.

All inspections, adjustments, replacements or renewals carried out by the contractor during the maintenance period, shall be subject to the same general conditions as the contract.

Until the final certificate shall have been issued, the contractor shall have the right of entry, at his own risk and expense, by himself or his duly authorised representatives, whose names shall have previously been communicated in writing to the engineer, at all reasonable working hours, upon all necessary parts of the works for the purpose of inspecting the working and the records of the plant and taking notes therefrom, and, if he desire, at his own risk and expense, making any tests, subject to the approval of the engineer which shall not be unreasonably withheld.

22. If it be desirable that the work is to be carried on departmentally and the contractor is required to supply the necessary plant and material according to specification agreed upon, the said contractor shall supply all working drawings in full detail, whenever required, or when called upon, by the engineer or his representative to do so and such part of the Clauses, aforementioned, as regards retention-money, as can apply under the altered conditions, shall be deemed to be applicable. The list, on completion, may be made by the engineer or his representative or in case of need and when there is dispute by the arbitration referred to, the payment of the retained money being regulated by the results of such tests in the same manner as has been provided for, when the erection of the work is entrusted to the contractor with such alterations as

Departmental Work.

may be required under the altered conditions and may be agreed to by the parties.

Arbitration.

23. If, at any time, any question, dispute, or difference whatsoever shall arise between the purchaser or the engineer and the contractor upon, or in relation to, or in connection with the contract, either party may forthwith give to the other, notice in writing of the existence of such question, dispute or difference, and the same shall be referred to the arbitration of a person to be mutually agreed upon, or, failing agreement, to some person appointed by the Electrical Adviser to the Government of India or any other competent person. This submission shall be deemed to be a submission to arbitration within the meaning of the Indian Arbitration Act, or any statutory modification thereof.

The award of the arbitrator shall be final and binding on the parties. Upon every or any such reference, the costs of and incidental to the reference and award, respectively, shall be in the discretion of the arbitrator, who may determine the amount thereof, or direct the same to be taxed as between solicitor and client or as between party and party, and shall direct by whom and to whom, and in what manner the same shall be borne and paid.

Work under the contract shall, if reasonably possible, continue during the arbitration proceedings, and no payments due or payable by the purchaser shall be withheld on account of such proceedings.

**For specification and the lay-out of the belting** the following points must be remembered :-

(a) A high speed driving of shaft is advantageous and economical.

(b) The economic limit of belt speed are 2,000-4,000 ft / min.

(c) Abnormally tight belts and heavy slow movements should be avoided.

(d) Try, as far as possible, to take heavy powers from the shafting at its ends and remote from the driving pulleys.

(*e*) That the shaft has a true alignment, *i.e.*, it rolls only and does not twist when running.

(*f*) Shafting speeds of 200-400 r. p. m. are distinctly economical.

(*g*) Long belt drives (up to 20 ft. from pulley to pulley) ensures sweet running and absence from belting troubles attending a short drive. Such an arrangement enables narrower belts to be used for transmission of a given power and keeps the cost of belting lower in the long run, though initially more expensive.

(*h*) Use stiff supports for pulleys, balanced pulleys and long ring lubricated or ball bearings of modern type to obviate the attendant losses of shaft driving.

Where satisfactory solutions to all the points summed up in this section are forthcoming, the machinery should be installed and got to work with the minimum delay and difficulty.

The following **forms of specification** have been taken from :—Electrical Engineering Practice by J. W. Meares and R. E. Neale.

The purchaser should give the following details, when asking for tenders, for steam plant and an oil or gas plant, unless for any particular item he thinks it advisable to leave the matter to the discretion of the tenderer ; in which case the latter should be asked to supply the necessary data in his tender :—

## Specification of Generators

(*a*) Normal full-load output in kilowatts.

(*b*) Maximum over-load and duration 25 % overload for two hours and 100 % overload momentarily.

(*c*) Terminal volts at full-load.

(*d*) Whether direct coupled or, if not, how driven.

(*e*) Revolutions per minute, according to drive and type of prime mover.

(*f*) Number of poles, if material to the case.

(*g*) Whether for parallel running with machines already at work; if so, full description of the same should be given.

(*h*) If the neutral point or neutral wire is to be connected to earth, the fact should be stated.

(*i*) Minimum efficiency at full, $\frac{3}{4}$, $\frac{1}{2}$ and $\frac{1}{4}$ load and at 25 °/o overload.

(*j*) Temperature rise over surrounding air of various components, after run of 6-10 hours at full-load and also after subsequent run at specified overload immediately following ordinary test run. Also whether temperature is to be determined by thermometer or resistance. Maximum air temperature of locality should be stated in the case of plant for the use in the tropics.

## C. C. Machines

(*k*) Winding—series, shunt, or compound.

(*l*) Rise of pressure from no-load to full-load for compound-wound machines.

(*m*) Extent of required pressure variation by means of field regulation in shunt-wound machines

(*n*) Sparkless commutation; if commutating interpoles are required, the fact should be stated.

## A. C. Machines

(*o*) Number of phases—single or 3-phase generally.

(*p*) Periodicity (standard 50 cycles).

(*q*) Output in K. V. A. at expected power factor 8·5 as well as in kW. at unity P. F.; the machine to conform to specified temperature rise under the conditions of the lower P. F., *i.e.*, with the larger current.

(*r*) Pressure regulation under conditions of non-inductive and inductive load at P F.= 1 and 0 8.

(*s*) Excitation required, and whether exciter is to be driven from the alternator shaft or seperately.

*Accessories* :—Field regulators; cables, connecting to switchboard; holding-down bolts; spare parts, *viz.*, armature coils or extra armature, brushes, and gear; bearing brushes; tools. If belt-driven, pulley, slide rails, belt tightener.

**Motors** :—In the case of motors the purchaser should state or ascertain from tenderers :—

(*a*) Whether open, ventilated, or enclosed type is to be supplied.

(*b*) Whether to be rated for continuous or intermittent working, and the normal B. H. P. on this basis.

(*c*) Maximum overload and duration, as in the case of generators.

(*d*) Terminal volts.

(*e*) Whether direct coupled and, if not, whether driven by belt, rope, helical gearing, worm gearing, etc. In the case of gearing down, the required reduction should be stated. If ball bearings or roller bearings are required, the fact should be stated.

(*f*) Revolutions per minute, according to drive and type of machine to be driven; allowable limits of variation at different loads, or required speed variation, as the case may be; size of driving pulley.

(*g*) Number of poles, if it matters.

(*h*) Required starting torque, if it matters.

(*i*) Whether system on which motor is to work is connected to earth at neutral point.

(*j*) Efficiency and temperature rise, as in the case of generators.

## C. C. Motors

(*k*) Whether series, shunt, or compound-wound; and whether required with commutating interpoles, as for variable speed motors

## A. C. Motors

(*l*) Number of phases and periodicity, as in the case of generators.

(*m*) Whether synchronous, commutator, or induction type, and in the last-named case, whether squirrel cage or slip-ring. In the case of synchronous motor, separate excitation is required and must be arranged for.

(*n*) Starting current should be stated in tender.

(*o*) Power factor at full, $\frac{3}{4}$ and $\frac{1}{2}$-load should be stated in tender.

*Accessories* :—Starting and regulating gear ; no-load and overload release ; cables from motor to starter, etc. ; spare parts, as in the case of generators ; holding-down bolts ; tools. If for belt driving, pulley, slide rails, belt tightener.

## Transformers

(*a*) Whether single-phase or three-phase ; periodicity.

(*b*) The required output on the secondary side should be given in kW. or, if the load to be supplied is inductive, in K. V. A. The nature of the load, or the probable P. F. at secondary terminals, should be stated.

(*c*) Pressure of supply at the primary terminals ; required pressure at the secondary terminals.

(*d*) Whether oil-insulated or not. Oil insulation is generally used for extra high pressures and in large sizes, where the heat generated can be carried away by water pipes in the oil space. Small transformers depend on the dielectric strength of the coils.

(*e*) Whether artificially cooled, and (if so) whether by air or water.

(*f*) Pressure regulation at full load on P. F. of unity and 0·8.

(*g*) Open-circuit losses.

(*h*) Overall efficiency at full, $\frac{3}{4}$, $\frac{1}{2}$ and $\frac{1}{4}$-load.

(*i*) If special tappings for variable pressure are required.

*Accessories* :—Transformer oil ; spare coils ; circulating fan or pump for cooling ; piping.

## Storage Batteries

(*a*) The number of cells, including regulating cells, must be stated, or the working pressure of the installation.

(*b*) The required capacity in ampere-hours must be given. This varies with the rate of discharge. It is usual to specify the capacity when the battery is discharged in 5 or 10 hours and also the maximum safe discharge current for 1 hour. Alternatively, the conditions of load and probable hours of working may be specified.

(*c*) Specify by whom the stands are to be supplied, painted, and erected.

(*d*) Specify by whom the electrolyte is to be supplied, exact a guarantee as to its purity.

(*e*) Ascertain the normal and maximum charging rates.

*Accessories* :—Hydrometers for specific gravity ; cell testing voltmeter 1 – 4V ; lamp to slip between plates for cell inspection : connection to switchboard ; spare plate sections. Lead-burner's outfit, if necessary ; tank for acid mixing ; water distilling apparatus ; anti-sulphuric enamel for stands, etc. Note the E. M. F. required for cell-charging. If necessary, a booster can be used.

## Switchboards

(*a*) The number of panels and apparatus required on each, and the current and pressure, should be stated. These may comprise the following :— (*i*) Panel for each generator, with ammeter (reading to about double the current of the generator) ; voltmeter (standard pressure central on scale) ; main switch or circuit breaker ; cut-outs, fusible or automatic ; reverse current circuit breaker—if required, shunt regulating switch and resistance, unless placed on separate pillar ; wattmeter, if required. For large currents shunted ammeters or current transformers may be required ; and for high-pressure voltmeters, transformers also. (*ii*) Panel for each feeder, similarly provided (according to the load on each) with ammeter, voltmeter, switches, cut-outs Where two sets of busbars are provided and kept at different potentials, change-over switches are required on generator and feeder panels. (*iii*) Total output panel, between generators and feeders, with ammeter and wattmeter for maximum output and also station voltmeter. (*iv*) Neutral panel on 3-wire systems, with centre-zero ammeter to show out-of-balance current. The earth connection of neutral may be taken from this panel, and a current-limiting resistance may be added, if necessary to keep the earth current down. (*v*) Balancer panel, where balancers are used on a 3-wire system. Centre-zero ammeter and voltmeter for each side of system. Switches, starting gear, and cut-outs for balancer, and shunt regulator. (*vi*) Station lighting panel. (*vii*) Battery panel with charge and discharge regulator switches and centre zero ammeter, showing charge or discharge current; automatic cut-in and cut-out.

(*b*) For A. C synchronising panel; power factor indicator If high tension, oil switches and instrument transformers.

(*c*) For tramways, 'Board of Trade panel'; also equalising bars and switches at generators.

(*d*) Recording (chart) voltmeters may be required.

(*e*) The type of switches, instruments, etc., and material of panel and framing may be specified or left to each tenderer.

(*f*) Special distant control and automatic regulators may be required also, special protective gear for excess pressure on A. C. lines.

*Accessories*:—Connecting cables to generators, balancers, regulating pillars, line, etc ; lightning arrestors and choking coils; isolating switches, which can be opened up on both sides of any H. T. apparatus when the circuit is broken for repairs; oil for oil switches; clock.

## Cables

(*a*) Specify whether for feeders or distributors or for trailing cables, or for house wiring, etc.
(*b*) Whether single, 2 or 3 core, or concentric, and for C. C. or A. C.
(*c*) Cross-sectional area of each conductor, to be of standard copper.
(*d*) Working pressure.
(*e*) Whether any conductor is to be connected to earth.
(*f*) Class and grade of cable.
(*g*) Method of laying.
(*h*) Length of route.
(*i*) Ascertain actual guaranteed insulation resistance, thickness and nature of dielectric, weight, conductor resistance – at standard temperature.
(*j*) If for A C. ascertain capacity, and charging current under working conditions.
(*k*) Specify who is to lay and joint cable.

*Accessories*:—Jointing material; distribution boxes, disconnecting links, feeder pillars; troughing, filling and protecting material (if any).

## Over-head Lines

(*a*) Whether solid or stranded hard-drawn wire, and S. W. G.
(*b*) Length of route and of wire required.
(*c*) Obtain guarantee as to standard conductivity and weight; also ultimate tensile strength.
(*d*) Specify maximum electrical pressure on insulators and also mechanical stress to be carried.
(*e*) Ascertain breaking-down conditions of insulators and pins, electrical and mechanical.
(*f*) State length and construction of brackets or cross-arms.

(*g*) Number of brackets or cross arms and of insulators and pins.

(*h*) Height above ground and overall length of poles.

(*i*) Type and ultimate strength of poles.

(*j*) Special poles, such as towers for long spans, feeder junction poles, heavy terminal or angle poles, etc., to be separately enumerated as in (*g*) and (*h*).

(*k*) Special strain or shackle insulators.

*Accessories*:—Jointing and binding material; earth wires and earth connections; struts and stays; anchors for stays; line lightning arrestors; disconnecting links; safety devices and guard wires; spare parts; lines-men's tools.

## Steam Plant

In the case of most of these subheads the tenderer should be allowed to specify what he considers most suitable, unless there are reasons to the contrary.

(*a*) Whether for direct coupling or belt or rope drive.

(*b*) Brake horse-power—or specify that each set shall be able continuously to drive its generator at the specified overload.

(*c*) Vertical or horizontal.

(*d*) Revolutions per minute, according to nature of drive.

(*e*) Maximum momentary and permanent variation in speed when running on governor and load is thrown on or off.

(*f*) Whether simple, compound, or triple expansion, or steam turbine.

(*g*) Condensing or non-condensing.

(*h*) Open or enclosed and method of lubrication.

(*i*) Number of cranks.

(*j*) Steam pressure of stop valve.

(*k*) Steam consumption and mechanical efficiency at full, $\frac{1}{2}$, and $\frac{1}{4}$-load and on specified overload of generator.

(*l*) In case of combined plant, overall efficiency of sets

*Accessories* :—Steam and exhaust piping and covering for same ; main valve ; steam traps, drain cocks, relief valves, gauges, tachometer ; condenser, air and circulating pumps, etc. ; spare parts ; tools.

## Boilers

(*a*) Type—Lancashire, water-tube, marine, loco, etc.
(*b*) Working pressure and whether superheat required or not.
(*c*) Fuel to be used and approximate average calorific value
(*d*) Nature of draught—natural, forced, or induced.
(*e*) Steam required per hour—or it may be specified that the boilers shall be capable of steaming continuously at the rate required to obtain the maximum overload of the generating sets.
(*f*) Whether mechanical stokers are required.
(*g*) The square feet of grate area, fuel consumption, and actual steaming capacity with given feed temperature.
(*h*) All certificates required by boiler act to be supplied.

*Accessories* :—Safety valves ; main stop valve ; feed check and stop valves ; blow-off valve ; pressure gauge and guards ; feed pump or injector ; feed water heater ; economiser ; oil extractor ; superheater ; steel or other chimney stack ; fan for mechanical draught ; motors for automatic stoker ; economiser, scraper, fan, etc ; firing tools ; spare fire bars and gauge glasses ; pipe work and valves for main steam range and all above accessories and lagging for boilers and pipes ; exhaust piping to condenser or atmosphere or to both.

## Oil and Gas Plant

See Steam Plant above, (*a*) to (*e*) being applicable here also. If the Diesel or semi-Diesel type is required, in preference to the ordinary oil engine, this should be made clear.

(*f*) State altitude and maximum temperature of place where engine is to be used.

(*g*) State nature of fuel and average calorific value.

(*h*) Specify (or inquire) fuel consumption and efficiency at full, $\frac{1}{2}$, and $\frac{1}{4}$-load and at specified overload.

(*i*) Cooling water tanks and all piping for water and exhaust.

(*j*) Fuel tanks for oil; producer and accessories for gas.

(*k*) C. I. silencer is expensive. A drain in the ground will do, if land is available.

(*l*) Starting gear when required; compressed air cylinder for Diesel type.

**Steam turbine** should cover the following items:—(*a*) Number of units and location; character of building. (*b*) Service, attachment to driven apparatus (direct, flexible coupling, reduction gear, etc.). (*c*) Speed, steam and back pressure conditions. (*d*) Capacity, overload, electric system data. (*e*) Regulation, variation of speed under change of load. (*f*) Noise, vibration. (*g*) Tests and inspection. (*h*) Mechanical details of connection of driven apparatus. (*i*) Type and system. H. P., bleeder mixed pressure, giving quantities for L.P., or bleeding steam. (*j*) Materials—casing, wheels, nozzles, blades, shaft. (*k*) Piping connections. (*l*) Bearings. (*m*) Foundations. (*n*) Oiling. (*o*) Auxiliary apparatus—oil pumps, relays, step-bearing pumps (for vertical turbines). (*p*) Painting and lagging. (*q*) Gauges and miscellaneous equipment.

## *Data Necessary in Purchasing Water Wheel

The following data should be furnished to manufacturers to aid in the economical design of water wheels:—

1. Number of units.
2. Horse-power of water wheels.

3. kW. of generator.
4. Net and gross head, quantity of water available.
5. Open flume or closed flume.
6. If closed flume, what is the number of pipes ?
7. What kind of pipe ?—wooden stave, steel or concrete ?
8. Diameter of pipes.
9. Effective head (unless design of all-water passages to and from wheel is left to water wheel manufacturer).
10. Head water elevation.
11. Floor elevation.
12. Tail water elevation.
13. Head variable, if so, what is normal operating head ?
14. If head is variable, what is the range of variation ?
15. Relative importance of power and economy at lowest head.
16. Speed of generator, if already decided.
17. If speed of generator is not decided, name speeds which seem to purchaser most desirable and ask recommendation. Name periodicity of A. C. system.
18. Fly wheel effect of generator.
19. What speed regulation is desired for different load changes ?
20. Will units run in parallel with other plants ? If so, give general characteristics of such plants.
21. If running in parallel with other plants, can these plants be used to regulate the system ?
22. What is the character of load factor ?
23. What is the nature of water (silty or clear)?
24. What date shipment of material is desired ?
25. Advise if it is expected that manufacturer shall furnish governor.
26. Give sketches of power plant site.
27. Give information as to what is to be expected in the way of guarantees.
28. Impulse or reaction wheels.

29. Method of regulating inlet; in case of high heads whether by spear, deflector, or deflecting nozzle.
30. Give any other information which you think would influence the design of the wheel.

*Accessories*:—Pressure gauge; techometer; taper pipes from main pipe to nozzle; main valve; relief valve; governor and connections, spare-parts.

***The following data should be supplied to the purchaser by the manufacturer :—**

1. A check of the calculation on effective head.
2. Horse-power guarantee at normal head
3. Guarantee at other heads, if head is variable.
4. Speed guarantee, including runaway speed.
5. Recommendation for best speed if same has not been determined.
6. Speed regulation guarantees.
7. Water consumption and efficiency guarantees at full-load, $\frac{3}{4}$-load, $\frac{1}{2}$-load and overload
8. Point of greatest efficiency of wheel and value of same in per cent.
9. Efficiency guarantees for available head conditions
10. If water wheel manufacturer furnishes governor, give information as to the type, make, power required to operate same, also what variation in speed will not be exceeded before the governor will begin to re-adjust gates to meet a change of load, either gradual or sudden
11. Complete drawings showing machinery proposed.
12. Complete description of machinery proposed.
13. Guarantee of durability.
14. Guarantee of shipment.

## Pipes

(*a*) Whether each wheel will have its own pipe or whether a common pipe will be used, with a buss pipe.

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* "Handbook of Mechanical and Electrical Cost Data," by Halbert P. Gillettee and Richard T. Dana.

(*b*) Length, vertical head, and quantity of water to be carried at full and overload.
(*c*) Diameter of pipes and loss of head at full and overload—or it may be specified that the pipes shall carry the quantity of water required, under the net head, for the specified performance of the plant.
(*d*) Whether single or double riveted, welded, or solid drawn, and thickness and factor of safety; or latter may be given and details left to the makers.
(*e*) Nature of joints.
(*f*) Details as to dipping for protection against corrosion.

*Accessories*:—Bends, vertical and horizontal, from exact survey of pipe line; expansion joints; thrust blocks, bell mouths; valves; air chambers, if necessary, strainers; jointing material; spares; tools.

## Tendering

The first object of a tenderer should be not to do the work as cheaply as he can, but to get as much for the work as he can.

The factors that should be taken into consideration in making up an estimate are—the cost of the goods or raw materials; any labour spent upon the goods or raw materials, this item including wages of workmen in manufacturing and adapting: freight charges, the cost of hauling the goods; office, counting-house, and supervision expenses; contingencies, profit, and the terms upon which the prospective customer will make payment.

If work is scare and it is highly desirable to keep the men and the machines going, something may even be taken off; but it must be remembered that, although such a course may be justified as a temporary measure of policy it is bad business as a permanent policy, and that if all the business were cut below the fixed minimums, the result would be a loss. If work is plentiful and overtime would be required to take this contract, the estimated extra cost of that overtime should be added to the figures.

## Checking a Tender

If a man tenders time after time and is never the successful tenderer, there is urgent need for enquiry. Any of several causes may be at work. His system may be at fault, if he has one. It may be pitched in too high a key; he may be exorbitant in his estimates of profit. His competitors, who are more successful than he, may be buying more keenly or manufacturing more cheaply. They may have better machines or a more improved plant, thereby making it possible for them to give lower prices. They may be working too cheaply, either of design or by mistake Or they may have the preference of the buyer thereby enabling them to get orders out of your teeth even at a slightly higher price, or enabling them to revise their prices after competing tenders have been received Or, again, it may be a case of fraud, where bribery explains many things. Whatever may be the reason, it must be found and remedied, if possible. If a random competitor is ruining himself by taking work too cheaply, let him go on. Your turn will come when he has gone, and you may purchase a few bargains at his break-up. But if the reason is any one of the others given, then find it out and act upon the finding.

## Quoting to Specification

A proper specification for tender is detailed in its points, expressly stating all quantities and qualities, enumerating brands, and leaving almost nothing to the discretion of the tenderer. Upon such a specification it is a pleasure and a satisfaction to quote. You know that the next man cannot under-cut you by putting in inferior material or work, and that if you lose the order you have at least had a fair chance. But there are many specifications that are so loosely drawn—either from incompetence or carelessness of the architect, engineer, or other individual who drew them up—that the order is likely to go to someone who keeps himself within the letter of the law, but who supplies material or executes work which will be neither a credit to himself nor a satisfaction to a customer. What is the business man to do in front of such a proposition? To quote just within the specification and execute the order thereon, if accepted, means giving bad work ; to quote for good work, such as he knows is wanted, is to lose the order. Clearly the course to be pursued is to quote on the specification, keeping to its letter and making possible a price just as low as the letter of the specification will allow. Then in a covering letter state how much extra will be the price for what you think the specification ought to have stipulated, specifying such omissions. This course opposes you to the shoddy man on his own ground, but you have done justice to yourself and the prospective customer by quoting him for what he failed to specify, but what you are sure he ought to want.

## Appendix to Chapter XXX

A. It will be many years before the young engineer acquires enough experience to foresee all of the many ways in which a plant may be deficient. If it falls to his lot early in his professional life to call for tenders for any engineering work, he will probably find it best to concentrate his attention on what the plant must do rather than on what it is. This he should specify with extreme care, and then call for proposals from every firm of repute he knows of, leaving to them the detail specifications of actual construction. When all tenders are in, he should compare them carefully when he will find that one specification points out omissions in another (by implication). These omissions he may now point out to those tenderers whose proposals impress him favourably, and ask them to submit ammended quotations.

By this strategy he will force competing firms to lend him experience which is, in all probability, much greater than that of most superintending engineers.

He must remember, however, that it is not playing the game to reveal in his second inquiry the sources of his suggested ammendments or the prices quoted by other firms. It is dishonest also to adopt this method of aquiring information if he has no intention of placing an order when he has ascertained where he can get the best value for his expenditure.

B. *Note*:—That if the contractors or the promoting company (being the manufacturing company or their agent) are entrusted with the design or the running of the plant, there is none to examine or scrutinise their adherence to the standard specification or "test on completion," etc., and thus there is no check on their work. The serious consequences of this require no comment.

# CHAPTER XXXI

## LAWS AFFECTING THE ENGINEER

"No man ever lost himself on a straight road."

—*Akbar the Great.*

WE commend this saying of the great emperor to those students (probably not a few) who will be appalled at the telescopic complications of this chapter. These laws and regulations are, for the most part, a kind of hedge intended to keep within reasonable limits those wayward members of the human family who prefer the crooked road to the straight one. It is a principle of the law that "Ignorance of the law is no excuse for breaking it," and this may, at first sight, seem rather unjust, but it should be remembered that the object of all law is to secure a fair division of as much liberty as is possible to gregarious mankind. There are two kinds of men who are likely to infringe the law. They are the unrighteous and selfish man and the stupid and inconsiderate man. Those who do not come under these classifications will find that nearly all law is merely a codification of their own natural instincts. They are not likely to infringe the law if in every dilemma they do what they instinctively know to be right.

Human society is so complex, and the ways in which a crookedly-inclined man or a stupid man may wander from the straight path are so numerous, that the system of laws required to keep them from doing so has absorbed the attention of some of the best brains of civilisation for many generations. We have said that the other aspect of the law is that it endeavours to make a fair division of liberty. To take an extreme case, the reason the law prohibits me from abolishing a person I dislike with an axe, is that would be a restriction of that person's right to live. I have to surrender a certain amount of my liberty to him in order to make a fair division. So does he Very likely he thinks the world would be a better place without me.

**The Indian Companies Act** :—Is principally concerned with providing that when the public is invited to subscribe to a new company it shall have a reasonable prospect of receiving value for its money.

**The Contracts Act** :—When any two men make some sort of a *bundobust*, both of them should understand it thoroughly, and both of them should stick to it. Both of them should be willing, and the *bundobust* should not be one to interfere with the liberty of a third person.

**The Factory Act** :—Is a sesquipedalian *hookum* that you must treat your workman with reasonable humanity and take reasonable precautions for their safety from accidents.

**The Boiler Act** :—You are not allowed to blow your workman through the roof just because you are too stingy to pay for a decent boiler or to keep it in proper order.

**The Workman's Compensation Act** :—If a workman in your employ gets injured or killed in the course of his work, you will have to pay compensation whether it is your fault or not If you are a man in a small way of business, you had better insure against the risk of having to do so.

**The Maxims of Equity** :—You must not take undue advantage of any one because he is in difficulty. The bare maxims of equity have been stated for the guidance of the general course of conduct of the engineer and the manager A fair knowledge of these maxims will avoid much troubles and litigation.

The reader may now read the following experts. They are elaborations of the above, intended to remove all excuse for misunderstanding the idea.

## The Indian Companies Act

"**A private company**" means a company which

(i) by its articles—

(*a*) restricts the right to transfer its share ; and

(*b*) limits the number of its members (exclusive of persons who are in the employ of the company) to fifty ; and

(*c*) prohibits any invitation to the public to subscribe for any shares or debentures of the company ; and

(ii) continues to observe such restrictions, limitation, and prohibitions :

Provided that, where two or more persons hold one or more shares in a company jointly, they shall, for the purposes of this definition, be considered as a single member :

A private company is distinguished from a public company by the simple expedient of introducing appropriate exceptions into the Act.

## Advantages of a Private Company

The advantages of a private company, which may not be at first apparent, may be briefly summarised as follows :—

The principal advantage is that of the limited liability of its members. "Ordinary partnerships are, by the law, assumed and presumed to be based on the mutual trust and confidence of each partner in the skill, knowledge, and integrity of every other partner. As between the partners and the outside world (whatever may be their private arrangements between themselves), each partner is the unlimited agent or every other in every matter connected with the partnership business, or which he represents as partnership business, and not being in its nature beyond the scope of the partnership. A partner who may not have a farthing of capital left may take moneys or assets of the partnership to the value of millions, may bind the partnership by contract to any amount, may give the partnership acceptances for any amount, and may even—as has been shown in many painful instances in this Court—involve his innocent partners in unlimited amounts for frauds which he has craftily concealed from them." (Per James L. J. in Baird's case, 5ch 725, 733).

## Registration

(1) The company, association or partnership formed for business of banking and consisting of more than 10 persons, or

(2) for the purpose of carrying on any other business that has for its objects the acquisition of gain by the company consisting of more than 20 persons shall be duly registered.

## Memorandum of Association

The memorandum of association of a company is its *charter* and defines the limitation of the powers of a company established under the Act. Its purpose is two-fold. The first is that the intending corporator who contemplates the investment of his capital shall know within what field it is to be put at risk. The second is that any one who shall deal with the company shall know without reasonable doubt whether the contractual relation into which he contemplates entering with the company is one relating to a matter within its corporate objects.

All persons dealing with a company are deemed to have knowledge of the contents of its memorandum and articles of association, and if a director enters into transactions beyond the scope of the company or beyond his authority as therein defined, the company will not be liable.

## Mode of Forming Incorporated Company

Any seven or more persons (or, where the company to be formed will be a private company, any two or more persons) associated for any lawful purpose may, by subscribing their names to a memorandum of association and otherwise complying with the requirements of this Act in respect of registration, form an incorporated company, with or without limited liability (that is to say), either—

(*i*) a company having the liability of its members limited by the memorandum to the amount, if any, unpaid on the shares respectively held by them (in this Act termed a company limited by shares); or

(*ii*) a company having the liability of its members limited by the memorandum to such amount as the members may respectively thereby undertake to contribute to the assets of the company in the event of its being wound up in this Act termed a company limited by guarantee); or

(*iii*) a company not having any limit on the liability of its members (in this Act termed an unlimited company).

**Memorandum of Company Limited by Shares**

In the case of a company limited by shares—

(1) the memorandum shall state—

(*i*) the name of the company, with "Limited" as the last word in its name ;

(*ii*) the province in which the registered office of the company is to be situated ;

(*iii*) the objects of the company ;

(*iv*) that the liability of the members is limited ;

(*v*) the amount of share capital with which the company proposes to be registered, and the division thereof into shares of a fixed amount ;

(2) no subscriber of the memorandum shall take less than one share ;

(3) each subscriber shall write opposite to his name the number of shares he takes.

**Memorandum of company limited by guarantee.**—In the case of a company limited by guarantee.—

(1) the memorandum shall state—

(*i*) the name of the company, with "Limited" as the last word in its name ;

(*ii*) the province in which the registered office of the company is to be situated ;

(*iii*) the objects of the company ;

(*iv*) that the liability of the members is limited ;

(*v*) that each member undertakes to contribute to the assets of the company in the event of its being wound up while he is a member, or within one year afterwards, for payment of the debts and liabilities of the company contracted before he ceases to be a member ; and of the costs, charges and expenses of winding up, and for adjustment of the rights of the contributaries among themselves, such amount as may be required, not exceeding a specified amount.

(2) if the company has a share capital—

(*i*) the memorandum shall also state the amount of share capital with which the company proposes to be registered and the division thereof into shares of a fixed amount ;

(*ii*) no subscriber of the memorandum shall take less than one share ;

(*iii*) each subscriber shall write opposite to his name the number of shares he takes.

## Memorandum of Unlimited Company

In the case of an unlimited company—

(1) the memorandum shall state—

(*i*) the name of the company ;

(*ii*) the province in which the registered office of the company is to be situated ;

(*iii*) the objects of the company ;

(2) if the company has a share capital—

(*i*) no subscribers of the memorandum shall take less than one share ;

(*ii*) each subscriber shall write opposite to his name the number of shares he takes.

## Signature of Memorandum

The memorandum shall be signed by each subscriber in the presence of at least one witness who shall attest the signature.

The witness must be "some person who stands by, but is not a party to the transaction."

Articles of association are the regulations of the company and are binding until altered in the manner prescribed by the Act. Such articles should be registered.

Form and signature of articles :—

Articles shall—

(*a*) be printed ;

(*b*) be divided into paragraphs numbered consecutively ; and

(*c*) be signed by each subscriber of the memorandum of association in the presence of at least one witness, who must attest the signature.

## Alteration of Articles by Special Resolution

(1) Subject to the provisions of this Act and to the conditions contained in it special resolution to alter or add to its articles may be made; and any alteration or addition, so made, shall be as valid as if originally contained in the articles, and be subject, in like manner, to alteration by special resolution.

(2) A company cannot contract itself out of its statutory right to alter its articles, even by an agreement independent of and outside the articles of association. Nor can it, by the introduction into its articles of clauses to that effect, deprive itself of such statutory right. A company will be restrained by injunction from altering its articles for the purpose of committing a breach of contract.

## Effect of Memorandum and Articles

(1) The memorandum and articles shall, when registered, bind the company and the members thereof to the same extent as if they respectively had been signed by each member and contained a covenant on the part

of each member, his heirs, and legal representatives to observe all the provisions of the memorandum and of the articles, subject to the provisions of this Act.

(2) All money payable by any member to the company under the memorandum or articles shall be a debt due from him to the company.

The articles constitute a contract between each member and the company, and they bind the company and the shareholders as much as if they had put their seals to them. It has been judicially stated that they also constitute a contract between each individual shareholder and every other, but Lord Herschell laid it down "that there is no contract in terms between the individual members of the company; but the articles do none the less, in my opinion, regulate their rights *inter se*."

The articles do not bind the company in relation to any person not a member, though they do in relation to a shareholder, *i.e.*, member, where the rights of the member are conferred by the articles.

The House of Lords decided in the case of a Life Assurance Company that the company could alter its by-laws and alter its practice in the distribution of profits, and thereby vary its contract with a policyholder.

The company shall keep proper books of account and prepare an authenticated BALANCE-SHEET at intervals of not more than 15 months.

The following sections of the Act are to be noted :—

(1) Qualification of Director, Sec. 73.

(2) Validity of Acts of Director, Sec. 74.

(3) Filing of prospectus, Sec. 80.

(4) Specific requirements as to particulars of prospectus, Sec. 81.

(5) Obligation of companies where no prospectus is issued, Sec. 82.

(6) Liability for statement in prospectus, Sec. 84.

(7) Restrictions as to allotment, Sec. 85.

(8) Effect of irregular allotment, Sec. 86.

(9) Restrictions on commencement of business, Sec. 87.

(10) Powers and duties of Auditors, Sec. 113.

(11) Conversion of private company into public company.

## A Specimen Memorandum of Association

*Memorandum of Association*

The Company's Act, 1913

Company Limited by Shares

Memorandum of Association of "The Lakshmi Trading Coy., Ltd."

(1) Name of the Company—" The Lakshmi Trading Coy., Ltd."

(2) The registered office of the Company will be situate at Benares.

(3) The objects for which the Company is established are :—" The purchase and trade of solely indigenous industrial articles grown and manufactured in India, the encouragement of Swadeshism, and the economic prosperity of India thereby, and doing all such other things as are incidental or conducive to the attainment of the above object."

(4) The liability of the members is limited.

(5) The Share Capital of the Company is one hundred thousand rupees, divided into one thousand shares of one hundred rupees each.

We, the several persons, whose names and addresses are subscribed, are desirous of being formed into a Company in pursuance of this Memorandum of Association, and we, respectively, agree to take the number of shares in the Capital of the Company set opposite our respective names.

| Names, addresses, and description of subscribers. | No. of shares taken by each. |
|---|---|
| 1. Rama, son of merchant, Benares | 100 |
| 2. Gopal, son of merchant, Benares | 75 |
| 3. Mahamod, son of merchant, Benares | 60 |
| 4. Bharat, son of merchant, Benares | 60 |
| 5. Pannalal, son of merchant, Benares | 55 |
| 6. Rama Krishna, son of merchant, Benares. | 50 |
| 7. Lakshman, son of merchant, Benares | 50 |

Total shares taken ... 450

Dated 3rd April, 1934.

*Witnesses to the above signatures*:—

Mathues, son of David.

Purand, son of Susil Roy.

## The Indian Contract Act

**Contract Act**:—Contracts are arrangements enforceable by law. *The meaning of such agreements must be certain.*

The **essentials of a contract**, according to the Indian Contract Act, are:—

(1) Two or more parties.

(2) A two-sided act by which they express their agreement.

(3) The agreement must be made by the free consent of the parties (Secs. 13-22). Thus there must not be coercion which is physical, undue influence which is moral, bodily infirmity or mental distress, or fraud involving (*a*) a false suggestion, (*b*) active concealment of facts, (*c*) a promise made without any intention of performing it, (*d*) some other act fitted to deceive, (*e*) some act or omission specially declared by the law to be fraudulent misrepresentation.

(4) The parties must be competent to contract (Secs. 11-12). The parties have (*i*) the age of majority, (*ii*) soundness of mind, (*iii*) not been disqualified by law.

(5) The consideration for the agreement must be lawful (Secs. 23-25). It is lawful when it is not (*i*) forbidden by law, or (*ii*) of such a nature as to defeat the provisions of any law, or (*iii*) is fraudulent, or (*iv*) involves or implies injury to the person or property of another, or (*v*) regarded by the Court as immoral or opposed to public policy.

(6) The object of the agreement must be lawful (Sec. 23).

(7) It must not fall within the class of agreements expressly declared to be void (Secs. 26-30)—such as are (1) immoral or opposed to public policy; (2) agreements without consideration excepting (*a*) those made between near relations, (*b*) when the agreement is to compensate a person who has already done something voluntarily for the person making the promise or something which the person making the promise was legally compellable to do, (*c*) when the agreement is

to pay a debt barred by limitation but otherwise enforceable by law and is made in writing and signed by the party to be charged or by his agent.

(8) It must not contravene any law in force in British India, by which any contract is required to be made in writing, or in the presence of witness, or any law relating to registration (Sec. 10).

Contracts in restraint of trade are discountenanced by law. The exceptions are in the case of (*i*) the goodwill of a business, (*ii*) partners in anticipation of a dissolution of partnership may agree that some or all of them will not carry on a business similar to the partnership business with certain local limits and they may agree that during the continuance of the partnership they will not carry on any other business than that of the partnership.

The law allows certain contingent contracts such as contracts of indemnity or of insurance, although agreements by way of wager are generally void.

## The Mode of Performance of Contract

The parties to a contract must perform or offer to perform their respective promises in such a way as the law considers tantamount to performance. The offer of performance must be :—

(*i*) unconditional;

(*ii*) made at a proper time and place and under such circumstances as to allow the other party a reasonable opportunity of ascertaining that the person offering to perform is able to perform the whole of that which he has promised.

(*iii*) When the offer is to deliver something, the promisee must have a reasonable opportunity of seeing that the thing offered is the same thing as that which the promiser is bound to deliver.

By a complete *sale* is meant a transfer of the ownership of a thing from a seller to the buyer in exchange for a price.

*By ownership* is meant the right by virtue of which a man exercises complete and exclusive dominion over a thing. It does not necessarily connote the right to immediate unconditional possession. A person is said to be the owner of a thing, though he is not in actual enjoyment of any of the rights of ownership, if upon the performance of some conditions he is entitled to be invested with those rights and can transfer that title to another.

A SALE IS COMPLETE when any one of the following conditions has been complied with :—

(1) Earnest, or tender, payment or part payment of the price, or

(2) Delivery or part delivery of the thing, or

(3) An agreement, expressed or implied for the postponement of the delivery or of payment or of both.

The occurrence of any one of these cricumstances coupled with OFFER and ACCEPTANCE of the price for the thing or the thing for the price render the sale complete and the ownership has passed. *Delivery* of a thing is effected by any act which has the effect of transferring the possession from one person to another.

The seller has got two rights :—(1) that of lien, (2) that of stoppage in transit to protect him against the insolvency or fraudulent acts of the buyer (*vide* p. 539).

The buyer obtains no better title to the goods than his seller had to convey excepting in the following cases :—

(1) In commercial dealings a bonafide purchaser is conveyed a good title by any one who, with the consent of the owner, has in his possession goods or documents showing a title to goods.

(2) A bonafide purchaser who sees his seller in possession and has no reason to suppose that he is not entitled to sell This has reference to the case of one of several joint owners having, by provision of the co-owners, the possession of goods.

(3) A **bonafide sub-purchaser** of goods from one who is in possession of goods under a contract avoidable at the option of the vendor.

**Warranty:** There are (*a*) warranty of title, (*b*) warranty of quality, and (*c*) implied warranty.

(*a*) *Warranty of Title*:—If the buyer, or any person claiming under him, is, by reason of the invalidity of the seller's title, deprived of the thing sold, the seller is responsible to the buyer, or the person claiming under him, for loss caused thereby, unless a contrary intention appears by the contract.

(*b*) *Warranty of Quality*:—An implied warranty of goodness or quality may be established by the custom of any particular trade.

(*c*) *Implied Warranty*:—(1) Of soundness on sale of provisions, (2) of bulk on sale of goods by sample, (3) when goods are sold of a certain denomination, (4) when ordered for a specified purpose.

**Law of Agency**:—An 'agent' is a person employed to do any act for another, or to represent another, in dealings with third persons. The person for whom the act is done, or who is so represented, is called the '*Principal.*'

**The responsibility for the acts of third person** may arise from (1) previous authorisation, or (2) from subsequent adoption of the service in respect of which the liability is sought to be enforced. The authority may be in express terms, or it may arise by presumption based on the general course of conduct on the nature of the circumstances or on the relations existing between the persons concerned.

**Extent of Agent's Authority**:—His authority, to be of a particular service, extends to all things necessary for its performance; and his authority to carry on a business means authority to do every lawful thing necessary for the purpose, or usually done in the course of conducting such business. He should act in emergency as a man of ordinary prudence would act under similar circumstances supposing that his own personal interests were at stake.

## Revocation or Termination of Authority

**Termination of Agency** :—An agency is terminated by the principal revoking his authority; or by the agent renouncing the business of the agency ; or by the business of the agency being complete ; or by either the principal or agent dying or becoming of unsound mind ; or by the principal being adjudicated an insolvent under the provisions of any Act for the time being in force for the relief of insolvent debtors.

*Termination of agency, where agent has an interest in the subject-matter.*—Where the agent has himself an interest in the property, which forms the subject-matter of the agency, the agency cannot, in the absence of an express contract, be terminated to the prejudice of such interest.

**Duty of Agent to Principal** :—(1) To act according to the directions of the principal or the local custom of the business; he must conduct the business with the proper skill and seek to obtain instructions ; show in different cases reasonable diligence unless the principal has notice of his want of skill. He should make compensation to his principal in respect of direct consequence of his own neglect, want of skill or misconduct but not in respect of loss or damage, which are indirectly or remotely caused by such neglect, want of skill or misconduct. He is bound to render proper accounts to his principal on demand.

A '**sub-agent**' is a person employed by, and acting under the control of, the original agent in the business of the agency.

**Representation of Principal by Sub-agent properly appointed** :—Where a sub-agent is properly appointed, the principal is, so far as regards third persons, represented by the sub-agent, and is bound by, and responsible for, his acts, as if he was an agent originally appointed by the principal.

**Agent's responsibility for Sub-agent:**—The agent is responsible to the principal for the acts of the sub-agent.

**Sub-agent's responsibility:**—The sub-agent is responsible for his acts to the agent, but not to the principal, except in cases of fraud or wilful wrong.

**When agent cannot delegate:**—An agent cannot lawfully employ another to perform acts which he has expressly or impliedly undertaken to perform personally, unless by the ordinary custom of trade, a sub-agent may, or from the nature of the agency, a sub-agent must, be employed.

**Agent's responsibility for sub-agent appointed without authority.**—Where an agent, without having authority to do so, has appointed a person to act as a sub-agent, the agent stands towards such person in the relation of a principal, and is responsible for his acts both to the principal and the third person; the principal is not represented by, or responsible for, the person so employed, nor is that person responsible to the principal.

**Principal's right to benefit gained by agent** dealing on his own account in business of agency. If an agent, without the knowledge of his principal, deals in the business of the agency on his own account, instead of on account of the principal, the principal is entitled to claim, from the agent, any benefit which may have resulted to him from the transaction.

**Agent's right of retainer** out of sums received on principal's account. An agent may retain, out of any sums received on account of the principal in the business of the agency, all moneys due to himself in respect of advances made, or expenses properly incurred by him in conducting such business, and also such remuneration as may be payable to him for acting as agent.

**Agent to be indemnified** against consequences of lawful acts. The employer of an agent is bound to indemnify him against the consequences of all lawful acts done by such agent in exercise of the authority conferred upon him.

*Agent to be idemnified against consequences of acts done in good faith.*—Where one person employs another to do an act, and the agent does the act in good faith, the employer is liable to indemnify the agent against the consequences of that act, though it causes an injury to the rights of third persons.

**Non-liability of employer of Agent to do a criminal act.**—Where one person employs another, to do an act which is criminal, the employer is not liable to the agent, either upon an express or an implied promise to indemnify him against the consequences of that act.

**Compensation to Agent for injury caused by principal's neglect.**—The principal must make compensation to his agent in respect of injury caused to such agent by the principal's neglect or want of skill.

**Enforcement and consequences of Agent's contracts.**—Contracts entered into through an agent, and obligation arising from acts done by an agent, may be enforced in the same manner, and will have the same legal consequences, as if contracts had been entered into and the acts done by the principal in person.

**Principal how far bound when Agent exceeds authority.**—When an agent does more than he is authorised to do, and when the part of what he does, which is within his authority, can be separated from the part which is beyond his authority, so much only, of what he does as is within his authority, is binding as between him and his principal.

*Principal not bound when excess of agent's authority is not separable.*—Where an agent has done more than he is authorised to do, and what he does beyond the scope of his authority cannot be separated from what is within it, the principal is not bound to recognise the transaction.

**Agent cannot personally enforce, nor be bound by, contracts on behalf of principal.**—In the absence of any contract to that effect, an agent cannot personally enforce contracts entered into by him on behalf of his principal, nor is he personally bound by them.

*Presumption of contract to contrary.*—Such a contract shall be presumed to exist in the following cases :—

(1) Where the contract is made by an agent for the sale or purchase of goods for a merchant resident abroad.

(2) Where the agent does not disclose the name of his principal.

(3) Where the principal, though disclosed, cannot be sued as out of jurisdiction.

(4) When agent personally binds himself by the contract entered into by him so far (*a*) as the principal, (*b*) as the other party to the contract are concerned.

**Rights of a person dealing with agent personally liable.**—In cases where the agent is personally liable, a person dealing with him may hold either him or his principal, or both of them, liable.

**Effect on agreement, of misrepresentation or fraud by agent.**—Misrepresentations made, or frauds committed, by agents acting in the course of their business for their principals, have the same effect on agreements made by such agents, as if such misrepresentations or frauds had been made or committed by the principals; but misrepresentations made, or fraud committed, by agents, in matters which do not fall within their authority, do not affect their principals.

**Rights of Unpaid Seller against the Goods**

The rights of the unpaid seller over the goods when the property in them has passed to the buyer, subject to any special statutory provisions, are :—

(*a*) A lien on the goods, or a right to retain them, for the price while he is in possession of them.

(*b*) In case of the insolvency of the buyer, right of stopping the goods in transit after he has parted with the possession of them.

(*c*) A limited right of resale.

Where the property in the goods has not passed to the buyer, the unpaid seller has, in addition to his other remedies, a right of withholding delivery similar to, and co-extensive with, his rights of lien and stoppage in transit, where the property has passed to the buyer.

## Seller's Lien

Subject to the other provision noticed, the unpaid seller remaining in possession of the goods may retain them until payment or tender of the price in the following cases :—

1. Where the goods have been sold without any stipulation as to credit.
2. Where the goods have been sold on credit and the term of credit has expired.
3. Where the buyer becomes insolvent.

The seller may exercise his right of lien, notwithstanding that he is in possession of the goods as agent, bailee, or custodier for the buyer

An unpaid seller does not lose his lien or right of retention by obtaining judgment or decree for the price of the goods. He does lose such rights—

(*a*) When he delivers the goods to a carrier, or other bailee or custodier, for the purpose of transmission to the buyer, without reserving the right of disposal of the goods.

(*b*) When the buyer or his agent lawfully obtains possession of the goods ; or

(*c*) By waiver, as for example, by assenting to a sub-sale, taking a bill for the price, etc.

## Stoppage in Transit

Subject to any other provision, when the buyer of goods becomes insolvent, an unpaid seller who has parted with the possession of the goods has the right of stopping them in transit ; that is to say, he may resume possession of the goods as long as they are in course of transit, and may retain them until payment or tender of the price. Goods are deemed in course of transit from the time they are delivered to a carrier by land or water, or other bailee or custodier for transmission to the buyer until the buyer or his agent in that behalf takes delivery of them from such carrier or other bailee or custodier.

With part delivery of the goods to the buyer or his agent, the transit is deemed to be at an end, where part delivery of the goods has been made under such circumstances as to show an agreement to give up possession of the whole of the goods.

The unpaid seller exercises his right of stoppage in transit either by taking actual possession of the goods or by giving notice of his claim to the carrier or other bailee or custodier in whose possession the goods are.

## Re-sale by Buyer or Seller

The unpaid seller's right of lien or retention or stoppage in transit is not affected by any sale or other disposition of the goods, which the buyer may have made, unless the seller has assented thereto.

## Partnership

"**Partnership**" is the relation which subsists between persons who have agreed to combine their property, labour, or skill in some business, and to share the profits thereof between them.

**Responsibility of person leading another to believe him a partner** :—A person who has, by words spoken or written, or by his conduct, led another to believe that he is a partner in a particular firm, is responsible to him as a partner in such firm.

**Liability of person on permitting himself to be represented as a partner.**—Any one consenting to allow himself to be represented as a partner, is liable, as such, to third persons who, on the faith thereof, give credit to the partnership.

**Partner's liability for debts of partnership.**—Every partner is liable for all debts and obligations incurred while he is a partner in the usual course of business by, or on behalf of, the partnership ; but a person who is admitted as a partner into an existing firm does not thereby become liable to the creditors of such firm for anything done before he became a partner.

**Partner's liability to third persons for neglect or fraud of co-partner.**—Every partner is liable to make compensation to third persons in respect of loss or damage arising from the neglect or fraud of any partner in the management of the business of the firm.

**Partner's power to bind co-partners:**—Each partner who does any act necessary for, or usually done in carrying on, the business of such a partnership as that of which he is a member, binds his co-partners to the same extent as if he were their agent duly appointed for that purpose.

**Rules determining partner's mutual relations, where no contract to contrary.**—In the absence of any contract to the contrary, the relations of partners to each other are determined by the following rules:—

(1) all partners are joint owners of all property originally brought into the partnership stock, or brought with money belonging to the partnership, or acquired for purposes of the partnership business. All such property is called partnership property. The share of each partner in the partnership property is the value of his original contribution, increased or diminished by his share of profit or loss:

(2) all partners are entitled to share equally in the profits of the partnership business, and must contribute equally towards the losses sustained by the partnership:

(3) each partner has a right to take part in the management of the partnership business:

(4) each partner is bound to attend diligently to the business of the partnership, and is not entitled to any remuneration for acting in such business:

(5) when differences arise as to ordinary matters connected with the partnership business, the decision shall be according to the opinion of the majority of the partners; but no change in the nature of the business of the partnership can be made except with the consent of all the partners:

(6) no person can introduce a new partner into a firm without the consent of all the partners :
(7) if, from any cause whatsoever, any member of a partnership ceases to be so, the partnership is dissolved as between all the other members :
(8) unless the partnership has been entered into for a fixed term, any partner may retire from it at any time :
(9) where a partnership has been entered into for a fixed term, no partner can, during such term, retire, except with the consent of all the partners, nor can he be expelled by his partners for any cause whatever, except by order of Court :
(10) partnerships, whether entered into for a fixed term or not, are dissolved by the death of any partner.

**When Court may dissolve partnership.**—At the suit of a partner, Court may dissolve the partnership in the following cases :—

(1) when a partner becomes of unsound mind :
(2) when a partner, other than the partner suing, has been adjudicated an insolvent under any law relating to insolvent debtors :
(3) when a partner, other than the partner suing, has done any act by which the whole interest of such partner is legally transferred to a third person :
(4) when any partner becomes incapable of performing his part of the partnership contract :
(5) when a partner, other than the partner suing, is guilty of gross misconduct in the affairs of the partnership or towards his partners :
(6) when the business of the partnership can only be carried on at a loss.

## General Duties of Partners

Partners are bound to carry on the business of the partnership for the greatest common advantage, to be just and faithful to each other, and to render true accounts and full information of all things affecting the partnership to any partner or his legal representatives.

## Description and Classification of Securities

Comprised in the general term, securities are a whole lot of different classes of stocks, shares, bonds, debentures, and so on, each with its distinctive features.

**Par Premium, Discount.**—If a share is issued at Rs. 10, then the " par " value is Rs. 10.

A share is said to be at a " premium " when it is issued at the price of Rs. 10, and selling at, say, Rs. 40, *i.e.*, at a premium of Rs. 30.

A share issued at Rs. 10, and selling at, say, Rs. 8, is at Rs. 2 discount.

**Stock and Shares.**—A share is issued for a fixed amount (Rs. 10, Rs. 50, Rs. 100, etc.) and while it may be dealt with, in up to almost any quantity, fractions of a share are unknown.

Stock may be defined as capital consolidated into one mass for the sake of convenience and is transferable in any fractions.

Every share bears a distinctive number, while stock possesses no numbers.

While referring to stock, we say " Rs. 12,454 of the Tata Iron and Steel Company Stock "; and while referring to shares, we say " Five shares of Rs. 10 each of the Benares Electric Light and Power Company, Ltd."

While selling stock, any fraction of it may be sold, *e.g.*, a stockholder may dispose of Rs. 454 out of Rs. 12,454 stock, but while selling shares, a shareholder has to dispose of a certain number of whole shares but not $2\frac{1}{2}$ shares or $3\frac{1}{4}$ shares.

**Share Capital and Debenture Capital.**—Holders of a company securities are, either its members holding securities such as ordinary and preference stocks, or shares entitling them to share in its profits, elect its directors and auditors, and govern its rules and regulations; or they are in position of secured creditors, holding securities such as BONDS and DEBENTURES, which give them a charge on the company for principal and a definite rate of interest, but do not entitle them to direct the company's affairs. Either of these classes can be represented by stock; but share is seldom applied to the creditor class—we speak of debentures, but not of debenture shares. Thus there arises the practice of referring to the members of a company as shareholders (although they may hold stock and not shares), and to a company's share capital—to distinguish it from debenture capital—although it may not be divided into shares. A shareholder always implies membership; a stockholder may be a debenture stockholder and, therefore, not a member at all.

Members of a company are sometimes called PROPRIETORS or CONTRIBUTORS.

**Bond.**—A receipt or certificate for a loan issued by governments or companies, and bearing a fixed rate of interest, redeemable in a given number of years.

**(A) Bonds to Bearer.**—Require no deed of transfer or assignment, but can be passed from hand to hand like currency notes. To each bond is attached a sheet containing a number of coupons or tickets bearing each an order for the payment of the interest at the due date.

**(B) Currency Bond.**—A bond in the currency or money of the country in which it is issued. For instance, an American currency bond is in dollars, Japanese in Yen, and so on.

**Debenture Stock.**—Debentures are practically the form of receipt or acknowledgment of a loan to a company secured by mortgage over its assets, and in almost all cases form a first charge over such assets. They bear a fixed rate of interest, generally about 5 %, and may be either permanent or redeemable at par, or at a premium in a fixed number of years. They may be issued in the form of stock, transferable in the usual form, or in the form of bonds to bearer, in which case interest coupons are attached.

**Guaranteed Stock.**—A stock issued by the company, and guaranteed by the company, by the assigning to the holders, as security, some of its assets, or it may be guaranteed by the municipality of the town in which the company is situated, or by some other company which has an interest in the company issuing the stock.

**Preference Stock or Share.**—Such stock or share generally comes next after the debentures of a company (when there are debentures), and has a fixed rate of dividend interest, generally about 7 %, out of the profits of each financial year, and ranks for dividend before the ordinary stock. In some cases, when the profits of a company are sufficient to pay a certain fixed dividend (a considerable percentage of the profit) on the ordinary stock after the preference dividend (interest) has been paid, the surplus falls to be divided equally between the preference and ordinary shareholders.

The preference stock is either CUMULATIVE or NON-CUMULATIVE. If it is cumulative and the profits of one year are not sufficient to pay the fixed rate of dividend (interest), then the holders are entitled to have the unpaid balance made out of some future year's profits before the ordinary stockholders receive any further dividend. On the other hand, if the preference stock is non-cumulative, its dividend is contingent on the profits of each separate year. If, in any year, the profits are insufficient to pay the fixed rate of dividend, then the unpaid dividend for that year is lost to the stockholder.

**Ordinary Stock and Share.**—The position of the ordinary stock or share in the company is that of being the last, but not, in every way, the least. When the balance-sheet of a company is struck and the profits are shown, the debenture and preference shareholders having been paid their interest, then the whole surplus remains to the ordinary shareholder, to be divided as the directors may think fit.

**Gilt-Edged Security.**—A term used to describe that class of security which, by the guarantee of a stable government or municipality, or ranking high in the order of preference of an important railway or other company, is never likely to default in the payment of either capital or interest.

**Bonus.**—When a company from some exceptional cause has made a larger profit than usual in one year and rather than declare an increased dividend, which it might not be able to pay in the next or subsequent years, it declares the usual rate of dividend, and distributes the extra-profit amongst the shareholders; this extra profit is called a "bonus."

**Summing up Investment Securities rank as follows** :—

1. Government Loans, Bonds and Debentures.
2. Preference Shares.
3. Ordinary Shares.

## Legal Constitution of Some Business Concerns

| Sole Trader. | Partnership. | Limited Partnership. | Public Limited Company. | Private Limited Company. |
|---|---|---|---|---|
| 1. Consists of one person, *viz.*, the owner of the business. | May consist of from 2 to 20 members (except in a banking partnership where they must not exceed 10). | Consists of one or more general partners, and one or more limited partners. (The maximum number of members is 20, and in the case of a bank, 10 members). | Cannot consist of less than seven members. | May consist of 2 members, but not more than 50 (excluding employees and ex-employees). |

| | | | | | |
|---|---|---|---|---|---|
| 2. | The proprietor is personally liable for all the debts of the business. | Partners are liable for the full amount of the debts of the partnership. | The general partners are liable without limitation for the debts of the firm. The liability of limited partners is limited to the amounts they contribute. | Each member's liability is limited to the nominal amount of capital undertaken to be contributed by him. | The members' liability is the same as in the public limited company. |
| 3. | The proprietor may dispose of his business at any time. | Shares are not transferable. | A limited partner may transfer his share with the consent of the general partners. | Shares are freely transferable. | There is a restriction on the transfer of the shares. |
| 4. | Audit of the accounts is optional. | Audit of the accounts is optional. | Audit of the accounts is optional. | The audit of the accounts is compulsory. | The audit of the accounts is compulsory. |

## Legal Constitution of Some Business Concerns—*Continued*

| Sole Trader. | Partnership. | Limited Partnership. | Public Limited Company | Private Limited Company. |
|---|---|---|---|---|
| 5. The capital is introduced by the proprietor, but he may obtain the use of outside loans. | The partners named in the articles of partnership introduce the capital. | The capital is introduced by the general and limited partners. | The public may be invited to subscribe the share capital. | The public must not be invited to subscribe the capital. |
| 6. An annual balance-sheet is not compulsory. | An annual balance-sheet is not compulsory. | An annual balance-sheet is not compulsory. | An annual balance-sheet is compulsory and a statement in the form of a balance-sheet must be filed, annually, at the company's registered office. | The annual balance-sheet is compulsory, but does not require to be filed at the company's registered office. |

## Partnership *vs.* Limited Liability Company

| | |
|---|---|
| (1) A firm is not a distinct person. It is made up of several persons who compose it. Thus the firm of A & Co. is, in law, A, B, C and D, etc., and the property belongs to all the members in common. Consequently, partners cannot make contract with the firm and judgment creditor can seize the property of any partner. | (1) A company is a distinct being or person. Thus the company of S. & Co., Ltd., is an entirely different person from Mr. S., even though he started it and practically owns all shares. The property is of S. & Co., Ltd., and not of Mr S. He can make contracts with the company and his personal property cannot be seized for the debts of the company. |
| (2) One partner cannot transfer his shares without the consent of all the partners. | (2) Shares are freely transferable. |
| (3) Each partner is an agent of the firm to make contract. | (3) A shareholder is not an agent of the company. |
| (4) The liability of each partner for the debts of the firm is unlimited, except in case of a limited partnership. | (4) The liability of each shareholder may be limited either by guarantee or by shares. |
| (5) Partners may make what private arrangements they may like, among themselves. | (5) The company must stick up to memorandum and articles of association. |

## The Indian Factories Act XXII of 1911

*Modified up to Ist July, 1922*

The following provisions of the Act are to be specially noted by all managers of a factory :—

Note that a **factory** is :—

(*a*) any premises wherein, or within the precincts of which, on any one day in the year, not less than twenty persons are simultaneously employed ; and steam, water or other mechanical or electrical power is used in aid of any process for, or incidental to making, altering, repairing, ornamenting, finishing or otherwise adopting for use for transport or for sale any article or part of an article ; or

(*b*) any premises wherein, or within the precincts of which, on any one day in the year, not less than ten persons are simultaneously employed, and any such process is carried on, whether any such power is used in aid thereof or not which have been declared by the Local Government, by notification in the local official Gazette, to be a factory.

A declaration under clause (*b*) may be made in respect of any class of premises, or in respect of any particular premises.

## Provisions for Health and Safety

There must be sufficient arrangements :—

(*a*) for proper sanitation with special reference to cleanliness, ventilation, lighting, pure water, latrine, urinal accommodation drainage and for supply of sufficient suitable water fit for drinking for the employees in the factory ;

(*b*) for precautions against fire and means of escape in case of fire. The doors of each room in which more than 30 persons are employed, shall, except in the case of sliding door, be so constructed as to open outwards.

(*c*) for necessary and efficient fencing round any machine or part;

(*d*) for prohibiting any person to smoke, or use a naked light, or cause or permit any such light to be used in the immediate vicinity of any inflammable material in any factory;

(*e*) to keep the buildings of the factory or machinery used therein in good repair to avoid all danger to life and property;

(*f*) to prohibit the employment of women and children in certain dangerous works, and in certain process if they are under 18 years. Note that a child, for working in a factory, must be duly certified to be not less than twelve years of age and is under the age of 15 years.

(1) " In every factory there shall be fixed—

(*a*) for each person employed on each working day—

(*i*) at intervals not exceeding six hours, periods of rest of not less than one hour, or

(*ii*) at the request of the employees concerned, periods of rest of not less than half an hour each, so arranged that, for each period of six hours' work done, there shall be periods of rest of not less than one hour's duration in all, and that no person shall work for more than five hours continuously, and

(*b*) for each child working more than five and a half hours in any day, a period of rest of not less than half an hour.

(2) The period of rest under clause (*b*) shall be so fixed that no such child shall be required to work continuously for more than four hours."

## Weekly Holidays

(1) No person shall be employed in any factory on a Sunday, or on one of the three days immediately preceding or succeeding the Sunday, provided that by

such substitution no person has to work for 10 consecutive days.

In order to enable the inspector to see that the provisions of the Act for a weekly holiday are observed, the manager of every factory shall keep a daily register of attendance, separately by departments, if he so desires, of all persons, including children, employed in special forms, showing the dates, whether Sundays or week days, on which the factory or any department thereof is closed and its employees are not working. It shall also show the hours of work on each day of all the persons working in the factory. The time of commencing work, rest period, the time of ending work, the days of absence and the nature of the respective employment of each person shall also be stated therein. Opposite the name of each child shall be entered his or her serial number as entered in the register for children. The register shall be posted within four hours of the starting time of the factory for each working period.

If a manager prefers, he may maintain the register in two parts, one for each half of the month. When this is done, particulars of father's name and caste need be entered only in the part which relates to the first half of the month.

## Provisions for Hours of Employment

(1) No child or woman shall be employed in any factory before half past five a. m. or after seven p. m.

(2) The maximum number of working hours in any one day for a child is six hours and for any person 11 hours, and the maximum number of working hours in any one week is 60 hours.

*Exemptions* :—The above provisions are subject to certain exceptions depending on—

(*a*) class of work preparatory or complementary to some other work. The rate of payment for overtime work shall be at least one and a quarter times the rate at which he is normaly paid.

(*b*) nature of the work being intermittent or otherwise ;

(*c*) work requiring continuous production for technical reasons ;

(*d*) the factory supplying articles of prime necessity which must be made or supplied every day ;

(*e*) that in any class of factories the work performed by the exigencies of the trade or by its nature, cannot be carried on except at stated seasons or at times dependent on the irregular action of natural forces ;

(*f*) exceptions sanctioned by the Local Government in case of (1) exceptional press of work, (2) works of urgent repairs and in certain cases for indigo, tea or coffee factories.

The total overtime permitted for women shall not exceed six hours during the week and for men the overtime shall not be such as to make the hours of work exceed twelve on any one day.

## Provisions for Notices and Registers

The inspector should be informed of :—(1) every change of manager by the occupier, within seven days from the date on which the change is made.

(2) Every accident causing death or bodily injury disabling the person from attending his work, within 48 hours of the occurrence of the accident.

In every factory there shall be kept, in the prescribed form, a register of all the persons employed in such factory, of their hours of work and of the nature of their respective employment.

(1) There shall be affixed, in some conspicuous place near the main entrance of every factory, in English and in the language of the majority of the operatives in such factory, the prescribed abstracts of this Act and of the rules made thereunder, and also a notice containing the standing orders of the factory upon the following matters, namely :—

(*a*) the time of beginning and ending work on each day ;

(*b*) the periods of rest fixed under Section 21 ;
(*c*) the hours of beginning and ending work for each shift (if any) ; and
(*d*) the hours of employment of (all persons employed) ;
(*e*) the weekly holidays fixed under Section 22.

(2) A copy of the said notice shall be sent to the inspector within one month of commencing work.

(3) The said notice shall be correctly maintained and kept up to date, and intimation of any change therein shall be sent by the manager to the inspector within seven days.

## Act No. V of 1923

Of the laws relating to **steam boilers**, the following provisions should be noted :—

*Definitions* :—(1) " Boilers " means any closed vessel exceeding five gallons in capacity which is used expressly for generating steam under pressure for use outside such vessel, and includes any mounting or other fitting attached to such vessel which is wholly or partly under pressure when steam is shut off.

(2) " Steam-pipe " means any main pipe exceeding three inches in internal diameter through which steam passes directly from a boiler to a prime-mover or other first user, and includes any connected fitting of a steam-pipe.

**Prohibition of use of unregistered or uncertificated boiler :—**

No owner of a boiler shall use the boiler or permit it to be used :—

(*a*) unless it has been duly registered ;
(*b*) when a boiler has been transferred from one province to another, until the transfer has been reported in the prescribed manner ;
(*c*) unless a certificate or provisional order authorising the use of the boiler is, for the time being, in force under this Act ;

(*d*) at a pressure higher than the maximum pressure recorded in such certificate or provisional order;

(*e*) where the local government has made rules requiring that boilers shall be in charge of persons holding certificates of competency, unless the boilers is in charge of a person holding the certificate required by such rules;

Provided that any boiler registered, or any boiler certified or licensed, under any Act hereby repealed, shall be deemed to have been registered or certified, as the case may be, under this Act.

Provided further, that, until the expiration of twelve months from the commencement of this Act, nothing in this section shall be deemed to prohibit the use of any boiler in any local area in which the registration of, or a certificate or license for the use of, a boiler was not previously required by law.

(1) The owners of unregistered boilers should apply to the boiler inspector accompanied by the prescribed fee.

(2) The inspector shall fix a date for examination of the boiler within thirty days from the date of the receipt of their application, and shall give the owner not less than 10 days' notice of the date so fixed.

(3) The inspector shall examine the boiler and determine the maximum pressure at which the boiler may be used and report the result to the chief inspector.

(4) The chief inspector, on receipt of the report, may—

(*a*) register the boiler and assign a register number thereto either forthwith or after satisfying himself that any structural alteration, addition or renewal, which he may deem necessary, has been made in or to the boiler or any steam-pipe attached thereto, or (*b*) refuse to register the boiler:

Provided that where the chief inspector refuses to register a boiler, he shall forthwith communicate his refusal to the owner of the boiler together with the reasons therefor.

(5) The chief inspector shall, on registering the boiler, order the issue to the owner of a certificate in the prescribed form authorising the use of the boiler for a period not exceeding twelve months at a pressure not exceeding such maximum pressure as he thinks fit and such order will be conveyed by the inspector to the owner.

(1) **A certificate authorising the use of a boiler shall cease to be in force :—**

(*a*) on the expiry of the period for which it was granted ; or

(*b*) when any accident occurs to the boiler ; or

(*c*) when the boiler is moved ; the boiler not being a vertical boiler the heating surface of which is less than two hundred square feet, or a portable or vehicular boiler ; or

(*d*) when any structural alteration, addition or renewal is made in or to the boiler ; or

(*e*) if the chief inspector in any particular case so directs, when any structural alteration, addition or renewal is made in or to any steam-pipe attached to the boiler ; or

(*f*) on the communication to the owner of the boiler of an order of the chief inspector or inspector prohibiting its use on the ground that it or any steam-pipe attached thereto is in a dangerous condition.

(2) When a certificate ceases to be in force, the owner of the boiler may apply to the inspector for a renewal thereof for such period not exceeding twelve months as he may specify in the application accompanied by the prescribed fee.

The **date of examination of the boiler** will be fixed and the **owner of the boiler notified,** the boiler will be examined and if the boiler and steam-pipes are in good condition, the certificate shall be renewed.

Provided that if the inspector—

(*a*) proposes to issue any certificate—

(*i*) having validity for a less period than the period entered in the application, or

(*ii*) increasing or reducing the maximum pressure at which the boiler may be used, or

(*b*) proposes to order any structural alteration, addition or renewal to be made in or to the boiler or any steam-pipe attached thereto, or

(*c*) is of opinion that the boiler is not fit for use, the inspector shall, within forty-eight hours of making the examination, inform the owner of the boiler, in writing, of his opinion and the reasons therefor, and shall forthwith report the case for orders to the chief inspector.

The chief inspector may renew the certificate in such terms and on such conditions as he thinks fit, or may refuse to renew it.

**Provisional orders :**—The inspector may grantto the owner thereof a provisional order in writing permitting the boiler to be used except when the boiler or steam-pipe is in a dangerous condition. Such provisional order shall cease to be in force—

(*a*) on the expiry of six months from the date on which it is granted, or

(*b*) on receipt of the orders of the chief inspector, or

(*c*) in any of the cases referred to in the clauses (*b*), (*c*), (*d*), (*e*) and (*f*) of sub-section (1), page 558, and on so ceasing to be in force shall be surrendered to the inspector.

**Use of boiler pending grant of certificate :**— The owner of a boiler may apply for a renewed certificate at any time during the currency of a certificate.

In this case the owner is entitled to use the boiler at the maximum pressure entered in the former certificate pending the issue of orders on the application.

**Alterations and renewal of boilers** :—No structural alteration, addition or renewal shall be made in or to any boiler registered under this Act unless such alteration, addition or renewal has been sanctioned in writing by the chief inspector.

**Alterations and renewals to steam-pipes** :—Before the owner of any boiler, registered under this Act, makes any structural alteration, addition or renewal in, or to, any stream-pipe attached to the boiler, he shall transmit to the chief inspector a report in writing of his intention, and shall send therewith such particulars of the proposed alteration, addition or renewal as may be prescribed.

## Duty of Owner at Examination

(1) On any date fixed under this Act for the examination of a boiler, the owner thereof shall be bound—

(*a*) to afford to the inspector all reasonable facilities for the examination and all such information as may reasonably be required of him ;

(*b*) to have the boiler properly prepared and ready for examination in the prescribed manner ; and

(*c*) in the case of an application for the registration of a boiler, to provide such drawings, specifications, certificates and other particulars as may be prescribed.

(2) If the owner fails, without reasonable cause, to comply with the provisions of sub-section (3), the inspector shall refuse to make the examination and shall report the case to the chief inspector who shall, unless sufficient cause to the contrary is shown, require the owner to file a fresh application under special section, as the case may be, and may forbid him to use the boiler.

**Production of certificate, etc.** :—The owner of a boiler must produce the boiler certificate or provisional order to the proper authority at all reasonable times.

**Transfer certificate, etc.** :—If any person becomes the owner of a boiler during the period for which a certificate or provisional order relating thereto is in force, the preceding owner shall be bound to make over to him the certificate or provisional order.

**Report of accidents** :—(1) If any accident occurs to a boiler or steam-pipe, the owner or person in charge thereof shall, within twenty-four hours of the accident, report the same in writing to the inspector. Every such report shall contain a true description of the nature of the accident and of the injury, if any, caused thereby to the boiler or to the steam-pipe or to any person, and shall be in sufficient detail to enable the inspector to judge of the gravity of the accident.

(2) Every person shall be bound to answer truly, to the best of his knowledge and ability, every question put to him in writing by the inspector as to the cause, nature or extent of the accident.

**Appeals to Appeal Authority** :—An aggrieved person may appeal against the orders of an inspector to the chief inspector. The period of limitation being within 30 days from the date on which such order or refusal is communicated to him, or may lodge with the chief inspector an appeal against an original order; or appellate order of the chief inspector to an appellate authority to be constituted by the Local Government under this Act.

## Workmen's Compensation Act, 1923

**Definitions** :—

(*a*) "*Dependant*" means any of the following relatives of a deceased workman, namely, a wife, husband, parent, minor son, unmarried daughter, married daughter who is a minor, brother or unmarried sister, and includes the minor children of a deceased son of the workman, and, where no parent of the workman is alive, a paternal grandparent.

(*b*) "*Employer*" includes any body of persons, whether incorporated or not, and any managing agent of an employer and the legal representative of a deceased employer, and, when the services of a workman are temporarily lent or let on hire to another person by the person with whom the workman has entered into a contract of service or apprenticeship, means such other person while the workman is working for him. The definition is not exhaustive.

(c) "*Managing Agent*" means any person appointed or acting as the representative of another person for the purpose of carrying on such other person's trade or business, but does not include an individual manager subordinate to an employer.

(d) "*Partial Disablement*" means, where the disablement is of a temporary nature, such disablement as reduces the earning capacity of a workman in any employment in which he was engaged at the time of the accident resulting in the disablement, and, where the disablement is of a permanent nature, such disablement as reduces his earning capacity in every employment which he was capable of undertaking at that time; provided that every injury specified in Schedule I shall be deemed to result in permanent partial disablement.

(e) "*Total Disablement*" means such disablement, whether of a temporary or permanent nature, as incapacitates a workman for all work which he was capable of performing at the time of the accident resulting in such disablement; provided that permanent total disablement shall be deemed to result from the permanent total loss of the sight of both eyes or from any combination of injuries specified in Schedule I, where the aggregate percentage of the loss of earning capacity, as specified in that Schedule against those injuries, amounts to one hundred per cent.

(f) "*Wages*" includes any privilege or benefit which is capable of being estimated in money, other than a travelling allowance or the value of travelling concession or a contribution paid by the employer of a workman towards any pension or provident fund or a sum paid to a workman to cover any special expenses entailed on him by the nature of his employment.

(*g*) "*Workman*" means any person (other than a person whose employment is of a casual nature and who is employed otherwise than for the purposes of the employer's trade or business) who is—

(*i*) a railway servant, as defined in section 3 of the Indian Railways Act, 1890, not permanently employed in any administrative district of sub-divisional office of a railway, and not employed in any such capacity as is specified in Schedule II, of the Act, 1923, or

(*ii*) employed, either by way of manual labour or on monthly wages not exceeding three hundred rupees, in any such capacity as is specified in Schedule II of the Act, 1920, whether the contract of employment was made before or after the passing of this Act and whether such contract is expressed or implied, oral or in writing; but does not include any person working in the capacity of a member of His Majesty's naval, military or air forces or of the Royal Indian Marine Service; of any reference to a workman who has been injured shall, where the workman is dead, include a reference to his dependants or any of them.

## Employer's Liability of Compensation

If a personal injury is caused to a workman by accident arising out of and in the course of his employment, his employer shall be liable to pay compensation as described hereunder.

(1) Provided that the employer shall not be so liable—

(*a*) in respect of any injury which does not result in the total or partial disablement of the workman for a period exceeding ten days:

(*b*) in respect of any injury to a workman resulting from an accident which is directly attributable to—

(*i*) the workman having been at the time thereof under the influence of drink or drugs, or (*ii*) the wilful disobedience of the workman to an order expressly given, or to a rule expressly framed, for the purpose of securing the safety of workmen, or

(*iii*) the wilful removal or disregard by the workman or any safety guard or other device which he knew to have been provided for the purpose of securing the safety of workmen ; or

(*iv*) except in the case of death or permanent total disablement, in respect of any workman employed in the construction, repair or demolition of a building or bridge.

(2) If a workman employed in any employment involving the handling of wool, hair, bristles, hides, or skins contracts the disease of anthrax, or if a workman, whilst in the service of an employer in whose service he has been employed for a continuous period of not less than six months in any employment specified in Schedule III, contracts any disease specified therein as an occupational disease peculiar to that employment, the contracting of the disease shall be deemed to be an injury by accident within the meaning of this section and, unless the employer proves the contrary, the accident shall be deemed to have arisen out of, and in the course of, the employment.

*Explanation* :—For the purpose of this sub-section a period of service shall be deemed to be continuous which has not included a period of service under any other employer.

(3) The Governor-General-in-Council, after giving, by notification in the Gazette of India, not less than three months' notice of his intention so to do, may, by a like notification, add any description of employment to the employments specified in Schedule III, and shall specify in the case of the employment so added the diseases which shall be deemed for the purposes of this section to be occupational diseases peculiar to those employments, respectively, and the provisions of sub-section (2) shall thereupon apply as if such diseases had been declared by this Act to be occupational diseases peculiar to those employments.

(4) Same as provided by sub-sections (2) and (3), no compensation shall be payable to a workman in respect of any disease unless the disease is solely and directly attributable to a specific injury by accident arising out of, and in the course of, his employment.

(5) Nothing herein contained shall be deemed to confer any right to compensation on a workman in respect of any injury, if he has instituted in a Civil Court a suit for damage in respect of the injury against the employer or any other person, and no suit for damages shall be maintainable by a workman in any Court of law in respect of any injury—

(*a*) if he has instituted a claim to compensation in respect of the injury before a Commissioner ; or

(*b*) if an agreement has been come to, between the workman and his employer, providing for the payment of compensation in respect of the injury in accordance with the provisions of this Act.

**Amount of compensation** (*A*) *where death results from the injury*—

(*i*) in the case of an adult, a sum equal to thirty months' wages or two thousand five hundred rupees, whichever is less ; and

(*ii*) in the case of a minor, two hundred rupees ;

(*B*). *Where permanent total disablement results from the injury*—

(*i*) in the case of an adult, a sum equal to forty-two months' wages or three thousand five hundred rupees, whichever is less, and

(*ii*) in the case of a minor, a sum equal to eighty-four months' wages or three thousand five hundred rupees, whichever is less ;

(*C*). *Where permanent partial disablement results from the injury*—

(*i*) in the case of an injury specified in Schedule I, such percentage of the compensation which would have been payable in the case of permanent total disablement as is specified therein as being the percentage of the loss of earning capacity caused by that injury ; and

(*ii*) in the case of an injury not specified in Schedule I, such percentage of the compensation payable in the case of permanent total disablement as is proportionate to the loss of earning capacity permanently caused by the injury ;

*Explanation.*—Where more injuries than one are caused by the same accident, the amount of compensation payable under this head shall be aggregated but not so in any case as to exceed the amount which would have been payable if permanent total disablement had resulted from the injuries.

(*D*). *Where temporary disablement, whether total or partial results from the injury*, a half-monthly payment payable on the sixteenth day after the expiry of a waiting period of ten days from the date of the disablement, and thereafter half-monthly during the disablement or during a period of five years, whichever period is shorter,—

(*i*) in the case of an adult, a sum of fifteen rupees or a sum equal to one-fourth of his monthly wages, whichever is less, and

(*ii*) in the case of a minor, of a sum equal to one-third, or, after he has attained the age of fifteen years, to one-half of his monthly wages, but not exceeding in any case fifteen rupees.

Provided that there shall be deducted from any lump sum, or any payment to which the workman is entitled, the amount of any payment or allowance which the workman has received from the employer by way of compensation during the period of disablement prior to the receipt of such lump sum or of the first half-monthly payment, as the case may be, and no half-monthly payment shall, in any case, exceed the amount, if any, by which half the amount of the monthly wages of the workman before the accident exceeds half the amount of such wages he is earning after the accident.

On the ceasing of the disablement before the date on which any half-monthly payment falls due, there shall be payable in respect of that half-month a sum proportionate to the duration of the disablement in that half-month.

**Method of calculating wages :**—(*a*) Where the workman has, during a continuous period of not less than twelve months immediately preceding the accident, been in the service of the employer who is liable to pay compensation, the monthly wages of the workman shall be one-twelfth of the total wages which have fallen due for payment to him by the employer in the last twelve months of that period.

(*b*) In other cases, the monthly wages shall be thirty times the total wages earned in respect of the last continuous period of service immediately preceding the accident from the employer, who is liable to pay compensation, divided by the number of days comprising such period.

Provided that the sum arrived at by a calculation under clause (*a*) or clause (*b*) shall be increased or decreased, as the case may be.

*Explanation* :—A period of service shall, for the purposes of this section, be deemed to be continuous which has not been interrupted by a period of absence from work exceeding fourteen days.

**Distribution of compensation :**—(1) Compensation payable in respect of a workman whose injury has resulted in death shall be deposited with the Commissioner and any sum so deposited shall be apportioned among the dependants of the deceased workman or any of them in such proportion as the Commissioner thinks fit, or may, in the discretion of the Commissioner, be allotted to any one of such dependants, and the sum so allotted to any dependant shall be paid to him, or, if he is a person under any legal disability, be invested, applied or otherwise dealt with for his benefit during such disability in such manner as the Commissioner thinks fit.

(2) Any other compensation payable under this Act may be deposited with the Commissioner and, when so deposited, shall be paid by the Commissioner to the person entitled thereto.

(3) The receipt of the Commissioner shall be a sufficient discharge in respect of any amount deposited with him under sub-section (1) or sub-section (2).

(4) On the deposit of any money under sub-section (1), the Commissioner may deduct therefrom the actual cost of the workman's funeral expenses, to an amount not exceeding fifty rupees and pay the same to the person by whom such expenses were incurred, and shall, if he thinks necessary, cause notice to be published or to be served on each dependant in such manner as he thinks fit, calling upon the dependants to appear before him on such date as he may fix for determining the distribution of the compensation. If the Commissioner is satisfied, after any inquiry which he may deem necessary, that no dependant exists, he shall repay the balance of the money to the employer by whom it was paid. The Commissioner shall, on application by the employer, furnish a statement showing in detail all disbursements made.

(5) Where a half-monthly payment is payable under this Act to a person under any legal disability, the Commissioner may, of his own motion or on application made to him in this behalf, order that the half-monthly payment be paid during the disability to any dependant of the workman or to any other person whom he thinks best fitted to provide for the welfare of the workman.

(6) Where, on application made to him in this behalf or otherwise, the Commissioner is satisfied that, on account of neglect of children on the part of a parent or on account of the variation of the circumstances of any dependant or for any other sufficient cause, an order of the Commissioner as to the distribution of any sum paid as compensation or as to the manner in which any sum payable to any such dependant is to be invested, applied or otherwise dealt with, ought to be varied, the Commissioner may make such orders for the variation of the

former order as he thinks just in the circumstances of the case:

Provided that no such order prejudicial to any person shall be made unless such person has been given an opportunity of showing cause why the order should not be made, or shall be made in any case in which it would involve the repayment by a dependant of any sum already paid to him.

**Notice and claim**:—(1) No proceedings for the recovery of compensation shall be maintainable before a Commissioner, unless notice of the accident has been given, in the manner hereinafter provided, as soon as practicable after the happening thereof and before the workman has voluntarily left the employment in which he was injured, and unless the claim for compensation with respect to such accident has been instituted within six months of the occurrence of the accident or, in case of death, within six months from the date of death.

Provided that, where the accident is the contracting of a disease in respect of which the provisions of sub-section (2) of section (3) are applicable, the accident shall be deemed to have occurred on the first of the days during which the workman was continuously absent from work in consequence of the disablement caused by the disease.

Provided, further, that the Commissioner may admit and decide any claim to compensation in any case notwithstanding that the notice has not been given, or the claim has not been instituted, in due time as provided in this sub-section, if he is satisfied that the failure so to give the notice or institute the claim, as the case may be, was due to sufficient cause.

(2) Every such notice shall give the name and address of the person injured and shall state in ordinary language the cause of the injury and the date on which the accident happened, and shall be served on the employer or upon any one or several employers, or upon any person directly responsible to the employer for the management of any branch of the trade or business in which the injured workman was employed.

(3) That notice may be served by delivering the same at, or sending it by registered post addressed to, the residence or any office or place of business of the person on whom it is to be served.

## SCHEDULE I.

*List of injuries deemed to result in permanent partial disablement.*

| Injury. | Percentage of loss of earning capacity. |
|---|---|
| Loss of right arm above or at the elbow ... | 70 |
| Loss of left arm above or at the elbow ... | 60 |
| Loss of right arm below the elbow ... | 60 |
| Loss of leg at or above the knee ... | 60 |
| Loss of left arm below the elbow ... | 50 |
| Loss of leg below the knee ... ... | 50 |
| Permanent total loss of hearing ... | 50 |
| Loss of one eye ... | 30 |
| Loss of thumb ... ... | 25 |
| Loss of all toes of one foot ... ... | 20 |
| Loss of one phalanx of thumb ... | 10 |
| Loss of index finger ... ... | 10 |
| Loss of great toe ... ... | 10 |
| Loss of any finger other than index finger | 5 |

## SCHEDULE II.

*List of Occupational Diseases.*

| *Occupational Disease.* | *Employment.* |
|---|---|
| Lead poisoning or its sequelæ. | Any process involving the use of lead or its preparations or compounds. |
| Phosphorus poisoning or its sequelæ. | Any process involving the use of phosphorus or its preparations or compounds. |

## Maxims of Equity

(1) *There is no wrong without a remedy.*—"Ubi Jus, ibi remedium." This is the foundation of equity jurisprudence; it means that equity will not, by reason of a mere technical defect, let a wrong go without a remedy.

(2) *He who seeks equity must do equity.*—That is, a person seeking the assistance of a court of equity must be prepared to do equity.

(3) *He who comes to equity must come with clean hands.*—It means that a person seeking the aid of equity must not have been guilty of fraud or gross negligence.

(4) *Where equities are equal, law will prevail.*—This means that where the defendant and the plaintiff are both equally entitled to the protection of equity, and on no equitable grounds can one be preferred to the other, equity will do nothing and let the legal title have the day.

(5) "*The prior in time the prior in title.*"—"Qui prior est tempore, potior in jure est." This means that where the equities of the two parties are absolutely equal and there is no other ground on which one may be preferred to the other, then will priority in the time give the better title.

(6) *Delay defeats equity.*—That is, a party must not sleep over his rights. He must file his suit or petition for equitable relief within the period prescribed by the law of limitations.

(7) "*Equity is equality*" or "*Equity delights in equality.*" That is, a court of equity will, where it can, put the parties to a transaction on the same equality, although the strict rules of common law may give one party an advantage over the other

(8) *Equity follows the law.*—For instance, it adheres strictly to the rules of descent or inheritance, and to the rules of limitation.

(9) *Equity looks to the intention and not to the form*—The intention of the parties guides a court of equity

and not the exact words in which they express that intention. Therefore, equity relieves against forfeitures and penalties.

(10) *Equity regards that as done which ought to have been done.*—That is, if a contract or an obligation is to be performed on a particular date and it is not, equity regards the contract or obligation to have been performed on the particular date, so far as the rights of parties interested in the contract or obligation is concerned.

(11) *Equity imputes an intention to fulfil an obligation.*—That is, a party is under an obligation to do a certain thing and does something like it without expressly appropriating the thing done to his obligation, equity thinks that the thing was done in fulfilment of the obligation.

(12) *Equity acts in personam, i.e.*, Equity enforces its behests by acting on the conscience of the person who is charged therewith. Though the property in dispute may be out of the jurisdiction of the court, equity will compel the defendant to carry out the decree of the court by constraining his person or seizing his property within the jurisdiction.

## CHAPTER XXXII

# LABOUR AND THE INDUSTRIAL REVOLUTION

BY labour is to be understood the Sudra caste generally, and by the Industrial Revolution that period of the history of Europe and America during which the Sudras have ceased to be, for the greater part, independent workmen buying their own raw material and selling their produce themselves at the nearest market town or *hat*, and have become employees depending on capitalist employers for the costly apparatus of modern manufacture. This change over is now all but complete in Western countries and is being sectionally introduced in India, where there are abundant opportunities for observing both ends of the process. Compare, for instance, the cotton weaving industry in Bihar and Orissa with the cotton Mills in Bombay.

Opinion is divided as to whether the change should be regarded as for the better or for the worse, and no decision on that point will be attempted here. There are very strong arguments on both sides—incontrovertible arguments, in fact—showing that it is both progressive and retrogressive. In this chapter we will attempt to distinguish the good effects from the bad. We shall not attempt to decide whether or not it is possible to so control the Industrial Revolution in India that the good features are preserved and the bad ones eliminated; or supposing that it is not, whether or not the balance is such that it should be allowed to take its natural course, or should be altogether suppressed.

It will be the fate of the young readers of this book to hear all these diverse and opposed opinions passionately expressed during all their active lives. It will be their duty to accept none of them without full knowledge of all the relevant facts; but also, of course, as citizens not to neglect any opportunity of acquiring such knowledge. The search for it will lead them in many unanticipated directions. They have the advantage of being able to make an historical retrospective survey which was not available in the West, but, on the other hand, in doing this must never forget that, after all, industry is a means to an end and not an end in itself, as many uselessly busy people assume. In the West that end has been, in general, material satisfaction ; but as will presently be apparent there are other possible ends, which might appeal more to the Eastern mind. A more effective organisation of industry, which produces more wealth for every workman's hour of labour may be used either to increase wealth or to increase leisure or both, as it has been in fact in the West. Unfortunately, the right use of leisure is little understood in Europe and America. The Western peoples are neither philosophic nor contemplative and leisure accruing from the Industrial revolution takes the accursed form of great numbers of people unemployed, wretched, and altogether bewildered in the midst of an enormous over-production.

The factors of the Industrial Revolution in Europe, in the order in which they have appeared, are :—

(1) The advent of power-driven machinery, replacing hand tools and such simple machines as the loom actuated by the weaver himself instead of by an engine.
(2) Progressive money or credit inflation. This is always going on.
(3) The Limited Liability Company Acts (about 1850).
(4) Universal Compulsory Primary Education (1870).
(5) The break-down of caste.
(6) The rise of Democratic Government.

Some of these, notably (5) and (6), cannot be exactly dated. The order in their cases is rather the order in which they became important and effective. Numbers (5) and (6) depend, for their effectiveness, on (4), and are only formal until that is achieved. If we had chosen to place these factors in the order of their ultimate importance rather than chronologically, (3) would have replaced

(2) and (2) would have been last. Inflation largely automatic and unconscious is " An old way to pay old debts " which has always been popular and is not entirely restricted to the period under consideration. Its effect on the employed class is, however, too important to be altogether neglected.

We will now consider, in turn, the effects of each of the factors tabulated above.

**Power-driven machinery** :—The first result of its introduction is a very great increase of the output of each worker—something of the order of ten times as much as he could produce by means of his primitive apparatus This is immediate consumption following slowly and after an interval. In a self-contained country it cannot follow pro-rata unless the wages of the people are increased in the same proportion, or, conversely, prices are lowered; actually both methods have been adopted, but (as must be clear) since there is a strong vested interest against them both, the process has been more or less effectively disguised by inflation. On the one hand, nominal wages have been increased, but the value of money has been decreased so that the increase of wages is not as great as it appears to be at first sight. As this process (owing to international commerce) has been reflected to India also, the reader may realise its nature by asking his oldest family member two questions :—

(*a*) How many rupees a month did an average workman make in the days of your youth ?

(*b*) How many seers of rice or yards of cloth would a rupee then buy ?

In spite of these devices *consumption tends to lag behind production*, because :—

(1) It is not at once that a people accustomed to make one cloth last year will bring themselves to buy ten, or be educated to consider certain other things necessary, which they had formerly regarded as luxuries.

(2) In some cases an employer replacing primitive apparatus by power-driven machinery will increase his total output without decreasing the number of his workmen, but in others he will continue the same output with fewer workmen. This is called "labour saving," but a reduction in the number of workmen is a reduction of consuming power.

In the early days of the Industrial Revolution in the West, though there were some riots, especially among weavers owing to reductions in the number of workmen, most employers were able to adopt the increased production method because the market for surplus production was found abroad. In these days, however, there is a back wash. The improved methods have spread or are rapidly spreading and foreign countries are supplying their own markets. Employers in the countries, where the Industrial Revolution started, are being driven, as apparatus is improved and made still more productive, against a market which has ceased to expand, to rather employ fewer men than to increase production. But this is an impossible policy that can end only in disaster (has so ended in fact), the discharged men being the ultimate and only possible customers where foreign markets are closed either by competitive production or tarifs designed to encourage such competitive production. This is the genesis of the serious unemployment at present prevailing in Europe and America. It is probably only a temporary phase such as has occurred before and will, no doubt, occur again. Consumption lags behind production, but it does follow, and the desires of mankind being insatiable, there is no ultimate limit to it. Luxuries unimaginable by one generation, *e g.*, railways, motor cars, wireless receiving sets, and aeroplanes, are regarded as indispensable necessities by the next. Nor are any of these "luxuries" for long confined to the rich. There are now many poor people in India even, who regard railways as necessary, and very few working class families in America who have not both a motor car and a radio set.

Thus, on the whole, it may be said in favour of the introduction of mechanical power, that it does, in general, raise the standard of living of the labourer and provides him with more leisure; but against it, that the leisure is, as a rule, divorced from the increased remuneration that would enable him to make use of it. At one time he is employed for the whole day, and often at night as well, and has no time to enjoy rationally the comparatively large wage he is receiving, and at another he is altogether unemployed and on the verge of starvation. The problem of how to wisely distribute the advantages made possible by the inventions of the engineer is a problem as yet only partially solved. Not many, but some things have been done to make the development smooth and continuous, some having that effect though not that intention and some being deliberate. In the former class education is compulsory, which incidentally withdraws large numbers of young people from the labour market and enlarges their conception of what a full life ought to be, and in the latter unemployment insurance, which taxes the labourer at the peak of the Trade Cycle, and endows him in the trough.

Before leaving this part of the subject, we must notice another tendency which has always been present, but which has been greatly accelerated by the advent of the Heat Engine. This is the replacement of the manual skill and empiric technique, which nearly every member of the Sudra caste formerly possessed, by scientific method and scientific technology, which is now the monopoly of a numerically small segregation from it. This segregation is composed of the engineer, the chemist, and other expert directors of industry who can, no longer, be adequately described as "Sudra" or "labour." The modern labourer, properly so called, tends more and more to be unskilled, working a "fool proof" machine engaged in a process which is (to its operator) a meaningless part of a larger synthesis. This is one of the most evil results of the Industrial Revolution.

It would, perhaps, be difficult to convince one who had not carefully considered both processes that the aboriginal of Chota Nagpur expends more skill and knowledge on his bow and arrow than do any of the workmen engaged in the manufacture of modern fire-arms on their shares of the work ; but such is, indeed, the case. The tendency is of agelong standing and probably inherent in, and indispensable to, human progress. The rifle is, after all, a much more efficient weapon than the bow and arrow, just as the safety match is more efficient than rubbing two sticks together to produce fire. And on the subjective side it must be said that the worker who knows that his manhood depends absolutely on his co-operation with other men is much nearer ultimate truth than he, who having made his own weapon or tool entirely by himself and used it for its designed purpose, thinks it possible to be fully a man alone, and self-sufficient. It is not.

Nevertheless, the social problem of how to prevent the decay of skill and intelligence among the working class calls louder and louder for solution Having drawn attention to it, we will leave it with the remark that sport and games of skill do not constitute a satisfactory solution. They are better than nothing, but not much better.

**The Limited Liability Company Acts :**—Though, in general, the workers along primitive lines in India are independent workers, there are a few examples of associations essentially the same in their nature as the old "guilds" of Europe. The nature of a guild is this :—

From the master craftsman down to the youngest apprentice, all the members are of the same caste. The youngest apprentice may aspire to become a master craftsman himself. In Europe if he could secure at once the favour of the master and the master's daughter (a somewhat difficult manœuvre, as these two deities have very different ideas as to what constitutes a satisfactory man), he might make sure of doing so while still young.

The primitive guild or factory is thus essentially a patriarchial institution. The master, being of the same caste with a more or less direct blood relation with his workmen, could not be an oppressive or unsympathetic master except in very rare instances.

This state of affairs for reasons too numerous and complex to be analysed here was already passing away in Europe in the Elizabethan (Akbar) period, but a traditional semipatriarchial relation between employer and employed persisted until well into the nineteenth century. Limited liability was its death blow.

The steps in the separation of manufactures into two different social classes, employee and employer, are :—

(1) It was not possible for the individual workman to provide long term finance for foreign trade or seasonal fluctuations in demand. This is what takes us back to Elizabeth's time.

(2) The coming of the Heat Engine, which was too costly for the small man to purchase himself. It is, at this stage, that the Industrial Revolution is said to begin.

(3) Limited Liability. (In effect one of the greatest and most successful advances in the direction of state socialism that has ever been made and exhibiting very clearly both its defects and advantages).

So long as liability was unlimited, the employer was bound to keep a keen watch on his business or else run a very serious risk of complete ruin. He perforce remained in close touch with his employees. There might be contentions between the two classes, but misunderstandings were unlikely.

It was not for long found possible, however, to finance the huge expansion in the use of mechanical power from the pockets of rich industrialists, even though these were being swollen by unprecedented profits. A method had to be found of tapping the savings of all classes. That method was Limited Liability. Its main feature has now been familiar to three generations and need not be recapitulated. We are concerned here, not so much with what it was meant to do, and most triumphantly did, but rather with its secondary unanticipated results. For that reason we have described it as socialistic in effect, the socialist and antisocialist being thus both enlisted in order to help us to realise both its good and evil aspects.

The owners of a large modern business are numbered in thousand. Not many of them are vitally concerned with it. If it fails, they will lose that portion of their savings which they have invested in it, probably (if they were wise) quite a small proportion, and if it is very successful, they will sell their shares at a profit and proceed to other gambles of a similar nature. They may know whether their employees are men or women, or they may not. It is, on the whole, unlikely that they trouble much as to whether these workmen are being justly treated, or brutally oppressed, or pampered. On reflection the reader will perceive that this relation is not very different from the relation between the tax-payer and such a socialised enterprise as (say) the post office or the road system. It grows more alike as time proceeds. In these days and in those countries where the development has matured, many, even of the employees, are also shareholders though not necessarily or even probably in the same business. This is the main reason why certain attempts to incite the underdog to attack and despoil the topdog, which will be fresh in the readers' memory, have been such fiascoes—notably the attempted general strike in England in 1926. Those who hoped or feared that it might succeed had omitted to notice that the two dogs were in reality only one dog. Also.—

**Universal compulsory education**:— Simultaneously with the dispersion downward, and dilution of ownership and the consequent breach of direct personal contact between employer and employed, the latter has been made articulate and been given votes in proportion to his numbers The contact which was broken in the workshops has been reconstituted in the legislature where the representatives of labour and capital meet on equal terms. The same thing is happening there that formerly happened in the workshop. Even where interests are antagonistic, the result of intimate personal contact is always a more or less friendly compromise. So long as the shareholder does not know whether his employees are men or women, it is possible for him to believe that they are utterly lazy and utterly dishonest with no ambition but to get excessive wages for as little work as possible. Conversely, the employee's mental picture of his employer is of a fat hog inspired by nothing but insatiable greed, already immensely rich and ruthlessly determined to become still richer, no matter at what cost to his workmen

All deadly quarrels between individuals, all wars, all truceless enmities between classes or between nations are based on the root fallacy, that the species of mankind are not one but many As soon as it occurs to one or both of the protagonists to make an open-minded unprejudiced investigation, the end of the trouble is in sight. Exchange of letters or other indirect communications are useless. LOOK CLOSELY AT THE FACE OF YOUR ENEMY, AND YOU WILL ALWAYS RECOGNISE YOUR BROTHER.

Unfortunately, we are often reluctant to do this ; thorough going hatred of something or some one assumed to be thoroughly hateful, being rather enjoyable like many other vices. However, contact between labour and capital being now re-established, as described above. there is every hope that a new equilibrium will, in due course, supervene, rather by progressive ameliorative modification of existing institutions than by violent revolution which could only mean beginning all over again.

**Caste** :—The clouds, the river and the seas remain apparently as they always were separate and distinct, but the same water flows through them all. So it is now tending more and more to be with castes in the West. For ages they were in fact as separate as they appeared to be, and still appear to be. There are still classes corresponding to the old castes. But in these days and in the West individual families are everywhere passing in the course of two or three generations throughout the whole range, some from the top to the bottom and others from the lowest to the highest. In comparing Western with Eastern conditions, this difference should never be forgotten, as it is a very important difference. Though superficially the class distinctions are much the same, there is now beginning to be a blood relation that did not exist before, and this blood relation implies a psychological interlocking of the classes which has a growing influence on the course of events.

We must, on this account, not expect an immediate setting up in the East of institutions in every respect the same as those in the West. Even if public opinion here should, by some miracle, come unanimously to regard such a change as desirable, some generations would still be required for its consummation.

The principal argument for *Democratic Government* (for that is what it comes to) is that it makes for national solidarity. The principal argument against it is that it commits the national fortunes to the direction of the average man, who is never so able as a ruler or a ruling caste, sufficiently able to elect itself to power. An analysis of history from the times of the Romam dictators to the present day will show that, in general, the democratic theory has worked out sufficiently well in times of peace, but has frequently failed in war or other crises demanding swift and unhesitating action.

**Inflation and deflation** :—This is a difficult matter to analyse and control, being, as it is, an unique combination of physical and psychological elements. The PRICES OF EVERY THING ON THE MARKET DEPEND ON THREE FACTORS, SUPPLY, DEMAND, and THE QUANTITY OF MONEY IN CIRCULATION, but the last INCLUDES CREDIT, and credit is, for all practical purposes, merely confidence in continuing and increasing prosperity.

When the Industrial Revolution was in its glory, say, roughly from 1840 to 1890, it was accompanied by a great expansion of credit principally in the forms of Bills of Exchange and Cheques based on bank loans. But depending, as it did, principally on confidence, it was subject to sudden and violent contractions, some times due to mere bazzar rumour and sometimes (more often, perhaps) to some event showing clearly that all this paper wealth was based on a future, that, after all, might never materialise.

These changes in the purchasing power of money, whether in the direction of inflation (increase of credit) or deflation (decrease of credit) have very greatly increased the social unrest inherent in the Industrial Revolution; for the following reasons:—

A period of rising prices is generally regarded by the business community as a period of prosperity (it is, in fact, a result of prosperity). But no employer hastens to increase wages simply because he is prospering. Rather, he employs more men at the same wage. These men, however, have to pay the increased prices for what they need as every one else has. Accordingly, such periods of strikes for higher wages which employers regard as a mean attempt to take advantage of an enterprise and resulting prosperity to which the strikers have contributed nothing, but which are often, in fact, a strike against a fall in real wages, rather than an attempt to increase them.

A time of falling prices is much worse. No one is benefited The employer finds that in the period between the purchase of raw material and sale of the finished product his estimated profit has either vanished or become an actual loss Accordingly, he restricts his operations and discharges workmen. But, as has already been noted, this is like trying to cure a headache by cutting one's throat. It does not help the employer to regain his prosperity, and it is, of course, to ruin the discharged workmen. It is to this reductio ad absurdum that the whole world has come to-day (1932). The whole world is involved, because credit, unlike other forms of money, is largely an international creation, which can only be internationally controlled. However, the problem is much better understood now than it has ever been before, and it seems a reasonable hope that the worst difficulties inherent in the Industrial Revolution have been overcome. The principal danger was of a plutocracy reigning over an ignorant depressed working class, but that danger vanished in 1870 with the coming of universal free education. That would have meant complete disaster, as a plutocracy never survives for long in competition with other nations; witness the fates of Phoenicia, of Carthage, of Venice, and of many others of the same nature.

## CHAPTER XXXIII

## LABOUR, SKILL AND CAPITAL

WE have hitherto considered the economics of engineering almost entirely from the engineer's point of view. In this, the final chapter, we purpose reconsidering the subject from the more general standpoint of the Indian citizen.

We do not think it possible that India will ever become as completely industrialised as Great Britain is, but there is little doubt that she is fated during the next two or three generations to traverse a good deal of the ground traversed by Great Britain during the time that has elapsed since the reign of Henry VIII.

He would be a good friend of India who would make a careful study of social conditions in England from Tudor times to the present day with the object of exhibiting to Indian statesmen where in the transition, first to commercialism and then to commercial industrialism made for a general increase in the general welfare, and wherein it did not.

The period of European history between 1453 and 1600 is commonly described by its historians as the "renaissance" (rebirth), because it saw a great quickening of intellectual activity among the literate classes, which is generally agreed to have been the result of the superposition of the Pagan and materialistic Greek learning upon the simple Catholicism of the middle ages. It is this intellectual revival, and the resulting political developments that occupy the pages of history and obscure the equally important fact that for the common people the renaissance period was one of cumulative disaster from the destruction of the guilds similar to, but not so rigid as the Indian workers' castes to the arrival of the Trade Union, which is a thing of yesterday.

In the year 1492 America was discovered, and one of the principal results during the following two centuries was a great inflation of European currencies by American gold. Spain and England, up to the reign of Elizabeth, imported little except treasure from the new world.

Now, while we are not among those who would draw exact parallels between Occidental and Oriental history, we venture to suggest that India is, in many ways, at this present moment, repeating something very like the renaissance at an accelerated pace. The philosophy of the West is, like the Greek and Roman from which it derives, essentially intellectual and materialistic, whereas the values to which the ancient Indian culture attaches most importance, are essentially spiritual as were those of the mediæval church in Europe. And though India suffered no influx of American gold (probably, on the contrary, she made a substantial contribution to the European gold inflation), she has suffered and is suffering a great increase of manufactured credit which has, as we have seen, the same results. A period of progressive inflation does little good to any class; but for the servile class it is an unmitigated curse, as their wage always lags behind the rising tide of prices.

"Ill fares the land, to hastening ills a prey,
Where wealth accumulates and men decay."

The poet means riches, of course, not wealth. The men of a nation *are* its wealth.

The correspondence between the mediæval guilds of Europe and the occupational castes of India is sufficiently close to make his familiarity with the latter a useful help to the Indian student in his efforts to understand the former. The zealous reformer of India, who has no doubt that the caste system is entirely evil, especially, would learn a good deal that would surprise him if he made even a superficial study of what followed upon the virtual destruction of the guilds under Henry VIII. It is not to be lightly forgotten that any system that lasts for centuries must have, at least, the merit of being a workable system. It is, no doubt, unfortunate that a large section of any community, such as a guild or caste, should be so rigidly confined within its own limits that an able man born within it and capable of rendering great service to, or even of leading the nation, should be prevented from doing so. But such births are very rare, especially if there is no marrying out of the caste.

On the other hand, the proposition that all men can, and ought to, be equal and equally free is one of the most insulting lies ever invented by unscrupulous politicians to flatter and mislead their ignorant dupes. A man can be free only to exert such capacity as he inherits and it has so far pleased the Creator to send few men with great power and many men fitted only to serve them. The servile caste or any other caste cannot be abolished as long as the laws of heredity persist. It can only be disorganised and made more easily the victim of its oppressors. The guildsman knew his work, and took a pride in it. It was he, far more than the King, who, by his unity, broke the tyrannous power of the Feudal System. Like that punkhawalla, who boasted that his primeval ancestor was a god who pulled a punkha for Indra, his work was his religion, and he rightly regarded his inherited abilities as in effect a mandate of his Creator, and the careful fulfilment of that command as the only honourable mode of existence.

यतः प्रवृत्तिर्भूतानां येन सर्वमिदं ततम् ।
स्वकर्मणा तमभ्यर्च्य सिद्धिं विन्दति मानवः ॥

४६।१८। गीता

The working class of the West remained unorganised and destitute of effective political power from the passing of the guild until the appearance of the Trade Union in the second half of the nineteenth century. The Trade Union differs from the guild or caste as follows :—

It is not conceived as being in any way hereditary. Until the arrival of Mass Production it was recruited by a system of apprenticeship copied from the guilds.

It is much more aggressive politically. It aims at the supreme power in the State and for some months during the year 1924 there was a labour government of the British Empire.

The master workman was a member of the guild, but the modern Employers' Federation is an organisation entirely separate from, and usually hostile to, the Trade Union.

Finally, a further segregation of capital and directing ability has followed upon the invention of the Limited Liability Company. The owner or capitalist is now, or is now tending to be, a financier with little or no technical knowledge. It is he whose organisation is the Employers' Federation. Technical ability is organised in such societies as the Institutions of Civil, Mechanical, and Electrical Engineering—the so-called "Technical Societies". The technical societies are not so much hostile to the Employers' Federation and the Trade Union, both of which are merely endeavouring to get as large a share of the profits of industry as possible as they are indifferent to them.

We do not think that India will succeed in retracing her steps, as an influential section of Indian opinion thinks she ought to do. We would rather suggest the careful study of Western institutions and of their history in a spirit of healthy scepticism following neither those who would accept the conquest of material nature as conclusive evidence that those institutions are faultless, nor those who would condemn them utterly because of their spiritual sterility. The immense possibilities of human betterment inherent in the application of science to human affairs is a thing amply demonstrated which no people can afford to ignore.

At the same time it is quite easy to make out a plausible case for the suggestion that the pre renaissance peasantry enjoyed a greater measure of real independence and liberty than does the mass production worker of these days, and was, in many ways, a more cultured class. And much the same may be said of the Indian ryot Ability to read and write is, by no means, the whole of culture, and an engineer should need no convincing of the fact. Literateness alone is the mere phantom of culture. ESSENTIAL CULTURE is the skill to provide for some universal human need The class which possesses such skill will always enjoy a considerable measure of independence and self-respect, no matter under what social system it has its being. It is good to know, but it is better to be able. Best of all is to use knowledge as the basis of increased power to satisfy the legitimate aspirations of all classes of mankind. Both the West and the East have so far failed in this. In the East knowledge has been the monopoly of a class that has failed to apply it to practical ends. Of the West, on the other hand, it must be said that though knowledge is available to almost every man to the limit of his ability, and that it has been largely applied to the increase of wealth, yet utter carelessness has left the servile class to a large extent homeless on the roads of an indifferent world, which has less and less use for it. The Indian ryot may be robbed of a large proportion of the fruits of his labour, but he is indispensable to the Nation's continued existence. He can stand upright in the consciousness that he is the Nation's bread winner.

It is far otherwise with the factory worker. It is no doubt true that he can read and write, that he can choose his own rulers, and that the community will, in the last resort, preserve him from absolute starvation. These are great advantages and every well-wisher of India must desire the same for our own people. But we are not prepared to pay for them with the sacrifice of what we already enjoy. We do not think it necessary or desirable that large numbers of workmen should be idle and helpless during trade depressions that sometimes last for years We do not consider it a matter of indifference that large numbers of shareholders of a great industry should know nothing of that industry, nor of those who work in it, and that their influence on it should be solely exerted to increase dividends. Nor could we rest satisfied with an industrial development that at every step makes large numbers of workers unnecessary to the community. It is not enough that they are preserved from starvation if at the same time they are robbed of that self-respect that comes only from effective co-operation in the world's work. And finally, though, as we have indicated, Mass Production methods are commercially and scientifically immeasurably superior to pre-existing methods, we consider that the price is too high if it means the reduction of the workers to mere automata.

This chapter has been re-written because it was at first a careful description of commercially successful Western organisations. For the reasons given above, however, we have decided that it is not our duty to represent these as models for exact imitation. Nor are we prepared to give any alternative on paper. No social or political problem ever has been or ever will be solved on paper. The problems inherent in the industrialisation or partial industrialisation of India will be solved by the generation at present in the schools by a process of trial and error. The Western learning is well worth having, but it contains perhaps as much of warning as of encouragement. It contains many things worthy of imitation and not a few to be avoided like the plague. Moreover, many Western writers and more Indians do not know which are which. So we come again to what we said in the preface; there is no substitute for thought. It has been our object throughout this book to arouse thought. We do not envisage our work as the providing of solutions. We see it rather as the clear formulation of a number of problems which our own generation has failed to solve, and at which we hope the new generation will be more successful. We, the old generation, would be glad to have our own successes, such as they were, appreciated, and it is possible that we have tended to magnify them. For that reason we conclude with the admonition: "Consider what we have said but take nothing for granted. Think for yourselves."

## Appendix to Chapter VII

The following are the transactions of Sree Ganesh, for the month of January, 1934. Enter into the proper books of prime entry, post to Ledger Accounts, and take out Trial Balance. Prepare Trading and Profit and Loss Account, and Balance Sheet.

| 1934 | | | Rs. | as. | p. |
|---|---|---|---|---|---|
| Jan. | 1. | Cash (capital) paid to Bank ... | 6,000 | 0 | 0 |
| | | Bought stationery for cash ... | 50 | 0 | 0 |
| ,, | 2. | Bought goods for cash ... | 2,000 | 0 | 0 |
| ,, | 3. | Bought postage stamps ... | 20 | 0 | 0 |
| ,, | 5. | Sold goods for cash ... | 1,000 | 0 | 0 |
| ,, | 6. | Bought office furniture from Radha Kant ... ... | 750 | 0 | 0 |
| ,, | 10. | Sold goods to Ram ... | 640 | 0 | 0 |
| ,, | 13. | Sold goods to Hari ... | 1,360 | 0 | 0 |
| ,, | 14. | Received cheque from Ram ... | 640 | 0 | 0 |
| ,, | 17. | Ram paid on account ... | 750 | 0 | 0 |
| ,, | 20. | Paid Radhakant ... | 750 | 0 | 0 |
| ,, | 21. | Bought goods from Kalicharan .. | 2,100 | 0 | 0 |
| ,, | 22. | Sold goods to Durga Das ... | 1,550 | 0 | 0 |
| ,, | 24. | Sold goods to Bhagwan Das ... | 600 | 0 | 0 |
| ,, | 28. | Received cash from Durga Das ... | 1,000 | 0 | 0 |
| | | Bought goods from Govinda ... | 620 | 0 | 0 |
| ,, | 29. | Received cash from Hari further on account ... ... | 250 | 0 | 0 |
| ,, | 30. | Paid Kalicharan on account ... | 1,100 | 0 | 0 |
| ,, | 31. | Paid salaries ... ... | 200 | 0 | 0 |
| | | Sree Ganesh drew for private use | 200 | 0 | 0 |
| | | Rent owing, not yet paid ... | 100 | 0 | 0 |

Stock on hand—Rs. 1,920.

*Fo. 1*

## Bought Day Book

| | | | Rs. | as. | p. |
|---|---|---|---|---|---|
| 1934 | | | | | |
| Jan. 21 ... | Kalicharan ... .. ... | 9 | 2,100 | 0 | 0 |
| Jan. 28 ... | Govinda ... ... ... | 10 | 620 | 0 | 0 |
| | | | 2,720 | 0 | 0 |
| | | | | Fo. 4. | |

*Fo. 1*

## Sales Day Book

| | | | Rs. | as. | p. |
|---|---|---|---|---|---|
| 1934 | | | | | |
| Jan. 10 ... | Ram ... ... ... | 11 | 640 | 0 | 0 |
| ,, 13 ... | Hari ... ... ... | 12 | 1,360 | 0 | 0 |
| ,, 22 ... | Durga Das ... ... ... | 13 | 1,550 | 0 | 0 |
| ,, 24 ... | Bhagwan Das ... ... ... | 14 | 600 | 0 | 0 |
| | | | 4,150 | 0 | 0 |
| | | | | Fo. 3 | |

*Fo. 1* **Journal**

| Date | Particulars | L.F. | Dr. Rs. | as. | p. | Cr. Rs. | as. | p. |
|---|---|---|---|---|---|---|---|---|
| 1934 | | | | | | | | |
| Jan. 6 ... | Office furniture ... ... | 7 | 750 | 0 | 0 | | | |
| | Radhakant ... ... | 15 | ... | | | 750 | 0 | 0 |
| | (Being office furniture bought this day) | | | | | | | |
| Jan. 31 ... | Rent ... ... | 8 | 100 | 0 | 0 | | | |
| | To landlord ... ... | 16 | ... | | | 100 | 0 | 0 |
| | (Being rent due not yet paid) | | | | | | | |

*Dr.* *Fo. 1* **Cash Book** *Cr.*

| 1934 | | | Rs. | as. | p. | 1929 | | | Rs. | as. | p. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Jan. 1 | To Sree Ganesh | — | | | | Jan. 1 | By Stationery... | 5 | 50 | 0 | 0 |
| | | 1 | 6,000 | 0 | 0 | ,, 2 | ,, Purchases ... | 4 | 2,000 | 0 | 0 |
| ,, 5 | ,, Sales ... | 3 | 1,000 | 0 | 0 | ,, 3 | ,, Postage Stamps | 5 | 20 | 0 | 0 |
| ,, 14 | ,, Ram ... | 11 | 640 | 0 | 0 | ,, 20 | ,, Radhakant ... | 15 | 750 | 0 | 0 |
| ,, 17 | ,, Hari ... | 12 | 750 | 0 | 0 | ,, 30 | ,, Kalicharan ... | 9 | 1,100 | 0 | 0 |
| ,, 28 | ,, Durgadas... | 13 | 1,000 | 0 | 0 | 31 | ,, Salaries ... | 6 | 200 | 0 | 0 |
| ,, 29 | ,, Hari ... | 12 | 250 | 0 | 0 | | ,, Sree Ganesh's drawings ... | 2 | 200 | 0 | 0 |
| | | | 9.640 | 0 | 0 | | ,, Balance ... | ✓ | 5.320 | 0 | 0 |
| Feb. 2 | To Balance ... | ✓ | 5,320 | 0 | 0 | | | | 9,640 | 0 | 0 |

*Dr.* *Fo.* 1 **Sree Ganesh Capital Account** *Cr.*

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | 1929 | | | Rs. as. p. |
| | | | | Jan. 1 | By Cash ... | C.B.I. | 6,000 0 0 |

*Dr.* *Fo.* 2 **Sree Ganesh Current Account** *Cr.*

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1929 | | | Rs as. p. | 1929 | | | Rs. as. p. |
| Jan. 31 | To Cash | C. B. I. | 200 0 0 | Jan. 31 | By P. & L. A/c Profit transferred | 18 | 1,980 0 0 |
| " 31 | " Balance c/down | | 1,780 0 0 | | | | |
| | | | 1,980 0 0 | | | | 1,980 0 0 |
| | | | | Feb. 2 | By Balance ... | | 1,780 0 0 |

*Dr.* *Fo.* *3* **Sales** *Cr.*

| 1929 | | | Rs. as. p. | 1929 | | | Rs. as. p. |
|---|---|---|---|---|---|---|---|
| Jan. 31 | To Trading Account... | 18 | 5,150 0 0 | Jan. 5 | By Cash ... | C.B.I. | 1,000 0 0 |
| | | | | ,, 31 | ,, Sundries | S.D.B.I | 4,150 0 0 |
| | | | 5,150 0 0 | | | | 5,150 0 0 |

*Dr.* *Fo.* *4* **Purchases** *Cr.*

| 1929 | | | Rs. as. p. | 1929 | | | Rs. as. p. |
|---|---|---|---|---|---|---|---|
| Jan. 2 | To Cash .. | C.B.I. | 2,000 0 0 | Jan. 31 | By Trading Account... | 18 | 4,720 0 0 |
| ,, 31 | ,, Sundries | B.D.B.I. | 2,720 0 0 | | | | |
| | | | 4,720 0 0 | | | | 4,720 0 0 |

*Dr.* *Fo.* 5

## Office Expenses

*Cr.*

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1929 | | | Rs. as. p. | 1929 | | | Rs. as. p. |
| Jan. 1 | To Cash— ,, Stationery | C.B I | 50 0 0 | Jan. 31 | By P. & L. A/c. | 18 | 70 0 0 |
| | ,, Postage Stamps . | C.B I | 20 0 0 | | | | |
| | | | 70 0 0 | | | | 70 0 0 |

*Dr.* *Fo.* 6

## Salaries

*Cr.*

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1929 | | | Rs. as p. | 1929 | | | Rs as. p. |
| Jan. 31 | To Cash .. | C.I.B. | 200 0 0 | Jan. 31 | By P. & L.A/c. | 18 | 200 0 0 |

*Dr.* *Fo.* 7

## Office Furniture

*Cr.*

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1929 | | | Rs as. p. | | | | |
| Jan. 6 | To Radha Kant ... | J. I. | 750 0 0 | | | | |

*Dr.* *Fo.* *8* **Rent** *Cr.*

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1929 Jan. 31 | To landlord | J. I | Rs as. p<br>100 0 0 | 1929 Jan. 31 | By P. & L. A/c. | 18 | Rs. as. p.<br>100 0 0 |

*Dr.* *Fo.* *9* **Kalicharan** *Cr.*

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1929 | | | Rs as. p. | 1929 | | | Rs. as. p. |
| Jan. 30 | To Cash ... | C. B. 1 | 1,100 0 0 | Jan. 21 | By Goods | B.D.B.I | 2,100 0 0 |
| Jan. 31 | To Balance | | 1,000 0 0 | | | | 2,100 0 0 |
| | | | 2,100 0 0 | Feb. 2 | By Balance | | 1,000 0 0 |

*Dr.* *Fo.* *10* **Govind** *Cr.*

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | 1929 Jan. 28 | By Goods | B.D.B.I | Rs as. p.<br>620 0 0 |

*Dr.* *Fo.* *11* **Ram** *Cr.*

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1929 | | | Rs. as. p. | 1929 | | | Rs. as. p. |
| Jan. 10 | To Goods | S.D.B.I. | 640 0 0 | Jan. 14 | By Cash | C. B I. | 640 0 0 |

*Dr.* *Fo.* *12* **Hari** *Cr.*

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1929 | | | Rs. as. p. | 1929 | | | Rs. as. p. |
| Jan. 13 | To Goods... | S.D.B I. | 1,360 0 0 | Jan. 17 | By Cash | C. B. I. | 750 0 0 |
| | | | | ,, 29 | ,, ,, | C. B. I | 250 0 0 |
| | | | | ,, 31 | ,, Balance | | 360 0 0 |
| | | | 1,360 0 0 | | | | 1,360 0 0 |
| Feb. 2 | To Balance | | 1,360 0 0 | | | | |

*Dr.* *Fo.* *13* **Durgadas** *Cr.*

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1929 | | | Rs. as. p. | 1929 | | | Rs. as. p. |
| Jan. 22 | To Goods··· | S D.B.I. | 1,550 0 0 | Jan. 28 | By Cash | C. B. I. | 1,000 0 0 |
| | | | 1,550 0 0 | ,, 31 | ,, Balance | | 550 0 0 |
| Feb. 2 | To Balance | | 550 0 0 | | | | 1,550 0 0 |

*Dr.* *Fo.* 14 **Bhagwandas** *Cr.*

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1929 Jan. 24 | To Goods... | S.D.B.I. | Rs. as. p. 600 0 0 | | | | |

*Dr.* *Fo.* 15 **Radhakant** *Cr.*

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1929 Jan. 20 | To Cash ... | C. B. I. | Rs. as p 750 0 0 | 1929 Jan. 6 | By office furniture. | J 1. | Rs. as. p. 750 0 0 |

*Dr.* *Fo.* 16 **Landlord** *Cr.*

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | 1929 Jan. 31 | By rent... | J. I. | Rs. as. p. 100 0 0 |

*Dr.* *Fo.* 17 **Stock Account** *Cr.*

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1929 Feb. 2 | To Trading A/c. | 18 | Rs as. p. 1,920 0 0 | | | | |

## Trial Balance

| | | Debit Balances. | | | Credit Balances. | | |
|---|---|---|---|---|---|---|---|
| | | Rs. | as. | p. | Rs. | as. | p. |
| C. B. J. | Cash ... ... ... ... | 5,320 | 0 | 0 | | | |
| L. 1 | Sree Ganesh Capital ... ... | ... | ... | ... | 6.000 | 0 | 0 |
| 2 | Sree Ganesh Current Account ... | 200 | 0 | 0 | | | |
| 3 | Sales ... ... ... | ... | ... | ... | 5,150 | 0 | 0 |
| 4 | Purchases ... ... ... | 4,720 | 0 | 0 | | | |
| 5 | Office expenses ... ... | 70 | 0 | 0 | | | |
| 6 | Salaries ... ... ... | 200 | 0 | 0 | | | |
| 7 | Office furniture ... ... | 750 | 0 | 0 | | | |
| 8 | Kalicharan ... ... ... | 100 | 0 | 0 | | | |
| 9 | Rent ... ... ... | ... | ... | ... | 1,000 | 0 | 0 |
| 10 | Govinda ... ... ... | ... | ... | ... | 620 | 0 | 0 |
| 12 | Hari ... ... ... | 360 | 0 | 0 | | | |
| 13 | Durga Das .. ... ... | 550 | 0 | 0 | | | |
| 14 | Bhagwan Das ... ... | 600 | 0 | 0 | | | |
| 15 | Landlord ... ... ... | ... | .. | ... | 100 | 0 | 0 |
| | | 12,870 | 0 | 0 | 12,870 | 0 | 0 |

**Trading and Profit and Loss Account for the Month Ended**
31st January, 1929

*Dr. Fo. 18.* *Cr.*

| | | Rs. | as. | p. | | | Rs. | as. | p. |
|---|---|---|---|---|---|---|---|---|---|
| To Purchases ... ... | 4 | 4,720 | 0 | 0 | By Sales ... | 3 | 5,150 | 0 | 0 |
| ,, Balance being Gross Profit. | | 2,350 | 0 | 0 | ,, Stock at 31st January, 1929. | 17 | 1,920 | 0 | 0 |
| | | 7,070 | 0 | 0 | | | 7,070 | 0 | 0 |
| | | | | | By Balance brought down. | | 2,350 | 0 | 0 |
| To Salaries ... ... | 6 | 200 | 0 | 0 | | | | | |
| ,, Rent ... .. | 8 | 100 | 0 | 0 | | | | | |
| ,, Office Expenses ... | 5 | 70 | 0 | 0 | | | | | |
| ,, Balance, being Net Profit carried to Current Account. | 2 | 1,980 | 0 | 0 | | | | | |
| | | 2,350 | 0 | 0 | | | 2,350 | 0 | 0 |

## Sree Ganesh

*Balance Sheet, 31st January, 1929*

| Liabilities. | Rs. | as. | p. | Rs. | as. | p. | Assets. | Rs. | as. | p. | Rs. | as. | p. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Capital .. | ... | | | 6,000 | 0 | 0 | Office furniture | ... | | | 750 | 0 | 0 |
| Current Account | 1,980 | 0 | 0 | ... | | | Stock ... | ... | | | 1,920 | 0 | 0 |
| Profit less drawings. | 200 | 0 | 0 | 1,780 | 0 | 0 | Sundry Debtors | | | | | | |
| Sundry Creditors— | | | | | | | Hari ... | 360 | 0 | 0 | | | |
| | | | | | | | Durga Das .. | 550 | 0 | 0 | | | |
| Kalicharan ... | 1,000 | 0 | 0 | | | | Bhagwan Das | 600 | 0 | 0 | 1,510 | 0 | 0 |
| Govinda .. | 620 | 0 | 0 | | | | Cash ... | ... | | | 5,320 | 0 | 0 |
| Landlord ... | 100 | 0 | 0 | 1,720 | 0 | 0 | | | | | 9,500 | 0 | 0 |
| | | | | 9,500 | 0 | 0 | | | | | | | |

*Note on Depreciation*—The B.E.ST Company of Bombay informed the authors that they depreciate Plant and Machinery which heading includes all Installed Electric Supply Plant, such as Rotary Converters, Transformers Receiving Station and Substation switchgear at 5 % per annum on the Straight Line Method ; Letter no. AST/10335/34, 3rd July, 1934. The Pykara Installation does not count any depreciation for the 1st 6 years.

# INDEX

*References are to pages*


Page

Abstract—bridge ... 412
—curve ... 411
—of cost of railway 403
—of estimated cost 459-463
Accident—insurance... 57
—report of ... 561
Account—clerk ...
—of profit and loss ... 83
—section 311-313
Accounting ... 336
Accrued depreciation 223
Act—Boiler ... 523
—Contracts .. 523
—Factory ... 523
—Indian Company's 523, 524
—Indian Contract ... 531
—Indian Factories ... 552
—No. V of 1923 ... 556
—of Land Acquisition 165, 167
—Workman's Compensation ... 523
Administration—factory ... 265
Advantages—of a private company ... 524
—of free exchanges... 20
Advertise—how and where ... 141
Advertisement ... 139
Agency—law of ... 535
—termination of .... 536
Agent—authority ... 535
—right to benefit gained ... 537

Page

—managing ... 562
—right of retainer ... 537
—responsibility ... 537
—to be indemnified 537
Allotment of duties ... 127
Allowances ... 353
Alterations—and renewal of boilers ... 560
—and renewal of steam pipes ... 560
—of articles ... 528
Amount of compensation ... 565
Amortized ... 222
Analysis—scientific essence of ... 128
—of market ... 195
—of foreman for training ... 132
—of scientific management ... 121
Annual inventory ... 309
Annuities ... 59
Appeals ... 561
Arbitration ... 505
Arguments—for and against gold standard ... 21
Arrangement of equipment in the power station ...
Articles, effects of ... 528
Assembling department ... 158

| | Page |
|---|---|
| Assets | ...53, 84 |
| Association—a specimen memorandum of ... | 530 |
| —memorandum of... | 525 |
| Atmospheric conditions ... | 152 |
| At par ... | 33 |
| Audit—continuous ... | 85 |
| —periodical ... | 85 |
| —plan of ... | 84 |
| —surprise ... | 85 |
| Auditing, object of ... | 84 |
| Authority—extent of agent's ... | 535 |
| —revocation of ... | 536 |
| Autocratic policies ... | 114 |
| Auxiliary books . | 86 |
| Available floor space | 178 |
| Babcock Wilcox boiler | 191 |
| Bad bill ... | 43 |
| Balance—reducing ... | 227 |
| —sheet | 53, 83 |
| Balanced ... | 77 |
| Bank—control of ... | 12 |
| —central ... | 12 |
| —business of ... | 52 |
| —book ... | 86 |
| Banker's draft ... | 42 |
| Banking facilities ... | 145 |
| Banks ... | 52 |
| Basis of comparison of annual cost ... | 250 |
| Batteries—storage ... | 510 |
| Bears and bulls ... | 34 |
| Belting ... | 505 |
| Bernoulli's law ... | 269 |
| Bill—of exchange ... | 6, 88 |
| —of lading ... | 46 |

| | Page |
|---|---|
| —book ... | 88 |
| —receivable ... | 54 |
| —payable ... | 53 |
| Bin—cards | 302, 309 |
| —number ... | 309 |
| —racks and ... | 305 |
| —overflow ... | 305 |
| Binning—double ... | 305 |
| Boiler—act ... | 523 |
| —choice of ... | 185 |
| —standard Lancashire | 190 |
| —standard size of Babcock Wilcox ... | 191 |
| Bonafides of sub-purchaser ... | 535 |
| Bond ... | 545 |
| Bond and contract ... | 493 |
| Bond to bearer ... | 545 |
| Bonus—collective or output ... | 352 |
| —system ... | 483 |
| Borings ... | 148 |
| Branches—objection to | 145 |
| Bridge—abstract ... | 412 |
| —important (bridges) | 413 |
| —work (major bridges) | 417 |
| Brokers ... | 33 |
| Buildings ... | 162 |
| —choice of a factory site and ... | 147 |
| —lay out of ... | 153 |
| —economics of ... | 163 |
| Bulls and bears ... | 34 |
| Bullion ... | 23 |
| Business ... | 106 |
| —ability of ... | 108 |
| —accuracy of ... | 107 |
| —adaptability of ... | 108 |
| —elements of ... | 109 |
| —extension of ... | 111 |

| | Page |
|---|---|
| — of bank ... | 52 |
| — qualities of ... | 107 |
| — tact ... | 107 |
| —training of ... | 108 |
| Business man ... | 106 |
| – definite purpose of | 107 |
| —maxims of ... | 106 |
| — responsibility of... | 107 |
| —temperament of... | 106 |
| —training of ... | 106 |
| Buy ... | 2 |
| Buyer ... | 135 |
| Buying ... | 135 |
| Bye-laws ... | 152 |
| Bye-products ... | 144 |
| Cables .. | 512 |
| — limit of current and temperature in | 400 |
| Calculations of the size of wire ... | 400 |
| Capacity factor of plant | 209 |
| Capital | 36, 37, 584 |
| —share and debenture ... | 544 |
| — shareholder's ... | 53 |
| Card progress | 273, 276 |
| —bin ... | 309 |
| —machine | 282, 286 |
| —workmen's time ... | 278 |
| Carnot's cycle ... | 269 |
| Cash ... | 110 |
| — books ... | 60 |
| — reserve ... | 111 |
| Caste | 581, 585 |
| Castings ... | 294 |
| Casual tender system | 297 |
| — form ... | 299 |

| | Page |
|---|---|
| Cement concrete roads | |
| —(analysis of the cost of) | 430-441 |
| —(details specification of) ... | 430 |
| —(general specification) ... | 425 |
| Certificate authorising the use of a boiler | 558 |
| —of engineer ... | 499 |
| — of transformer ... | 561 |
| —production of | 561 |
| — use of boiler—pending grant of | 559 |
| Central power station | 193 |
| Changes in purchasing power ... | 11 |
| Charges—overhead | 318, 352 |
| Chargehands ... | 131 |
| Charges—establishment | 353 |
| Cheap material .. | 296 |
| Cheque ... | 5, 47 |
| —crossed ... | 6 |
| Choice of boilers ... | 185 |
| —of factory site and building ... | 147 |
| — of source of power | 170 |
| Clerk—cost | 138 |
| — dispatch ... | 137 |
| —progress ... | 134 |
| —purchasing ... | 136 |
| —store ... | 137 |
| —time and wages ... | 137 |
| Coal ... | 209 |
| Coat—intermediate ... | 445 |
| — wearing ... | 446 |
| —seal | 450 |
| Collection of establishment expenses ... | 339 |

| | Page |
|---|---|
| Collective piece-work | 483 |
| Company—memorandum of unlimited | 527 |
| —mode of forming incorporated ... | 525 |
| —private ... | 524 |
| —partnership *vs.* limited liability ... | 551 |
| Completion—test on | 500 |
| Compulsory education | 580 |
| Concern—legal constitution of some business ... | 548 |
| Conditions—atmospheric ... | 152 |
| Constructive—standard of ... | 406 |
| —notes on Railway | 409 |
| Consumer—relation of the manager to the | 128 |
| Contour of the ground | 148 |
| Contract Act ... | 523 |
| —and specification | 487 |
| —and bond ... | 493 |
| —drawing ... | 493 |
| —enforcement and consequences of agent's ... | 538 |
| —essentials of ... | 532 |
| —mode of performance ... | 533 |
| —points to be covered in ... | 491 |
| —rules determining partner's mutual relation when no contract to contrary | 542 |
| —subletting of ... | 494 |
| —tender system ... | 297 |
| —tender schedule ... | 299 |
| Contractor's representative and workman | 495 |
| Control ... | 195 |
| —central bank | 12 |
| —gate ... | 278 |
| Co-partners—partners to bind ... | 542 |
| Corner—a share ... | 34 |
| Correspondence—opening of ... | 98 |
| —reply to ... | 98 |
| Cost—abstract of estimated ... | 459 |
| —concrete road ... | 464 |
| —element of ... | 327 |
| —handling ... | 150 |
| —summary of ... | 467 |
| —of water power ... | 177 |
| —of Railway ... | 403 |
| —of two-course concrete carriageway | 465 |
| —of fuel | 183, 184 |
| —total production ... | 209 |
| —summary ... | 318 |
| —sheet ... | 320 |
| —of transport ... | 48 |
| —prime ... | 330 |
| —process ... | 331 |
| —of indirect material | 339 |
| Costing | 267, 325 |
| —principal object of | 326 |
| —main advantages of | 326 |
| —definition of ... | 328 |
| Court—when may dissolve partnership ... | 543 |

Page

Credit note 307, 310
Credit 7, 8, 61
Creditor ... 30
Counter foil ... 88
Currency bond ... 545
Cycle—of manufacture 119
—of trade ... 474
Damage—liability for 496
Danger of false standardisation ... 123
Data necessary in purchasing water wheels 515
Datum line ... 148
Debenture ... 33
Debit ... 61
Decisions of engineers 495
Deflation 42, 582
Deflationists ... 24
Deflationary pressure 20
Definition—of costing 328
—of day-rate system 337
—of depreciation ... 341
—of terms ... 491
—of standard ... 122
Delegate, when agent cannot ... 537
Delivery from stores 307
Demand ... 41
Demand factor ... 210
Democratic government ... 582
Dependant ... 561
Deposit account ... 53
Department—assembling ... 158
—of double binning 305
—of enquiries ... 273
—of inspection ... 158
—of machining ... 157
—of metal works ... 158

Page

Departmental work ... 504
Depreciation ... 261
Design—modern tendency in power-plant ... 198
Dispatch—clerk ... 137
—and packing ... 158
Deterioration ... 258
Determining the size of the sets ... 203
Diminished values ... 261
Direct purchase ... 297
Disablement—partial 562
—total ... 562
Discount ... 33
Distortion ... 37
Distribution of compensation .. 567
Diversity factor ... 210
Drawings contract ... 493
Duty—allotment of ... 127
—of a foreman ... 131
—of agent to principal 536
Economic—consideration and limitations ... 256
—limit of prime movers ... 175
—rent 153, 321
Economics—of mass production ... 474
—power plant and tariffs ... 207
—of the buildings ... 163
Edging ... 449
Education—universal compulsory ... 580
Efficient control ... 125
Embankment ... 410
Employer ... 561

| | Page |
|---|---|
| Endorses ... | 6 |
| Engine—Crude oil ... | 174 |
| —Diesel ... | 173 |
| —fuel consumption of gas ... | 173 |
| —gasoline ... | 174 |
| —high-speed | 172 |
| —internal combustion ... | 172 |
| —kerosene ... | 173 |
| —mill ... | 171 |
| —producer and gas | 172 |
| —semi-Diesel ... | 173 |
| —uniflow ... | 172 |
| Engineer—certificates of ... | 499 |
| —consulting ... | 205 |
| —laws affecting the | 522 |
| —resident ... | 205 |
| —works ... | 130 |
| Engineer's—decision | 495 |
| —supervision ... | 495 |
| Engineering—structural ... | 413 |
| Equal annual payment ... | 225 |
| Essentials of—contract ... | 532 |
| Establishment for repair works ... | 153 |
| Estimate—of masonry structure ... | 356 |
| —of measurement and calculation of quantities ... | 361 |
| Estimated life of plant | 229 |
| Estimating ... | 267 |
| Estimation—of a railway | 403-405 |
| —of irrigation project ... | 470 |
| Estimator ... | 133 |
| Expansion ... | 144 |
| Expenses—building... | 352 |
| —distribution of ... | 354 |
| —factory ... | 339 |
| —general ... | 353 |
| —indirect ... | 341 |
| —nature and distribution of ... | 353 |
| —sales ... | 353 |
| —under working ... | 469 |
| Expert—selection of | 205 |
| —and improvements | 473 |
| —facility for ... | 153 |
| Extension—expenditure ... | 467 |
| Extra cost of overtime ... | 353 |
| Estimate of interior wiring ... | 396 |
| Facility for—extension | 155 |
| —banking ... | 145 |
| Factory—act ... | 523 |
| —administration ... | 265 |
| —choice of site and building for ... | 147 |
| —department ... | 333 |
| —expenses ... | 339 |
| —ground, layout of | 153 |
| —order ... | 333 |
| —strategic location for ... | 153 |
| Filing and indexing | 94 |
| Fire insurance ... | 56 |
| First notification ... | 168 |
| Fireman's reputation, | 297 |
| Fixed capital ... | 118 |

| | Page |
|---|---|
| Fixed station machinery ... | 415 |
| Flat rate ... | 215 |
| Floor space ... | 178 |
| Forms of incentive | 124 |
| Form—casual tender | 299 |
| Form—indent ... | 300 |
| —material received report ... | 302 |
| —material despatch | 303 |
| —of small inquiries | 299 |
| —of incentive ... | 124 |
| —purchase order ... | 299 |
| —standard ... | 274 |
| —used by purchasing section ... | 298 |
| Foreman—selection and duties of ... | 131 |
| —training of ... | 132 |
| —departmental ... | 133 |
| —section ... | 133 |
| Forging ... | 294 |
| Formula—annual depreciation ... | 226 |
| —general ... | 401 |
| —sinking fund ... | 229 |
| —straight line ... | 226 |
| Foundation ... | 444 |
| —condition of ... | 148 |
| Fuel—cost of | 183, 184 |
| Functional depreciation ... | 221 |
| Future expansion ... | 144 |
| Gambling act ... | 58 |
| Gas plant ... | 514 |
| Gate control | 278, 280 |
| General—condition of contract ... | 491 |
| —organisation of central power station... | 193 |
| Geographical distance | 144 |
| Gold—as regulator of credit ... | 13 |
| —reserves ... | 18 |
| —real function of ... | 18 |
| —standard | 14, 19, 21 |
| —superiority of ... | 14 |
| —tyrant or constitutional monarch ... | 16 |
| Good faith ... | 58 |
| Good will ... | 84 |
| Grouping of industries ... | 144 |
| Guarantee ... | 526 |
| Guilt-edged investment ... | 28 |
| —security | 29, 547 |
| Halsey—system ... | 349 |
| —weir system ... | 349 |
| Handling cost ... | 150 |
| Heads (minor) ... | 469 |
| Health insurance .. | 57 |
| High-speed engine ... | 172 |
| Horizontal mill engine ... | 171 |
| Hundi ... | 6 |
| Hydro-electric plant | 176 |
| —economic basis of ... | 176 |
| Illumination—cost of | 397 |
| Inadequacy ... | 221 |
| Imprest cash ... | 92 |
| Improvement and extensions ... | 473 |
| Income ... | 37 |
| —tax ... | 235 |
| —depreciation of income tax ... | 235 |
| Indian Companies Act | 523 |
| Indent ... | 45 |
| —form ... | 300 |

Page

Industry, location of 143
— location of site for 143
— principles of scientific management of 126
— re-location of an ... 145

Industrial system — aggregation of ... 102
— origin of ... 100
— reflex influence of 102
— standardisation of 101, 103

Industrial engineering 100
Industry, underlying principles of ... 100
— cycle of operation 100
— active, creative and synthetic phase of 101
Inflation 4, 6, 41, 582
Inflationary ... 20
Inflationist ... 24
Information ... 300
Inspection ... 301
— department 158
Inspector ... 135
Inquiries ... 273
— department ... 273
— small ... 299
Installation--demand of 209
Instruction ... 132
Instrument—wireman's tools ... 399
Insurance 341, 497
— companies 52, 55
— of property ... 56
— policy ... 55
— life ... 55
Insurable interest ... 57
Interchangability of parts ... 104

Page

Interest 37, 241
— compound ... 241
— elements of ... 241
— pure ... 37
Interference with tests ... 502
Interim valuation ... 259
Intermediate coat ... 445
Inventory annual ... 309
— perpetual 308, 310
— physical ... 308
Investors - requirements of ... 197
Invoices 88, 89, 301
Jigs ... 482
Job analysis 116, 117
Jobbers ... 33
Jobbing ... 267
— shop ... 267
Job ticket ... 118
Kinds of audits ... 85
Kites ... 43
Labour 37, 149, 584
— indirect and non-productive ... 339
— operating ... 209
— question ... 148
— supply ... 144
— unclassified ... 352
Land ... 37
— acquisition ... 165
— values 144, 168
Laws affecting the engineer .... 522
— of insurance ... 57
Laying ... 447
Lay-out—of belting 505
— of building ... 153

| | Page |
|---|---|
| Ledger ... | 60 |
| —sales ... | 60 |
| —purchase ... | 60 |
| Legal tender .. | 5 |
| Letter—commencement of ... | 98 |
| —composition of ... | 98 |
| —direction of ... | 98 |
| —finish of ... | 98 |
| —libellous ... | 98 |
| —private ... | 97 |
| —property in ... | 97 |
| —style of ... | 98 |
| —without prejudice | 97 |
| Liabilities—limited | 30,83,578 |
| —for damage ... | 496 |
| —of employer's compensation .. | 563 |
| Lien ... | 46 |
| Life assurance ... | 55 |
| Life cost product ... | 226 |
| —equated ... | 226 |
| —insurance ... | 55 |
| —of a plant ... | 223 |
| Lighting facilities ... | 151 |
| Limits ... | 481 |
| —of current and temperature in cables .. | 400 |
| Limit service ... | 257 |
| —time ... | 257 |
| Line organisation ... | 115 |
| —overhead | 572 |
| Liquid ... | 54 |
| —capital ... | 118 |
| List of—injuries ... | 570 |
| —occupational diseases ... | 570 |
| Load fluctuation ... | 207 |
| —factor of a machine | 207 |

| | Page |
|---|---|
| Load factor ... | 208 |
| —daily or for a period ... | 208 |
| —influence on cost of power ... | 208 |
| —period of ... | 209 |
| —plant ... | 208 |
| —the station ... | 208 |
| Local government, attitude of ... | 144 |
| Local power ... | 151 |
| Local taxation ... | 152 |
| Location of stores ... | 306 |
| Locomobile ... | 172 |
| Loose plant—valuation of ... | 264 |
| Macadam specification | 443 |
| Machines C. C. ... | 507 |
| A. C. ... | 507 |
| —card ... | 282 |
| Machinery arrangements ... | 101 |
| —department ... | 157 |
| —fixed station ... | 415 |
| —installation .. | 101 |
| —operation ... | 101 |
| —selection ... | 101 |
| Main divisions of purchasing section | 300 |
| Maintenance ... | 503 |
| —of firm's reputation | 217 |
| Man—progress ... | 134 |
| Manager—works ... | 127 |
| —to the owner ... | 128 |
| —to labour ... | 128 |
| —to the consumer... | 128 |
| —production ... | 129 |
| —sales ... | 139 |

Page

Management 101, 120, 132
—analysis of ... 121
—as distinguished from leadership ... 127
—directing ... 120
—experiment on .. 121
—organising ... 120
—preparing ... 120
—principles of scientific ... 126
—research on ... 121
—scientific ... 121
—standardisation ... 121
Management—system in ... 125
Manner of execution 495
Market ... 101
—watching the ... 296
—analysis ... 195
Mass—production ... 267
—economics of ... 474
—organisation for ... 479
—production shop... 269
—production from national point of view ... 271
Material 446, 466
—arrival report ... 302
—cheap ... 296
—credit summary 313, 314
—credit note 310, 336
—issue and credit ... 313
—despatch form ... 303
—received report ... 302
—sources of raw ... 143
—inspection of ... 301
—quality of 301, 495
—quantity of ... 301
—replacement of defective ... 497

Page

—raw ... 289
—relation of market 143
—storing and issuing of ... 309
—ledger summary ... 313
Material—received report form .. 302
—cost and storekeeping ... 336
—issue of ... 336
—requisition ... 336
Maxims—of equity 571, 572
Maximum—cost ... 193
—demand system ... 216
—stock ... 315
Memorandum of—unlimited company 527
—signature of ... 528
—effect of and articles ... 528
Metal worker's department ... 158
Method—man-hour 353
—percentage on wages ... 353
—of purchasing ... 297
Middlemen ... 36
Minimum stocks ... 297
Minor heads ... 469
Misrepresentation—effect on agreement of ... 539
—of company limited by shares ... 526
—of association ... 525
Mode of forming incorporated company ... 52

| | Page |
|---|---|
| Model—form of ... | 491 |
| Money | 2, 101 |
| —international ... | 39 |
| — commodity ... | 2 |
| —qualities of good | 2 |
| —token .. | 4 |
| —order .. | 42 |
| Monetary system—of England ... | 25 |
| —of U. S. A. ... | 26 |
| Monthly rate system | 337 |
| Mortgages ... | 54 |
| Motors ... | 508 |
| —A. C. ... | 508 |
| Nature and distribution of expense ... | 353 |
| Negotiable instrument | 47 |
| Note paper, heading of | 99 |
| Notes on railway construction ... | 409 |
| Notice and claim ... | 569 |
| Notices, provisions for | 555 |
| Objection to branches | 145 |
| Obsolescence ... | 221 |
| Occupational diseases | 570 |
| Oil and gas plant ... | 514 |
| Operating labour ... | 209 |
| Operating repair .. | 209 |
| Order book | ...87,88 |
| Order purchase ... | 299 |
| Organisation | ... 87,88 |
| —building a new ... | 116 |
| —for mass production .. | 479 |
| —keeping up to date | 117 |
| Original cost ... | 223 |
| Output—value of ... | 257 |
| Overhead charges ... | 318 |
| Over-time—extra-cost of | 353 |

| | Page |
|---|---|
| Ownership—industrial | 118 |
| Packing ... | 158 |
| Paint shops ... | 158 |
| Par premium, discount | 544 |
| Partner—responsibility of person leading another to believe him a ... | 541 |
| —liability of ... | 541 |
| Partnership—active ... | 29 |
| —sleeping ... | 29 |
| Partial disablement ... | 562 |
| Pattern shop ... | 158 |
| Payment—terms of ... | 498 |
| Percentage on wage method ... | 353 |
| Period of load factor | 209 |
| Physical inventory | 308 |
| Physical depreciation | 221 |
| Piece work—collective | 483 |
| —rate ... | 483 |
| —system of ... | 337 |
| Plant—capacity factor | 209 |
| —determination of the capacity of ... | 198 |
| —hydro-electric ... | 176 |
| —improvement of ... | 214 |
| —subdividing a ... | 145 |
| —use factor ... | 209 |
| Planner ... | 133 |
| Points to be covered in a contract ... | 491 |
| Policy to be followed in a contract ... | 487 |
| Posting ... | 82 |
| Power plant ... | 213 |

Page

—design of ... 198
—economics and tariff of ... 207
Power-station—arrangement and equipment in ... 195
Premium ...33, 55
Presentation ... 196
Present worth ... 243
Prime movers—economic limit for ... 175
—final selection of... 177
—reliability of operation of ... 177
Principal—compensation to agent for injury caused by principal's neglect 538
—duty of agent to ... 536
—how far bound when agent exceeds authority ... 538
—right to benefit gained by agent ... 537
—representation of 536
—by a sub-agent properly appointed ... 536
Principles—of scientific management in industry ... 126
Private company ... 36
—advantages of ... 524
—definition of ... 524
Production—of wealth 37
—manager ... 129
Profit 37,100
Property—all kinds of 262

Page

Progress—cards 273, 276
—chaser ... 135
—clerk ... 134
—man ... 134
—manager ... 134
—store-keeper ... 137
Prospectus ... 31
Protection—of stores 306
—of road surface .. 451
—of workmen ... 451
Provision of power ... 352
Purchase ... 295
—direct purchase ... 297
—requisitions 298, 309
Purchasing ... 295
—with due reference to stock ... 296
—goods ... 296
—seasonable ... 296
—method of ... 297
—reasons for ... 298
—forms used by ... 298
—clerk ... 136
Pouring ... 450
Quantity buying ... 296
—re-order ... 315
Questions how to ask 128
—labour ... 148
Quoting to specification ... 519
Racks and bins ... 305
Railway—abstract of cost of 403, 404, 405
—construction ... 409
—receipt ... 47
—siding ... 149
Raised ... 29
Rate—fixer ... 134
—machine-hour ... 353

Page

—of exchange ... 40
—of stock material... 358
Rate demand—theory of ... 215
Raw materials ... 289
Receipt book ... 91
Recording ... 338
Reducing balance ... 227
Registration ... 525
Regulation ... 257
Rejection of defective works ... 502
Re-location of an industry ... 145
Renewals—repairs and 257
Rent 37, 341
—economic ... 153
Re-order quantity ... 315
Repair works ... 153
Repairs and renewals 257
Replacement—of defective work ... 497
—value ... 260
Report 452-458
Representation of principal ... 36
Representative contractors and workmen ... 495
Requirements of investors ... 197
Requisition-purchase 307, 309
Reserve ... 35
Residential possibility 149
Resolution—alteration of articles by special 528
Responsibility for the act of third person 535

Page

Responsibility of agent or sub-agent ... 536
Revenue ... 468
Rights of use before test ... 501
Road—cement concrete 425, 441
—cost of concrete ... 464
—crossing ... 414
—detailed specification of ... 430
Room—tool 158, 289, 293
Salary ... 37
Sales expense ... 353
—manager ... 139
—manship ... 138
Salvage ... 223
Saw tooth ... 162
Schedule 357, 358
Schedule contract tender ... 299
Scientific principle of management ... 126
Scrap material forms 310
—value ... 223
Seasonable purchasing 296
Section accounts ... 311
—main division in purchasing ... 300
—receiving ... 301
Storing and issuing ... 303
Securities—Government ... 54
—other ... 54
Selection of expert ... 205
—of foreman ... 131
—of units .. 202
Selling price 318, 321
Selling and salesmanship ... 138

Page

Service-limit ... 257
Service value ... 223
Shares—classification of 32
—cumulative preference 32
—companies limited by ... 526
Sheet-cost ... 320
Sick-pay ... 57
Signalling ... 411
Signature ... 99
—of memorandum 528
Silver ... 17
Silver coin ... 23
Sinking fund 59, 229, 243
Site—choice of ... 147
—cost of ... 152
—for factory ... 147
—intramural ... 152
—physical condition for 148
Size of the sets ... 203
Skill ... 584
Smith on Smith ... 43
Specie 23, 54
Specification ... 45
—and contract ... 487
—defined ... 488
—final ... 490
—form of 488, 506
—in preliminary ... 489
—of generators 506
—quoting ... 519
—for Macadam ... 443
—and layout of the building ... 505
Staff organisation ... 115
Stamp-book ... 94
Standard, definition of 122
—form ... 274
—of construction ... 406

Page

Standardisation and individuality ... 123
—dangers of false ... 123
—Ford on ... 123
Station and station yard ... 411
Steam plant ... 513
Steam turbine ... 515
Stock ... 31
—book ... 292
—exchange ... 33
—ledgers 302, 311, 312
—maximum ... 315
—minimum ... 297
—purchasing with due reference to... 296
Surplus and obsolete 296
—visible ... 293
Storage—batteries ... 510
—principle of ... 304
Store 289, 295
—clerk ... 137
—day book ... 290
—delivery from ... 307
—journal ... 291
—keeping ... 295
—location of ... 306
—protection of ... 306
Store-keeper ... 135
—the component ... 137
—the head ... 135
—the material ... 137
—the miscellaneous 137
—the progress ... 137
—the receiving ... 137
—the tool ... 137
Store-keeping and material cost ... 336
Store-keeper's book 290

| | Page |
|---|---|
| Storing ... | 303 |
| Strategic location for factory ... | 153 |
| Structural engineering | 413, 416 |
| Subdividing a plant | 145 |
| Subject index book ... | 95 |
| Summary—cost ... | 318 |
| Super-power report | 231 |
| Supply ... | 41 |
| Surplus stock ... | 296 |
| Supplies receiving materials ... | 304 |
| Supervision ... | 132 |
| Supervision—engineer's ... | 495 |
| Surrender value ... | 55 |
| System—bonus ... | 483 |
| —casual tender ... | 297 |
| —contract tender ... | 297 |
| —efficient control of | 125 |
| —Halsey ... | 349 |
| —Halsey weir ... | 349 |
| —in management ... | 125 |
| —maximum demand | 216 |
| —Rowan ... | 349 |
| —the telephone ... | 217 |
| Tariff ... | 215 |
| Task system ... | 484 |
| Tax ... | 341 |
| Telephone system ... | 217 |
| Tender—casual | 297, 299 |
| —checking ... | 519 |
| —contract | 297, 299 |
| —form ... | 299 |
| —legal ... | 5 |
| —schedule ... | 299 |
| —system ... | 297 |
| Terms of payment ... | 498 |
| Test—on completion | 500 |
| —rights of use before | 501 |
| Tidyness ... | 306 |
| Time—card ... | 278 |
| —of taking over ... | 501 |
| —keeping ... | 338 |
| —limit ... | 257 |
| Tool—wireman's instrument and ... | 399 |
| Tool room | 289, 293 |
| Total production cost | 209 |
| Trade cycle ... | 474 |
| Trade bills ... | 43 |
| Training— | |
| —foreman's ... | 132 |
| —analysing foremanship for ... | 132 |
| Transformers ... | 509 |
| Transport | 149, 341 |
| —facilities ... | 144 |
| Transportation ... | 302 |
| Turbine ... | 171 |
| —steam ... | 515 |
| Under working expense ... | 469 |
| Units—selection of .. | 202 |
| Universal compulsory education ... | 580 |
| Use—factor of plant | 209 |
| Value ... | 2 |
| —basis ... | 261 |
| —diminished ... | 261 |
| —marginal ... | 5 |
| —of output ... | 257 |
| —of land ... | 168 |
| —replacement ... | 260 |
| —scrap ... | 261 |
| Valuation—interim ... | 259 |
| —of loose plant .. | 264 |
| —the basis for ... | 260 |

Page

Ventilation ... 163
Vertical high-speed engine ... 172
Voucher 83, 84, 92
Wage .. 37
Warehouseman ... 137
Warranty 535
Wasting assets ... 260
Watching the market 296
Water fronting ... 150
Water-wheel data necessary in purchasing 515
Wealth ... 36
—production of .. 37
Wearing coat . 446
Wire—calculation of the size of ... 400
—overhead ... 400
Work—bridge 417, 418
—condition of contract for electrical 491
—departmental ... 504

Page

—orders 334, 118
—piece-work rate ... 483
—rejection of defective ... 502
Works—engineer ... 130
—manager ... 127
—structural engineering (preliminary expenses) ... 416
—(formation) .. 416
—(bridge work) . 418
—(fencing, mile and gradient post) ... 419
—(ballast and permanent way) 420, 422, 423 ... 424
Workmen—compensation act ... 523
—protection of ... 451
—time card ... 278
Worth—future ... 243
—present 223, 243
Yard—station and station yard ... 411