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PRACTICAL
COTTON MILL
MANAGEMENT

Revised and Enlarged
particularly the Chapters
on
Yarn and Cloth Costing,
Designing
and
Questions and Answers.

PRACTICAL COTTON MILL MANAGEMENT

BY

B. S. BENJAMIN

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CONTENTS

CHAPTER LXI

QUESTIONS AND ANSWERS

ENGINEERING

Absolute Pressure

Pressure measured from the true zero or absolute vacuum. Thus a steam pressure commonly quoted as 50 lb. per square inch is 65 lb. if measured from the absolute zero or true vacuum but is 50 lb. more than the pressure of the atmosphere.

Absolute Strength

The total load necessary to break a piece of material.

Absolute Unit of Current

A current which exerts unit magnetic force (1 degree per unit pole) at the centre of an arc of the conductor carrying the current, the arc being of unit length (1 cm.) and unit radius. This unit is too large for practical use, and the Ampere, which is one-tenth of an absolute unit, is used instead.

Absolute Units

Units connected by a simple physical relation with certain fundamental units, usually three in number, the units of Time, Length, and Mass. Thus a unit of volume directly derived from the unit of length is an absloute unit——*e.g.*, a cubic foot or cubic centimetre. A dyne (q.v.) is also an absolute unit of force, while the weight of a pound or of a gram is not, since it depends on the force exerted by gravity at the place as well as on the fundamental units.

Absolute Zero

The temperature at which no heat would remain in a body. It is found that this would be the case if one could cool a substance to—273° or —274° on the centrigrade scale. At this temperature the vibrations consistuting the heat energy of the substance would have entirely ceased. The absolute zero has been approached to within about 25°; *i.e.*, bodies have been cooled to —250°*C*.

Action

The action of an engine or machin denotes its mode of working. In mechanics it is an axiom that action and re-action are equal and opposite.

Accumulator (Hydraulic)

In hydraulic machinery, using water intermittantly, as presses etc., there are regular or irregular periods during wihch the consumption is greater than the supply and *vice versa*. The function of the accumulator is to maintain a constant pressure of water under both conditions and to prevent an injurious pressure from arising when the water is suddenly shut off from the machinery or from some other cause. The pumps deliver the water into a tall vertical cylinder, having a piston so loaded with weights that it will not rise till the water beneath it is under working pressure. From this cylinder the water is also distributed to the machinery. When the water is used faster than the pumps can supply it, the piston descends, but when the consumption falls or stops, it rises, thus the pressure remaining constant. A projection on the weight comes in contact with a lever when it is raised to its extreme point, and automatically shuts off the water from the pumps.

Addendum

Sometimes used to signify the point or face of the tooth of a gear-wheel, lying without the pitch circle.

Air

A cubic foot of dry air (Barometer at 30°) weighs :—at 32°*F*, 566.85 grains ; at 60°*F*, 536.28 grains ; at 100°*F*, 497.93 grains.

Air Brake

A brake in which the blocks are moved by pistons actuated by air pressure.

Air Casing

A space surrounding a flue, boiler, etc., intended to prevent the undue transmission of heat to surrounding objects.

Air Compressor

A pump for driving air under pressure into a reservoir for use in ventilation or to supply motive power.

Air Pump

The air pump is a machine for removing air from a vessel.

Anion

The ion which carries the negative charge against the direction of the current and delivers it at the anode.

Asbestos

It is a fibrous incombustible mineral of a long, fine and flexible nature consisting of silica and magnesia in chemical combination. It is usually of a white colour. It is an extremely bad conductor of heat, and is often used to keep heat in or out. It has a great pressure of resisting moisture, friction, high temperature and even flame itself. It is also not affected by acids, gases, etc. It can be woven into cloth, and in the form of mill board, rope or string is much used for putting between joints, packing steams, pistons and pump rods, stuffing boxes, and man-hole plates, and to form a non-conducting, covering for steam boilers and pipes.

Ashes

Ruble coal gives about 15%.

Atmosphere

Average pressure at sea level is 14.7 lbs. per sq. inch and balances a mercury column 29.92 ins. high or water 33.9 feet. Temperature falls 1° F. per 275 feet rise. At 1° cent. is roughly 6 kilos (14.7 lb.) per sq. inch.

It falls one-tenth of an inch for every 100 feet of rise in 30 ins. at sea level——

2,000 ft. 27.9 ins.

4,000 ft. 25.9 ins.

At sea level water boils 212°*F*, but 1° lower for each 530 ft.

Q.—What is the purpose of apprenticeship ?

A.—The purpose of apprenticeship is to take hold of the human material of the right thinking grade, and to still further guide, mould and modulate it into use for meeting and economically satisfying the material needs and demands of the community.

Q.—What is the surface area of a cylinder 30 inches in diameter and 20 inches high ?

A.—Multiply the circumference of base by the height of the cylinder and to this product add the area of ends. The area of one end is equal to :—

$30^2 \times .7854 = 706.86$ sq. inches

$706.86 \times 2 = 1413.72$ sq. inches = area of both ends.

Length of circumference $= 30 \times 3.1416 = 94.2480$ inches.

Area of convex surface $= 94.2480 \times 20 = 1884.9600$ sq. inches.

Then the surface area of the cylinder $= 1884.9600 + 1413.72 = 3298.68$ sq. inches.

Q.—What is the area of a circle the diameter of which is 60 inches.

A.—Multiply the square of the diameter by .7854

$\therefore 60^2 = 3600 \times .7854 = 2827.44$ sq. inches.

Q.—Find the area of parallelogram the base of which is 250 inches and the altitude 300 inches.

A.—Multiply the altitude by the base = the area.

$250 \times 300 = 75{,}000$ sq. inches.

Banking Up

Covering a bright fire in a boiler with a closely beaten mass of small coal, to secure slow combustion when little or no steam has to be produced.

Barometer

The atmospheric pressure is not exactly the same at all times. but varies with certain conditions. Consequently, the height of the mercurial column supported by the atmospheric pressure will also vary, and, in so doing, will indicate the varying atmospheric conditions.

Beam

Any bar that rests in a horizontal position on supports is called a beam.

Belts

To find the length—add the diameter of the two pulleys together and divide by 2, then multiply the rest by 3.1428 plus that to twice the distance between the centres of the 2 pulleys. You then have the length of an open belt. If one pulley is 4 or 5 times as large as the other, allow an extra inch of belt for every foot of the two pulleys diameters added together. When the belt is crossed add 1½ inches for every foot of the 2 pulleys' diameters provided the shafts are not closer together than three times the added pulleys' diameters in feet. If the shafts are closer than this, 3 inches of every foot of the pulleys' diameters will generally meet the case.

Balanced Belting

When the elasticity and stretch of the leather strips are so arranged in a double belt as to neutralize one another in the two plies, the belting is said to be balanced.

Belt Speed

Diameter of pulley × 3.1428 × Revolutions.

If the pulley diameter is given in inches, divide the answer by 12 to get it into feet per minute.

Example :—

Dia. of pulley = 12
Revolutions = 500

$\frac{12 \times 3.1428 \times 500}{12}$ = 1570, the velocity of the belt in feet per minute.

Boiler Pressure

Varies from 40 to 50 lb. per square inch to several hundreds in modern "tubular" and "water-tube" types. The best boilers can evaporate about 11 to 12½ lbs. of water from and at 212° per pound of combustible.

British Measures of Length

Measurements of length on the British system are made in inches, feet, yards, or miles.

The Metre——Lengths are not measured in yards, feet, and inches in all countries. In France, and many other countries, the Standard length is what is called a metre. The metre is longer than the yard. There are thirty-six inches in the yard, but the metre measures about 39⅓ inches, or three feet, three and one-third inches.

It is useful to remember that 2.54 or about 2½ centimetres are equal to 1 inch, 30.5 centimetres are equal to 1 foot and 8 kilometres are about equal to 5 miles.

Bronze

An alloy of copper and tin is called bronze, and the term is extended to all alloys in which these two metals are the foundation although certain other elements, as lead, zinc, antimony, phosphorus, arsenic, iron, etc., may be added in small quantities for various purposes. The different bronzes in use are many.

Burnett's Fluid

A fluid used for the impregnation of timber. It is composed of chloride of zinc diluted with water, and applied under pressure.

Bursting Pressure

The pressure necessary to produce actual rupture in a closed vessel, such as a boiler or pipe.

Q.—What are the points for the purpose of inspecting belts ?

A.—(1) whether the belting is too dry, (2) whether the belting is saturated with oil, excessive dressing, etc., (3) whether the belting is dirty (4) whether the belting is too slack (5) whether the pulleys are in line (6) what is the general condition of the laps and piles ? (7) what is the condition of the lacing and the ends of the belts that are laced ?

Q.—What should be the tensile strength of Leather Belt.

A.—The minimum tensile strength of leather belt should be 3,000 pounds per square inch of cross section. The average tensile strength taken throughout for single belts should be 3,750 pounds per square inch, and for double belts 3,500 pounds per square inch.

Q.—What do you mean by Balancing a Pulley ?

A.—All pulleys that rotate at high speeds should be carefully balanced. A pulley that is badly out of balance will produce vibration and cause the belts to work badly, and also induce heavy stresses in the shaft and extra pressure on the bearings. It is not commercially practicable to obtain cast-iron pulleys that are in perfect balance.

It is important that pulleys should run true in order that the tension in the belt may be equal at all parts of the revolution, thus making the transmitting power constant. The smoother the surface of a pulley, the greater its driving power. The transmitting power of a pulley can be increased by covering its face with leather or rubber ; this increases the driving power about one-quarter. In pulleys that run at a rim speed of 6,000 to 7,000 feet per minute, perfect intimate contact of belt and rim is prevented owing to the layer of air that gets in between them ; this causes slip. To mitigate this, some pulleys have holes drilled in all round the rim. This allows air to escape, and certainly gives a better grip. For very high-speed pulleys, with wide rims a minimum of crowning is desirable, as the belt tends to assume a level surface and so leaves the two outside positions of the rim and thus decreases the area of contact and, hence th · driving effect of the belt.

Q.—What is the difference between an elastic belt and a stretchy belt ?

A.—An elastic belt is one that, when subjected to tension and released, returns to its original length. While a stretchy belt, is one that, when loaded or put under tension and released, remains permanently in a distended form.

Elasticity is desirable in belting, and stretch is the reverse. The belt must not stretch excessively so that the production will not be effected too greatly.

Q.—What is the coefficient of "friction" of leather belt.

A.—The coefficient of friction in general use, for leather belt on cast iron pulleys is 0.30, a belt must have a good frictional surface in order that slippage be reduced to a minimum.

Q.—When would you use waterproof belting ?

A.—When extreme dampness or water itself is present, then waterproof cemented belts are necessary.

Q.—How would you clean tarnished bronze and brass work ?

A.—By rubbing with a paste made of oxalic acid, 1 oz. ; rottenstone 6 ozs. ; powdered gum arabic, ½ oz. ; sweet oil, 1 oz. ; water sufficient to make a paste ; rinse with water, and finish with whiting and leather. A golden colour may be given to clean brass by first pickling it, and dipping for a few seconds in a solution of water, muriatic acid, and alum.

Q.—State briefly why is it necessary that the "boiler feed water" should be of a very good quality ?

A.—The most important industrial application of water is its use for steam raising in boilers. Engineers are aware of the fact that the efficiency and life of a boiler are greatly influenced by the quality of the feed water. In recent years there has been a tendency to raise the working pressure of boilers, and to utilise the steam in turbines, and the quality of the feed water has become, in consequence, a question of even greater importance than formerly. The use of unsuitable feed water may result in (*a*) scale-formation ; (*b*) corrosion ; (*c*) Priming ; (*d*) oil-films.

Q.—How would you convert H. P. cost to cost per I. H. P. ?

A.—I would add .2 pie per pie of H. P. cost. This cost of .2 pie was the cost of a mill that used Bengal coal and the engine was of about 900 H. P. The boilers were Lancashire boilers working at 200 lbs. per square inch, hand fired and equipped with standard equipment such as economisers, etc.

Q.—What is the best tension at which to install a belt ?

A.—The best tension at which to install a belt is the tension at which the belt will carry its load easily without straining and with a minimum bearing pressure. Operate all leather belts just as slack as possible without slipping. When it is necessary to operate a belt tightly on a drive in order to make it pull, there is something wrong with that drive and it should be carefully investigated and remedied. Either the belt does not have a good pulling surface or it is too small for a job. Narrow belts may be easily slipped over the rim of the pulleys. It is a dangerous practice to put on belts while the pulleys are in motion.

Surplus grease and oil are injurious to belting and give it a poor frictional surface, which causes slippage.

Q.—What are the factors to be borne in mind by a purchaser of leather belting ?

A.—A purchaser of leather belting should weigh the following factors :

(*a*) Frictional surface ;
(*b*) Stretch.
(*c*) Life

in order to decide which is the most economical belt for his particular requirements.

Q.—State the disadvantage of cheap leather belts.

A.—It is quite an easy matter to produce leather belting made cheaply by using dipped hides of inferior quality. These are dipped into vats at 120° *F*. and the hides are impregnated with stearine, glucose, sugar, and other adulterants and when these belts are used on machinery producing valuable goods and in a Mill where the heat is always great the leather becomes soft and flabby, and stretches indefinitely. Such a belt has a short life and ultimately costs the mill many times more than if they had used the best quality.

Q.—How much do you gain by increasing belt speed ?

A.—There is little to be gained by increasing belt speed above 4,200 feet per minute for flat belts or 8,500 for V belts. Further increase in capacity with increased speed is almost completely nullified by the effects of centrifugal force, while belt life and drive loses are affected unfavourably.

Q.—How would you establish Economical Belt Practice ?

A.—By adequate periodical inspection at reasonable intervals and maintenance of belting by prompt, skilful attention and repairs as requred.

Q.—What are the points that cover inspection of leather belting with a view to establish economy ?

A.—(1) Is the belting too dry ?

(2) Is the belting saturated with oil or excessive dressing, etc. ?

(3) Is the belting dirty ?

(4) Is the belting too slack ?

(5) Are the pulleys in line ?

(6) What is the general condition of the joints and plies.

(7) What is the condition of the lacing and the ends of belts that are laced ?

Q.—What is meant by stating that the belt is purely dressed ?

A.—It is meant that the leather is tanned by the best English slow process and it is afterwards curried and dressed by hand with pure cod oil and tallow which can be tested chemically. Leather prepared in this way can stand the longest life, as by it stretching quality and pliability helps to give better products.

Q.—Is a long belt-drive advantageous ? Discuss fully the difference between a short and a long drive. Also what do you understand about a cross-belt drive ?

A.—A long belt drive is advantageous because it gives a better drive. But care must be taken that the length be not too great, short belts require to be tighter than long ones, a long belt working horizontally increases the tension by its own weights acting in the curve formed between the pulleys. Horizontal, inclined and long belts give a much better effect than vertical and short ones. Long belts are less liable to slip than short ones. If too great distance is attempted, the weight of the belts will produce a very heavy 'Sag' drawing so hard on the shaft as to produce great friction in the bearings, while at the same time the belt will have an unsteady flapping motion, which will destroy both the belt and the machinery. With a cross-belt drive the crossing should be made in such a way that the following side of the belt goes on the outside and the pulling side of the belt on the inside of the loom pulley.

Q.—Is the friction greater on wood or cast iron pulley ?

A.—The friction of the belt is double on wood than it is on cast iron. The softer woods are better for pulleys than harder kinds.

Q.—What are bevel wheels ?

A.—Bevel wheels are designed to transmit power from one shaft to another when the shafts are in the same plane but not parallel.

Q.—Name some of the points to be considered while selecting a driving belt ?

A.—There are three main factors that determine for efficiency of a driving belt namely : (1) The percentage of power transmitted ; (2) the life of belt, and (3) the first cost.

Q.—What are the means of preventing belt slipping ?

A.—It is bad practice to use resin to prevent slipping. It gums the belt, causes it to crack, and prevent slipping for only a short time. It collects the dirt and dust and forms lumps on the surface of the belt, which impairs the driving efficiency.

If a belt that persists in slipping is found to be in a good condition, the only thing to do is to put on a wider one—if the puley will permit. Often a troublesome drive is cured by putting on larger pulleys on both the driving and driven shafts, as these increase the belt speed and reduce the stress in the belt where a belt has refused to pull its load, this has often proved a remedy ; namely, simply putting on large pulleys, observing to maintain the same proportion in size as before. Belts may be kept soft and pliable by oiling them once a month with castor or neatsfoot oil.

Q.—Suppose you are running with a 36-inch pulley with a belt and wish to change it to a 26-inch pulley. How many inches must you take out from the belt ?

A.—Take the difference in diameter of the two pulleys and multiply it by 3, and divide this product by 2.

$36—26=10$

$\frac{10\times3}{2}=15$ inches must be taken out of the belt.

Q.—Explain why is the flapping of belts injurious and objectionable.

A.—One of the most annoying troubles experienced with belting of all kinds is the violent flapping of the slack side. This is very objectionable, as affecting injuriously the belt itself, the bearings, and also the machinery being driven. Flapping may be due to the pulleys being out of truth, which alternately stretches and relieves the belt at each revolution. Or, it may be that the shafts are too far apart—for the size of pulleys and belt. It should also be obesrved whether one or both of the shafts are bent.

Lack of steadiness in running, due either to sudden variations in the speed of the engine or to sudden changes in the load of the machines driven by the belt, will produce a flapping that it is almost impossible to cure. The only sure remedy is to take such steps as will ensure steady running, as, for instance, increasing the weight of the fly wheel on the engine, or placing a flywheel instead of a pulley on the driven machine, also, if the belt is not joined squarely, flapping will result, especially when the belt is running at a rather high speed. The remedy is to unlace or unfasten the joint and make it square.

Q.—Define combustion.

A.—The term combustion may be defined as a rapid chemical combination of two or more substances, with the production of heat, which may be used for generating steam or for any other purpose. The form of combustion made use of for power production is the chemical combination of carbon and hydrogen, of which the common classes of fuel are mainly composed wit the oxygen of the air.

Q.—How is the heat-producing power of fuel liberated ?

A.—By a process called combustion.

Q.—Describe Combustible substances in Coal.

A.—The Combination of oxygen with the carbon and hydrogen of the fuel produces gases, which pass away through the flues and chimney.

Q.—State into how many classes are the volatile substances divided.

A.—The Volatile substances may be divided into two classes namely non-combustible and combustible substances.

The first class consists mostly of water, free oxygen, and nitrogen.

The second class consists of the hydro-carbons, which comprise numerous compounds of hydrogen and carbon.

Q.—What are the fuels used in the generation of Steam ?

A.—The fuels used in the generation of steam are chiefly, Coal, Coke, Wood, the mineral oils such as petroleum and natural gas.

Q.—What are the points to be Considered while making a selection of fuel ?

A.—In deciding on the class of fuel to be used the following points are important (1) the calorific value (2) physical suitability for the particular kind of grate on which it is to be burned (3) amount of volatile mater and nature of Coke, (4) ash contents (5) price per ton delivered on site (6) best means of handling, including cost of labour for firing, removal of ash, etc.

Q.—Give the classification of coal.

A.—Coal is the product of the decomposition of vegetable matter, such as trees, ferns, etc., which has solidified under the immense pressure of overlying strata during the course of ages.

Q.—Give your reasons as to why should Durability and Capacity of a boiler be of great considerations.

A.—Because the first has the advantage that the wear and tear of the boiler are but slight, and the second ensures that there will be sufficient steam and water to prevent any fluctuations in the steam pressure and water level respectively.

Q.—State what is the principal item that affects the working cost of a boiler.

A.—The principal item affecting the cost of steam production in different types of boilers is the evaporative efficiency, the second item being reasonably expert and careful attention, generally, the boiler that has the highest efficiency will cost the least for working expenses. With regard to repairs, it may be said that in general the water-tube is the more costly, if it is to be maintained in first-class condition.

Q.—Have you an idea of distributing cost of (*a*) Steam power (*b*) Bleeder type turbine. If so, give an example.

A.—(a) Fuel =0.64 pies per H.P.

Stores maintenance and incidents	=0.31 pies per H.P.	
Interest at 5%	=1.01 pies per H.P.	These two figures will vary as the plant, building, etc. vary.
Depreciation at 6%	=0.88 pies per H.P.	
Fuel	=2.60 pies per B.H.P. per hour.	

(b) Engine-room, Boiler-house, Wages, and Cost of establishment	=0.60 pies per B.H.P. per hour.
Stores maintenance and incidents	=0.30 pies for B.H.P. per hour.
Interest at 5%	=0.70 pies per B.H.P. per hour.
Depreciation at 6%	=0.58 pies per B.H.P. per hour.

Q.—What is meant by isothermal compression and expansion?

A.—When a gas such as air compressed or allowed to expand, and during the process, its temperature remains the same, it is said to have been compressed or expanded isothermally. To effect this, the heat generated during the compression process has to be conducted away as fast as it is generated, and the heat lost on expanding would require to be given to the gas to maintain the temperature.

Q.—When air is compressed or expanded in the cylinder of an oil engine what changes occur ?

A.—During compression the pressure and temperature of the air are increased and the volume decreased. During expansion these changes are reversed.

Q.—Is castor oil a good preparation for the preservation of leather belting ?

A.—Yes, castor oil, used properly, is a really good preservative for leather belting. It should be used alone on the outside of the belt, but mixed with chalk or crocus powder, it can be used on the driving side of the belt.

Q.—Do all gases expand and contract ?

A.—All gases expand upon heat being applied to them and contract if their temperature is reduced.

Q.—What is "Caulking," and how are seams prepared for caulking ?

A.—By Caulking is meant the closing up of the edge of the seam after riveting to make it steam or water-tight, the edges of the plate are chipped or planed, then a blunt chisel about $\frac{1}{4}''$ thick is used to burr up the inner edge of the plate.

After the shank of the rivet has contracted, the high pressure produced on the parts between the heads is not always sufficient to ensure a steam-tight or water tight joint. An additional treatment, termed caulking, is then necessary.

The caulking edge of a plate should not be bevelled to an angle of about 15° with a line normal to the contact surface of the plate. To ensure a good caulking edge, the lap of the joint should not be excessive, or the plate will buckle instead of having its edge upset. Likewise, the pitch of the rivets should be such as to make it possible to produce a tight joint by caulking without springing the plate between the rivets.

Q.—Explain what do you understand by condensing and non-condensing engines.

A.—If the exhaust from a steam engine is led into a drum or vessel and condensed, and provision is made to keep the temperature low enough, so that the condensation is continuous, the vessel in which the steam is condensed is called a "condenser." When an engine is working with a condenser, provision must be made for the removal of the water condensed from the steam, and also for the removal of any air that may enter with the steam. The air and water are ordinarily removed by means of an air pump, which serves the double purpose of maintaining a low pressure in the condenser and of getting rid of the water. This reduction of pressure in the condenser makes it possible to obtain a greater range of expansion in the cylinder and to operate the engine with a lower back pressure. By the use of a condenser and air pump, a vacuum of from 24 to 28 inches can be maintained. This means a back pressure of from 1 to 3, instead of from 15 to 17, pounds per square inch absolute, the latter being the case when exhausting into the atmosphere. The latent heat of the steam is taken up by allowing cold water to flow through the condenser, or by spraying it into the space into which the exhaust steam passes. The temperature of the steam end of the water due to condensation will also be lowered during this process, thus making it possible for the pump to maintain a low pressure in the condenser. The exhaust steam will flow from the engine into the steam space of a condenser so long as the cooling water condenses the steam and the air pump removes the air and water. When the engine exhausts into the atmosphere, it is said to be a non-condensing engine, when it exhausts into a condenser, operated as explained, it is said to be a condensing engine.

Q.—Which engine holds first rank as the most economical and generally satisfactory type ?

A.—The Corliss.

Q.—What are the two great classes into which engines are divided ?

A.—Throttling and automatic.

Q.—Is regularity of speed in an engine of importance ?

A.—One of the most essential features of a good engine is regularity of speed under varying loads. A high attainment in this respect is a variation of 8 per cent. in two revolutions.

Q.—Describe Corliss Engine.

A.—A Corliss Engine is a very economical type of engine, the working of whose valves is controlled in an automatic manner from the governor. The inlet and exhaust valves are distinct from each other, and while the latter are always opened to their full extent, the former are only opened so much as is permitted by the position of the governors. The valves are moved by rods from a disc or wrist-plate, but are disconnected at every stroke of the engine, and are then closed instantaneously by a dash-piston and spring. The advantages of Corliss engines are that they are strictly automatic in action, the steam supply being proportioned to the requirements of the engine at the moment, and that the steam passages are extremely short, preventing loss due to back pressure and the waste inseparable from long passages, and that the sudden or positive cut-off of the valves is substituted for the gradual cut-off of the ordinary slide-valve.

Q.—What is adiabatic compression and expansion ?

A.—When a gas is compressed or expanded without loss or gain of heat from an external source it is said to have been compressed or expanded adiabatically.

Q.—Most internal combustion engines operate on one of two distinct heat cycles. What are they ?

A.—(1) The constant-pressure cycle and (2) the constant-volume cycle.

Q.—Describe (*a*) the constant-pressure cycle and (*b*) the constant-volume cycle.

A.—(*a*) In the constant-pressure cycle the pressure to which the gas is compressed in the cylinder before ignition is the maximum pressure of the cycle, and is maintained more or less over an interval of time by the gradual injection of fuel during which the volume of the combustion chamber is increasing owing to the outward movement of the piston ; (*b*) In the constant-volume cycle the whole of the fuel charge is in the cylinder and is ignited at the point of maximum compression when the piston is practically stationary in the cylinder, resulting in a rapid increase of pressure.

Q.—Has the process we call boiling anything to do with steam.

A.—Yes. Boiling is caused by the formation of steam particles.

Q.—Give the duties of a boiler attendant.

A.—The duties of a boiler attendant are as follows :—

(1) *Firing.*—The fire should be kept at a uniform thickness and air-holes should not be allowed in the bed of fuel.

(2) *Water-Level.*—The first duty of the fire-man on going to work should be to examine the water-level. The gauge-cocks should be tried.

(3) *Low water.*—If the water is discovered to be so low as not to appear in the glass, quickly cover the fire with ashes, or, if these are not convenient, with fresh coal, but do not turn on the feed and do not tamper with the safety valve or any other steam out-let. The fire must be drawn as soon as possible.

(4) *Foaming or Priming.*—In case of foaming, close the throttle valve of the engine or the stop-valve of the supply pipe, and keep it closed long enough to show the true water-level. Foaming must be stopped by blowing down and feeding fresh water. In case of violent foaming due to dirty water or unsuitable solvents, etc., check the draught and cover the fire with fresh coal.

(5) *Leaks.*—Any leaks discovered should be repaired at once.

(6) *Blowing down.*—When blowing down, the steam pressure should not exceed 20 pounds per sq. inch, but this does not refer to blowing down surplus water, though it is always wise to blow only when the steam is relatively low. The boiler should be emptied every week, at least every 2 weeks, and filled up with fresh water. If the water is muddy, blow down several inches every day.

(7) *Filling up.*—Allow the boiler to become cold before filling with cold water, because the practice of filling a hot boiler with cold water causes leaks and fractures and sometimes explosions.

(8) *Safety Valves.*—Raise the safety valves from their seats cautiously and frequently to prevent the valves and their seats from sticking together. Do not allow the valve to be overloaded under any circumstances.

(9) *Pressure Gauge.*—The pressure gauge should stand at 0 when the steam pressure is off, and should be marked to indicate the blowing off pressure when the safety valve begins to act. If gauge does not do this, it should be compared with the standard gauge, and, if wrong, corrected.

(10) *Gauge-Cocks and gauge glasses*—should be kept clean and should be in constant use. The water gauge should be blown out frequently and the glasses and passages to gauges kept clean. An obstructed gauge may show a false water level. To prevent a glass becoming dim quickly, fill it with glycerine and pour out again, so leaving a film of the glycerine on the inside surface of the glass.

(11) *Feed Pumps.*—These should be of ample size and should be made to work as uniformly and continuously as possible. It is better to have two independent means of feeding the boiler, as if one fails the other is available.

Check Valves should be frequently examined.

(12) *Removal of Sediment and Incrustation*—Scale and sediment should be frequently removed. In tubular boilers, particularly, the handhole and manhole should be frequently opened and the sediment removed from the portion of the plate over the furnace,

Care should be taken to keep the boiler as free as possible from incrustation. Before opening out a manhole, always ease the safety valve or air-cock, and keep it open until the cover is removed.

(13) *Cleaning.*—All heating surfaces should be kept free from soot and dirt. Tubes should be cleaned frequently.

(14) *Exterior of Boiler.*—Care should be taken that water does not come in contact with the exterior of the boiler, either from leaky joints or other sources. Avoid dampness in both the setting and covering of the boiler, as this leads to external corrosion. Never stand damp ashes against the front of the boiler.

(15) *Blisters and Cracks.*—A blister on a plate should be examined at once, and trimmed or patched. A badly cracked plate must be renewed.

(16) *Fusible Plugs.*—When the boiler is cleaned, the fusible plugs should be examined and scraped clean on both sides; otherwise they are liable to prove worthless. New plugs should be put in at the annual inspection.

(17) *Air Leaks.*—The furnace, Combustion chamber, and flues must be kept airtight. The admission of air through the brick work of the setting is sometimes the source of considerable loss.

(18) *Galvanic Action.*—Examine the parts of the boiler where brass or copper comes in contact with iron in the presence of water. Galvanic action may produce corrosion in such circumstances, but this corrosion may be prevented by placing pieces of zinc in the boiler.

(19) *Rapid Firing.*—To prevent overheating steam should be raised slowly in boilers having thick seams or seams exposed to the fire.

(20) *Cleanliness.*—The boiler room, boiler, and mountings should be kept clean and in good order. Keep up the stock of spare parts, and especially asbestos and red lead for the joints. Safety valves or low water alarms, etc., should be tested daily to see that they are in working order.

(21) *Unused boilers.*—(*a*) These may be kept in good condition by filling them with water in which a quantity of common washing soda has been dissolved; (*b*) or they can be emptied, thoroughly dried, trays of quicklime placed in the bottom, and the boilers sealed as nearly airtight as possible.

Q.—How is slow combustion effected in the Diesel engine ?

A.—By injecting the fuel comparatively slowly into the cylinders during the early part of the working stroke of the cylce.

Q.—What is the approximate fuel consumption of an engine using petrol and one using paraffin ?

A.—The average consumption per B.H.P. per hour is, petrol 0.75 lb. and paraffin 0.70 lb.

Q.—What are the chief combustible substances of liquid fuel ?

A.—Carbon and hydrogen.

Q.—What is the frictional resistance of bearings dependent upon ?

A.—The velocity of the rubbing surfaces (the higher the speed the greater the friction), the area of the rubbing surfaces, the viscosity of the oil (which depends upon the temperative), and the pressure forcing the rubbing surfaces together.

Q.—Whence is the oxygen necessary for combustion obtained ?

A.—The oxygen for combustion is obtained from the air.

Q.—What do we mean by a Vacuum ?

A.—Any space Void of all pressure.

Q.—What is the object of a crank ?

A.—To convert a straight line motion into a circular one.

Q.—What are the products of the combustion of carbon and hydrogen with oxygen.

A.—The chemical combination of carbon and oxygen and of hydrogen and oxygen produces different gaseous compounds. Carbon and oxygen from two compounds, namely, carbon dioxide and carbon monoxide. Hydrogen and oxygen form only one compound, namely, water.

Q.—When electric unit power is supplied under a flat rate per unit (Kwh). How would you make correct allocation of power costs ?

A.—Correct allocation of power costs can be made very simply and at small initial expense by the installation of sub-meters in the main feeds from the point of supply to the various sections provided that these sections correspond to definite areas of feeding in the works. Generally, with a 3-phase A.C. power, simple single-phase meters supplied by current transformers, each in one line of the feeds will give sufficient accuracy.

Sufficient sub-meters should be provided to measure the whole consumption taken from the supply, and no section should remain unmetered. The sum of the registrations of the sub-meters will then correspond nominally to the registeration of the supply meter.

Q.—What are silencers and why are they always fitted in connection with internal combustion engines ?

A.—All internal combustion engines exhaust at a moderately high pressure or at a pressure very much higher than that of the atmosphere. If an engine exhausted direct into the atmosphere great noise would result owing to the sudden expansion of the high pressure gas. To obviate this, silencers are fitted through which the exhaust gases pass on their way into the atmosphere, with the object of causing the gases to expand gradually and so enter the atmosphere without noise. A simple form of silencer would be a long pipe of increasing diameter. In practice it usually takes the form of a large, mild steel, riveted cylindrical vessel, closed at both ends with baffle plates fitted inside. The exhaust from the engine enters one end and is made to take a zigzag course by the baffle plates before issuing from the opposite end of the silencer.

Q.—When a boiler is in use what is the effect of heating and cooling it ?

A.—The heat expands and enlarges the whole structure, and it should be so constructed and set in the brick work, that this change in form may be as uniform as possible—one part equally with another.

Q.—Does the cold contract the boiler ?

A.—Yes, and the process of enlarging and contracting is a continual process, as long as the boiler is making steam.

Q.—What is the effect of unequal expansion and contraction ?

A.—It is a severe test of the strength of the boiler, the tubes or flues expanding lengthwise with a force sufficient to tear the heads out of the boiler.

Q.—What is the cylinder ?

A.—The cylinder consists of a cast iron true bored chamber and a steam chest or valve box.

Q.—Would you recommend Boiler Compounds to be used to soften feed water, if so, give your reasons.

A.—No. Not unless the compound is suitable for the water that is being used. There are on the market a number of chemical preparations, which are intended to prevent the deposition of hard scale in a boiler. These compounds are not suitable for all kinds of feed-water. Many of them will, if used indiscrimately, seriously damage the plates and tubes of a boiler. The addition of chemicals in the form of boiler compounds can only convert a hard scale into a soft one. They do not prevent its accumulation in the feed-pipes and economizer tubes. The only rational way is to soften and purify the hard water before it enters the boiler by the use of a softening and purifying apparatus.

Q.—Is any difficulty experienced in working hydraulic cranes in frosty weather? If so, Why?

A.—In climates where the temperature is below freezing point, trouble is sure to take place if the water used in the pipes is kept quite fresh. To prevent ice forming it is usual to add salt to the water, a common density being about 10 ounces to the gallon.

Q.—What are the three vital parts of a steam boiler?

A.—The grate and heating surfaces and the steam-space are the three parts of a boiler that enter most vitally into its capacity as a steam producer.

Q.—Explain why it is important that the feed water should be introduced into the boiler at as high temperature as possible.

A.—It is important that the feed water should be introduced into the boiler at as high a temperature as possible. The advantages of hot feed water are :—(1) the avoidance of the strains produced by the unequal expansion of the plates of the boiler by the introduction of cold feed water. (2) the saving of fuel effected by the higher temperature of the feedwater. Every increase of 10° Fah., in the temperature of feedwater effects a saving of approximately one per cent. of fuel.

Q.—Define incrustation and corrosion in connection with steam boilers?

A.—Any deposit that is formed on the plates and tubes of a boiler is broadly termed incrustation, and is commonly known as scale; it is caused by impurities that enter with the water and that are left behind in the boiler when the water is evaporated. If the water used in a boiler were perfectly pure, there would be, of course, no trouble from incrustation. Unfortunately, however, in passing through the soil, water dissolves certain mineral substances, the most important of which are Carbonate of Lime, which is the same thing as lime-stone or marble, and sulphate of lime, which is the same as Plaster of Paris. Other substances frequently present in small quantities are chloride of sodium, or common salt, and chloride of magnesium. Boiler feed water also often contains other troublesome substances, such as acids, which eat away the iron of the plates and rivets, this action being termed corrosion.

Q.—Describe a steam boiler ?

A.—A steam boiler is a closed vessel in which steam is generated for power or heating purposes. The boiler when in use is only partly filled with water, the level of which is called the 'water-line,' while the space above is called the 'steam space.' The heating surface of a boiler is the part of its surface that is exosed to the fire and to the hot gases from the fire as they pass from the furnace to the chimney. The fittings consists of such attachments as gauges for showing the steam pressure and the amount of water in the boiler, the safety valve, the steam stop-valve, etc.

Steam boilers may be classified according to their form, construction, and use. Thus, according to their form, boilers are vertical or horizontal ; according to their construction, they are either Shell or Water-tube boilers, according to the different conditions under which they are used, they are referred to as stationary, portable, or marine boilers ; and according to whether the furnace is inside the boiler or outside, they are internally fired or externally fied.

Q.—Is the force of expansion and contraction known so that it can be "nearly" calculated ?

A.—Yes, iron will exert a strain of 150 pounds per square inch for every degree of temperature. Suppose iron has been heated to 350 degrees and cooled down to 60 degrees ; if it is so securely riveted or otherwise fastened it will be cooled $350^\circ - 60^\circ = 290^\circ \times 150 = 43{,}500 = 21\frac{3}{4}$ tons, on every square inch of section.

Q.—How would you prevent incrustation of boilers ?

A.—(1) Two ounces of muriate of ammonia in a boiler twice a week prevents incrustation and decomposes scale.

(2) Molases fed into a boiler prevents incrustation.

(3) Twelve parts salt, 2½ caustic soda ⅛ extract of oak bark. ⅛ of potash.

Q.—How thick should be the body of coal in the furnace ?

A.—The thickness of fire to be carried depends altogether on the draught. If the draught is strong it should be heavier than when it is weak, and a bituminous (sott) coal fire should be thicker than one of authracite (hard) coal. For hard coal four to six inches should be the depth, and for soft coal six to eight inches.

Q.—How should the coal be spread ?

A.—It should be kept spread evenly all over the grate, and not allowed to burn in holes, leaving the bars bare, as the cold air will rush in and chill the heating surface.

Q.—What should be the first aim in firing ?

A.—To keep an even pressure on the boiler ; to adjust the firing to the work demanded of the engine.

Q.—State what causes a boiler explosion ?

A.—A boiler explosion is generally assumed to be caused by over-pressure of steam. Either the boiler is not strong enough to carry its ordinary working pressure or the pressure has been allowed to rise above the usual point.

Q.—How would you manage the Boiler House ?

A.—To check the quality of Boiler Room operation get monthly reports covering, at least the following information :

(1) Total steam produced. (2) Total coal burnt. (3) Evaporation per pound of coal. (4) Total cost of Fuel. (5) Total cost of Labour. (6) Total cost of Repairs. (7) Total cost of Maintenance. (8) Total cost of supplies. (9) Total operating cost per 1,000 pounds of steam.

Whether an Industrial Plant generates steam and electricity or steam only, the boiler room is a big problem. There lie the greatest potential savings in most plants—the opportunity to reduce fuel bills from 10 to 25 per cent.

Q.—How does the heating of the Boiler Feed water save in coal bill ?

A.—Heat the Boiler Feed water as hot as possible. Each 10 degrees of heating saves 1 % of the fuel bill.

Q.—How does scale from hard water effect the coal bill.

A.—Scale from hard water blocks off heat flow. One-eighth inch of scale may run the coal bill upto 5 or 10 per cent. It may also cause boiler tubes to overheat and burn out.

Q.—What is the average evaporative power of fuel in a boiler.

A.—One pound of coal evaporates about 9 lbs. of water.

Q.—What is the biggest waster in an industry boiler plant ?

A.—Air is the biggest waster. There should be a Co_2 recorder, or other instruments enabling the operator to maintain, the correct proportions of air and fuel. Theoritically, it requires from 11 to 15 pounds of air to burn one pound of coal. Practically it can with about 20 per cent. more.

Ten pounds of unnecessary air per pound of fuel will waste about 10 per cent of the fuel purchased. Boilers settings should be kept tight to avoid air leaks which cause excess air and low Co_2.

Q.—Is it necessary to have boiler-room instruments ?

A.—Yes. An adequate set of boiler-room instruments will probably save more than 10 per cent of the coal bill. They should indicate and record steam pressure, steam temperature, feed water pressure and temperatures, weight of feed water pressure and temperature, weight of feed water, quantity of steam produced.

Q.—What is the meaning of Tensile strength when applied to rivets, braces and boiler plates ?

A.—It is the amount of force—usually expressed in pounds—which, steadily and slowly applied in a straight line, just overcomes the cohesion of the particles and pulls it into separate parts.

Q.—What is a compound engine ?

A.—An engine built with two cylinders, a high and a low, to get more expansion.

Q.—What is good boiler efficiency for an industrial boiler plant of moderate size.

A.—I should rate efficiencies about this way :—

85 per cent, extremely good ; 80 per cent, very good ; 75 per cent, good ; 70 per cent, fair ; 65 per cent, poor ; 60 per cent bad.

Q.—What is the greatest allowable distance between bearings for a 3-inch shaft of mild steel, used only to transmit power ?

A.—Add 1 to the diameter of the shaft in inches and multiply the sum by 55. The result is the greatest allowable distance, in inches, between adjacent bearings

$$3+1 = 4; \quad 4 \times 55 = 220.$$

Thus 220 ins. or 18 ft. 4 ins. is the distance allowable.

Capacity

The volume which a hollow vessel will hold is usually referred to as the capacity of the vessel.

Capacity of 12-inch cube = 6.232 gallons.

1 Carat. = $8\frac{1}{5}$ grains.

Calorie

The French practical unit of heat. It is the quantity necessary to raise one kilogramme of water to 1°C., the temperature being taken between 0° and 4°C.

Calorific Power

Signifies the amount of heat given out by a substance during combustion, independently of its rate of combustion.

Calorimeter

The sectional area of a boiler-flue, given in square inches, is sometimes termed the calorimeter of the boiler.

Castor Oil

An excellent lubricant for heavy bearings, having much body or viscosity, but becoming dry or gummy after long exposure to the atmosphere. Its sp. gr. is about 960, taking water at 1,000, and its flashing point 550°*F*. Cold-drawn oil is that expressed without the aid of heat, and is the best, in the preparation of the second quality the heat of steam is employed. Castor oil is adulterated with black poppy or other inferior oils, but the adulteration may be detected by mixing with absolute alcohol, in which the castor oil is completely soluble leaving the inferior admixture as a deposit.

Case-Hardening

The production of a thin layer of steel on the surface of wrought iron bodies by heating them to bright red in contact with carbonaceous matter. All surfaces which are subject to a great amount of wear and tear are generally case-hardened.

Case-Hardening

Place horn, hoof, bone dust, or shreds of leather, together with the article to be case hardened, in an iron box, heat to blood red, then dip article in cold water.

Some engineers add white wine vinegar and salt.

Case-Hardening with Prussiate of Potash

Polish the article, then heat to a bright red, rub the surface over with prussiate of potash, and when a dull red colour is reached dip in water.

Case-Hardening Mixtures

Two of prussiate of potash to one of salammoniac mixed, or,

Two of salammoniac, 2 of bone dust and 1 of prussiate of potash.

Castings

(Foundry) (1) The metal object produced by pouring molten metal into mould of requisite shape; (2) the operation of producing the above.

Casting (Brass)

An alloy of copper and zinc in the proportions of about 2 to 1 is known as brass. The zinc helps to produce a solid casting and also lessens the cost, being a cheaper metal than copper. The greater the proportion of copper, the redder is the colour. Thus, red brass consists of about 90 parts of copper and 10 parts of zinc. A good yellow brass may contain 70 parts copper and 30 of zinc. Common castings will range up to 40 parts of zinc, the strength meanwhile falling and the colour becoming lighter. A small proportion of lead is often added, as this helps to produce a better surface and also renders the castings easier to machine.

Cation

The ion which carries the positive charge in the direction of the current and delivers it at the cathode.

Cast Iron

That variety of iron which has been, or is suitable to be melted and run into moulds for the production of castings. It contains more carbon than any of the alloys of iron and carbon, which go by the name of iron or steel, has a crystaline structure, is unweldable, hard and brittle.

The average tensile strength varies from 7 to 8 tons per square inch, while it will stand 45 to 50 tons in compression.

Cast Steel

A variety of steel used for tools, cutlery, springs, etc. It becomes as hard as glass and very brittle if suddenly cooled from a red heat, but any degree of toughness may be produced at the expense of hardness, by a process of tempering. Cast steel can he welded but not so freely as wrought iron, and it takes a high polisb. It is made from wrought iron bars by heating them for some days in contact with charcoal in closed vessels (cementation process). In this process iron absorbs carbon from the charcoal and is changed from a fibrous to a crystalline substance, having the qualities described. In this stage it is called blister steel, from the appearance of the surface of the bars. The blister steel is brokem up, melted in crucibles, and cast into ingots, which are rolled into bars.

Cement

A strong glue is made by adding powdered chalk to common glue when melted, and a glue to resist heat may be made by boiling one pound of common glue in two quarts of skimmed milk.

Centrifugal Pumps

A type of pump in which water being set in rapid rotation by the blades of a rapidly rotating fan. Its continuous action and the absence of valves are its chief advantages.

Centrifugal Pumps can be broadly divided into two classes, under the heading of volute pumps, in which a volute or spiral-shaped casing surrounds a rotating impeller, or guide-vane pumps, where the liquid being pumped leaves the tip of an impeller and enters the vanes of a diffuser. A combination of the two systems is sometimes adopted for particular duties, but generally the volute type is employed when the volume of liquid is large compared with the head and the guide-vane multistage pump when the head is large in relation to the volume.

In all cases pressure energy is obtained by the rotation of an impeller. The liquid entering the eye or centre of the impeller is thrown outward by centrifugal force, and the kinetic energy developed is largely converted into pressure energy by the uniformly increasing area of the volute casing or by the diffusing vanes, which prevent the dissipation of the kinetic energy.

Centre Punch

A punch used for making the point where the centre of a hole is to be drilled, or as guide for some other measurement.

Compression

A term used to indicate the state the particles of a body are in when a force tends to crush the particles together.

Concrete-Reinforced

Safe adhesion strength of concrete to steel = 100 lbs. per square inch of area of metal.

Approximate percentage of strength of concrete at different ages :—

28 days old	.. ..	60% of full strength
2 months	.. ..	75% ,, ,,
3 ,,	.. ..	85% ,, ,,
4 ,,	.. ..	90% ,, ,,
6 ,,	.. ..	95% ,, ,,
1 year	.. ..	100% ,, ,,

Full tensile strength of good 1—2—4 concrete = about 300 lbs. per square inch at 28 days.

1 cubic foot of loose Portland cement paste will make about

4.1	cubic foot of concrete mixed	.. 1—2—4
5.1	,, ,, ,,	.. 1—2½—5
5.8	,, ,, ,,	.. 1—3—6
7.5	,, ,, ,,	.. 1—4—8

Cooling Compound for Hot Bearings

Mercurial ointment mixed with black cylinder oil and applied every quarter of an hour, or as often as expedient. The following is also recommended as a good cooling compound for heavy bearings :—

Tallow, 2 pounds, plumbago, 6 ounces, sugar of lead, 4 ounces. Melt the tallow with a gentle heat, and add the other ingredients, stirring until cold.

For lubricating gearing, wooden cogs, etc., nothing better need be used than a thin mixture of soft soap and blacklead.

Cooling Towers

A Cooling tower is generally a wooden erection, in which the condensing water is lifted some 30 ft. to 50 ft., and then broken up in its fall to give a maximum of surface. At the same time a counter current of air passes up the tower.

There are three types of cooling towers—natural draught, forced draught, and the open type. In deciding the type to adopt, the climatic conditions of the district constitute the determining factor, and to a less degree, ground space and cost.

In the open type, it is usual to allow 1 sq. ft. of ground space for 20 lbs. steam condensed, while allowing 30 lbs. Condensing water per pound of steam. The height of tower varies from 40 ft. to 80 ft.

In the fan-draught type, which is higher in first cost and maintenance, 1 sq. ft. area suffices for condensing from 40 lbs. to 50 lbs. of steam, but the height is usually limited to about 50 ft. The fan gives a draught of 2 to 3 inches of water.

With the ordinary open type 1 sq. ft. must be allowed per 12 lbs. stream condensed.

The capacity of dry air to absorb water increases with its temperature. The following table gives the weight of water in pounds, that 1 lb. of dry air becomes saturated with.

Temperature in degrees F..	50	70	95	113	140
Weight of water in lb. ..	0.0076	0.015	0.036	0.064	0.152

Chains-Breaking Weight in Tons

To find, divide the square of the diameter of one bar of a link in sixteenths of an inch, by 10 in the case of short linked chains, and by 11 for studded chains.

Circle = 360°.

Cost of Coal = about .4 pies per I.H.P. per hour.

Cost of Electric Power = about .6 pies per I.H.P. per hour.

Note.—Bear in mind that the cost of Steam as well as Electric power depends upon the cost of coal and efficiency of the plant.

Dash Pot

A small cylinder forming a portion of engines of the Corliss and similar types, whose function is that of a buffer case to the sharp closing of the steam and exhaust valves. It is furnished with springs of steel or India rubber, which deaden the blow of the dash piston.

Datum Line

Any base or fundamental line from which dimensions are taken, or graphic calculations.

Dead Centres

Supporting points of a lathe, etc., which do not rotate. Also applied to the Dead Points (q.v.) of an engine.

Dead Load Safety Valve

A safety valve (q.v.) kept down by a simple weight on the top, without any lever being used, as in the ordinary form of safety valve.

Decagramme = A French measure of weight containing 10 grm. and equivalent to 154.84 English grains.

1 Decimeter = 3.937 inches.

Decalitre = A French measure of capacity containing 10 litres or 2.201 English gallons.

Delta Metal

May be defined as a brass alloy to which a small proportion of iron has been added. It can be worked either hot or cold, and is employed for hot stamping. It is much stronger than ordinary brass.

Density

Different solids, though of the same size, may differ in heaviness, that is, in mass or weight.

Density is definied as the mass of unit volume of a substance that is, the mass in gm. of 1 c.c. of a substance or the mass in lb. of 1 cubic foot of it. Thus, the density of iron is 7.8 grams per cubic centimetre, or 480 lbs. per cubic foot; the density of water is 1 gram per cubic centimetre, or 62.5 per cubic foot.

$$\text{Volume} \times \text{density} = \text{mass}$$

$$\text{or density} = \frac{\text{Mass}}{\text{Volume}}$$

Diminishing Socket

A socket for connecting two pipes of different diameters.

Draught

Chimney draught is relied upon often for the production of the required current of air through the furnace. The chimney operates by reason of the difference in temperature inside and outside of it. Hot air weighs less per cubic foot than cold air. Thus, the column of gas inside the chimney weighs less than the corresponding column outside, and there will be less pressure inside at the base of the chimney than exists outside. The excess pressure of the atmosphere outside will cause a current to flow through the furnace towards the chimney.

Ductility

A metal is said to be ductile when it can be drawn and extended by a tensile or pulling force.

Earth

	Circumference miles	Diameter miles	AV. Diameter miles	Distance from Sun miles
At Equator ..	24,856	7,926.6	7,918	92,89,7000
At Poles	24,899	7,899.6	..	..

The Superficial Area of the Earth is estimated to be 196,550,000 square miles of which 55,500,000 square miles are Land and 141,050,000 square miles Water.

Europe forms 14th of the land surface of the globe. Asia extends over nearly ⅓th of the land surface of the glove. Africa is about three times the area of Europe. North America including Mexico, is a little less than twice the size of Europe. South America is a little more than 1¾ times the size of Europe.

"Area and Population of the World"

	Area in sq. miles	Estimated Population
Europe	8,750,000	475,000,000
Asia	17,000,000	1,013,000,000
Africa	11,500,000	143,000,000
North America	8,000,000	146,000,000
South America	6,800,000	64,000,000
Oceania	3,450,000	8,500,000
Polar Regions	5,000,000	....

Depreciation

The loss in value which machinery sustains with the lapse of time, which amount has to be written off the prime cost annually. The loss due to wear and tear, is added to this. The totalamount is usually taken at 6 per cent. for engines, 10 for boilers, 8 for machines. 5 to 6 for gearing, etc., and 45 for belting.

Electron

The fundamental unit of negative electricity. Its charge, as determined by Millikan, is 4.774×10^{-10} negative electrostatic unit and its mass 9.00×10^{-28} gramme at low velocities.

Elasticity

The power of a metal to return to its original shape after a force has been applied and then released.

Elastic Limit

If a metal is subjected to a gradually increasing strain, a certain limit is reached within which the stresses are proportional to the strains.

Elongation

The amount a piece of metal stretches between two fixed points is called elongation. It is made up of two parts, one due to the general stretch, the other to the contraction at the point of fracture.

Energy

The capacity of overcoming resistance or doing work is called energy. All moving bodies possess energy. Potential energy is the energy of matter due to its position or condition. The energy of a moving body is proportional to the square of its velocity.

Epicycloid

A cyclodial curve which is formed by a generating circle rolling upon and without a fundamental circle. The faces of external or spur-wheel teeth are so formed.

Equality of Moments

The condition of equilibrium in a system of forces, by which when power is gained time is lost, and *vice versa.* When opposing forces balance one another, so that equilibrium results, there is said to be equality of moments.

Equilibrium

(*a*) Forces are in equilibrium when they neutralise each other's influence.

(*b*) A body resting upon its base is in equilibrium when its centre of gravity lies vertically over the base on which it is supported.

Expansion

Expansion is usually expressed as a coefficient, and which is the amount every unit of length expands for every degree of rise in temperature.

Ether

The all-pervading medium postulated to explain observed phenomena of electric and magnetic field.

Expansion Joint

A form of joint in pipes, etc., which allows a certain degree of movement, in consequence of logitudinal expansion, without breaking the joint. Various devices are used; a sliding socket joint, or a corrugated hoop, or pair of plates, or sometimes a simple bight or bend inserted between two straight lengths of pipe.

Flue Bridge

A barrier of firebrick placed so as to deflect the flames and hot gases in a furnace.

Flush

At the same level, forming part of the same surface.

Foundry Sand

Sand composed chiefly of Silica, and free from earthly matter; used to form the moulds for castings.

Force

Force is that which produces motion in a body or alters its existing state of motion.

Force

1 dyne = the force which, acting on 1 gramme for 1 second, gives it a velocity of 1 centimetre per second.

1 gramme weight, at London = 981.19 dynes; at Edinburgh = 981.54 dynes.

The power or cause which impresses or tends to impress motion on matter.

Forward Eccentric

The eccentric which opens the slide valve to steam when the engine is to run forward. Sometimes called fore-gear eccentric.

Forward Gear

An engine is said to be in forward gear when the eccentric, slot links, and levers are arranged for the running forward of the engine.

Fouling

(*a*) The incrustation of steam boilers, and steam and water-pipes with scale. (*b*) The interference of machine or structural parts generally with each other, hindering their action; being due to errors in design or in constructions.

Friction of Shafts

Friction is governed by pressure, and is independent of surface, and the friction of a revolving body is nearly independent of its velocity. Shafting should be made as light as possible consistent with strength and stiffness, because the friction of shafts on their bearings is directly proportional to their weight. The friction of any two surfaces when no lubricant is interposed, is directly proportional to the force with which they are pressed together, and is entirely independent of the extent of surfaces in contact; so that the power absorbed by friction does not increase with the length of bearing. But when the surfaces in contact are lubricated, then the amount of friction depends upon the adhesive nature of the lubricant, and the effect will be in proportion to the extent of the surfaces between which it is interposed. Therefore, to diminish the power absorbed by friction as much as possible, and to secure easy workihg, it is very essential to use the best quality of oil.

Fuels and Combustion

The chief combustible elements of fuels are carbon, hydrogen, and sulphur, which on combining with oxygen from the air produce carbonic oxide or carbonic acid, water, and sulphurous oxide. The latter is absorbing water forms sulphurous acid, which causes corrosion of metalic surfaces. The ash which remains after combustion contains chiefly Silica and Alumina.

Fusibility

The property of becoming liquid on the application of heat is termed the fusibility of the metal.

Gallons

A gallon has a volume of 276.48 cubic inches, a pint therefore holds about 34.56 cubic inches, and one fluid ounce has the volume of nearly 1.728 cubic inches.

U.S. Gallon

231 cubic inches, 0.83 Imperial gallon, 3.8 litres.

Gases

Gas has neither definite shape nor size, it possesses the property of "expansibility." Some gases are light, some heavy, some coloured, some invisible, some elements, some compounds, some mixtures, some soluble in water, some nearly insoluble, but certain properties they have in common.

Gearing

A name generally applied to toothed wheels or other apparatus for communicating rotary motion, as *Spur Gearing* toothed wheels engaging one another whose axles are parallel ; *Bevel Gearing* toothed wheels on axles set at an angle with each other ; *Friction Gearing*, toothless wheels engaging each other by friction between their surfaces ; *Worm Gearings*, a toothed wheel engaging with a screw ; *Belt Gearing*, smooth wheels connected by an endless belt ; *Chain Gearing*, tooth wheels connected by a chain.

German Silver Wire

German Silver is an alloy consisting of 18 to 30% nickel, and the balance about four parts copper to one part zinc. It is very largely used as a resistance material in making resistance Coils, and is sold in the form of wire, and strip. The resistance of this wire varies with its composition. The resistance of the 18% alloy at 25°C is 18 times that of copper, and of the 30% alloy about 28 times that of copper.

1 Gramme = 15.342 grains.

1 Great Gross = 12 gross.

Gun-metal

A hard and tough alloy of copper with 9 or 10 per cent of tin and sometimes a smaller proportion of zinc. It is much used for bearings and for many of the smaller parts of machinery or,

90 parts of copper, 8 parts of tin and 2 parts of zinc.

Gun-metal (Eng.)

An alloy of copper and tin (often 9 copper to 1 tin). The alloy is used for parts that require to be strong or to possess good wearing qualities; hence, being much stronger than brass, it is largely used for engine and machine parts, gears, bearings of various kinds, Valves and Cocks for high steam and water pressures, high-pressure air or water pumps, and also for parts of electrical machinery that require considerable strength—but yet must not be of iron or steel on account of the magnetic properties of these metals. Probably the greatest defect in the bronzes used for bearings is caused by granules of red oxide of copper due to a lack of proper precautions in melting and pouring. These granules are very hard, and the bearing is liable to cut if any of these spots occur on the surface.

Hardness

Hardness is the power of the surface of a metal to resist penetration by cutting or scratching. It can be expressed in relative terms.

Heat Conducting

The property possessed in varying degree by metals for transmitting heat along or through them.

Hydraulic Pumps

Hydraulic pumps are used to supply water or other liquids under pressure in order to transmit power to presses, rams, and lifts, and for the many purposes hydraulic pressure is required in modern industry.

Q.—What are high-speed engines suitable for?

A.—High-speed engines are suitable for many purposes for which power is required, though they are used chiefly in connection with the generation of electricity. Until recent years high-speed engines were made in sizes ranging from 5 to 2,500 horse-power and running at speeds up to 800 revolutions per miinute in the small engines; but the largest sizes are now less frequently made, owing to the increasing use of steam turbines.

Q.—What is an indicator diagram?

A.—It is the figure drawn by the pencil attached to the indicator from which the mean effective pressure in the cylinder is calculated.

Q.—What is an indicator card?

A.—It is a paper wound round the cylinder of the indicator upon which the pencil has drawn the lines indicating the work done by the steam in the cylinder. The extreme length of the diagram may be 5¼ inches.

Q.—What is the expansion line?

A.—It is that part showing the curve of expansion, *i.e.*, the movement between the cut-off and the exhaust.

Q.—What is the steam-line?

A.—It is the line on the card which shows the place of admission to beginning of cut-off.

Q.—What is the exhaust line?

A.—It is that part of the diagram which shows the point of exhaust.

Q.—What base line is always assumed in figuring the indicator card and why?

A.—All figures are made from absolute vacuum, or $14\frac{7}{10}$ lbs. per square inch below atmospheric pressure.

For, from the line of absolute vacuum are made up all tables of weight, volume, expansion and all other properties of steam.

Q.—What four points does an indicator show?

A.—Highest and lowest pressure, cut-off and lead.

Q.—What do you understand by the number of an indicator spring?

A.—The number marked on a spring (several of which are furnished with each indicator) is designed to show the number o lbs. steam pressure on the boiler at which it is to be used: thus a 80 lbs. spring is one in which a pressure of 80 lbs. will cause the piston inside the indicator to rise one inch above the atmosphere line of the diagram.

Q.—Describe a simple and Compound Engines.

A.—The earliest engines were all of the simple or single-cylinder type, but as higher steam pressures came into use the compound engine was introduced. In this type of engine two cylinders are employed, the steam, after expanding somewhat and performing part of its work in the high pressure cylinder, is led into a cylinder of larger diameter, or, as it is termed, the low-pressure cylinder, to complete its expansion. By thus subdividing the range of expansion, a considerable gain in economy is obtained, due principally to the fact that the loss by cylinder condensation is reduced.

Q.—Explain Multiple-Expansion Engines.

A.—In modern practice, it is frequently found advantageous to expand the steam in more than two cylinders, when the expansion takes place in three successive stages, the engine is said to be triple expansion, and when it takes place in four successive stages, quadruple expansion. All engines in which the expansion of the steam takes place in more than one stage are also called multiple expansion engines.

Q.—Find the force (acting along the slope) necessary to pull a weight of 8 tons up a smooth inclined plane whose slope is 5 horizontal to vertical.

A.—$\frac{8 \times 2240}{5} = 1344$ lbs.

Q.—What is the reason for the economic running of the Deisel Engine.

A.—The Deisel Engine is a self-contained engine and powerhouse in itself, and that is the reason of its economic running. The fuel consumption is also much less.

Q.—When can mechanical power losses occur ?

A.—Mechanical power losses in a drive can only occur in the bearings, pulleys and belts. The pulleys and belts or equivalent means of power transmission are approximately the same in number in both modern group drive and unit drive. The number of bearings however, is less for group drive than for unit drive, which results in over mechanical power loss for modern group drive than for unit drive.

Q.—How would you cool a hot shaft ?

A.—Make a belt of something of a loose water absorbing nature, and hang it over the shaft as near the hot journal as possible, allowing it to hang down and run loose on the shaft. A bucket of water may now be fixed so the lower part of the belt will run in it, and in this simple way the shaft may be cooled while running.

Q.—What is case-hardening ?

A.—Case-hardening consists in putting a hard skin on the surface of finished wrought iron or mild steel. The article to be treated is placed in an iron box and covered over with scraps of leather, bone, or anything which contains carbon, then placed in a furnace for several hours, after which it is plunged with cold water. Another method is to heat the article to a blood-red heat then put salamoniac or prussiate of potash on the surface and cool at once, which is quicker. The surface of iron is by this means simply converted into hard steel.

Q.—What is implied by the term "back pressure" ?

A.—As perfect vacuum is impossible, a certain vapour retards the piston equal to the distance between a perfect vacuum and what the gauge reads.

Q.—How is the horse power of steam engines determined ?

A.—By the following rule : Multiply the area of the piston in square inches by the average force of the steam in pounds and by the velocity of the piston in feet per minute ; divide the product by 33,000, and 7/10 of the quotient equal the effective power.

Q.—Describe Unit of Force.

A.—It is essential to have a standard unit for the measurement of force. The British unit of force is the pound avoirdupois, and is spoken of as the engineer's unit or gravitation unit.

A force of 1 lb. is that which will just support a weight of 1 lb. against the action of gravity.

Q.—State the maximum bore, to the nearest sixteenth of an inch, that could be given to the six cylinders of a car engine if the rated horse-power is not to exceed 25.

A.—H = rated horse-power of engine.
d = diameter of cylinder, in inches ;
n = number of cylinders in engines.

Rule :— $d = \sqrt{\dfrac{2—5H}{n}}$

H = rated horse-power which, it is given, is not to exceed 25.
n = number of cylinders = 6.

substituting these values diameter of bore $= \sqrt{\dfrac{2.5 \times 25}{6}}$

Now extract the square root of the quantity.

$\frac{2.5 \times 25}{6}$ and express this to the nearest sixteenth of an inch.

The value of d $= \sqrt{\frac{62.5}{6}} = \sqrt{10.41667} = 3.227 = 3\frac{3.6}{16} = 3\frac{4}{16}$ approximately.

But if this approximate value is used for the bore, the H.P. will exceed 25; so that it will be necessary to make the diameter $3\frac{3}{16}''$ in order to answer the conditions.

Q.—Name the sources of heat.

A.—(1) Physical sources. (2) Mechanical sources. (3) Chemical sources.

Q.—How is heat produced chemically ?

A.—When two or more substances, which act chemically upon one another, are brought together and allowed to combine, heat is evolved.

Q.—Why are Economisers necessary to be included in the boiler plant ?

A.—An economiser utilises the heat in the waste furnace gases after they have passed round the super-heater, when one is installed, to raise the temperature of the feed water. The gases enter the economiser chamber at a temperature of from 450° to 650° Fah., and they give up such a proportion of their heat to the water that their exit temperature is only 250° or 300° Fah., thus, the system must result in a marked economy. The hot gases from the boilers pass on their way to the chimney, around and between rows of vertical tubes. These tubes contain the boiler feed water, which becomes heated to a temperature of about 300° Fah. As this result is obtained from heat which would otherwise pass into the chimney and out to waste.

Q.—Describe Natural Draught ?

A.—The difference between the weight of a Column of hot gases contained within a chimney and the weight of an equal column of cold air results in an upward motion of the hot gases within the chimney, which motion is called natural draught, or chimney draught. It is well known that any gas, when heated, is lighter, bulk for bulk than when cool.

Q.—What are the factors that are essential for determining the economical and profitable working of a power plant ?

A.—The higher the effective output of the engine, the lower the costs per H. P.—hour, and the more economical the working. The higher the number of running hours, the lower the costs per running hour, and the more economical the operation. The running costs increase as the load is reduced, so that all partial loads should be avoided as much as possible.

Q.—What are the Elements of Force ?

A.—The following are the three elements of force :—

(*a*) *Its place or point of application.*—The point or place of application of a force may be actually a point, a line, or a surface.

(*b*) *The direction in which it acts.*—The direction of a force is that line or path in which the force moves, or tends to move, the body on which it acts.

(*c*) *Its magnitude or size.*—The magnitude or size of a force is the number of pounds of pull or push with which the force acts on a body.

Q.—A hole is punched in a piece of leather belting $\frac{1}{4}$-inch thick, the pressure exerted being estimated at 50 lbs. Assuming the resistance to be uniform, find the number of foot-pounds of work done.

A.—Work done = Distance in feet × force or resistance in lbs.

$= \frac{1}{4}$ inch ÷ 12 inch per foot × 50 lb.

$= (\frac{1}{4} \times \frac{1}{12} \times \frac{50}{1})$ ft.-lb.

$= \frac{50}{48} = 1.042$ ft.-lb.

Q.—What is the meaning of shearing strength ?

A.—It is that amount of force—usually expressed in pounds—which, if steadily and slowly applied to the rivet, at right angles to its axis, causes it to separate in parts, which slide over each other. This separation is nearly always at right angles, and in common language is called "Shearing off the rivets."

Q.—What is meant by Mechanical Efficiency ?

A.—The mechanical efficiency of a machine is the ratio of the work done in the cylinders to the effective work got out of the machine, and is obtained by dividing the brake horse-power by the indicated horse-power, or $\frac{\text{B.H.P.}}{\text{I.H.P.}} \times 100 =$ per cent. mechanical efficiency.

Q.—Give the causes of unburnt coal in the ashes and how would you remedy it ?

A.—With bad hand firing and bad adjustment and arrangement of fire grate in Cornish and Lancashire boilers a large quantity of small pieces of coal, and unburnt carbon in the form of coke fall down in the ashpit through the firebars.

Bad adjustment and bad arrangement consist of wide spaces between the fire bars, broken bars, more or less grate area than what is actually needed for the efficient rate of combustion, uneven distribution and height of coal on the grate, frequent disturbance or raking of fire or shaking of the bars, etc. Some engineers arrange to have the unburnt coal and coke picked up from the ashes by employing special labourer for this purpose, but it has been found by experience that it does not pay, unless the work is carried out on a contract basis to supply picked coal and coke at a price equal to about half that of coal. Some machines were devised to separate the fuel from ashes, working on specific gravity system, but they failed to give satisfactory result. Picking up of unburnt fuel from ashes should open the eyes of the engineers to find out if the steam boilers under his charge are well handled and economically fired by the fire-men. With good hand-firing the carbon contents in the ashes should not be more than five per cent., but it has been found 10 to 15 per cent. of the weight of ashes as unburnt fuel in several factories, and even large pieces of good coke are allowed to go waste when the fire is cleaned and fused ahses or clinkers are removed.

In boilers fitted with automatic chain grate stokers a certain quantity of small pieces of coal and unburnt carbon (or "riddlings" as they are called) drop down into the ashpit through broken or missings links In stokers kept under good repairs there should not be more than three per cent. of the coal consumed. These are collected and uniformly mixed with fresh coal for firing. When coal contains a large quantity of coal-dust the percentage of carbon wasted is much increased, because unburnt coal-dust drops down into the ashpit with ashes. When ashes melt or fuse, they spread on the grate as a molten mass and clog the air spaces of the fire bars. Sometimes the molten ash is so hard and adhesive that it is very difficult to remove, and requires a long time to do it keeping the fire doors open, which lowers the efficiency of the boilers besides giving great trouble to the firemen. In such cases the coal should be changed and a new brand having a higher melting point of its ashes should be preferred. In large and modern water tube boilers special automatic devices are fitted for cleaning fire, recovering riddings, controlling temperature of the combustion, removing, cooling and transporting ashes, maintaining a high percentage of Co_2 in waste gases, spreading the fire evenly on the whole of the grate, preventing the fusing of ashes, etc., etc. In fact the efficiency of a steam power plant depends more on the working of boilers than on the steam engines or turbines, and more attention is now paid to boilers and to the control of combustion of fuel than to steam engines or turbines.

Q.—Define Heat.

A.—Heat is a form of energy. It is usually defined as being energy of molecular motion and is not a material substance. In the case of gases this molecular motion is rectilinear and changes in velocity and direction as the gas molecules approach each other. In liquids the motion is irregular and is more restricted than in gases, whilst in solids the motion is very restricted and is oscillatory instead of translatory. The transmission of heat can be effected in three ways, namely, by convection, conduction or radiation. All molecular motion ceases at the temperature of absolute zero, *i.e.*, 492 degrees F., below freezing point (460°F. below zero).

Q.—Define temperature.

A.—Temperature is the term used to denote the hotness of a body or, in other words, the intensity of heat. It does not denote the quantity of heat in a body, since two bodies of equal weight may be at the same temperature, yet the amount of heat necessary to raise each to that temperature may vary widely.

Q.—Heat is not produced at ordinary temperatures. Why ?

A.—Neither Carbon and oxygen, nor hydrogen and oxygen, will combine at ordinary temperatures. Their temperature must first of all be raised to what is called the ignition temperature before the attraction between the two is sufficient to make them combine.

Q.—What parts of an engine are generally made of wrought iron ?

A.—The parts made of wrought iron are those that are easily forged and liable to great tensile stresses, such as piston rods, connecting rods, eccentric rods, valve spindles, crank shafts, air-pump lever, etc.

Q.—What parts of an engine are generally made of cast iron ?

A.—The parts made of cast iron are those that are not easily forged, or require to be strong in compression, such as cylinders, slide valves, columns, condenser, bed-plates; also all pumps, air vessels, valve boxes, etc.

Q.—For what parts of an engine is steel sometimes used ?

A.—The parts sometimes made of steel are piston and connecting rods, valve spindles, eccentric rods, and all shafting, or all wrought iron parts may be made of mild steel, also cylinder liners, escape and relief valve springs, piston springs, etc.

Q.—What parts of an engine are generally made of brass or gun metal ?

A.—Brass or gun metal is mostly used for all working parts or bearings, such as all gland and neck bushes, pump chambers or liners, bucket guards, and seats, also bushes for stern tube, all cocks and valves, except slide valves.

Q.—A swift 50 inches diameter is 60 inches long. Find the length of filleting 2 inches wide required to cover the surface.

A.—Now the area of filleting required is equal to the area of the curved surface of the cylinder. If the length required is X inches, then area of filleting = 2X square inches.

Also Area of curved surface of cylinder

$= X$ Circumference $\times$ length.

$= X\ 3.1416 \times 50 \times 60$ square inches.

Hence $2X = 3.1416 \times 50 \times 60$

$$X = \frac{3.1416 \times 50 \times 60}{2} = 3.1416 \times 1500 = 4712.4$$

$\therefore$ Length of filleting $= 4712.4$ inches $= 392.27$ feet.

Q.—Describe Friction and its effect.

A.—Whenever two surfaces slide over each other, there is friction.

Friction brings with it wear, heat, shortened life, and the need for lubrication.

Frication makes it possible for a man to walk, for a belt to pull, for an automobile to move. Without it man could not exist.

Q.—What is the size of a driven gear if 150 teeth gear making 40 revolutions per minute imparts 120 revolutions per minute to a driven shaft ?

A.—$\dfrac{150 \times 40}{120} = 50$ teeth driven gear.

Q.—What does the word combustion mean ?

A.—To burn, to kindle, to light.

Q.—Where is "white metal" sometimes used ? On account of what property possessed by it is it adopted ? What objection is there to its more general use ?

A.—White metal is often used for bearings and guide blocks, on account of its anti-friction properties, and in modern engines the crank shafting revolve in cast iron or cast steel bushes lined with white metal. The great objection to its more general use is its low melting point, 600°F., and should it be allowed to get hot is liable to run out of the bearing, causing great inconvenience.

Q.—Find the grate area of a boiler that is required to evaporate 8,000 pounds of water per hour from and at 212° ; the rate of combustion, under forced draught, is 24.4 pounds per square foot of grate surface per hour, and the evaporation 10.1 pounds of water from and at 212° per pound of coal.

A.—Formula :—

Let G. = area of grate in square feet.

F. = pounds of coal burnt per square foot of grate per hour.

W. = weight of water, in pounds, to be evaporated per hour by the boiler or boilers.

e. Evaporation, in pounds of water per pound of coal.

$$G = \frac{W}{Fe}$$

$$G = \frac{8000}{24.4 \times 10.1} = 32.5 \text{ square ft. nearly.}$$

Q.—How does the engineer obtain the heat he employs ?

A.—By combustion, which results from the chemical combination of carbon and hydrogen, of which solid or liquid fuel is mainly composed, with the oxygen contained in the air.

Q.—Give the cause that brings about constant stoppages of the engine.

A.—It is a common practice for managers to keep on adding little by little machinery to the already overtaxed engines, and trying to keep pace with higher pressure steam, but it is ultimately found that the repair account is very excessive owing to constant stoppages, brought about by bevel driving wheels, pulleys, machinery balance wheels, all coming loose at the key bed, and all being traceable to an under-balanced fly wheel.

Q.—What are the effects of heat, and what happens when a substance is heated ?

A.—The effects of heating a substance may be classified as follows :—

(1) Change of state ; (2) Change of temperature ; (3) Change of size. Each and every molecule of a substance has a rapid vibratory motion to and fro, and the molecules are prevented from separating by the attractive force of cohesion. When a body is heated, the frequency of these vibrations increases proportionally to the amount of heat supplied and the distance through which each molecule travels is increased. As the molecules move further away from each other the attractive force of cohesion is reduced. If sufficient heat is given to a body the force of cohesion is overcome and the body melts. If still more heat is supplied, the melted body is changed into a gas, and so long as the temperature is maintained, the force of cohesion has no effect owing to the number of vibrations having been so much increased and the distance between any two molecules having become too great for the force of cohesion to act.

Q.—What is material substance ?

A.—Matter is material substance. It is anything which occupies space. It is composed of molecules and atoms. Matter cannot be produced or destroyed. Its appearance may be changed over and over again, but nothing can be added and nothing taken away. Coke may be burnt and only a little ash left, but the matter represented by the difference in weight of the coke and the ash has been converted into an exactly equivalent quantity of colourless gas which passes away unseen.

Q.—Are all gases compressible and have they any property not common to other forms and matter ?

A.—All gases can be compressed. A distinctive property of gases not shared by other forms of matter is their prompt elastic recovery when the compressive force is removed.

Q.—How would you harden hammers and other tools ?

A.—I would heat them to a cherry red and plunge them into a compound made of bone dust, 2 parts ; common salt, 3 parts ; burnt leather shreds, 1 part ; prussiate of potash, 1 part.

Q.—What would you use in turning hard iron or steel for dripping ?

A.—I would use a drip for the tool, of petroleum, 2 parts ; turpentine, 1 part ; and a little camphor.

Q.—What part of coal is first consumed ?

A.—The gas. This unites with the oxygen of the air and burns first.

Q.—How many cubic inches of marble are there in a marble ball 4 inches in diameter ?

A.—Multiply the cube of the diameter by .5236

$4^3 = 64$

$64 \times .5236 = 33.5184$ cubic inches.

Q.—What is the solid content of a cone 33 feet high and 2 feet in diameter at the base ?

A.—Multiply the area of the base by one-third of the altitude

The area of base $= 2^2 \times .7854 = 3.1416$ feet

$\frac{1}{3}$ of $33 = 11$ feet.

Then the contents of the cone are $3.1416 \times 11 = 34.5676$ cubic feet.

Q.—How many cubic feet of water will a cylindrical tank 10 feet in diameter and 12 feet high hold ?

A.—Area of base $= 10^2 \times .7854 = 5400$ square feet.

Capacity of tank $= 78.5400 \times 12 = 942.4800$ c.ft.

Q.—What is the capacity of a box 30 inches long, the ends being 20 inches by 10 inches ?

A.—Multiply the length by the width and by the depth.

$30 \times 20 \times 10 = 6000$ cubic inches.

Q.—What is the circumference of a circle the diameter of which is 40 inches ?

A.—Multiply the diameter by 3.1416

$40'' \times 3.1416 = 125.6640$ inches.

Q.—Describe the Elasticity of a body.

A.—The elasticity of a body is that property by virtue of which it tends to return to its original size and shape when it has been distorted by an external force ; it is the quality that gives "Spring" to a material. Information as to the strength and elasticity of a material is obtained by means, of a testing machine, in which a piece of the material, known as a test piece may be pulled apart, crushed, or sheared.

Q.—A countershaft is to be driven from a main shaft by an open belt, the distance between the centres of the shafts being 14 feet. If the driving pulley is 4 feet in diameter and the driven, pulley 2 feet in diameter what length of belt is required ?

A.—Multiply half the sum of the diameter of the driving and the driven pulleys by 3.1416 and to the product add twice the distance between the centres of the shafts the total sum will be the length of open belt required.

Half the sum of the pulley's diameters is $2+1=3$ feet
Twice the distance between centres $=2\times14\times28$ feet
$\therefore 3.1416\times3=9.4248+28=37.4248$ feet or $37\frac{1}{2}$ feet.

Q.—What is a coupling ?

A.—A coupling joins two short lengths of shafts in order to secure the transmission of the power where long line of shafting is needed for distributing the power.

Q.—What are speed cones or stepped pulleys ?

A.—The speed cones or stepped pulleys are used when rapid changes in speed are required. The changes are affected by means of driving, and driven pulleys having several different diameters.

Q.—A drum 10 inches in diameter and 6 feet long, is completely covered with a close wrapping of wire 0.05 inch in diameter, find the length of the wire.

A.—$.05=\frac{1}{20}$

$\therefore$ 2.0 wires in one inch
6 feet $\times$ 12 (inches) $=$ 72 inches
$72\times20=1440$ wires.

The circumference of 10 inches diameter $=31.41$ inches.
$1440\times31.41=45230.4$ inches or 3769.2 feet length of wire.

Q.—What is a drum ?

A.—A drum is a flat pulley the face of which is sufficiently wide to admit two or four belts to be driven from it.

Q.—What is the diameter of a circle the length of circumference of which is 4 feet ?

A.—Divide the circumference by 3.1416
4 feet $\div$ 3.1416 $=$ 1.2732 feet.

Q.—What is the difference between friction and contact ?

A.—The difference between friction and contact is that the former produces heat while the latter does not and is only driven by touch.

Friction makes heat enough to make a bearing expand and seize heat enough to burn any one that touches it, whenever bearing lubrication breaks down completely.

Q.—A drum, 12 inches diameter, is fixed on a barrel 5 inches diameter. If the weight 100 pounds is attached to a cord which is coiled round a barrel, what force will be exerted at the circumference of the drum ?

A.—This is an example of the 'wheel and axle,' the wheel (drum) being 12 inches in diameter and the axle (barrel) 5 inches in diameter.

$$\frac{1000 \times 5}{12} = 41.6 \text{ lbs.}$$

Q.—What is a flange pulley ?

A.—In some belt drives the nature of the work is such that there will be severe momentary increases in the load. The tendency of the belt is then to run off the pulley ; to guard against this, the rim may be cast with flanges.

Such pulleys are also used sometimes on vertical shafts to prevent the belt running off.

Q.—How would you find the velocities, etc., of toothed gears.

A.—The relative velocities of gears is as the number of their thete.

Where idle or intermediate gears intervene they are not reckoned.

Hand Warm Water

110° to 120° Fah., water boils when it is raised to a temperature of 202° Fah. = 100°C.

Horse Power

A unit of work used to express the power of a prime mover, and fixed arbitrarily at 33000 feet pounds, or 33000 pounds lifted 1 foot high in a minute.

Horse Power (Indicated)

The measure of the actual work done, as deducted from the mean pressure in the cylinder without deducting any of the subsequent losses due to friction and other causes.

Horse Power (Gross) and Brake Horse Power

The net power actually available for useful work after all losses in the engine have been deducted. It is measured by a Dynamometer or 'Brake' which indicates the actual weight lifted by the engine during the trial.

" Hydrostatics "

Hydrostatics treats of liquids at rest under the action of forces.

Liquids are very nearly incompressible. A pressure of 15 pounds per square inch Compresses Water less than 1/20,000 of its volume.

Inch = 25.4 millimetres (or 2.54 cms.)

Ion

A molecular or atomic aggregate which carries an excess of either positive or negative electrical charge.

Iron Wire

This kind of wire is largely used for telegraph and telephone lines, although it is rapidly being replaced by copper in long lines.

There are three grades of iron wire :—

(1) Extra best best (EBB.), which has the highest conductivity and is the nearest to being uniform in quality, being both tough and pliable. (2) Best best (BB.), which varies in quality, is not so tough, and is lower in conductivity. It is frequently sold as EBB. (3) Best (B), which is the poorest grade made, being more brittle, and lowest in conductivity. Iron wire should be well galvanized.

Jilttermetre

Is a delicate and ingenuious contrivance when placed on a man's head, it makes a record of his fear, alarm, consternation.

Q.—What is Heat.

A.—The sensations of warmth and Cold are familiar to everyone. If the hand is placed in water, a sensation is produced ; and, according to the sensation, the water is pronounced cold, luke-warm, or hot. It is customary to ascribe the cause of the differences between these states of the water to something called heat ; thus, when the water gives the sensation of warmth, it is said to have been heated, or to have had heat added to it ; when it gives the opposite sensation, it is said to have been cooled, or to have had heat taken from it. Heat can be recognised and measured.

Heat is derived from the following sources : 'Physical sources,' which are the radiation of heat from the sun, terrestrial heat, change of state in bodies ; and electricity ; Chemical sources' or molecular combinations, more especially combustion ; 'mechanical sources,' Comprising friction, percussion and pressure.

A unit of heat is the quantity of heat required to raise the temperature of 1 pound of water at or near its temperature of greatest density (31.9°F) through 1° F.

Q.—Water-gauge test-cocks; where are they placed? At what heights? Must the cocks tehmselves be at those heights? What provision is made for cleaning these cocks should they ever become choked? When there are no test cocks, how is the height of the water ascertained?

A.—Test cocks are placed generally on the end plate of the boiler, although some makers prefer to put them on the side of the water-gauge column. The bottom one should be placed at least 3 inches above the combustion chamber tops, the middle one at the working level, and the top one in the steam space. The cocks are better placed at those heights, but internal pipes leading to the cocks might be fitted. This is not considered good practice as they are liable to become choked or broken. To allow for cleaning, a small plug is screwed into the cock opposite the bore of the plug. When no test cocks are fitted, the water level can only be ascertained by means of the gauge glass.

Q.—How is the gas in the coal ignited?

A.—The heat under which the gas itself distills will always ignite it if the required quantity of air is immediately obtained.

Q.—What is the Combustion Chamber?

A.—It is that space under the boiler where the burning or combustion of the fuel takes place.

Q.—What is the thinnest sheet which should be used in a boiler?

A.—One-quarter of an inch, this is the thinnest which can be caulked to advantage.

Q.—Of what pieces does a glass water-gauge mounting consist? How does it act? Where is it placed? At what height? Is it liable to derangement? How is its working tested?

A.—Water-gauge mountings consist of a column or hollow pillar, into which cocks are fitted with stuffing boxes to receive a glass gauge. The column is connected to the end of the boiler by means of copper pipes. As the water stands in the glass it gives a correct reading of the height of the water in the boiler. The bottom of the glass should be at least 5 inches above the combustion chamber tops. It might show a false level should the passages become choked. It is tested by double-shutting-off and draining the glass.

An engineer on duty should always be able to tell when it is necessary to blow the gauge glass through by noticing whether the water level is stationary or rising or falling with the motion of the water inside the boiler. Should the water level appear stationary the drain cock should be at once opened and allowed to remain so for a few seconds, if on shutting it no water is seen to return to the glass, then in all probability the glass is full of steam, so proving the bottom or water cock to be chocked, in which case shut off the top or steam cock and clear the water cock. Should, however, on shutting the drain the water be seen to rise up and fill the glass, then in all probability the steam cock is choked, in which case the bottom or water cock would be shut off and the top or steam cock cleared, so that whenever the water appears stationary or sluggish in the glass open the drain and blow the glass through, then shut off whatever appears in the glass and try to get the other.

Q.—What fuels are generally used for internal combustion engines ?

A.—Petroleum, shale oil distilled from shale, and tar oil distilled from coal.

Q.—What is meant by the "Conduction" of heat ? Give examples of it in the boiler and in the engine.

A.—Conduction is the transmission of heat through different metals. In the boiler, heat is conducted through the shell plates from the inside to the outside, and from the fire side of all heating surfaces to the water side of the plate. In the engines, heat is conducted through the metal in the cylinder from the inside to the outside.

Q.—Describe the Physical Laws of Heat ?

A.—The first Law is :—"Heat always flows from the hotter to the colder object."

If a cup of hot water is placed on a piece of ice, some of the ice will be melted and turned into water, and the hot water in the cup will become cooler. Thus the heat in the hot water has passed through the cup into the ice.

The second Law is :—"When a solid such as ice is turned into a liquid, heat is absorbed."

This law is illustrated by the piece of ice absorbing the heat from the cup of hot water, and the ice changing into water.

The third Law is :—"When a liquid is turned into a Vapour or a gas, the gas has a higher temperature because heat is absorbed."

This law is illustrated by pouring slowly a few drops of water on a red-hot iron plate. The first few drops of water that strike the red-hot iron plate are turned into steam or hot vapour instantly, and disappear in the air. Then it takes longer and longer for the drops of water to be turned into steam, and finally the drops of water will not turn into steam. This proves that when the drops of water turn into steam, the heat in the iron plate is absorbed by the water in forming steam and by the surrounding air, so that the iron plate finally has the same temperature as the air around it.

The opposite is also true :—"When a vapour or gas is turned into liquid, heat is given up." If a cold iron plate is held over a jet of steam, drops of water will form on the plate whenever the steam strikes it ; in other words, the cold plate condenses the steam. After a little while it will be noticed that the cold plate has become warm. This shows that when the steam or gas was condensed into water or liquid, it gave up its heat to the surrounding objects.

Another Law is :—Different liquids have different temperatures at which they boil.

We find that water boils at 212 degrees, alcohol at 170 degrees, ether at 94 degrees, sulphur dioxide at 14 degrees, and freezol at 10 degrees above zero Fah. ; while methyl chloride boils at minus 10.65 degrees or at 10.65 degrees below zero Fahrenheit. When methyl chloride reaches 10.65 degrees below zero, it begins to boil and to absorb heat units from anything warmer, so one can easily see why it cools off things very rapidly. It is difficult to conceive of a liquid boiling at a temperature below zero, as we always seem to have water in mind, which boils only at the high temperature of 212 degrees ; yet a glass of methyl chloride placed on a table will boil, the heat being supplied by the temperature of the air.

It is clear, therefore, that if you bring any warm object near a substance like liquid methyl chloride or sulphur dioxide, which have low boiling points, that the heat will flow to them, because heat always flows from the hotter to the colder object. This point can best be illustrated as follows :—

Suppose a pan of liquid methyl chloride and a bottle of lemonade are placed in a refrigerator box, the box having a vent to the outer air. The ordinary heat in the interior of the box added to that contained in the lemonade, which may be around 70 degrees Fah., would start the methyl chloride to boil. Heat, therefore, would be absorbed. Some of the liquid methyl would be turned into vapour, just as water would be turned into steam, and would escape through the vent. Soon both the interior of the box and the bottle of lemonade would become very cold—which is the desired result. But as methyl chloride is too expensive to be wasted in vapour, a means has been devised whereby the vapour can be reconverted into its liquid form by compressing the gas and then condensing or cooling it.

Another Law is :—"The boiling point of liquids changes with pressure." If any liquid, such as water, alcohol, ether, etc., were placed in a tight tank and the pressure in the tank was increased to 100 pounds as read on the gauge, the liquid would not boil at the temperature given, but would have to be heated to a higher temperature in order to boil. If this liquid were water, the temperature would have to be raised to 338 degrees Fah. before the water would boil and turn into steam. Also at a pressure of 100 pounds, steam can be condensed into a liquid at 338 degrees Fah. Thus it is evident that steam can be condensed at a higher temperature with a high pressure than with a low pressure. Sulphur-dioxide under a pressure of 17.5 pounds (gauge) condenses to a liquid at 50 degrees Fahrenheit.

Q.—What are the chief combustible substances of liquid fuel ?

A.—Carbon and hydrogen.

Q.—How would you increase the heat efficiency in an steam engine ?

A.—There are two ways by which the heat efficiency of the ideal steam engine may be increased.

(1) The temperature, and consequently the pressure, at which the steam enters the engine may be increased.

(2) The temperature and pressure at which the steam leaves the engine may be decreased. The purpose of a condenser is to increase the heat efficiency by means of the second of these two methods.

In non-condensing engine the steam is exhausted into the atmosphere, and therefore the exhaust steam must have at least the pressure of the atmosphere; in practice, the back pressure of steam in a non-condensing engine is scarcely ever less than 16 pounds per square inch, absolute, and is usually 17 pounds or more. In good condensing engines the back pressure is sometimes as low as 2 pounds above the absolute zero of pressure.

In the economical operation of steam turbines a high degree of vacuum is one of the most important factors, and a back pressure of 1 pound, or even less, is obtained.

Q.—What is the job of a Lubrication Engineer.

A.—The job of a Lubrication Engineer is to put at the service of his employer information that will enable them to enjoy the benefit of correct Lubrication. For every job requiring lubrication these things are necessary : the right oil, applied in the right way at the right place, at the right time.

The author has the experience of an artificial silk weaving mill where a straight mineral oil was used instead of a compounded oil for lubricating the looms. The result was that every piece that was produced had stains which could not be removed. But thousands of rupees were saved when the oil was changed to compounded oil. As the stains could easily be removed and the pieces were sold as good pieces and not as seconds.

Q.—What is fuel ?

A.—Fuel is matter containing substances which, if combined with certain other substances, produce heat.

1 Kilogramme-Kilo = 2.204 lbs.
1 Kilometre = 1094 yards.
1 Kilo-calorie = A unit of heat equal to 1000 calories.

Q.—What horse power is required for an hoist to lift a weight of 2200 lbs. through a distance of 30 feet in one minute ?

A.—Multiply the force in pounds by the distance through which it acts, in feet, and divide the product by 33000 times the time required in a minute.

$$\frac{2200 \times 30}{33000} = 2 \text{ horse power.}$$

Q.—A main driving belt has a speed of 3000 feet per minute and is 12 inches wide. If the belt is single what horse power is transmitted ?

A.—The horse power transmitted by a single belt is equal to the product of the width of the belt in inches, and the speed of the belt in foot per minute, divided by 900.

$$\frac{12 \times 300}{900} = 40 \text{ horse power.}$$

Q.—Two pulleys, each of which is 36 inches in diameter, are to be connected by a single belt and are to make 240 revolutions per minute, what width of belt is required to transmit 30 horse power ?

A.—The width of single belt, in inches, required to transmit a given horse power is equal to 900 times the horse power divided by the speed of the belt in foot per minute.

The diameter of each pulley is 36 inches or 3 feet.

Find the surface speed of the pulley.

$\therefore$ Surface speed of the pulley $= 3.1416 \times 3 \times 240$
$= 2262$ feet, per minute approximately.

The width of belt required is $\dfrac{900 \times 36}{2262} = 14.32$ inches.

Q.—What is a line shaft ?

A.—A line shaft is that which is driven from the main shaft and it is the main driving shaft of the loom.

Q.—What is a hanger ?

A.—A hanger is that which supports for convenience and safety the shafting from ceiling.

Q.—What does the Science of Mechanics consists of ?

A.—The science of mechanics consists of two distinct parts namely (1) statics which deals with forces not in motion; and (2) dynamics, which deals with forces in motion.

Q.—What is Force ?

A.—Force is that which causes, or tends to cause, motion or change of motion in the matter upon which it acts, The most usual result of force, and that which is most easily understood, is the simple case of pushing or pulling a body of any kind so as to cause it to be moved from one position to another. If, on the other hand, the force applied is not sufficiently great to move the body, it nevertheless tends to move it, and in this condition the body may be subjected to one of many kinds of force-actions, *e.g.*, pressure, tension, etc.

Q.—What is latent heat ?

A.—Latent heat is a hidden heat.

Q.—How would you ascertain the best size of Injector for any given boiler.

A.—Multiply the nominal horse power by 10, which gives the number of gallons of water required per hour.

Q.—What is a key ?

A.—A key is tapered piece of metal that fits into slots in both a shaft and cone drum (of a sizing frame). The slot is also known as a key way, key seat or bed.

Q.—What are lubricants and for what purpose are they used in machinery ?

A.—Lubricants are substance of a greasy nature, and are used to reduce the friction when two substances are working in contact as in a shaft and its bearing.

Q.—What is a lever ?

A.—A lever is an inflexible bar capable of being freely moved about a fixed point or line, called the fulcrum.

Q.—If the weight arm of a lever is 6 inches long and the force arm is 4 feet long, how great a weight can be raised by a force of 20 pounds at the end of the force arm ?

Rule :—The force multiplied by the distance through which it acts equals the weight multiplied by the distance through which it moves.

A.—In this example, the weight is unknown ; hence representing it by X, after reducing 4 ft. to inches, $20 \times 48 = 960 =$ the force multiplied by the force arm ; and $X \times 6 =$ weight multiplied by the weight arm. Dividing 960 by $6 = 160$ lbs. $=$ the weight.

Q.—What is a compound lever.

A.—A compound lever is a series of single levers arranged in such a manner that when a force is applied to the first it is communicated to the second, and from this to the third and so on.

Q.—How would you find the number of Horse-power that the teeth of wheels (spurs and Bevel Wheels) are capable of transmitting.

A.—Multiply the square of the pitch in inches by the breadth of tooth and by the velocity in feet per minute, and divide the product by 1000 the result will be the number of horse-power the gear will transmit.

Q.—What are necessary qualities for every good lubricant to possess ?

A.—(1) Body to resist the pressure of the two rubbing surfaces, (2) freedom from acid, (3) permanent fluidity.

Q.—A wedge has a slope of 1 vertical to 20 horizontal if this wedge is used to lift roller by being pushed horizontally beneath it, how far will it have to be pushed in order to lift the roller $\frac{5}{8}$ inch ?

$$1 : \tfrac{5}{8} : : 20$$

$$\frac{20 \times 5}{8} = \frac{25}{2} = 12.5 \text{ inches.}$$

Q.—Explain briefly what do you understand by the term Specific Gravity in connection with lubricating oil.

A.—The specific gravity of an oil is the ratio of its weight to that of an equal volume of water at the same temperature. As one Imperial gallon of water weighs 10 lbs., the weight of one Imperial gallon of oil, in pounfls, is equal to ten times the specific gravity of the oil. It is customary in England for lubricating oils to be bought and sold on the basis of a unit of 9 lbs. specific gravities are determined usually with an hydrometer, which may be graduated to read specific gravity or Beaumé degrees. In England the former is customary; but in the petroleum industry of America both are employed. On the Continent, it is usual to determine density at 15°C. Density is defined as the weight of unit volume, and in the metric system indicates in grammes the weight of one millilitre (1 ml.) of the liquid. As one ml. of pure water at 4°C (approx.) weighs one gramme, density is almost identical with specific gravity. The hydrometer is placed in the oil and allowed to remain long enough to become stationary. It then registers the specific gravity at the temperature of the oil in which it is placed. For lubricating oils, owing to expansion, an approximate correction is made by adding to the observed specific gravity reading when the temperature is above 60°F., and subtracting if below, an amount equal to the coefficient of expansion multiplied by the number of degrees the temperature differs from 60°F. On the Beaumé scale the correction is made by adding to the observed gravity reading when the temperature is below 60°F., and subtracting when the temperature is above 60°F., 1° Beaumé for each 20°F. The coefficient of expansion is approximately the same for all lubricating oils, and can be taken for practical purposes as being 0.00034 per °F. or 0.00061 per °C. Specific gravity, by itself, is of no assistance whatever in determining the lubricating value or quality of an oil.

It must be known for converting Redwood or other viscosity readings to absolute viscosity. Apart from its uses in refining, it is of service for tonnage—Volume Calculation, *e.g.*, in measuring the contents of storage tanks.

Q.—Explain what is meant by the terms "Protective" and "Selective" specifications in connection with lubricating oil.

A.—Protective specifications aim at providing safeguards against the purchase of inferior, adulterated or unsuitable materials. Their stipulations include chemical and physical tests intended to eliminate definetly products that would be unsatisfactory in service.

Selective specifications aim at defining charactersistics that are essential to satisfactory performance.

Q.—How are the properties or characteristics of lubricating oil divided both physically and chemically.

A.—The properties or characteristics of lubricating oils can be divided roughly into those ascertainable by physical and by chemical tests respectively, as follows :—

"Physical."

Specific Gravity.
Viscosity.
Volatility or Loss by Evaporation.
Flash Point and Fire Point.
Setting Point.
Colour and Fluorescence.
Specific Heat.
Surface Tension.
Capillarity.
Demulsification.

"Chemical."

Saponifiable matter.
Acidity—Inorganic and Organic.
Unsaturation.
Oxidation and Gumming.
Carbon Residue.
Ash.
Oiliness.

Q.—What are the points to be taken into considerations when selecting a lubricant ?

A.—The consistency of some preparations varies considerably with the temperature, it may even be necessary to use lubricants of different character according to the season of the year. For a general rule it may be added that the quicker the speed of the parts the higher the melting point of the lubricating agent. The speed of the machine parts, and the amount of friction which is convertible into heat, are determining factors. It is obvious that the oils used should be non-drying and free from gummy matter.

Q.—Explain the use of Lubrication of Textile Machinery ?

A.—In textile factories the lubricant has not only to reduce the friction in the bearings, but must not damage the fabric if it gets on it ; and owing to the presence of fine fluff gathering on the floor in the mill, which, if it gets mixed with oil, becomes highly inflammable and may ignite spontaneously, it is important that the oil leakage from the bearings is reduced to a minimum.

On all ball and roller bearings it is preferable to use grease, as this is not so likely to leak out as oil, and also seals the bearings against the entry of grit. Mineral oil, if it gets on the fabric, irretrievably damages it, as it cannot be removed without seriously damaging the material. In some cases manufacturers have discarded the use of mineral oils in some processes, using instead a mixture of sperm and castor oil, as this makes a good lubricant and the stain it makes is removable.

In the spinning department the difference in power consumption caused by good or bad lubrication may amount to 15 per cent. of the total load, and this calls for serious attention. A very light oil should be used. Bad lubrication, besides causing power losses, results in wear which in time destroys the accuracy of the machine.

As any oil which leaks out will probably get mixed with fluff, etc., making a higher inflammable mixture, places where oil leakage is likely to occur should have a container so fixed that it will catch any dripping oil or the bearing should be kept clean by continual wiping. Chain drives, as are now largely used, need to be well lubricated if their efficiency is to be maintained. Chain cases are often used which contain an oil-bath in which the chain dips while running.

Q.—Should a quantity of oil take fire, how can it best be extinguished ?

A.—Should the fire take place in a confined space gases which do not support combustion, such as carbon dioxide and sulphur dioxide, can be used with success. If the compartment in which the fire takes place can be sealed up to exclude air, which is necessary for combustion, te fire will die out when the air in the compartment has been used up. When the fire is unconfined or in the open, the best way to extinguish the flame in the absence of suitable fire-extinguishing apparatus, is to smother the flame with sand, asbestos matting, or other inert material.

Lacquering Brass

Boil the brass in a solution of potash and soda, after which dip it in aquafortis, 3 parts water. Wash it in two waters and rub in saw-dust. Place on a gas stove, when warm brush it, then apply lacquer. Put the finished work on the stove covered with brown paper.

1 Large Ream = 500 sheets.

Latitude

1° of latitude increases gradually from 68.7 miles at the Equator to 69.4 miles at the Poles in Britain = 69.2 miles Longitude.

Latitude 0°		10°	20°	30°	40°	50°	60°	70°	80°
0°	69.00	67.96	64.86	59.80	52.92	44.44	34.59	23.67	12.02
5°	68.74	66.66	62.57	56.58	48.87	39.66	29.24	17.91	11.97

Leaky Pistons

Leaky pistons are another source of loss, and the amount of steam which from this cause. escapes past the piston increases with the pressure of the steam and also with the age of the engine, so that a quantity of steam is continually passing through the cylinder without performing any work.

Leaky Valves

Leaky valves also cause loss by admitting the steam after it is supposed to be cut off, and the initial work of such steam is lost, the cause of leakage being either want of stiffness in the valve, which allows it to bend into the ports in passing over them, or the surface is made so small that capillary attrction does not properly take place between the valve and its seat.

The Lever

A lever is a rigid bar which can be turned freely about a fixed point called the fulcrum.

Light

Travels 186,325 miles in 1 second. The light of the sun takes about 8 minutes to reach the earth.

1 Litre = $1\frac{3}{4}$ pints (approximately).

Lubricating Mixture

Sixteen ounces of good lard, 2 ounces of bee's wax, 8 ounces of flour of sulphur, 5 ounces of black lead, 16 ounces of white soap.

Malleable Iron Castings

Iron casting which have been rendered soft and ductile by prolonged heating in contact with a discarbonising substance, such as oxide of iron, which, by depriving them of some of the carbon combined with them, converts their metal to a greater or less depth into malleable iron.

1 Maund = $82\frac{7}{8}$ lbs.

Matter

Matter means all things which can be recognised by the help of the senses.

Malleability

The changing of the shape by hammering, pressing, or rolling without causing fracture.

Mechanics

Mechanics is that science which treats the action of forces on bodies and the effects that they produce. It treats of the laws that govern the movement and equilibrium of bodies and shows how they may be applied.

Measurement of Change of Temperature

A change in the state of hotness of a body is spoken of as change of temperature. The change of size which takes place when a thing is heated thus provides a means of measuring the change of temperature which it undergoes. A thermometer, therefore, is an instrument used to measure change of temperature.

Mensuration

It treats of the measurement of lines, angles, surfaces and solids.

Mild Steel

It is an alloy of iron with a very small percentage of carbon. It has a crystalline structure, and is weldable but cannot be hardened.

Safe strength of mild steel in tension = 16,000 lbs. per sq. inch.

Ultimate strength of mild steel in tension = 60,000 lbs. per sq. inch.

Mild Steel

It is cheaper than wrought iron and similar to cut and file. It is not so safely welded. It is crystalline in structure and is largely used for structural work and simple machine parts. It is obtainable in many qualities from a soft form which can be carburised for skin hardness to a form which can be toughened by heat treatment.

1 Millimetre = .03937 inches.

Mitre Wheels

Bevel wheels which gear with and are exactly similar to each other.

Motion — Motion means change of place.

Muntz Metal

Is an alloy of 60 per cent of copper and 40 per cent of zinc, although a small percentage of lead is sometimes included. It has a tensile strength of 22 tons per square inch, which is about equal to wrought iron.

Q.—How would you remove nuts which have rusted fast on bolts ?

A.—I would make a funnel of clay round the nut, and fill it with petroleum, and let it remain for a few hours.

Q.—Define a Jet Condenser.

A.—A jet condenser may be defined as a condenser in which the exhaust steam and the condensing water mingle, and where the steam, consequently, is condensed by direct contact with the water. Jet condensers may be further classified, according to their methods of action, as common jet condensers, barometic condensers, and ejector condensers.

Q.—How would you test the oiliness of oil ?

A.—Oiliness is the capacity of an oil to retain an unbroken film, sustained by its viscosity. The unsaturated hydro-carbons forming a friction decreasing surface with the metals. The adhesive property in the definition of viscosity meant the adhesive quality of the oil particles within their own body of composition enabling them to resist disruption under pressure. This is a fundamental characteristic of the viscous property.

Water is easily squeezed out from between two contact surfaces. The water particles are not adhesive enough or have not that affinity between themselves to stick and resist separation. Thus water would not be as viscous as castor oil.

Clean and dry two household saucers, then smear thinly with the oil to be tested, and hold at an angle of about 45 degrees under a running water tap. It will be found that the "oiler" the oil is, the greater is the time taken to wash off the film and "wet" the plate.

Q.—State why correct lubrication is very important.

A.—Correct lubrication of gears accomplishes definite, appreciable economies. Most outstanding is the reduction of wear, since this in turn affects maintenance and replacement costs, reliability and accuracy of operation, and hence may influence both quantity and quality as well as cost of the product manufactured.

Q.—What is the function of lubricating oil when applied to bearings ?

A.—The function of lubricating oil is to separate the metallic rubbing surfaces and so reduce the frictional resistance by substituting fluid friction for metallic friction.

Q.—Does crude oil control quality of oil ?

A.—No. Because good, bad and middling oils often come from the same crude. Crudes, therefore, never actually control quality.

Q.—Explain, what is meant by saying one crude oil is better than another.

A.—Quality in lubricating oil is wholly a matter of chemistry, when an oil man says that one crude oil is better than another, he really means that the chemical constituents of one are more useful for his purposes, or are more easily handled than the chemical constituents of the other.

Q.—What does an oil depend upon for its quality ?

A.—The chemical composition of any crude must be changed before it can be used as a quality lubricant, and the quality of the finished oil depends upon the chemical changes which are brought about in the refinery. Quality comes from control of manufacturing processes.

Q.—What is the ideal chemical composition for a good lubricating oil ?

A.—The Paraffins are chemically stable compounds. They stand up well under heat and consume slowly. But their chief distinguishing characteristic is that their viscosity changes only moderately under changing temperatures.

The Naphthenes, also, are chemically stable compounds. They are tough and heat resist out, but their chief distinguishing characteristics are found in their control of carbon deposits. Oils rich in Naphthenes have been found to have a low rate of carbon formation.

The Olefins are among the best of the lubricant hydro-carbons. They are chemically more active than paraffins and naphthenes. Consequently, they consume more rapidly than paraffins and naphthenes, but they contribute an essential quality to the oil in their ability to cling to metal surfaces and to deposit an oily film which will protect the metal even when no liquid oil film is present. In other words, olefins give to oil its "oily character." So we see that all mineral lubricating oils are made principally from three main types of chemical compounds while the three types have some physical characteristics in common—that is to say, they look and feel much alike—they are chemically different [illegible] they impart different characteristics to a lubricant. The distinguishing characteristics of these three groups or families of compounds might be listed as follows :—

Paraffins maintain viscosity best under temperature changes.

Olefins contribute oily character. Naphthenes lessen hard carbon deposit.

Q.—How would you judge the Viscosity in oil ?

A.—Viscosity in oil is judged by the number of seconds it takes for a standard quantity of the oil to flow through a standard orifice at certain temperatures, usually 60°F., 140°, and 200°. If buyers would only go to this little trouble of getting the above tests from the firms from whom they obtain their supplies they would thus be in possession of facts which would help them materially when buying their goods. If, for some reason, one does not wish to ask for these figures from the suppliers of their lubricants, the samples may be sent to an analyst, and on the payment of a small fee or charge they can have independent figures to work from. The advantage to be gained from this is easily seen, as you can call for a price for a given quality of oil based on these tests, and each firm submitting a price should be required to quote on these figures as a minimum and give their guarantee to conform to the tests at all times. It is not sufficient to give a sample out and ask for a match of this or that oil ; their appearance may be identical, but proof of the quality of oil is based on the actual test figures.

Q.—State whether it is advisable to use grease as a lubricant. If not. Why ?

A.—In a good many mills shafting is lubricated by a special shafting grease and the only reason is the ease with which it is applied and the little attention that it calls for. Now shafting that is lubricated by grease is another drain on the Coal account. It has many disadvantages. Where a shaft has oil bottles on, its lubrication is complete after the first revolution of the shaft, but not so with grease, especially in cold weather, as the grease is well up near the glass in the shed and becomes stiff and chilled, so that the shaft must get hot through friction before it obtains its lubrication. In some cases where the grease is made from a soft soap base the heat dries the grease up, it shrinks and the shaft runs what is known as "hollow," that is, it is not in contact with the grease and, consequently, receives no lubrication whatever. The result is worn bearings, shafting out of line, and increased engine load.

Q.—Point out one of the weaknesses that a buyer of lubricating oil suffers from.

A.—The chief weakness with buyers of oils that they invariably do not know what they are buying except that it bears a certain firm's name and grade, and that it "does." All oils have a test, that is, they have a value in quality by which they can be judged and the value is determined by the specific gravity (the thickness of the oil) at 60°F., open and closed flash point. The latter is the temperature Fahrenheit at which the oils when heated give off a gas or Vapour that will light momentarily. Fire test is the temperature Fahrenheit at which the oils when heated will give off a vapour that will continue to burn.

Q.—Describe the term viscosity of an oil.

A.—The Viscosity of an oil is the measure of its resistance to flow—its internal friction. Fluidity is the inverse of viscosity, *i.e.*, a very fluid oil is one of low viscosity, whilst an oil of low fluidity possesses high viscosity.

Q.—Describe briefly the extend of loss sustained by lubricating oil due to evaporation.

A.—On exposure to the atmosphere, all liquids tend to evaporate, some more quickly than others. Petrol, for instance, evaporates readily at ordinary temperatures; whereas lubricating oils evaporate so slowly that a coating of lubricating oil may protect metal against corrosion almost indefinitely.

Lubricating oils differ one from another in their rates of evaporation. This is because all lubricating oils are composed of varying proportions of individual hydrocarbons, each of which possesses its own definite vapour pressure and boiling point. The rate of evaporation is therefore influenced by the proportion and nature of each of these hydrocarbons in a given oil.

Q.—Is petroleum oil in its crude state suitable as a fuel for Diesel engines?

A.—Most crude petroleums are suitable as fuel for Diesel engines, providing they do not contain too much water or earthy matter.

Q.—What do you understand by the terms "Flash point" and "Fire point" in connection with lubricating oil?

A.—Flash point is the temperature at which a definite volume of oil, when heated in standardized apparatus, will give off vapour in sufficient quantity to flash momentarily when a small test flame is applied.

The fire point of an oil is the temperature at which sufficient vapour is given off to maintain combustion after ignition.

Q.—What do you understand by the "Setting Point" of a lubricating oil ?

A.—The temperature at which an oil ceases to flow when cooled under specified conditions without disturbance of the mass is known as the Setting Point.

The Setting Point of a lubricating oil must be low enough for the oil to retain sufficient fluidity, at the lowest temperature encountered in service, to ensure an adequate supply to the working parts immediately those parts are put in motion.

Q.—What are the three forms of surface tension that are of interest to oil users.

A.—The three forms of surface tension of interest to oil users, are as follows :—

(*a*) that between oil and metals ; (*b*) that between oil and air ; (*c*) and that between oil and water.

The degree of surface tension between an oil and metals determines the rapidity of spread of the oil film over metallic surfaces, and also its tenacity under high pressures and high speeds.

The capacity of an oil to adhere, under operating conditions, to the surface to be lubricated determines to a large extent its value as a lubricant.

Q.—What do you understand by Emulsification of lubricating oil ?

A.—Emulsification is the mechanical combination of two or more liquid substances which, although normally unmixable, are intimately mixed. The emulsion may separate quickly or may remain stable for long periods.

The rate at which an emulsion of lubricating oil and water will separate and the completeness of the separation depend upon the surface tension, specific, gravity and viscosity of the oil, the intimacy of the original mixture, temperature, and the presence in the water of impurities which act as emulsifying agents.

Q.—What is the difference between mineral oils and fixed oil ?

A.—Fixed oils contain corrosive acids while mineral oils do not. Upon being heated to a temperature sufficiently high to vaporise them, animal and vegetable oils decompose.

Q.—What essential properties should oil for bearing lubrication possess ?

A.—It should retain as much as possible of its viscosity at the working temperature of the bearings, and be free from corrosive acids. The flash point should be moderately high, *i.e.*, about 400°F.

1 oz. = 2½ tollas.
1 Palm = 8 inches.
1 Pint = 20 ozs.

Pitch of a Screw

The distance between any two consecutive threads or turns of the spiral measured parallel to the axis. It represents the distance with one complete revolution of a screw that will advance or withdraw it if it revolves in an unyielding substance.

Pitch of a Gear

The distance apart of the teeth from each other, and gears of unequal pitch cannot run together.

Pitch Line of a Gear

The pitch line of a gear is a circle struck from the centre, and passing through the middle of the teeth. It defines the diameter of a gear, which is not, as many suppose, the whole distance across from point to point of teeth, but half way from bottom to top of teeth.

Plank

It is a flat piece of timber irrespective of dimensions.

A motion driven by gearing as distinct from one driven friction or some non-positive force.

Power

Power is the rate of doing work, and it is measured by the work done in a second. The unit power used by the engineers is the horse-power, and it has a value of 33,000 foot-pounds per minute, or 550-foot-pounds a second.

Power or Rate of doing Work.—1 joule per second = 1 watt = 44.24 foot-pounds per minute. 100 watts = 1 kilo-watt. 746 watts = British horse-power = 33,000 foot-pounds per minute = 550 foot-pounds per second. 1 metric horse-power = 1 cheval de force = cheval-vapeur = 1 Pferdekfrat (German) = 75 kilogrammetres per second = 0.9863 British horse-power = 735.75 watts = 542.475 foot-pounds per second.

Pressure—1 pound per square inch = 0.0708 kilogramme per square centimetre.

1 kilogramme per square centimere = 14.223 lbs. per square inch.

1 atmosphere = 30 inches of mercury = nearly 76 centimetres of mercury = nearly 15 lbs. per square inch = nearly 1,000,000 dynes per square centimetre.

Protan

The fundamental unit of positive electricity. Its charge is 4.774×10^{-10} positive electrostatic unit and its mass, as determined by Rutherford, is practically identical with that of the neutral atom of hydrogen, *i.e.*, 1.66×10^{-24} gramme, or 1.007 on the oxygen scale.

Pulley

A pulley transmits power by means of a belt that runs round the face of the pulley.

Pulleys for the transmission of power by belt may be divided into two principal classes (*a*) The solid pulley, in wh ch the hub, arms, and rim are one entire casting; (*b*) The split pulley which is cast in halves, and bolted together.

1 Quire = 24 sheets of paper.

Q.—A steam pipe is 4 inches diameter and the metal is $\frac{3}{8}$ inch thick; if the pipe is of cast-iron which weighs ·26 lbs. per cubic inch and is 15 feet long, find its weight.

A.—Area of pipe (outside) $= \frac{22}{7} \times 2 \times 2 = \frac{88}{7}$ square inch.

Area of inside hole $= \frac{22}{7} \times \frac{13}{8} \times \frac{13}{8} = \frac{1859}{224}$

∴ Area of metal $= \frac{88}{7} - \frac{1859}{224} = \frac{957}{224}$ square inch.

∴ Weight of pipe $= \frac{957}{224} \times 15 \times 12 \times .26$

$= 200$ lbs.

Q.—What does the total power costs consist of.

A.—The total power costs consist of economic generation and economic utilisation.

Q.—How would you remove old paint ?

A.—By using a strong solution of caustic soda.

Q.—What is a Priming Pipe ?

A.—This usually consists of a pipe and screw-down valve connecting the discharge pipe to the suction pipe, by means of which water can be run into the suction pipe and pump just before starting up. Any leakage past the foot valve is made up and the system charged. Most pumps are provided with a filling plug for use when a priming pipe is not fitted.

Q.—The fly-wheel 10 feet diameter drives a factory lighting dynamo by means of countershafts pulleys, and belts. Find the velocity ratio between the fly-wheel of the engine and the dynamo allowing 3 per cent. for slippage.

A.—Fly-wheel 10 feet drives a pulley 3 feet and attached to the driven pulley there is a driving pulley 4 feet diameter which drives a pulley 30″ diameter and attached to this driven pulley there is another pulley 2 feet diameter driving the dynamo pulley 10″ diameter.

$$\text{Velocity ratio} = \frac{\text{product of all driven pulleys}}{\text{product of all driving pulleys}} = \frac{10''}{30''} \times \frac{2'}{4'} \times \frac{3'}{10'} = \frac{1}{20}$$

i.e., 1 rev. of engine fly-wheel = 20 revs. of dynamo.

hence : speed of dynamo = 70 revs. × 20 = 1,400 R.P.M.

$$\text{or dynamo speed} = 70 \times \frac{10'}{3'} \times \frac{4'}{2'} \times \frac{30''}{10''} = 1{,}400 \text{ R.P.M.}$$

If 3 per cent. is lost in slip, the actual speed will be 97 per cent. of 1,400 R.P.M.

$$\text{Thus : } \left(\frac{100-3 \text{ per cent.}}{100}\right) 1{,}400 = \frac{97}{100} \text{ of } 1{,}400 = 1{,}358 \text{ R.P.M.}$$

Q.—How would you harden the surface of wooden pulleys.

A.—By boiling them for 10 minutes in olive oil, and allow them to dry.

Q.—How would you divide the power consumption ?

A.—The consumption of power can be divided into :—

(1) The transmission of shaftings, cables, motors, etc.
(2) Power consumption by the process machines.
(3) Power consumption by auxiliary machines, machine and repair shops, etc.
(4) Humidification.
(5) Lighting.
(6) Fire protection equipment.

Q.—How much would you allow for frictional loss for an engine driven mills and electrically driven mills.

A.—In steam-engine-driven mills it is sufficiently accurate to assume that the friction loss in the engine is the same from no load to full load. The same can be said of shaftings. On the basis, the estimated loss in two such rope-driven mills worked out to be 31 and 33 per cent. In electrically-group driven mills the losses amounted to 14.5 per cent. in spinning department and 14 per cent. in weaving department. The shaftings had ball or roller bearings throughout and the belts were on loose pulleys.

In another old rope-driven mill with shaftings worn out and out of alignment and grease lubrication, the shafting losses alone were estimated to be 35 percent.

Q.—What do you understand by a compounded lubricating oil ?

A.—A compounded lubricating oil is a mixture of straight mineral oil and fixed or fatty oil.

Q.—How many types of pumps are there ?

A.—(*a*) Reciprocating pumps in which a plunger or piston is mechanically reciprocated in a liquid cylinder.

(*b*) Centrifugal pumps in which pressure energy is given to the liquid by the rotation of an impeller and centrifugal force.

(*c*) Rotary pumps when the liquid is forced through the pump cylinder or casing by means of rotating drums or pistons without the aid of centrifugal force.

(*d*) Air-lift pumps which raise water by the buoyancy of an aerated column of water in a submerged tube.

Q.—Explain briefly the saponification value of a compounded lubricating oil.

A.—The Saponification value of a compounded lubricating oil is the number of milligrammes of caustic potash required to saponify the fatty constituent in one gramme of the oil.

The test is made by boiling the oil with a standard solution of caustic potash in alcohol and then neutralizing the excess of alkali with a standard solution of hydrochloric acid.

If the nature of the fixed oil be known, its percentage is determined by dividing the saponification number of the compounded oil by that of the fixed oil, each fixed oil having its own specific saponification number.

Q.—What are the three kinds of acids found in lubricating oil ?

A.—The acids that one considers in dealing with lubricating oils are of three kinds : (*a*) Petroleum or Naphthenic acids, which are indigenous to petroleum oils ; (*b*) Mineral acids, *e.g.*, sulphuric, that can only be found in mineral oils that have been carelessly refined ; (*c*) and Fatty acids introduced in compounding. The first and third are organic, and the second inorganic.

Q.—Explain the use of Wick feed oilers ?

A.—Wick feed oilers are very reliable if properly taken care of and their limitations understood. The rate of oil fed is dependent upon the material used for wicking, the number of strands of wicking, the temperature and viscosity of the oil and the oil level in the reservoir. Increasing the number of strands of wicking will increase the rate of oil feed but when the proper number has been determined there will usually be no necessity for further adjustment. The viscosity of the oil used affects the rate of feed as light bodied oils will feed faster than oils of heavier body. Oils too heavy at the operating temperature will not feed through the wicks and for this reason very heavy oils cannot be used with this method of application.

Q.—Describe the duty of an Air Pump.

A.—The functions of the air pump is to remove the air, vapour, and in some cases also the water, from the condensor. In the case of the ordinary type of jet condenser, the air pump removes the condensed steam and the injection water together with the air brought into the condenser with the steam and injection water. When used in connection with a surface condenser, the air pump is required to remove only the air and the condensed steam.

If a very high vacuum is required with a surface condenser two or three pumps are often used, one pump removing the condensed steam and the other pump or pumps removing the air and vapour.

Air pumps may be horizontal or vertical and either single-acting or double-acting. The vertical single-acting type is by far the most generally used.

Q.—Define a Pump ?

A.—A pump is mechanical device for raising, circulating, compressing, or exhausting fluids by forcing them through pipes. In the case of a vacuum pump, the fluids acted upon are air and vapour, but water is the fluid most commonly pumped, when not otherwise specifically stated, a pump is generally understood to be a machine for lifting or forcing water.

Q.—Describe (*a*) a reciprocating pump, (*b*) centrifugal or rotary pump, (*c*) a displacement pump.

A.—(*a*) In a reciprocating pump, the fluid is moved by a piston or plunger that has a reciprocating, that is, a to-and-fro motions (*b*) In a centrifugal or rotary pump the fluid is drawn into and expelled from a casing by the rotary action of the parts within the casing, (*c*) In a displacement pump, the fluid is forced through pipes by the direct action of, and contact with, steam or compressed air.

These pumps may be either lift pumps, force pumps, or a combination of both.

Q.—What is a salinometer? Of what does it consist? How does it act? How it is graduated? Can it be used at any temperature indiscriminately?

A.—A salinometer is an instrument used to indicate the density of the boiler water. It consists of a hollow bulb and stem, which is weighted at the bottom in order to make it float upright in the water. The less dense the water the more it will be immersed, and the more dense the higher it will float. The stem is graduated either in ounces or 32nds. It must be used at the correct temperature for which it is marked invariably, 200°Fah.

Rain— An inch of rain falling on an acre weighs 100 tons.

Screw

A screw is a straight cylinderical bar having threads running spirally round it, these threads being cut in the bar. A thread may be either right-hand or left-hand.

Semi-Steel

This material, made by melting a mixture of steel scrap and pig-iron, is to be recommended for the production of metal with the desired structure giving high strength, durability and reistance to heat conditions. Rather similar to Cast Iron to work. Can be bent, and is softer to cut or file.

Shearing

The shearing strength of a metal is equal to the force which, if applied at right angles to the line of axis, would cause the parts to separate.

Solder for Brass

One-half lead and half tin, with a little resin. This solder will adhere to iron, but first rub the iron on a piece of tin.

Solder for Lead

Melt one part of block tin, and when fusing add two parts of lead. Use resin with this solder.

Solder for Tin—4 parts pewter, 1 part tin, 1 part bismuth.

,, *Pewter*—2 parts bismuth, 1 part lead, 2 parts tin.

,, *Brass*—2 parts brass, 1 part zinc.

,, *Gold*—12 parts gold, 2 parts silver, 4 parts copper.

,, *Silver*—6 parts brass, 5 parts silver, 2 parts zinc.

Hard Solder—2 parts copper, 1 part zinc.

Soft Solder—2 parts tin, 1 part lead.

1 Span = 9 inches.

Speed Gearing

The ratio of the number of teeth in a pair of wheels, must be the same as that of their diameters

To find the Speed of the Driving Wheel.—Multiply the number of teeth in the driven wheel, by the number of revolutions it makes per minute, and divide the product by the number of teeth in the driving wheel.

To find the final Speed of a train of Wheels.—Multiply the number of revolutions per minute of the first driving wheel, by the product of the number of teeth in the driving wheels and divide the result by the product of the number of teeth in the driven wheels.

To find the number of teeth in the driving Wheel.—Multiply the number of teeth in the driven wheel, by the number of revolutions it makes per minute, and divide the product by the number of revolutions of the driving wheel.

To find the number of teeth in the driven Wheel.—Multiply the number of teeth in the driving wheel, by the number of revolutions it makes per minute, and divide the product by the number of revolutions of the driven wheel.

To find the relative numbers of teeth in a pair of Wheels.—When the speeds of the driving and driven shafts are given—divide the speed of the driven shaft, by the speed of the driving shafts, the quotient is the ratio of their speeds, and the number of teeth in the wheels must be the same ratio.

To find the diameters of a pair of Wheels.—The distance between the centres, and also the speed of each shaft being given. Multiply the speed of one shaft by the distance between the centres in inches, and divide the product by the sum of the speeds of the two shafts, the result will give the radius of one wheel, which doubled, will give its pitch diameter in inches. The radius of this wheel subtracted from the distance between the centres, will give the radius of the other wheel.

To find the pitch of a Wheel.—Divide the diameter of the wheel at the pitch circle, by the number of teeth, and multiply the quotient by 3.1416.

To find the number of teeth in a Wheel.—Divide 3.1416 by the pitch, and multiply the quotient, by the diameter of the pitch circle in inches.

To find the diameter of a wheel at the pitch circle.—Divide the pitch by 3.1416, and multiply the quotient by the number of teeth.

1 Stone = 14 lbs.

Stone—absorbtion of water by :—

Bath and other soft stones	= 16 to 17	per cent.
Chalk	= 20 to 22	,,
Granite	= $\frac{1}{4}$ to 2	,,
Lime Stone (compact)	= $\frac{1}{8}$ to $\frac{3}{4}$	,,
Lime Stone (granular)	= 6 to 12	,,
Sand Stone	= $1\frac{1}{2}$ to 6	,,
Slate	= $\frac{1}{4}$ to $\frac{1}{2}$	,,

Specific Gravity

The ratio of a volume of metal to the weight of an equal volume of water is termed the specific gravity.

Specific Heat

The relative amount of heat absorbed by metals, compared to the heat absorbed by an equal quantity of water when raised through the same temperature.

Surface Condenser and Evaporative Condenser

A surface condenser is one in which the exhaust steam and the condensing water do not mingle ; the exhaust steam is condensed by coming in contact with metallic surfaces that are kept cool by cold water constantly flowing over them.

A evaporative condenser is one in which the heat of the steam is carried away by the evaporation of a thin film of water that is not in actual contact with the steam, but which by evaporation cools a metallic surface sufficiently to condense the steam. Strictly speaking, this is a form of surface condenser, but to avoid confusion it is generally regarded as a distinct type of Jet condensers.

Q.—What is the difference between a driving and driven pulleys.

A.—The pulley that imparts motion to the belt is called the driving pulley, and that which receives the motion is called the driven pulley ; or, shortly, the driver and the driven.

The revolutions of any two pulleys over which a belt is run vary in an inverse proportion to their diameters. Consequently, if a pulley 30 inches in diameter is driven by one 15 inches in diameter, the 20-inch pulley will make 1 revolution while the 10-inch pulley makes 2 revolutions ; or, the revolutions are in the ratio of 2 to 1. From this fact, certain formulae have been deduced in which—

D = diameter of the driver

d = diameter of the driven

N = Number of revolutions of the driver

n = number of revolutions of the driven.

To find the diameter of the driver when the diameter is of the driven and the number of revolutions per minute, usually abbreviated to R. P. M. of each is given.

$$D = \frac{dN}{N}$$

The diameter and number of revolutions per minute of the driver being given, to find the diameter of the driven such that it will make a given number of revolutions per minute.

$$d = \frac{DN}{n}$$

To find the number of revolutions per minute of the driver, its diameter and the diameter and the number of revolutions per minute of the driven being given.

$$N = \frac{dn}{D}$$

To find the number of revolutions per minute of the driven, its diameter and the diameter and number of revolutions per minute of the driver being given.

$$n = \frac{DN}{d}$$

Q.—What size of pulley will be required to put on a shaft that makes 800 revolutions per minute to drive a machine which has to make 560 revolutions per minute and is equipped with 10 inches fast and loose pulleys ?

A.—$\frac{500 \times 10}{250} = 20$ inches pulley.

Q.—A pulley 16 inches in diameter on a mchine is to make 180 revolutions per minute and is to be driven by a pulley on a counter-shaft making 240 revolutions per minute; what is the diameter of the pulley required on the counter-shaft ?

A.—$\frac{16 \times 180}{240} = 12$ inches pulley.

Q.—What is the diameter of a pulley making 400 revolutions per minute ? It is driven by a pulley of 20 inches in diameter making 200 revolutions per minute.

A.—$\frac{20 \times 1200}{400} = 10$ inches pulley.

Q.—Where are the pulleys attached ?

A.—The pulleys are attached to shafts for the purpose of transmitting the power to them.

Q.—How would you ascertain the size of a pulley ?

A.—The size of a pulley is gauged by its diameter, the width of the face, and the bore.

Q.—What is a solid pulley ?

A.—A pulley which is made in one piece, that must be placed on the shafts, is placed into position on its hangers.

Q.—What is split pulley ?

A.—A split pulley is made in halves so that it may be fixed to a shaft already in position only clamping the boss of the pulley in shaft.

Q.—What is a loose pulley ?

A.—A loose pulley is that round which a belt runs without imparting motion to any particular mechanism other than itself.

Q.—A wedge has a slope of 1 vertical to 20 horizontal; if this wedge is used to lift a roller by being pushed horizontally beneath it, how far will it have to be pushed in order to lift the $\frac{5}{8}$ inch?

$$1 : \tfrac{5}{8} : : 20$$

$$\therefore \frac{20 \times 5}{8} = \frac{25}{2} = 12.5 \text{ inches.}$$

Q.—State some reasons for a rope drive being advantageous.

A.—The advantages of a rope drive are (1) great amount of power can be transmitted to unlimited distance and in any direction by means of grooved pulleys; (2) it is the cheapest method of driving, not only on the first cost, but in the maintenance; (3) it imparts evenness of motion on account of its lightness, elasticity, and slackness of the rope, which takes up all inequalities between the power and the load.

The ropes consist of three or four strands, and range from ½ inch to 2 inches in daimeter. The weight of ordinary manila or cotton rope is about. $3D^2$ pounds per foot of length, where D represents the diameter of the rope in inches. Letting W1 equal the weight per foot of length, we have the formula.

$$W1 = .3D^2.$$

The breaking Strength of the rope varies from 7,000 to 11,000 pounds per square inch of cross section. The average value may be taken as $7{,}000D^2$; when D is the diameter of rope in inches. For a continuous transmission, it has been determined by experiment that the best results are obtained when the tension in the driving side of the rope is about 1/35 the breaking strength. Expressing this as a formula, letting, T_1 denote the tension in the tight side, we have.

$$T1 = \frac{7{,}000D^2}{35} = 200D^2$$

Q.—What percentage of slippage would you advise for a rope driven motion?

A.—Practically no slippage is allowed in rope driving.

Q.—What is a crossed strap for?

A.—A crossed strap gives us the opposite motion of the driving drum.

Q.—A pair of toothed wheels work together, their numbers of teeth being 190 and 33. If the first makes 92 revolutions per minute, how many will the second make?

A.—$\dfrac{190 \times 92}{33} = 529.69.$

Q.—A disc is attached to a worm wheel having 240 teeth. If this is rotated by means of a single worm running 820 revolutions per minute, find how many turns the disc will make in an hour.

A.—$\frac{820 \times 60}{240}$ = 205 revolutions per minute.

Q.—What is a main shaft ?

A.—A main shaft is one that is driven directly from the engine or other source of power and distributes it to the other lines of shafting or the various machines to be driven.

Q.—How would you find the specific Heat of a Substance ?

A.—Specific Heat of a substance may be defined as the ratio borne by the number of heat units required to raise the temperature of 1 lb. of that substance through 1°F. to that required to raise the temperature of 1 lb. of water through the same range.

Q.—When a quantity of gas is compressed is the whole of the energy expended in compressing it absorbed by the compressed gas ?

A.—When gases are compressed, heat is generated. If any of this heat should leave the compressed gas and pass through the walls of the containing vessel the amount of energy stored up in the compressed gas will be less than the energy expended in compressing it by an amount equal to the mechanical equivalent of the heat lost.

Q.—If the speed of an engine fly-wheel is 72 R.P.M. and its diameter is 30 feet, and the diameter of main shaft pulley is 6 feet, find out the R.P.M. of the main shaft ?

A.- $\frac{\text{Rev. of Fly-wheel} \times \text{diameter of Fly-wheel}}{\text{Diameter of Pulley.}}$

$$\frac{72 \times 30}{6} = 360 \text{ R.P.M.}$$

Q.—The main shaft pulley makes 180 R.P.M. and its diameter is 15 inches. Find out the picks per minute of a loom that is being run with a 10-inch pulley.

A.—$\frac{180 \times 15}{10}$ = 270 Picks per minute.

Q.—A wheel of 100 teeth drives a wheel of 20 teeth making 5 R.P.M. Find out the R.P.M. of driver wheel ?

A.—$\frac{20 \times 5}{100} = 1.$

Q.—What are heat engines ?

A.—Any machine which receives heat and converts some portion of it into mechanical work is called a heat engine. They are of two kinds, namely, external combustion engines (steam engines) and internal combustion engines, both of which depend for their operation upon the suply of energy in the form of heat from external sources. For its operation the internal combustion engine is dependent upon the heat energy actually produced by burning fuel inside the engine cylinders.

Q.—Describe Work.

A.—When any force acts on a body, and causes that body to move, the force is said to have done work.

In the measurement of work done there is no question of the time which the force takes to complete the movement, If for an example it be assumed that a loom is running at 180 picks per minute, the full cycle of operations, so far as the revolution of the crank is concerned, is completed in the $\frac{1}{180}$th part of a minute, or in one revolution of the usual driving pulley.

If the speed of the loom for any reason is reduced to 160 picks per minute, the same quantity of work is still done in one revolution of the pulley ; the difference is that the complete cycle of operations has occurred in the $\frac{1}{160}$th part of a minute.

If the force simply moves the body through any distance, great or small, in any period of time, work is done. Two things only are considered : (1) the size or magnitude of the force, and (2) the distance through which the force acts, or through which it overcomes resistance.

Q.—Which internal combustion engines operate on the constant-volume cycle ?

A.—All internal combustion engines with the exception of the Diesel engine operate on the constant-volume cycle. The Diesel engine alone carries out or, to be strictly correct, approaches the constant-pressure cycle.

Q.—In a screw with 15 threads to the inch, through what distance will it move 8 complete revolutions ?

A.—15 : 8 : : 1 inch $=\frac{8}{15}$ inches or .533 inches.

Q.—How many revolutions will a screw 10 threads per inch working in a nut have to make in order to move a distance of 87 inches in the direction of its length ?

A.—1 : 87 : : 10

$\therefore 87 \times 10 = 870$ revolutions.

Q.—Discuss oil Engine *versus* Steam Engine ?

A.—(1) Cleaner and less space is required by the former.

(2) Less Boilers—one Vertical boiler will only be required to give steam to sizing department.

(3) Vertical Boiler is cheaper than Horizontal Boiler.

(4) The thermal efficiency is greater.

(5) Upkeep cheaper.

(6) Can generate electrical energy by a separate set for the purpose without having recourse to the boiler and hence greater efficiency in conversion power.

(7) Efficient and competent attendant or driver is absolutely necessary for the oil Engine.

(8) Transmission by ropes is eliminated and hence a great saving in initial cost.

Q.—What do you understand by Action and Reaction ?

A.—When any fixed rigid body is acted on by a force there is immediately produced in that body a secondary force equal in magnitude but opposite in direction to the primary force. This secondary force is termed a force of reaction, the primary one being regarded as a force of action, the chief point to grasp at present is that one cannot exist without the other.

Q.—Define Force of gravity.

A.—Gravity is the name given to that force of attraction which all bodies possess for one another. This force varies with many factors, the chief of which are the distance between the bodies and their relative sizes and densities. The sun, moon, earth, stars and other constituents of the solar sytem are all maintained in position in space by the forces of attraction exerted by one and all the bodies. This property of attraction is briefly termed the force of gravity. Any bodies near the earth are attracted by the force of gravity towards the centre of the earth. This gravitational attraction causes a body to possess that which is termed weight. The weight of a body is thus a measure of the gravitational attraction of the earth upon the body.

Q.—What is a gas producer ?

A.—A gas producer is a sealed furnace wherein gas is produced by the partial combustion of fuel. A limited amount of air and steam is allowed to enter the furnace and pass through the burning, or, to be more correct, the glowing fuel.

Q.—Why is a "fat" spark desirable at the sparking plugs of gas and petrol engines ?

A.—A "fat" spark improves the running of the engine by ensuring regular firing. It also produces quicker ignition and brings about maximum pressure conditions in the cylinder in a shorter time. It also resists the tendency for soot to deposit on the sparking plug points better than a weak spark.

Q.—What are the approximate proportions of air and gas required by a gas engine and a petrol engine ?

A.—In a gas engine burning coal gas the mixture contains 17 per cent. by volume of gas, while in the petrol engine a mixture of air with about 2 per cent. of petrol vapour only is necessary

Q.—What are the principal items that affect the cost of steam power.

A.—The principal items affecting the cost of steam power are as follows :—

(1) Amount of power produced.

(2) Operating charges comprising :—

(*a*) Cost of fuel delivered to boilers inclusive of banking and stack losses.

(*b*) Attendance and supplies, *i.e.*, wages and stores.

(*c*) Make-up water.

(*d*) Maintenance and repairs.

(3) Fixed charges on cost of plant comprising interest, depreciation, insurance and taxes.

Q.—How would you distinguish steel from iron ?

A.—Nitric acid does not affect iron but produces a black spot on steel. The darker the spot the harder the steel.

Q.—How would you soften copper and brass, gold and silver ?

A.—I would heat them to a low red heat, and quench in a solution of salt and water.

Q.—How would you harden a drill to drill glass ?

A.—I would heat the drill to cherry red, and quench it in mercury. when drilling I would moisten with turpentine and a little camphor.

Q.—What are the two distinct methods of controlling the steam supply.

A.—The work required from a steam engine does not as a rule remain constant, and it is therefore necessary to have some means of automatically adjusting the steam supply to suit the varying demands of the load. There are two distinct methods of controlling the steam supply to achieve this result. The first of these is by the use of a simple "Throttling Governor," which regulates a valve through which the steam passes and thereby reduces the steam pressure to suit the load that is being carried. Governing by throttling in this manner is not very economical and in slow-speed work only small engines are governed in this way. The simplicity of this method of governing, however, led to its adoption in most of the earlier types of high-speed engines, where other types of governors could not be made to give satisfaction.

The second, and better, method of governing is by some form of "Expansion Governor"; in this case the period during which the steam is admitted to the cylinder is altered, so that cut-off takes place earlier as the load decreases. The full steam pressure is thus always available at admission and the earlier cut-off enables the steam to be used very economically at light loads. This method of governing is applied to all Corliss and drop-valve engines and also to many piston-valve and slide-valve engines. In the two latter cases either "shifting eccentrics" or special "cut-off valves" may be employed.

Q.—How would you drill hard steel ?

A.—I would heat the drill in a charcoal fire, and quench it in mercury. I would moisten the work when drilling with a mixture of turpentine and camphor.

Q.—How would you recognise a left-hand threaded screw from a right-hand one ?

A.—If the thread advances away from the observer, when the screw is looked at from the end, and runs round the bar in the same direction as the hand of a watch or when the incline has its highest part towards the right hand it is a right-handed thread. If it advances away from observer by running in the opposite direction round the bar or when the incline has its highest part towards the left hand it is left-handed thread.

Q.—A 20-inch driving pulley is fastened to shaft making 200 revolutions per minute and drives 10-inch pulley on a machine. What is the speed of the machine ?

A.—$\dfrac{20 \times 200}{10} = 400$ revolutions per minute.

Q.—A worm wheel revolving 750 times per minute, drives a 150-tooth wheel, what is the speed of the latter ?

A.—Worm wheels—as drivers only are usually single threaded and are equal to one tooth as a multiplier of speed. Worm wheels are used to rapidly diminish speed.

$750 \times 1 \div 150 = 5$ Revs. per minute.

Q.—What are the various kinds of stress ?

A.—Stresses may be either.

(1) *Tensile Stress.*—The two forces acting on the body act away from each other in a straight line, tending to pull the molecules of the body apart.

(2) *Compressive Stress.*—The two forces act toward each other, tending to push the molecules closer together.

(3) *Shearing Stress.*—The two forces act parallel to each other and tend to make the molecules slide past each other, cutting them apart.

The following may be taken as the average breaking stress per square inch :—

Cast Iron	= 7 to 8 tons in tension.		
Cast Iron	= 45 to 50 tons in compression.		
Wrought Iron	= 20 to 28 tons in tension.		
Mild Steel	= 26 to 30	,,	,,
Mumtz Metal	= 22 to 24	,,	,,
Copper	= 10 to 15	,,	,,
Yellow Brass	= 10 to 12	,,	,,
Gun Metal	= 16 to 17	,,	,,

Q.—Define the Principal of Work and its Efficiency.

A.—The principle of work asserts that the total work put into a mahine is invariably equal to the work got out of the machine *plus* the work done in overcoming the internal resistances of the machine. The work got out of the machine may conveniently be called the Useful Work, that is to say, it is the work for which the machine is actually designed. The work done in overcoming the internal resistances of the machine is often termed Lost Work; it is work done incidentally to the chief purpose of the machine, not because it is necessary for the ordinary purposes of the machine, but because it is unavoidable. The principle of work may therefore be concisely summed up as under :—

Work put in = Useful Work + Lost Work.

The efficiency of a machine is thus the ratio of the useful work to the work put in. Thus, if 100 ft.-lbs. of work are put into a machine, and 80 ft.-lbs of useful work are obtained from the machine, its efficiency is :—

$$\frac{\text{Useful Work}}{\text{Work put in}} = \frac{80 \text{ ft.-lbs.}}{100 \text{ ft.-lbs.}} = 4/5 \text{ or } 80 \text{ per cent. efficiency.}$$

Q.—What is Tension.

A.—When two forces act on a body in opposite directions away from each other, the body is said to be in tension. The two forces tend to elongate the body and thus induce a tensile stress and a corresponding deformation.

Q.—How would you find the number of cubic feet of exhaust steam emitted from cylinder per minute.

A.—Multiply area of piston (in square feet) by speed of piston in feet per minute.

Q.—In a worm and wheel gear the worm has a double thread and the worm wheel 115 teeth. How many revolutions per minute will the worm have to make in order that the wheel may make 48 revolutions ?

A.—$115 \div 2 = 57.5$

$57.5 \times 48 = 2760$ revolutions per minute.

Q.—A cog wheel having 190 teeth and rotating at 120 revolutions per minute drives a shaft carrying a pinion of 17 teeth. Find the speed of the second shaft.

A.—$\frac{120 \times 190}{17} = 184$ revolutions per minute practically.

Q.—A toothed wheel having 280 teeth is driven by a pinion having 14 teeth. If the pinion shaft runs at 815 revolutions per minute find the speed of the wheel shaft.

A.—$\frac{815 \times 4}{280} = 15.75$ revolutions.

Q.—What is the diameter of a circle the length of circumference of which is 4 feet ?

A.—Divide the circumference by 3.1416

$\therefore 4 \div 3.1416 = 1.2732$ feet.

Q.—Find the size of pulley to be used on a machine which has to be driven at 2000 revolutions per minute from the fly-wheel of an engine running at 120 revolutions per minute, the fly-wheel having a diameter of 6 feet.

A.—$\dfrac{120 \times 6 \times 12}{2000} = \dfrac{108}{25} = 4.32$ inches diameter.

Q.—Find the surface speed in feet per minute of a pulley, 30 inches in diameter making 120 revolutions per minute.

A.—$3.1416 \times \dfrac{30 \times 120}{12} = 942.4800$ or 942.48 feet.

Q.—In pushing a loaded cloth-truck along the level floor of a mill, the operative has to exert a constant force of 50 lbs. How much work does he do in 5 minutes, supposing he travels at the rate of 3 miles per hour ?

A.—$\dfrac{3 \text{ miles per hour}}{60 \text{ min. per hour}} = \dfrac{3 \times 5280 \text{ ft.}}{60 \text{ minutes}} = 264$ ft. per minute.

264 feet per minute $\times$ 5 minutes $=$ 1320 feet in 5 minutes.

$\therefore$ Work done in 5 minutes $=$ 50 lbs. $\times$ 1320 feet $=$ 66,000 ft.-lbs.

Q.—Give the causes of variation in Engine Speed.

A.—A steam engine may suffer a variation in speed from various causes. There may be a gradual variation in the boiler pressure, or there may be sudden or gradual variations in the load of the engine. There is also a tendency to sudden variations in speed from causes found within the engine itself. Thus, at the beginning of a stroke there is a greater steam pressure in the cylinder than at the end of the stroke, when the steam has been allowed to expand. Aslo, the transmission of the piston pressure to the crank is not carried out with a uniform efficiency throughout a revolution of the crank. For instance, when the piston is near the middle of its stroke, the turning effort on the crank is at a maximum, at either side of this position the turning effort is decreasing. In other words, when on the front centre, the piston thrust produces no turning effect whatever on the crank ; as the stroke proceeds the crank effort increases to a maximum at about the point where the crank and connecting-rod are at right angles, and then it decreases again to nothing when on the back centre. Thus, the turning effect (or crank effort) is very uneven, ranging from a minimum to a maximum twice in each revolution. It is thus seen that there is not only a tendency to vary the speed over relatively long periods, but also through the short period of one revolution. The former variations are regulated by the governor, the latter by the fly-wheel.

Q.—What is meant by the terms, "breaking stress," "proof stress," "safe working stress"?

A.—By the term "Breaking Stress" is meant the weight or pressure per square inch that any material will stand just before fracture. "Proof Stress," the pressure per square inch the material will stand without taking a permanent set. The proof stress is usually about ⅓rd of the breaking stress. "Safe Working Stress," the pressure per square inch allowed upon the material, usually about ⅙th the breaking stress.

Q.—A pump at work in a Dyeing department is employed in raising water from a well to an overhead tank; find the amount of work done in raising 100 cubic feet of water to a height of 10 yards. 1 cubic foot of water = 62½ lbs.

A.—Work done = weight lifted in lbs. × distance moved in feet.

= (100 c. ft. × 62½ lbs. per c. ft.) lbs. × (10 yds. × 3 ft. per yd.) ft.

= (100 × 62.5 × 10 × 3) ft.-lbs.

= 187,500 ft.-lbs.

Q.—The plunger of a force-pump in a certain bleaching department is 8 inches in diameter, the length of its strok is 2 feet 6 inches, and the pressure of the water is 50 lbs. per square inch. Find the number of units of work done per stroke.

A.—Work done = Distance in feet × force in lbs. × total pressure on plunger.

= 2 ft. 6 ins. stroke × 50 lbs. per square inch × area of 8-inch diameter.

= 2.5 × (50 × .7854 × 8 inches × 8 inches) lbs.

= (2.5 × 50 × .7854 × 8 × 8) ft.-lbs.

= 6283.16 ft.-lbs.

Q.—What is the difference between a gas engine and a petrol engine ?

A.—Petrol engines and gas engines so far as cylinders, pistons and valves are concerned, are of practically the same design. The parts dealing with the fuel, however, are widely different, since the petrol engine needs a carburettor to vaporise the liquid fuel, whereas in the gas engine the fuel is supplied to the engine in a gaseous state.

Q.—State the necessity of a Cooling Tower.

A.—Advantage has been taken of the cooling effect of evaporation to cool the discharge water of a condenser so that it may be used again as cooling water. The application of the principle is usually through the medium of an apparatus called a cooling tower which consists, as its name implies, of a tower-like structure, erected in the open air and usually about 30 feet high, to the top of which the warm water is pumped and there liberated and allowed to fall to the bottom against a current of air. The water in descending is broken into spray or thin sheets by coming into contact with obstructions placed in its path for that purpose, thus presenting the greatest possible area of evaporating surface to be acted upon by the air. The warm water falling through the tower is cooled by two processes : first, by contact with cool air ; and second, by evaporation. The lătter is by far the most effective and important, for the reason that the evaporation of a pound of water in this way carries off 965.8 B.Th.U. There are a number of cooling towers in use, and while they differ somewhat in construction and material, they are all governed by the same principle.

Q.—When it is stated that the 'thermal efficiency' of an engine is 40 per cent., what does this really mean ?

A.—Broadly speaking, it means that 40 per cent. of the heat in the fuel is converted into work in the engine cylinders, and that the remaining 60 per cent. is wasted. When judging an engine, however, its thermal efficiency must be compared with the maximum possible efficiency, or what is termed the ideal standard cycle. If, then, the maximum possible is 60 per cent., an engine having a thermal efficiency of 40 per cent. will really convert into work in the engine cylinder $\frac{0.40 \times 100}{60} = 66$ per cent. of the possible.

Q.—Under what circumstances would a worm and wheel be used to connect two shafts ? If the worm is single-threaded and the wheel has 80 teeth, find how many revolutions the worm must make to rotate the wheel $2\frac{1}{3}$ times.

A.—$80 \times 2\frac{1}{3} = \frac{80 \times 7}{3} = 186.66$ revolutions.

Q.—What is steam ?

A.—Steam is the vapour water.

The temperature at which water boils depends upon the pressure, that is, for every pressure there is a corresponding definite temperature. This temperature is termed the saturation temperature.

Wet steam or saturated steam is steam containing a proportion of unevaporated water. If in one pound of steam stuff the fraction present as steam is q, with (1—q) lb. present as water, then the dryness fraction is q and the wetness fraction is (1—q).

Dry Steam, or dry saturated steam, is steam which is completely free from all watery particles, *i.e.*, q = 1. It is steam which is at the greatest possible density for its pressure.

Superheated steam is dry steam which has been heated to a temperature above the saturation temperature corresponding to its pressure.

Q.—What is the surface area of a sphere 10 inches in diameter ?

A.—Square the diameter and multiply the result by 3.1416.

$10^2 = 100 \times 3.1416 = 314.1600$ square inches.

Q.—What is the area of a trapezoid if the parallel sides are 10 and 20 feet in length and the altitude is 12 feet ?

A.—Multiply one-half the sum of the parallel sides by the altitude.

$10 + 20 = 30$ feet
$30 \div 2 = 15$ feet
$15 \times 12 = 180$ square feet.

Q.—What is the area of triangle if the base is 12 inches in length and the altitude is 8 inches ?

A.—Mu'tiply the base by the altitude and divide the product by 2

$$\frac{12 \times 8}{2} = 48 \text{ inches.}$$

Q.—What is the convex surface of a solid ?

A.—The convex surface of a solid is the curved surface, thus the area of the convex surface of a cylinder is its total surface area less the area of the ends.

Q—A wheel A, 40 teeth, gears with a wheel B, 60 teeth, and on the same shaft as B, is a wheel C, 20 teeth, gearing with a wheel D, having 50 teeth. If the wheel A makes 60 revolutions per minute, find the revolutions per minute of the wheel D.

A.—$\dfrac{60 \times 40 \times 20}{60 \times 50} = 16$ revolutions per minute.

Q.—A belt has a velocity of 500 feet per minute and transmits 6 H.P. What is the effective tension in the belt ?

A.—$6 \times 33000 = 198000$

$198000 \div 500 = 396$ lbs.

Q.—Determine how many foot pounds of work will have to be performed in order to raise 1550 gallons of water to the height of 72 feet. One gallon of water weighs 10 lbs.

A.—$1550 \times 10 \times 72 = 1{,}116{,}000$ ft.-lbs.

Q.—If a 20 teeth wheel making 60 revolutions per minute drives a 40 teeth wheel what will be the speed of the 40 teeth wheel ?

A.—$\dfrac{20 \times 60}{40} = 30$ will be the speed.

Q.—A wheel containing 80 teeth is fixed on a shaft that makes 220 revolutions per minute and is driven by a wheel having 44 teeth. How many revolutions per minute does the driving wheel make ?

A.—$\dfrac{80 \times 2}{4204} = 400$ revolutions per minute.

Q.—How would you find the quantity of water discharged by ordinary cast-iron pipes ?

A.—The quantity of water discharged by ordinary cast-iron pipes, when fully of water running pressure, may be found by the following rule.

Multiply the fifth power of the internal diameter of the pipe in inches by the head of water in feet, divide the product by the length of the pipe in feet, and the square root of the quotient multiplied by 4.5 will give the quantity of water discharged per minute in cubic feet, which multiplied by 6.24 will give the quantity of water in gallons discharged per minute.

Example :—

Required the discharge of a line of pipes of 6 inches diameter 2,600 feet long, when full of water running under a head of 40 feet.

Then $\dfrac{6\times6\times6\times6\times6 \text{ inches}\times40 \text{ feet}}{2{,}600 \text{ feet length of pipe}} = 120$ and $\sqrt{120} = 10.95$

$10.95\times4.5 = 49.275$ cubic feet of water flowing per minute, and $49.275\times6.24 = 308$ gallons, the quantity of water discharged by the line of cast-iron pipes per minute.

The discharge of pipes is considerably diminished by rough surfaces and incrustation.

Sound

The velocity of sound through air is 1,098 feet at a temperature of 32°F. It increases at about 1.0966 feet for every degree Fah. The intensity of sound is inversely as the square of the distance, it increases with the density of the air and varies with the direction of the wind. Sound travels 1 mile in 5 seconds (approximately)

Steel—"Temper"—Degrees and colours for:—

Light Straw	= 430°F. or 222°C.
Straw	= 450°F. or 232°C.
Dark Straw	= 470°F. or 244°C.
Yellow Brown	= 490°F. or 255°C.
Dark Brown	= 510°F. or 265°C.
Brown Purple	= 520°F. or 271°C.
Dark Purple	= 530°F. or 277°C.
Bright Blue	= 550°F. or 288°C.
Deep Blue	= 560°F. or 293°C.
Dark Blue	= 600°F. or 316°C.

Tempering Steel Springs

Wet the Spring (hardened) with olive oil, turn it gently round on the fire till it catches a light. If it is a very particular job, take a pan and boil in oil.

Tempering Turning Tools

When the nature of the steel is not known, it is a good plan to heat the tool and try with a file at the different shades of colour, and when the file is felt to bite the least bit dip the tool.

1 Tola = .0257 lb. (avoir.)

1 Ton = 2240 lbs.

1 Ton—	**River sand**	= 21 cubic feet.
	Pit sand	= 22 cubic feet.
	Ballast	= 22 cubic feet.
	Coarse gravel	= 28 cubic feet.
	Clean shingle	= 24 cubic feet.

1 Ton Portland Cement = 20 bags.

One cubic foot of Portland Cement weighs 85 to 90 lbs., when loosely filled. Average weight of 1—2—4 concrete; coke-breeze aggregate 100 lbs. per cubic foot; clinker aggregate 110 lbs. per cubic foot; Brick aggregate 125 lbs. per cubic foot; Ballast aggregate 145 lbs. per cubic foot. Average weight of 1—2—4 reinforced concrete is 150 lbs. per cubic foot.

Tenacity

The tenacity of a metal is the power to resist the effort of stretching or pulling apart.

Toughness

A metal is said to be tough when it can be bent first in one direction and then in the opposite, without developing a fracture.

Q.—Describe the Otto cycle.

A.—The Otto cycle, commonly called the four-stroke cycle, is completed by four strokes of a reciprocating piston working in a cylinder. The method of working is as follows :—

(1) An explosive gas is drawn into the cylinder during the first outward stroke of the reciprocating piston.

(2) During the return inward stroke the explosive gas is compressed.

(8) At the beginning of the second outward stroke the explosive gas is ignited and a high pressure is built up in the cylinder. The gas expands and forces the piston outward.

(4) During the fourth and last stroke the inward movement of the piston drives the burnt gases out of the cylinder.

Q.—What is tar oil and how is it obtained ?

A.—Tar oil is a dark, viscous liquid, which is fluid at ordinary atmospheric temperatures and has a specific gravity of from 1.0 to

1.2, a calorific value of about 15,000 B.T.U. per lb. and a flash point between 200° and 300°Fah. Coal tar is obtained from the carbonisation of bituminous coal ; this tar is then distilled and yields tar oil.

Q.—How would you find the number of gallons contained in a cistern.

A.—Multiply the length, width, and depth together, all in feet, This will give the contents in cubic feet, which should be multiplied by 6.24 and the product will be the number of gallons. If the diemsnions are in inches use .003607 in place of 6.24.

Q.—If two dimensions of a cistern are given how would you find the third to contain a given number of gallons ?

A.—Multiply the required number of gallons by .16046 if the dimensions are in feet or by 277.274 if the dimensions are in inches, and divide the result by the product of the two given dimensions. The quotient will be the third dimensions required.

Q.—What is steam ?

A.—Steam is an invisible elastic fluid, or water, brought to the state of gas by the application of heat.

Q.—What is live steam ?

A.—Live steam is steam under the pressure and ready to do work through the agency of the steam cylinder or for heating, boiling, etc.

Q.—What is dead steam ?

A.—Dead steam is the opposite of live steam—such as exhaust steam or the vapour which fills the steam generator before there is any pressure.

Q.—What is dry steam ?

A.—Dry steam is that which holds no water in suspension. High pressure steam has been proved by experiment to be dry like dust.

Q.—Why is steam invisible except as it is being condensed ?

A.—Like many other gases it possesses the quality of invisibility.

Q.—Which is the heaviest at atmospheric pressure, steam or air ?

A.—Steam is the lightest, because it always rises. It is about two-thirds the weight of air.

Q.—What is saturated steam ?

A.—This is steam under pressure in contact with water in the boiler, its condensing point agrees with the boiling point of the water on which it rests.

Q.—If water is confined in a boiler, and the vessel entirely full, and then heated to a high temperature, will there be any steam formed ?

A.—No. Because steam requires space in which to expand.

Q.—What is wet steam ?

A.—Steam full of spray—or with water mechanically suspended in the steam.

Q.—How would you find the number of gallons contained in a cylinder ?

A.—Multiply the square of the diameter in feet by the length in feet of the cylinder, and multiply the product by 4.895 ; or multiply the square of the diameter in inches by the length in feet, and multiply the product by .034 ; or multiply the square of the diameter in inches by the length in inches, and multiply the product by .00283.

Q.—If the diameter of a cylinder is given, how would you find the length ?

A.—Multiply the number of gallons by .2043 and divide the product by the square of the diameter in feet, and the quotient is the length in feet.

Q.—If the length of a cylinder is given, how would you find the diameter ?

A.—Multiply the number of gallons by .2043, and divide the product by length in feet, and the square root of the quotient is the diameter in feet. If the dimensions are in inches use 353 in place of .2043.

Q.—What is meant by the Mechanical Equivalent of Heat ?

A.—The mechanical equivalent of heat is the amount of work in ft.-lbs. which one unit of heat is capable of doing. One unit of heat (1 B.Th.U.) is capable of doing 778 ft.-lbs. of work.

Q.—What will be the loss of water by evaporation ?

A.—When cooling water is recooled, the loss of water by evaporation is proportional to the amount of heat carried off and depends on the difference between the temperature of the water before and after cooling.

For example, if 200,000 pounds of water is cooled down from 120° to 60° in a given time, 60 B.Th.U. is absorbed from every pound of water that is evaporated ; therefore, 200,000 × 60 = 12,000,000. B.Th.U. is carried off with the vapour. Now as it requires about

1,000 B.Th.U. to vaporize one pound of water, 12,000,000÷1,000 = 12,000 pounds of the water or 6 per cent., has been converted into vapour and lost. This amount must therefore be added to the cooling water in the given time, or the supply will gradually diminish.

Q.—What is the temperature of (1) melting ice; (2) of boiling water; (3) of steam about 60 lbs. pressure by the steam gauge; (4) of steam about 100 lbs.; and (5) of steam about 150 lbs.

A.—The temperature of—

Melting ice = 32°F.
Boiling water at 14.7 lbs. = 212°Fah.
Steam about 60 lbs. pressure = 307.2°Fah.
,, ,, 100 ,, ,, = 337.7°Fah.
,, ,, 150 ,, ,, = 365.6°Fah.

Q.—Is petroleum gas lighter or heavier than air?

A.—Petroleum gas is extremely heavy in comparison with air, so that when liberated into the atmosphere it tends to flow to the lowest level it can find.

Q.—Why is it necessary to pay particular attention to the efficiency of lubricating oil strainers of an enclosed engine?

A.—The oil should be free from solid matter, otherwise the bearing surfaces will be damaged. Also dirt in the oil will deposit in the small pipes feeding the small bearings located inside the crank case and may eventually choke them, with the result that the bearing will become excessively hot without being detected.

Q.—A wheel having 44 teeth and running at 60 revolutions per minute drives another wheel at 220 revolutions per minute. How many teeth has the driven wheel?

A.—$\frac{44 \times 60}{220} = 12$ teeth.

Q.—A 12 pinion revolving 350 times in a minute, drives a mangle wheel of 140 teeth. How many times will the mangle revolve in a minute?

A.—A Mangle wheel is a driven wheel only, and is used to reverse its own direction of motion. The speed for it is calculated as for an ordinary wheel, but since the tooth at each end is used only once in a double revolution (all the others being used twice) its size is taken as one tooth less than it actually is

$350 \times 12 \div 140$ = Revs. (equally 15 in each direction) speed of mangle in a minute.

Q.—How would you straighten a crooked shaft ?

A.—Set the shaft on the blocks at each end, and under the hollow side make a fire, or apply sufficient heat to make the shaft hot. Now, with a swab, put water on the top, and the contraction will by repeated operations, finally straighten the shaft.

Q.—When fuel is injected into the cylinder of a Diesel engine does an explosion occur ?

A.—No. Since the injection of fuel takes place gradually the timing is so arranged that there is no explosion, but, instead, a period of burning which lasts until the fuel supply to the cylinder is cut off.

Q.—Does the cooling water of an oil engine receive heat from any source apart from combustion ?

A.—The engine friction produces heat, most of which is carried off by the lubricating oil, thence to the cooling water, or radiated to the atmosphere. The heat produced by piston ring friction will pass into the cooling water, while nearly all the heat generated in the injection air compressor cylinders is carried away by the cooling water.

Unit of Heat

The amount of heat necessary to raise the temperature of one pound of water at 32° one degree Fahrenheit (*i.e.*, from 32° to 33°) is called the standard unit of heat.

Uniting Metals

For uniting wrought and cast iron, or steel. Take 20 parts (by weight) of wrought iron filings, 10 of salammoniac, and 5 of balsm of copaiba, melt together and beat until dry and hard. This will join metals and fill in holes, cracks, or other defects, in iron or steel plates.

Vacuum

The space between the upper end of the tube and the upper surface of the mercury is a Vacuum, being an entirely empty space not containing any substance—solid, liquid, or gaseous. If there were a gas of some kind there, no matter how small the quantity might be, it would expand and fill the space, and its pressure would cause the mercury to fall and the column to become shorter, according to the amount of gas or air present. The condition then existing in the space would becalled a partial vacuum.

Variable Speed Gears

Variable speed gears are established as the most practical and economical method of obtaining infinite speed variation within a predetermined range. Experience has proved that the ability to drive machinery at the highest speed consistent with the type and characteristics of the material being manufactured is of special importance to the textile industry. By means of variable speed gears this object can be achieved economically and efficiently, and they ensure infinite increase or decrease of machine speeds to a fraction of a revolution at will without having to stop the machine.

Velocity

Signifies rate of motion in a fixed direction.

Water

Cubic foot of—6.23 Imperial gallons; 7.47 U.S. gallon, 61.0 cubic inches; .0353 cubic foot.

Weight of Foundation for an Engine

The weight of a foundation in stone or brick may be—one ton per nominal horse-power of the engine.

Weldability

The property possessed by a metal which renders it capable of being joined when in a state of fusion.

Wheels and Pinions

A wheel should not have more teeth than 6 for 1 of its pinion. Large pinion are desirable, because when a large wheel drives a small pinion rapidly, the teeth of the pinion moving in a small circle, abruptly meet the teeth of the wheel, and cause an uneven jolting motion. When wheels drive pinions, no pinion should have less than 20 teeth, and in millwork not less than from 35 to 45 teeth, to enable them to work properly, and have a sufficient number of teeth in gear at the same time. When pinions drive wheels no pinion should have a less number than 13 teeth; rather 16 or 18. When quick speed is required instead of using a large wheel and very small pinion, it is beter to get up the speed by using an intermediate shaft with wheel and pinion and the friction will not be materially increased thereby.

White Metal

Another name for Babbett's metal.—A white alloy largely composed of tin, used for lining bearings to diminish the friction. A good composition is tin 96, antimony 8, copper 4 parts, by weight.

Work.—1 erg = the amount of work done by 1 dyne acting through a distance of 1 centimetre. 1 joule = 10,000,000 ergs = 10^7 ergs.

1 kilogrammetre = the work done in lifting 1 kilogramme vertically through 1 metre = 100,000 × 981.19 ergs at London.

1 foot-pound is the work required to lift 1 pound vertically through 1 foot. 1 foot-pound at London = 1.356 joules. 1 kilogrammetre = 7.233 foot-pound. 1 foot-pound = 0.1382 kilogrammetre.

Work

Work is done when the point of application of a force moves.

Newton's first Law of Motion states that a body at rest is only set in motion by the action of a force upon it, and also that a moving body only changes the direction of its motion, or its speed, as the result of the action of a force.

When a body moves from rest the continued action of the force upon it causes an acceleration in the body.

The work done (measurement of work) in all cases is proportional to the force overcome and to the distance through which the force has been overcome; or,

Work = force overcome × distance.

Wrought Iron

It is easy to cut and file. It has a fibrous structure. It readily bends and is chiefly used for parts which must be welded during manufacture. It can be carburised for skin hardness.

Another composition is 84 per cent. tin, 8 per cent. antimony, and 8 per cent. cooper is greatly used now for all bearings instead of brass, being run into cast iron or steel bushes.

Proportions that have been found satisfactory are, for heavy service, 50 parts of tin, 2 parts of copper, and 8 parts of antimony; for light service, 50 parts of tin, 1 part of copper, and 5 parts of antimony. The antimony gives hardness to the alloy and diminishes the contraction, while the tin gives it the antifriction quality.

Q.—What is a valve seat.

A.—The surface on which a valve rests; applied to disc, ball, and other forms of valve other than a side valve.

Q.—What is a Diesel engine?

A.—A Diesel engine is a reciprocating heat engine of the internal combustion type which works on either the four-stroke or two-stroke cycle and operates on the slow combustion (constant pressure) principle.

Q.—How is the specific gravity of liquid fuel affected by temperature?

A.—Since all classes of oils expand upon being heated, a known specific gravity is correct only for a certain temperature. The necessary correction for a difference in temperature is made by allowing for the expansion of the oil. For fuel oil as used in Diesel engines the co-efficient of expansion is generally taken as 0.0004 per degree F. rise in temperature, or 0.00072 per degree C. The specific gravity of the oil decreases with a rise in temperature and *vice versa.*

Q.—What is the specific gravity of crude petroleum?

A.—The specific gravity of crude petroleum varies widely according to the source of the petroleum. It ranges from 0.75 to unity as a maximum, but rarely exceeds 0.9. Should it do so, more than the usual amount of water is generally indicated.

Q.—Is scale all of one kind?

A.—No. The nature and hardness of the scale depend upon the kind of substance held in solution and suspension by the water in the boiler.

Q.—What general course is the best in dealing with the sediment?

A.—It is more profitable to soften and filter the water than to trust to blowing out or dissolving the sediment and scale after it is there.

Q.—How would you distinguish between steel and iron.

A.—To distinguish steel from iron pour on the object to be tested a drop of nitric acid; let it act for one minute then rinse with water. On iron the acid will cause a greyish-white, on steel a black stain.

Q.—How would you harden cast iron.

A.—Heat the iron into cherry red, then sprinkle on it cyanide of potassium and heat it to a little above red; then dip in water. The cyanide may also be used to case-harden wrought iron.

Q.—What is tempering ?

A.—Tempering is the process of producing in steel implements the degree of hardness suitable to the purpose for which they are to be used. The implement is first brought to the extreme degree of hardness by plunging it when red hot into cold water. Being then extremely brittle, it is let down by heating it until a certain colour which invariably accompanies the desired temper, appears on its surface ; it is again then plunged into water.

The series of colours begin with faint yellow (a temper suitable to instruments requiring a fine cutting edge) and passes through straw colour (suitable for wood cutting tools, pen-knives, etc.), brown (for cold chisels, axes, etc.), purple (for table knives) to dark blue (saws, etc.), only the harder varieties of steel can be tempered.

Q.—A helical (spiral) spring when stretched one inch exerts a force of 8 lbs. what force will it exert when stretched $1\frac{5}{8}$ inches ?

A.—$1 : 1\frac{5}{8} \quad 8 : \times$

$$\times = \frac{8 \times 13}{8} = 13 \text{ lbs.}$$

Q.—To what process is crude petroleum subjected after it is taken from the earth ?

A.—It is distilled, during which process the lighter and more valuable oils are separated and collected, the residue, in some cases, being used as fuel for Diesel engines and boilers.

Q.—Give the names of liquid fuels which can be used in the Diesel engine, and state the class of fuel mostly used.

A.—Almost all known classes of liquid fuel, including the various grades of petroleum, tar oil, shale oil, and animal and vegetable oils, can be used for power production in the Diesel engine. The class of fuel mostly used is petroleum oil called Diesel oil, which is the heavier oil remaining from crude petroleum after the lighter oils have been distilled off. Shale oil is also used to drive Diesel and, more extensively, hot-bulb engines.

Q.—Can a mixture be made to use in a great majority of cases of scale.

A.—One that has been strongly recommended is made up of 40 lbs. of sal soda, to which is to be added 5 lbs. of catichu and 5 lbs. of salamoniac—one lb. of the mixture to be added to each barrel of water used, until the scale disappears, when the use of sal soda alone is all that is necessary.

Q.—Can one preparation be made that will be beneficial in all cases of deposited sediment ?

A.—No. This is owing to the variety of chemical matter contained in water, and the varying quantities existing in the steam generators, to say nothing of the different temperatures in which the "compound" may be expected to operate.

Q.—A circular loom shaft is 1¾ inches in diameter and 4½ feet long. Find its weight when one cubic inch of wrought iron weighs 0.277 lbs.

A.—$1.75 \times .7854 = 2.4052$
$2.4052 \times 4.5 = 10.82340$
$10.82340 \times 12 = 129.8808$ cubic inches
$129.880 \times .277 = 35.9759$ lbs.

Q.—A driven wheel has 70 teeth and is fixed on a shaft making 120 revolutions per minute, and driving wheel makes 60 revolutions per minute. How many teeth are there in the driving wheel ?

A.—$\dfrac{70 \times 120}{60} = 140$ teeth.

Q.—What is worm gearing and bevel gearing ?

A.—A worm gear is a shaft with worm round it at one end of the ends, a bevel gear is a wheel with teeth by the side of it.

Q.—Describe Torsion.

A.—When a force is applied to a beam, bar, or rod in such a manner that it tends to twist it, the stress thus produced is termed torsion. Torsion manifests itself in the case of rotating shafts.

Q.—Describe Siphon.

A.—The action of the siphon illustrates the effect of atmospheric pressure. The siphon is simply a bent tube with branches of unequal length open at both ends, and is used to convey, a liquid from a higher point to a lower one, over an intermediate point higher than either.

Q.—At what temperature does water evaporate ?

A.—Water evaporates at all temperatures above freezing point, and boils at 212°Fah.

Q.—What is the origin of petroleum ?

A.—The exact origin of petroleum is unknown, but several likely theories have been advanced, the three most popular being as follows :—That it is the result of the decomposition of vegetable matter, the liquid state being an earlier stage in the process of coal formation. (2) That it is the result of the decomposition of animal matter. (3) That it is the product of the action of high temperature steam on metallic carbides.

Q.—What is a dead weight Safety Valve? Of what are the rubbing surfaces formed? How is a lock-up valve arranged to admit of lifting it or of turning it round, and to prevent adding to the weight?

A.—It is a Safety Valve fitted with weights of cast iron or lead, the load being equal to the pressure carried in the boiler multiplied by the area of the valve. The rubbing surfaces should be made of brass. To allow for locking-up, a cap is fitted over the end of the spindle. A cottar being passed through cross-handles are fitted to allow of its being turned round or lifted by hand gear.

To calculate the lift necessary in order to make area of escape equal to area of valve.

$$\text{Diameter} \times 3.1416 \times \text{Lift} = \text{Diameter}^2 \times .7854$$

$$\therefore \text{Lift} = \frac{\text{Diameter}^2 \times .7854}{\text{Diameter} \times 3.1416} = \frac{\text{Diameter.}}{4}$$

∴ the clearance is made $\frac{D}{4}$ at three different places in a dead weight valve. (1st) From top of weights to under side of cover; (2nd) From bottom of cottar to bottom of slot in spindle; (3rd) From top of spindle to top of cap inside. The cap and cross-handle simply rest on the cover, therefore, does not put any weight on the valve.

Q.—What is the approximate mechanical efficiency and the thermal efficiency of a four-cycle petrol engine?

A.—The mechanical efficiency is 75 to 85 per cent., and the thermal efficiency, on I.H.P. basis about 22 per cent.

Q.—What is the nearest approach to the chemist standard of a perfect water?

A.—Rain Water.

Q.—What are waters containing impurities held in solution termed?

A.—They are termed hard.

Q.—What are the methods of purification of Feed Water for Boilers.

A.—The purification of feed water may be carried out as follows:—

(1) by settlement (2) filteration, or (3) by Chemical means.

Q.—Give a mixture for Welding Steel.

A.—One part of salammoniac and ten parts borax. Pound these together and fuse until clear; pour out, and when cool reduce to a powder.

Q.—What is the Unit of Work?

A.—Work is measured in foot-pounds (ft.-lbs.), one foot-pound or one unit being the work done in lifting a mass weighing one pound vertically through a distance of one-foot. Consequently, if a force of P pounds is applied through a vertical distance of h feet the work done will be Ph ft.-lbs.

Q.—To what pressure is the air compressed in the cylinders of the various types of heavy oil engines?

A.—With four-cycle air injection, 460 to 480 lbs. per square inch; with four-cycle airless injection, 320 to 400 lbs. per square inch; with two-cycle air injection, 500 lbs. per square inch; and with two-cycle airless injection, 450 lbs. per square inch.

Q.—Give a mixture for welding cast steel.

A.—One ounce powdered glass, one ounce salammoniac, and 16 parts borax. For mild steel, borax may be used alone.

Q.—Give a mixture for cold soldering without fire.

A.—Bismuth ¼ ounce, quicksilver ¼ ounce, block tin filings 1 ounce, spirits of salt one ounce. Mix well together.

Q.—Give a mixture for cold brazing without fire or lamp.

A.—Floric acid ½ ounce, oxymuriate acid ½ ounce, mix in lead bottle, put a chalk mark at each side of the part that is going to be brazed.

This mixture is kept in a lead bottle will last for six months.

Q.—What is the Unit of Power?

A.—The unit of power is the horse-power. The work which any machine is capable of doing is measured in terms of horse-power. One horse-power or one unit of power is the measure of a machine capable of doing 33,000 ft.-lbs. of work every minute. An engine developing one horse-power (I.H.P.) is, therefore doing $\frac{33,000}{60}$ = 550 ft.-lbs. every second, or 33,000 ×60 = 1,980,000 ft. lbs.

Q.—Give a recipe for a Black Varnish.

A.—One pint of vitriol and two gallons of gas tar. Apply after effervescence has nearly exhausted.

Q.—Give a recipe for wheel-grease.

A.—Twenty-five pounds of tallow, 25 lbs. of tar, 15 lbs. of soda, and 8½ gallons of water. Boil water and soda, then add tallow and tar.

Q.—What is the Unit of Heat ?

A.—The unit of heat (B.Th.U.) is the amount of heat required to raise the temperature of one pound of water one degree Fah.

Q.—What is the amount of air required for the proper ventilation of apartments ?

A.—The amount of air required for the proper ventilation of apartments is from 4 to 5 cubic feet of air per head per minute in winter, and from 6 to 10 cubic feet in summer. A man makes about 17 respirations per minute each of 40 cubic inches, or $\frac{17 \times 40 \times 60}{1728} =$ 23.6 cubic feet per hour ; for respiration and transpiration. A man requires 215 cubic feet of air per hour. A man generates about 290 units of heat per hour, 100 units of which go to the formation of vapour, and the remaining 190 units are dissipated by radiation to the surrounding objects and contact with cold air. An ordinary gas burner consumes about 5 feet of gas per hour, and requires for combustion 12 cubic feet of air per cubic foot of gas, or 60 cubic feet per hour for each gas burner ; each cubic foot of gas burned emits about 690 units of heat ; each pound of candles or oil burnt requires 160 cubic feet of air for combustion, and emits 16,000 units of heat. For apartments with healthy occupants 300 cubic feet per head per hour are required.

Q.—Describe crude petroleum and state where and how it occurs.

A.—Crude petroleum in its many different forms is found in various countries under many widely different circumstances ; sometimes in great abundance, sometimes in only small quantities ; sometimes near the earth's surface, sometimes at great depths ; sometimes very light in weight, sometimes very heavy ; sometimes pleasant smelling and pure, and sometimes evil smelling and containing a high proportion of impurities. Crude petroleum occurs in porous rock and sands in which it is contained like water in a sponge. In cases where such rock is near the earth's surface, or forms an outcrop at the surface, the oil has evaporated and left a semi-solid bitumen behind. In other cases the oil has been imprisoned in its porous bed by a protecting cover of hard rock. The oil beds occur at depths varying from 100 to 7,000 feet.

Q.—What is Vacuum ?

A.—A vacuum theoretically is a perfectly void space. Among engineers the term is more properly "partial" Vacuum, for a "perfect" Vacuum can scarcely exist on the surface of our earth. In practice, the term is applied to a space containing a small quantity of some gas at a very low pressure. The lowest pressure attained is less than the fifty-millionith part of an atmosphere.

Q.—Give the causes of low vacuum.

A.—An imperfect, that is, a low, vacuum is due to one or more of the following three causes :—

(*a*) The amount of condensing water supplied may be insufficient ;

(*b*) the air pump may be out of order ;

(*c*) there may be air leaks.

The probable cause may be ascertained easily if a log of the performance of the engine is kept. In this log the temperature of the hot well, the temperature of the discharged condensing water, and the initial temperature of the entering condensing water are entered at regular intervals, such as every hour.

Q.—Define Valve gear of a steam engine.

A.—The Valve gear of a steam engine may be defined as that part of the mechanism which acts to control the distribution of steam to the cylinder.

Q.—What are the main objects to be attained in our dwellings and places of business with regard to ventilation ? Explain fully.

A.—The ventilating and heating Engineer hitherto has followed a great illusion in thinking that the main objects to be attained in our dwellings and places of business are chemical purity of the air and a uniform draughtless summer temperature.

Life is the reaction of the living substances to the ceaseless play of environment. Biotic energy arises from the transformation of those other forms of energy—heat, light, sound, etc., which beat up on the transformers—the living substance.

Thus when all the avenues of sense are closed the central nervous system is no longer around and consciousness lapses.

A sense organ is not stimulated unless there is a change of rate in the transference of energy, and this is to be effectual must occur in most cases with considerable quickness. If a weak agent is to stimulate its application must be abrupt. Thus the slow changes of barometric pressure on the body-surface originate no skin sensations, though, such changes of pressure if applied suddenly are much above the threshold value for touch. A touch excited by constant mechanical pressure of slight intensity fades quickly below the threshold of sensation. Thus the almost unbearable discomfort which a child feels on putting on for the first time a natural wool fades away and is no longer noticed with continued wear.

It is not the wind which God tempers to the shorn lamb, but the skin of the lamb to the wind. The ingrow of sensations keeps us active and alive and all the organs working in their appointed functions. The continuous sensations are of the highest importance. The salt and sand of wind-driven sea air particularly act on the skin and through it braces the whole body. The changing play of wind, of light, cold, and warmth stimulate the activity and health of mind and body. Monotony of sedentary occupation and of an overwarm still atmosphere endured for long working hours destroys vigour and brings about the atrophy of disease. The brain-worker, can keep himself perfect fit if his hours of sedentary employment are not too long and he balances these by open-air exercise. The chemical purity of the air is of no importance. Analyses show that the oxygen in the worst ventilated school-room, chapel or theatre is, never lessened by more than 1 per cent. of an atmosphere. The ventilation through chink and cranny, chimney, door, and window and the porous brickwall suffice to prevent a greater diminution. So long as there is present a partial pressure of oxygen sufficient to change the haemoglobin of the xenous blood into oxyhaemoglobin there can arise no lack of oxygen. The percentage of Co_2 in the worst ventilated room does not rise above 0.5 per cent. or at the outside 1 per cent. It is impossible that any excess of Co_2 should enter into our bodies when we breathe such air for whatever the percentage of Co_2 in the atmosphere may be that in the pulmonary air is kept constant at about .5 to .6 per cent. of an atmosphere-centre. It is the concentration of Co_2 which rules the respiratory centre and to such purpose as to keep the concentration both in the lungs and in the blood uniform. The only result from breathing air containing 0.5 to 1 per cent. of Co_2 is an inappreciable increase in the ventilation of the lungs. The very same thing happens when we take gentle exercise and produce more Co_2 in our bodies.

Q.—What is meant by "Welding"? Which of the common metals can be welded?

A.—By welding is meant the joining together of two pieces of iron or mild steel; they are heated to a white heat, sand being used as a flux, then carefully cleaned and hammered together until they become a solid mass.

To weld two pieces of iron together heat one end of each piece and jump them up to make sure you will have sufficient metal to get the original size after welding, then scarf the ends and heat to a white heat (using sand as a flux) then hammer them together until solid. There is also another method of welding called the burning process by which means metals which cannot be forged such as cast iron and brass can be joined together by placing the broken parts in a suitable mould, the molten metal is run into the mould between the broken parts until they are seen to fuse when the gutter way in the sand is closed and the metal surrounds the broken parts and so joins them together in one solid piece. There is still another method of welding called the elctric process by which means any metal may be welded by fusing the parts and joining them together.

Q.—Define wheel and Axle.

A.—The contrivance known as the wheel and axle consists of two cylinders of different diameters rigidly connected so that they turn together about a common axis.

Q.—Describe a Wedge.

A.—The Wedge is a movable inclined plane that in various modifications serves for many different purposes.

It may be employed to move heavy weights or to separate closely joined pieces of material. In the form of an axe, it is used to sever substances. In the form of a cotter it serves to tighten up the brasses in the different pin connections of a steam engine.

Q.—Describe a Safety Valve of a Boiler.

A.—The safety valve of a boiler is a device to prevent the pressure of steam exceeding the safe working limit, by automatically allowing the surplus steam to escape as fast as it is generated when the safe pressure is exceeded the valve lifts and liberates the excess steam until the pressure again becomes normal, when the load on the valve causes it to close again. It is therefore essential that the valve should not only be correctly loaded but that it should also have sufficient area to prevent the steam from rising above a certain limit, usually about 10 per cent. in excess of the working pressure. There are two forms of safety valves that are used on stationary boilers namely the dead-weight safety valve and the lever safety valve.

Q.—Describe the purpose and application of Pressure Gauges.

A.—The factory and workshop acts require that every steam boiler shall be fitted with a steam gauge to show the pressure in the boiler and the gauge must be maintained in proper condition. Pressure gauges and safety valves are set to work together and act as a check on each other. If a safety valve is stuck on its seat, or has not been correctly adjusted after overhauling the fact would be noted by the engineer or the manager by observation of the pressure indicated on the dial of the steam gauge.

Q.—What is the difference between high and low pressure steam ?

A.—High pressure steam is commonly understood to mean steam used in high pressure engines and low pressure steam is that used at low pressure in condensing engines heating apparatus etc., at 15 lbs. pressure or under.

Q.—What is initial pressure ?

A.—Initial pressure is that in the cylinder of an engine at the beginning of the forward stroke of the piston.

Q.—What is terminal pressure ?

A.—Terminal pressure is that which would be in the cylinder at the end of the stroke of the piston if the exhaust valve did not open until the stroke was finished.

CHAPTER LXII

ELECTRICAL UNITS

The three most commonly used are :—

(*a*) The unit o' current, called the "Ampere."
(*b*) The unit of potential, called the "Volt."
(*c*) The unit of resistence, called the "Ohm."
(*d*) The unit of Electrical power the "Watt."

The electrical pressure required to drive one ampre through a resistance (fri tion) of 1 ohm. or that offered to the passage of electricity by a thread of mercury 106.3 centimetres long and 1 square millimetre in area.

Quantity, pressure, and friction, merely describe analogus electrical phenomena.

The power of a current, is its Amps multiplied by its volts is measured by the watt (.0013 horse-power) or current of 1 amp. at 1 volt pressure.

A unit (Board of trade B.T.U.) or kilowatt-hour is 1,000 watts f r 1 hour or 10 watts for 100 hours or other factors of 1,000.

1 Unit-heats a 500-watt radiator for 2 hours - 3425 B.Th.Us.

Lights a 15-watt lamp for 66 hours 30-watts for 33 hours 45-watt for 25 hours 60-watt for 17 hours.

Ampere.—The international ampere (rate of flow of electricity) is the unvarying electric current which when passed through a solution of nitrate of silver in water, deposits silver at the rate of 0.00111800 of a gramme per second. One ampere is also equal to one coulomb per second.

1 international ampere 0.99991 absolute ampere
1 absolute ampere = 1.00009 international amperes
1 absolute ampere = 0.1 c.g.s. magnetic unit.

Volt.—The international volt (unit of electrical pressure of electromotive force) is the electrical pressure which, when steadily applied to a conductor the resistance of which is one international ohm, will produce a current of one international ampere. The Weston normal cell gives 1.0183 inte national volts at 20 degrees centigrade. One kilovolt equal 1,000 volts.

1 int rnational volt = 1.00043 absolute volts
1 absolute volt = 0.99957 international volt
1 absolute volt = 100,000,000 c.g.s. magnetic units.

Ohm.—The international ohm (unit of resistance) is the resistance offered to an unvarying electric current by a column of mercury at the temperature of melting ice, 14.4521 grammes in mass, of a constant cross-sectional area and of a length of 106.300 centimeters.

1 international ohm = 1.00052 absolute ohms
1 absolute ohm = 0.99948 international ohm
1 absolute ohm = 1,000,000,000 c.g.s. magnetic units.

Watt.—The international watt (unit of power) is the energy expended per second by an unvarying electric current of one international ampere under an electric pressure of one international volt. One watt is also equal to one joule per second. One kilowatt is equal to 1,000 watts

1 international watt = 1.00034 absolute watts
1 absolute watt = 0.99966 international watt
1 absolute watt = 10,000,000 c.g.s. magnetic units.

The units in common use are :—

(1) *The Kilowatt*...written Kw. and equal to 1,000 watts or 1.3405 H.P. or 737.27 foot-pounds per second, or 44.236 foot-pounds per minute.

(2) *The Kilowatt-hour*...This is the Board of Trade unit of electricity, in which electricity metres are calibrated. One Kilowatt-hour equals 1,000 watt-hours, or 1.3405 horse-power-hours or 2654200 foot-pounds.

Horse-Power...One horse power equal 746 watts, or 550 foot-pounds per second, or 33,000 foot-pounds per minute.

There are two principal systems of electric supply used in mills, known as the "direct" current system or D.C. and "alternating" current or A.C.

Each system has its special advantages, the alternating current having been, however, largely adopted for driving purposes owing to the simpler construction of the motors required.

Conversion of Mechanical into Electrical Units.

$$\text{kw.} = \text{h.p.} \times .746.$$

$$h.p. = \frac{\text{Kw}}{.746}$$

i.e., 1 h.p. is equivalent to 746 watts, or approximately three quarters of a Kilowatt.

The voltages most commonly used are :—

100, 110, 200, 220, 400, 440, and 500 volts.

The lower voltages are chiefly used for lighting and the higher voltages for power.

Amperes = Volts÷Ohms.

Watt = Amperes × Volts.

Horse-power = Watts÷746.

$$k.w. = \frac{\text{Volts} \times \text{Amperes.}}{1{,}000}$$

$$h.p. = \frac{\text{kw.}}{.746 \times \text{efficiency}}$$

$$k.w. = \frac{\text{h.p.} \times .746}{\text{efficiency.}}$$

The efficiency varying according to the size and character of the machine from about .78 (78 per cent) for one 1-h.p. machine to about .92 (92 per cent) for one 100-h.p. machine.

There is no fundamental difference between a direct-current motor and a dynamo. A dynamo would for a specific voltage will run as a motor on the same voltage at a reduced speed, *vice versa*, a motor will operate as a dynamo if its speed is increased.

The Board of Trade Unit.—For commercial pu poses electrical energy is charged for in units of 1000 watt-hours each. This unit is known as the Board of Trade Unit (B.T.U.) 1 Board of Trade Unit =1000/746 =1⅓ h.p. hours, practically =3402 British thermal units.

All the units in scientific work are defined in terms of the fundamental units which are :—

Unit of Length = 1 centimetre ;

Unit of Mass = 1 gramme ;

Unit of Time = 1 second.

These are spoken of as the C. G. S. units.

A. D. C. motor taking 10 amps. at 400 volts will therefore be using 4 kw., or 4 B.O.T. units per hour.

Example :—

What is the full-load current of a 10 h.p. d.c. motor working at 110 volts.

$$\text{Full-load current} = \frac{10 \times 746}{110 \times .9} = 75.45$$

Example :—

A d.c. motor working on a 220-volt supply is taking 85 amps. and the efficiency is taken as 90 per cent what is the load ?

$$\text{Approx. load} = \frac{85 \times 220 \times .90}{746} = 22.57 \text{ B-ake horse-power.}$$

An easy way to convert watts in'o 'he equivalent horse-power is to mark off three places and add one-third.

Example :—

What is the equivalent horse-power of 27,000 watts ?

Set off three decimal places		27.000
Add one-third		9.000
The horse-power required	=	36.000

Example :—

Find the equivalent number of watts of 48 elec. h.p. ?

Multiply the horse-power by 1000, thus 48 × 1000	=	48,000
Subtract one-quarter, (48,000 ÷ 4)	=	12,000
The required number of Watts	=	36,000

Alternating Current

An electric current which alternately reverses its direction in a circuit in a periodic manner, the frequency being independent of the constants of the circuit.

Alternating-Current Supply may be :—

(1) Single phase (using two conductors).
(2) Two phase (using either four or three conductors).
(3) Three phase (using three conductors).

In the case of alternating current, the relations between current, supply pressure, and ki'owatts are not so easily expresed as for continuous current.

Where :—

W = Watts.
A = Amperes.
V = Supply voltage.
K = Power factor.

The formula for single-phase circuits :—

$$Kw. = \frac{\text{Volts} \times \text{Amperes} \times \text{power factor}}{1000}$$

For two-phase circuits :—

$$Kw = \frac{2\ \text{Volts} \times \text{Amperes} \times \text{power factor.}}{1000}$$

For three-phase circuits :—

$$Kw = \frac{1.73\ \text{Volts} \times \text{Amperes} \times \text{power factor.}}{1000}$$

Standard Frequency and Voltages.—The British Standards Institution have standardised a frequency of 50 cycles and Voltages of 230,460 and 400 volts for alternating current low-voltage distribution. The voltages of 230 and 460 are used on single-phase three-wire systems for lighting and power, and the voltages of 230 and 400 are used in three-phase, four-wire systems for lighting and power supply, the lighting being supplied as single phase and the power as three-phase.

The frequency denotes the changes in direction of the current, and is referred to as cycles per second, a cycle being two complete reversals of direction. Thus, 50 cycles per second means that the current alternates 100 times per second.

The horse-power required to drive a three-phase generator is calculated thus :—

$$h.p. = \frac{\text{kw.}}{.746 \times \text{efficiency}} = \frac{1.73 \times \text{Volts} \times \text{Amperes} \times \text{power factor.}}{.746 \times \text{efficiency.}}$$

The Electrical power consumed by a three-phase motor is calculated thus :—

$$Kw. = \frac{\text{h.p.} \times .746}{\text{efficiency}}$$

$$Amperes = \frac{\text{h.p.} \times .746}{1.73 \times \text{power factor} \times \text{volts} \times \text{efficiency.}}$$

Example :—

What will be the power aken by 100 h.p. motor working on a 400-Volt three-phase circuit :—

$$\frac{100 \times .746}{400 \times .9 \times .85 \times 1.73} = 141.29\ \text{Amps.}$$

Examanple :—

The current taken by a motor on a 440-volt three-phase circuit is 80 amps. what is the approximate load ?

$$\frac{80 \times 440 \times .8 \times 1.73}{.746} = 65.30 \text{ h.p.}$$

When selecting a motor it is advisable to choose a motor with as high a speed as can be conveniently used. It is not desirable to instal a three-phase motor which is much too big for its work, since a lower power-factor means that the motor will take a bigger current. The best results are obtained at full-load both for efficiency and power-factor.

Charge of Electricity

The excess of positive or negative electricity on a body or in a space. If the excess is positive, the body is said to have a positive charge ; if negative, a negative charge.

Cycle

The complete series of changes taking place in the value of a recurring variable quantity during a period. For example, an alternating current passes through its cycle of values once in every period.

Direct Current

An electric current flowing in one direction only ; it may be constant in magnitude or pulsating.

Dyne

A unit of force. It is that force which acting on a mass of one gramme, gives to it an accelaration of one centimetre per second.

Electric Force

At any point, it is measured in magnitude and direction by the mechanical force in dynes per unit charge experienced by a very small electrically-charged body when placed at the point. In a solid medium the small charged body is assumed to be situated in a long narrow tunnel in the direction of the electric force.

Frequency

The number of cycles per second.

Fundamental Units

Units in terms of which all other units can be expressed.

Generator

A machine for converting mechanical energy into electrical energy.

Negative

A qualifying term applied to one of two points between which a difference of potential exists, to distinguish that one which corresponds, as far as the tendency to set up a current in an external circuit is concerned, to the zinc plate of a Daniell-cell.

Oscillating Current

An electric current which alternately reverses its direction in a circuit in a periodic manner, the frequency being dependent solely on the constants of the circuit.

Positive

A qualifying term applied to one of two points between which a difference of potential exists, to distinguish that one which corresponds, as far as the tendency to set up a current in an external circuit is concerned, to the copper plate of a Daniell-cell.

Pulsating Current

An electric current which undergoes regular recurring variations in magnitude. The term is usually confined to a unidirectional current.

Resistance Drop

With alternating current, that component of the voltage drop which equals the current in amperes multiplied by the resistance in ohms between the two points.

Voltage Drop

The voltage between any two given points on a conductor. With direct current the voltage drop equals the current in amperes multiplied by the resistance in ohms between the two points. With alternating current the voltage drop equals the current in amperes multiplied by the impedance in ohms between the two points.

Q.—What is "Short Circuiting" and to what evil does it give rise to?

A.—When a current of electricity leaves the circuit provided for it, and for itself another or shorter route for returning to the dynamo, it is called a Short Circuit. Should this take place it naturally follows that the lamps, etc., beyond this would not light, therefore, the current generated would be too much for the remaining lamps, consequently they would fuse, or if the engine were not stopped in time, it might be the means of fusing the whole of the armature. "Short Circuiting" may be said to occur when the wires taken from opposite brushes that is positive and negative) come together with little resistance between them, the rush of current would either blow the fuses or burn up the armature.

Q.—What is Electricity ?

A.—Electricity is a form of energy.

Q.—How are positive and negative electricity designated ?

A.—By the plus sign + for positive and the negative sign — for negative electricity. These signs are very useful in designating the two.

Q.—How do the signs + and — stand in relation to each other ?

A.—It is said that + electricity attracts — electricity, and that — electricity attracts + and the contrary, + repels +, — repels —.

Q.—Explain how is the flow of Electric Current directed.

A.—To direct the flow of electricity to the desired place, a copper wire is usually used. This flow of electricity, which is called electric current, flows through the copper wire just as water flows through the pipe down the side of the building. Electricity, however, is not a liquid, even though practicable electricians often refer to it as "the juice" and in closing a switch they will speak of "turning on the juice."

It is necessary however, to have some word to express the rate of flow of electric current. This word is "Ampere," when speaking in terms of electricity we say that the rate of flow of current is so many Amperes, as, for example, 1 Ampere 2 Amperes, 100 or 1,000 Amperes, as the case may be. If there are 5 amperes flowing in one wire and 10 amperes flowing in another wire, there is twice as much current flowing through the second wire as the first. Therefore whenever you see the word Ampere it means the rate of flow of current.

Q.—What do you understand by Electrical Pressure ?

A.—Electric current flows through a wire or conductor on the same principle that water flows through a pipe. We have found that it is pressure that causes water to flow through a pipe. Therefore, it is pressure that causes electric current to flow through a wire or conductor—except that with the electric current it is an electrical pressure, which comes from dry cells, wet cells, storage batteries, and electrical generators.

Q.—What do you understand by "Volt"?

A.—The electrical pressure produced by a dry cell, a storage battery, or an electric generator is not always the same. An electrical generator can be designed and built to produce almost any desired pressure. The word used to express electrical pressure is "Volt." The electrical pressure of a dry cell is 1½ volts; that of an automobile storage battery is about 6 volts; that of electric current used to furnish light in our homes is about 110 to 120 volts; the electrical pressure of the big transmission or power lines run through the country from one city to another is 33,000 volts, 66,000 volts or 132,000 volts.

Q.—What do you understand by Resistance?

A.—There are some metals or substances that allow electric current to flow through them easier than through other substances. Every substance or metal, however, has a tendency to resist or hold back the electric current to some extent from flowing through it, just as the banks of the ditches resist the tendency of the water to flow out of the ditches.

Q.—What do you understand by "Ohm"?

A.—The electrical term used to compare the resistance offered to the flow of electricity by one substance with another is the "Ohm."

Q.—What is a "Circuit"?

A.—The action of electricity, or the flow of electric current, is in many respects very similar to water, but in some cases the action is just the opposite to that of water. Water will flow out of the end of an open hose, when that end of the hose is lower than the surface of the water in the barrel. Electricity or electric current will not flow out of the end of an open wire because the air with which it comes in contact is an insulator, the same as rubber, and prevents t from flowing out of the bare wire just the same way as a cork put in the end of a hose would stop the water from flowing out of the hose when it is placed on the ground.

Since electricity will not flow out of the ends of the wire, a circuit must be formed in order to have a flow of electric current through the wires.

An electrical circuit is the path or route that an electric current takes in flowing from one place through a wire, conductor or apparatus, on to the next, and to the next, etc., and finally arrives at the starting place.

Let Pressure	= Volt	= E.
Let Current	= Ampere	= I.
Let Resistance	= Ohm	= R

Example :—

A voltage of 6 volts is used to force a current through a resistance of 8 ohms. What is the current ?

A.—The voltage (E) is 6 volts and the resistance (R) is 3 ohms, now to find the current (I) proceed thus :—

$$I = \frac{E}{R} = \frac{6}{3} = 2 \text{ Amperes.}$$

Example :—

What voltage is required to force a current of 2 Amperes through a resistance of 10 ohms ?

A.—The current (I) is 2 amperes and the resistance (R) is 10 ohms. to find the voltage (E) proceed thus :—

$$E = I \times R = 2 \text{ amperes} \times 10 \text{ ohms} = 20 \text{ volts.}$$

Example :—

A voltage of 20 volts is required to force a current of 5 amperes through a coils what is the resistance of the Coil ?

A.—Voltage (E) = 20 volts. Current (I) = 5 amperes

$$R = \frac{E}{I} = \frac{20 \text{ volts}}{5 \text{ amperes}} = 4 \text{ ohms.}$$

Example :—

The voltage between the ends of a piece of wire is 15 volts and its resistance is 8 ohms. What current will flow through it ?

A.—E = 15.

R = 8

$$\therefore \frac{E}{R} = \frac{15}{8} = 5 \text{ Amperes.}$$

Example :—

A current of 10 amperes is forced through a conductor by a pressure or voltage of 30 volts. What is the resistance of the conductor ?

A.—E = 30.

I = 10.

$$\therefore \frac{E}{I} = \frac{30}{10} = 30 \text{ ohms.}$$

Example :—

A current o' 10 amperes flows through a resistance of 2 ohms. What is the voltage that is forcing the current through the resistance?

A.—I = 10.

R = 2.

$\therefore I \times R = 10 \times 2 = 20$ volts.

Q.—What are Lightning Rods ?

A.—This form of arrester consists of a conducting rod or cable erected on the outside of a building and connected to earth, in order to afford protection from lightning by carrying the lightning discharge into the ground ; or to prevent lightning by leading the electricity from the earth to the cloud without disturbance.

Q.—Does lightning often strike telephone or electric light lines ?

A.—No, the lines become charged to a high pressure by induction from lightning flashes or from the passing of clouds that are highly charged.

Q.—What voltages are ordinarily used on two phase lines of more than moderate length ?

A.—For transmission distances of more than two or three miles, pressures of from 1,000 to 2,000 volts or more are employed to economize in copper. For long distance transmission of over fifty miles, from 30,000 to 100,000 and over are used.

Q.—What is an auxiliary bus bar ?

A.—An extra bus bar which is kept at higher pressure than the main bar.

Q.—What are the disadvantages of rubber insulation ?

A.—It deteriorates more or less rapidly and is quickly injured by temperatures above 140°Fah.

Q.—What are the advantages of rubber insulation for conductors ?

A.—It is waterproof, flexible, fairly strong, and has high insulating qualities.

Q.—What is the most efficient insulating material for transformers ?

A.—Mica.

Q.—What name is given to the coil through which current from the source flows ?

A.—The primary winding.

Q.—What name is given to the coil in which a current is induced?

A.—The secondary winding.

Q.—What instructions are usually given to the electrician who does the wiring ?

A.—In many cases simply a plan showing the location and number of lights, from which he must figure out how to install them using the least amount of material and labour consistent with a good installation that will pass inspection.

Q.—What is the prime condition for operation of a storage battery ?

A.—The resistance of the electrolyte should be as low as possible in order that the current may pass freely and with full effect between the electrodes. If the resistance of the electrolyte be too small, the intensity of the current will cause the water to boil rather than to occasion the electrolytic effects noted above.

Q.—How is the electrolyte prepared ?

A.—One part of chemically pure concentrated sulpheric acid is mixed with several parts of water. The proportion of water differs with several types of cell from three to eight parts, as specified in the directions accompanying the cells.

Q.—What test is necessary in preparing the electrolyte ?

A.—In mixing the water and acid, the hydrometer should be used to test the specific gravity of both the acid and the solution. The most suitable acid should show a specific gravity of about 1.760 or 66° Beaumé.

Q.—In preparing the electrolyte, how should the water and acid be mixed ?

A.—The mixture should be made by pouring the acid slowly into the water, "never the reverse." As cannot be too strongly emphasized, in mixing, the liquid should be stirred with a clean wooden stick, the acid being added to the water slowly; the latter is corrosive and will painfully burn the flesh.

Q.—What are the advantages of alternating current over direct current?

A.—The reduced cost of transmission by use of high voltages and transformers, greater simplicity of generators and motors, facility of transforming from one voltage to another (either higher or lower) for different purposes.

Q.—For what service are rubber covered conductors adapted?

A.—For interior wiring.

Q.—Is pure rubber used?

A.—No. The covering should be made from a compound containing from 20 to 35 per cent. of pure rubber.

Q.—How is three-phase current generated?

A.—It requires three equal windings on the alternator armature, and they must be spaced out over its surface so as to be successfully $\frac{1}{3}$ and $\frac{2}{3}$ of the period (that is, of the double pole pitch) apart from one other.

Q.—Define the term "Phase."

A.—As applied to an alternating current, phase denotes the angle turned through by the generating element reckoned from a given instant. Phase is usually measured in degrees from the initial position of zero generation.

Q.—How should the size of units be determined?

A.—By considering the characteristics of the building or place to be lighted.

Q.—Define mean horizontal candle power.

A.—If, from a source of light there be drawn lines equally in all directions in a plane, and their lengths be made proportional to the candle power in these directions then the sum of all these lengths, divided by their number, gives the mean candle power in that plane.

Q.—What does the expression "in phase" mean?

A.—Two alternating quantities are said to be in phase, when there is no phase difference between; that is when the angle of phase difference equals zero.

Q.—How must an alternator be constructed to generate two-phase current?

A.—It must have two independent windings, and these must be so spaced out that when the volts generated in one of the two phases are at a maximum, those generated in the other are at zero.

Q.—What points are to be considered in choosing between three-phase and single-phase transformers for three-phase current transformation ?

A.—No specific rule can be given regarding the selection of single-phase or three-phase transformers since both designs are equally reliable ; local conditions will generally determine which type is preferable.

Q.—How are three-phase alternators used for single-phase circuits ?

A.—The single phase circuit is connected to any two of the three-phase terminal leads.

Q.—What factor increases the difficulties of single-phase alternator construction ?

A.—The difficulties appear to increase with a decrease in frequency.

Q.—What is a candle foot ?

A.—The illumination produced by a light of one candle power at a distance of one foot.

Q.—What is one candle power ?

A.—The amount of light emitted by a sperm candle seven-eighths inch in diameter and burning 120 grains (7.776 grams) per hour.

Q.—What standard is employed for measuring light ?

A.—The candle power.

Q.—On what does the intensity of light depend ?

A.—On the amount of energy in the light waves.

Q.—How is light propagated ?

A.—Light waves move out in every direction from a luminous point.

Q.—Describe the nature of light ?

A.—Light is a rapid vibratory motion which is transmitted in the form of waves on the ether ; in other words, light is a sensation received through the organ of sight and is caused by waves which are transmitted on the ether.

A.—What are the disadvantages of open wiring ?

A.—The wiring is not sufficiently protected from moisture, and the effects of fire which will destroy the insulation of the wires ; it is also liable to mechanical injury.

Q.—Upon what does the intensity of the light given out by the arc depend ?

A.—On the temperature to which the electrodes can be heated before being vaporized.

Q.—What is the appearance of the arc when observed through a smoked glass ?

A.—It is plainly seen passing from the positive to the negative carbon.

Q.—How much energy is usually consumed by the arc ?

A.—About 10 amperes at 45 volts or 450 watts.

Q.—What temperature is produced by the arc ?

A.—About 6300°Fahr.

Q.—Describe the term "illumination."

A.—The term illumination may be defined as the density of light flux projected on a surface, and by extension, it denotes the art of using artificial sources of light, that is to say the problem of illumination involves the selection and arrangement of these artificial sources of light so that the objects to be lighted will show up to the best advantage and with the minimum amount of artificial light.

Q. Explain the use of a booster ?

A.—When a number of feeders run out from a station, the longest and those carrying the heaviest loads will have so much drop on the line that the pressure at distant points is too low. It is therefore necessary to raise the pressure to compensate for the drop and this is done by inserting a booster in the circuit.

It would not be economical to raise the voltage on all the lines by supplying current from the main dynamo at higher pressure, hence the voltage is raised only on the lines which need it by means of the booster working in series with the main dynamo.

Q. How should the distributing centres or cut out cabinets be located ?

A.—They should be installed near a partition that is so located as to make the running of risers easy, and should be on an inside wall to guard against dampness.

Q.—What provision should be made in rooms where lamps are suspended from the ceiling ?

A.—A switch should be placed at a point where it will be convenient for any one entering to turn on the light.

Q.—What is a switch ?

A.—A switch is a device used to make or break a circuit—the switch is so arranged that the hand will start it, while a powerful spring throws the switch open or closes it immediately.

Q.—How many kinds of electricity are there ?

A.—One—although it is spoken of and treated as two, positive and negative.

Q.—How can a two-way switch be distinguished ?

A.—It has three binding screws, two on one end and one on the other.

Q.—What are some of the disadvantages of alternating current ?

A.—The high pressure at which it is used renders it dangerous, and requires more efficient insulation ; alternating current cannot be used for such purposes as electroplating, charging storage batteries, etc.

Q.—Describe the action of a condenser when current is applied.

A.—When the current begins to flow into a condenser, that is, when the flow is maximu, the back pressure set up by the condenser (called the condenser pressure) is zero, and when the flow finally becomes zero, the condenser pressure is a maximum.

Q.—What may be said with respect to impurities in the electrolyte ?

A.—The electrolyte should be free from chlorine, nitrates, acetates, iron, copper, arsenic, mercury, and the slightest trace of platinum.

Mercury alone has no injurious affect unless it be present in sufficient quantity to amalgamate the plates, but in combination with any other metal, may cause local action.

The following tests should be made for impurities before the electrolyte is poured in the cells.

"*Chlorine.*"—To a small sample of the electrolyte add a few drops of silver solution (20 grains of silver dissolved in 1,000 cu. Cm. of water). A white precipitate indicates chlorine.

"*Nitrates.*"—Place some of the electrolyte in a test tube, and add 10 grains of strong ferrous sulphate solution carefully pour down the side of the test tube a small amount of chemically pure concentrated sulphuric acid. A brown stratum between the electrolyte and the concentrated acid indicates the presence of nitric acid.

"*Acetic Acid.*"—Neutralize the electrolyte with ammonia, then add ferric chloride. If the solution turn red, and is afterwards bleached by the addition of hydrochloric acid, acetic acid is present.

"*Iron.*"—Neutralize a sample of the electrolyte with ammonia, boil a small portion with hydrogen peroxide, and add ammonia or caustic potash solution until the mixture becomes alkaline. If a brownish red precipitate form, it indicates iron.

"*Copper.*"—If copper be present, a bluish white precipitate will be formed when ammonia solution is added to the electrolyte.

"*Mercury.*"—This is indicated by an olive green precipitate when a solution of potassium iodide is added to the electrolyte, or by a black precipitate when lime water is added.

"*Platinum.*"—A rough test for traces of platinum is made by pouring the electrolyte into a cell in which the battery plates are immersed. If gassing take place for some time on open circuit, it is an indication of the presence of platinum.

Q.—What use is made of two and three-phase current ? and how are they used for power and lighting purposes ?

A.—They are employed rather for power purposes than for lighting, but such systems are often installed for both services.

For lighting purposes the phases are isolated in separate circuits, that is, each is used as a single phase current. For driving motors the circuits are combined.

Q.—What is the difficulty encountered in starting a motor with single-phase current ?

A.—A single-phase current requires either a synchronous motor to develop mechanical power from it, or a specially constructed motor of dual type, the idea of which is to provide a method of getting rotation by foreign means and then to throw in the single phase current for power.

Q.—How would you improve the power factor in a mill driven by motors to save paying penalties ?

A.—Most utilities have penalty provisions incorporated in their power schedules for low-power-factor service, where these penalties are enforced, one of the best method of improving conditions is to rearrange your motors so that they operate at or near full load. Where such methods cannot be put into effect, then the installation of a synchronous condenser should be considered.

Q.—What is the cause of starter becoming excessively hot when starting with a full load and it may be noticed that there is a rush of current on the last notches with a probable consequence of the blowing-off of the fuse. How would you remedy it.

A.—The cause is, the starter is too small and to remove it the load should be reduced.

Q.—What is the possible cause of a motor becoming excessively hot ?

A.—Ascertain if the exciting circuit is highly connected and then test the load on the motor by means of an ammeter and then either reduce the load or use a larger motor.

Q.—Give the causes of hot bearings and state how would you remedy it ?

A.—(1) The belt is too tight. (2) The motor is not fixed accurately or properly on its foundation. To remedy it the belt should be loosen and the temperature watched. If this does not cure it then run the motor light without the belt and if this also does not reduce the temperature then the fault lies with the erection of the motor which should be re-erected.

Q.—What are the causes of the motor sparking when the load is put on and how would you remove the causes.

A.—The causes are (1) Overload (2) Incorrect position of brush-rocker (3) The auxiliary poles are wrongly connected.

The causes may be removed (1) By reducing the load or use a larger motor after testing the load by an ammeter (2) In motors without auxiliary poles and adjustable brush-rockers, the rocker should be moved against the direction of rotation. In larger motors the rocker must be moved in the direction of rotation (3) Test the connections of the auxiliary poles with a compass and change over the connections of the auxiliary poles contiously.

Q.—How would you rectify a motor running in the wrong direction.

A.—By altering the connecting link in accordance to the diagram submitted by the makers and the conductors reversed.

Q.—What is the cause of some brushes spark excessively and become hot, whilst others remain cold.

A.—The motor is provided with brushes made of different qualities of carbon.

Q.—State briefly how would you test motors before putting them to work. Give also the possible cause of motors going out of order and their remedy.

A.—A test is first made to determine whether the motor is in order mechanically, and whether the shaft is easily turned. Journal bearings must be filled with oil and lubricating rings turn easily. Occasionally the bearing bushes will have been displaced during transit and the lubricating rings will have become jammed.

"Direct-Current Motors"

The supply conductors must be tested for leakage and short-circuit. The motor and starter are then connected up in accordance with the appropriate diagram submitted by the makers. The rated current of the fuse must be selected to correspond with the size of the wire and with the rating of the motor (indicated on the name-plate of the motor). The brush rocker must be in its right position.

A piece of paper is next placed under each brush so that the brushes do not touch the commutator and the main switch and starter are closed. A test lamp connected to two adjoining brush-holders (two lamps in series must be used on 440V) should glow and a piece of iron, for instance a screw-driver, should be strnogly attracted by the magnets. If this is not the case, the fault must be investigated and remedied. Either the circuit is broken, or a wrong connection has been made.

When everything is in order, the starter and main switch are opened, the pieces of paper are removed and the motor can then be started according to the instructions given by the makers.

Q.—What is the cause of the motor starts irregularly, and takes an excessive current.

A.—The armature windings are short-circuited.

Chapter LXIII

COTTON

Q.—Describe cotton ?

A.—Cotton consists of a seed-hair of the cotton plant, and is obtained from the ripened husks. There are several kinds of cotton distinguished according to the country of origin and the species of plant grown there. They are valued according to the widely varying staple, diameter, tensile strength, colour, twist and evenness of the fibres. The superior long-stapled cottons have a smaller diameter than the inferior short-stapled varieties, whilst the latter show a greater affinity for dye-stuffs.

The cotton fibre consists of a long, flat, ribbon-like cell twisted to an irregular longitudinal spiral. Down the centre of this cell runs a canal (lumen), whilst outside it is covered by a thin skin, the cuticula. In chemical composition cotton is the purest form of cellulose found in nature. It contains only 5% impurities mainly pectines, also saponifiable and unsaponifiable cotton wax, cotton oil, etc.

Q.—How are the varieties of fibres of raw materials classified.

A.—They are classified as follows :—

(A) Animal Fibres (B) Vegetable Fibres (C) Re-manu-actured Fibres.

Q.—What are the properties to observe when comparing one lot of cotton with another for quality and value.

A.—The properties are as follows :—

(1) Natural twist (2) Length of fibre (3) Strength of fibre (4) Fineness (5) Uniformity (6) Colour (7) Elasticity (8) Cleanliness (9) Freedom from short-cut fibres, neppy, or dead fibres (10) Curls or Stringiness. Cotton fibres vary very considerably in length being from about $2\frac{1}{4}''$ in the best sea Islands to about $\frac{5}{8}''$ in the poorest Indian, and invariably the longest fibres are the thinnest. Sea Island Cotton will be found to be $1/1600''$ in diameter, while Indian is something like $1/1100''$.

The longest and thinnest fibres make the finest and best yarns because they contain the most natural twists and we are able to get the largest number of fibres in the cross-section of the yarn.

In colour cotton is, generally speaking, from white to creamy, but there are many exceptions, the most notable being Brown Egyptian and Red Peruvian.

Q.—Give the trade description of cotton.

A.—"*Bengals*"

United Provinces
Punjab
Sind
Rajputana

"*Oomras*"

Central Provinces Oomras
Berar Oomras
Khandesh Banilla
Khandesh Oomras
Central India Malvi
Barsi and Nagar Oomras
Verum 262
Hyderabad Gaorani.

"*Americans*"

Punjab 289F
Punjab 4F
Sind-Sudhar (289F—1)
Dharwar (Gadag—1)
Dharwar (Upland)
Cambodia (Coimbatore No. 2).

"*Broach*"

Surat Navsari (Surti).

"*Dholleras*"

Matheo
Cutch
Wagad.

"*Southerns*"

Kumptas (Jayawant)
Western (Jawari and Mungari)
Northerns
Coconadas (and Warangal)
Karungani
Tinnevellies
Salems.

"Comillas"

Burmas (Wagale and Wagyi)

Americans (U.S.A.)

Egyptians.

East Africans.

Q.—What are the defects found in cotton ?

A.—The defects are : (1) Seeds (2) Seed husks (3) Broken leaf and stalk (4) Sand and Mineral matter (5) Excessive moisture (6) Nep (7) Broken fibres (8) Unripe fibres (9) Dead fibres (10) Motes (11) Stained fibres.

Q.—Give your reasons why the number of mixings should be kept down to a minimum.

A.—The practice should as far as possible be to keep the number of mixings down to the minimum from the point of view of economy because reduction in number of mixings means reduction in waste and efficient organisation.

Besides the technique of mixing enables the work to be done in a more stable manner, favourably and lends itself easily to reduction of manufacturing cost both in respect to raw material price and cost of production.

Q.—What are the necessary requirements to qualify a testing room ?

A.—Testing room should have standard atmosphere throughout the whole year, *i.e.*, 70°F. room temperature and 65% relative humidity. The control of temperature is best accomplished by means of apparatus known as "Thermostat," and that of humidity by means of "psychrostat."

The sample under test should be properly conditioned on "Conditioning Frames" which freely expose the sample to air on both sides and under slow motion, in order to bring them to moisture equilibrium.

Q.—What is the object sought by mixing cotton from a number of bales.

A.—The object sought by mixing cotton from a number of bales is generally (1) to allow the cotton to assume its normal condition (2) to establish an average quality of grade in the lot (3) to obtain a certain quality of yarn as low a cost as possible (4) it is possible by kilful selection to mix a chaper grade of raw cotton with cotton of a better grade, and thus reduce the cost of yarn without reducing the quality appreciably. But it is very essential to be borne in mind that the fewer the varieties blended the better the result, as regards :

(*a*) Wastage (*b*) production (*c*) more labour in keeping the machinery clean (*d*) general discontent throughout the mill, (*e*) the mill gets a bad name in the market, etc.

Experience, knowledge or skill, attention and care coupled with cheapness are the foremost factors in laying a mixing.

Q.—How is raw material identified ?

A.—This requires the help of a microscope.

Q.—How is the strength of individual fibres is detirmined ?

A.—The strength of individual fibres is determined by means of a regular clamp textile machine of 10 lbs. capacity.

Q.—How is the elasticity in cotton fibres is ascertained.

A.—This can be found out or noted while testing for strength.

Q.—What are the most essential points or factors for a cotton selector to bear in mind ?

A.—A cotton selector must have the knowledge of the basic considerations for selection and blending of cottons and of the elements of variation in value of cottons under examination to other saleable stock, also variation arising from other conditions of market, the influence of future prices, supply, demand, market value of money and the possibilities of combining different grades.

Furthermore he must remember that while the efficiency of cottons for profitable manufacture could be measured in terms of their spinning value, only those cottons that could bear without nursing, optimum value of drafts for a given case, dictated by cost of production margin should be selected to spin into that count.

Q.—What are the main factors that a spinner must bear in imnd when he is selecting cotton ?

A.—Consistent with the price at which the yarn must be produced the spinner is always searching for that cotton which will best produce his particular yarns, and which will give the minimum of trouble in working and hence the maximum production and minimum waste. If the cotton is irregular in length or strength it means more waste in preparing and spinning processes, and so increase the cost of production and depreciate the value of the yarn. Also there are defects that must be looked for such as neps or dirt, colour, etc.

Q.—What are the four most important cotton growing countries.

A.—The four most important cotton growing countries of the world, named in the order of quantity are as follows :—

America, India, Egypt, and China.

Q.—Describe the appearance of the fully ripe cotton fibe as exhibited under a microscope.

A.—The appearance of the fully ripe cotton fibre as exhibited under a microscope is of a much more complicated construction than is apparent to the naked eye. When the mature cotton fibre is magnified a large number of times it is, approximately, similar to a corkscrew thread which has been drawn out, or elongated, to some extent. Each individual ripe fibre is not unlike the appearance of a twisted ribbon with thickened edges and a collapsed centre. The twists or convolutions, are not all in one direction, nor is there any regular order of a number of twists in one direction and a similar number in the opposite direction.

Q.—State briefly the various faults of ginning cotton and their specific causes.

A.—Neps, can be caused by faulty setting of saws, excessive speed of saws, feeding the machine to excess, feeding damp or unripe cotton.

Curls, can be caused by ginning damp or green cotton. The fau't may also be termed stringiness.

Cut Staple, will result if the speed of saws is too great, saws in contact with the grid, lack of repair to saws, careless feeding.

Q.—State the points to be borne in mind when selecting cotton for making into twist yarn.

A.—The selection of cotton for spinning into twist, or warp yarn, should be determined by the following characteristics. The staple ought to be both longer and stronger than for similar counts of weft yarn, the natural twist of the fibres should be well developed so that the cotton is a little harsh to feel, and when "drawing" a tuft of fibres by hand more power is required than for a soft or weft cotton ; the strength of the cotton is very important as twist yarn must be stronger than weft yarn, the colour of the cotton, although much less important than that for weft yarns, must be noted and considered in conjunction with the effect of the process of sizing the warp yarn.

Q.—What are the characteristics to be borne in mind when selecting cotton for making into weft yarns.

A.—When choosing cotton for making into weft yarns, the characteristics of the required yarn and its use must be borne in mind. Generally, the cotton must be as regular in staple as possible, the length depending on the counts and quality of the yarn; the cotton ought to feel fairly soft, but yet strong enough for good Spinning and without it being necessary to insert more than the usual amount of twist in the yarn, the cotton should be as clean as possible and also a good bloom Cotton that is tinged and dark coloured should no be used for weft. In many cases, soft waste made at various machines in the mill is used up gradually along with the new cotton for making into weft yarns. Card strippings of superior quality of cotton can be used for making weft yarns for blankets (raised) or flannelette cloths.

Q.—What are the defects likely to take place in cotton bales due to being insufficiently covered with burlap?

A.—Some of the bales of cotton received are defective in that they are insufficiently covered with burlap. Inadequately covered bales permit the outside of the bales to become wet and dirty. If, however, both well covered and insufficiently covered bales are allowed to be stored on wet and dirty floors, such bales are termed country damaged. Other causes for bales of cotton not being sufficiently covered on their arrival at the mi l are:—An unnecessary amount of covering removed when extracting samples; when unloading bales from the ship's holds some of the bands are liable to be detached and covering torn; excessive moisture, or bump cotton is also a fault sometimes found in bales, as also is excessive sand; occasionally when covering has been torn off bales, excessively heavy patches are sewn on, to increese the weight of the bale; this is a fault to guard against. "Humps," caused through city crop or brokers waste cotton being added to the surface of the bale and a patch stitched over it, also constitutes a faulty bale.

Q.—What do you understand by the designation "Staple of Cotton."

A.—The designation "Staple of Cotton" is understood to refer to the mean, or average, length of the cotton fibres being sampled or examined. The small sample being examined generally is representative of a quantity say 100 bales of cotton. When finding the staple of cotton, the strength of the cotton is also noted, hence the word staple may be used in various ways, such as, Length of staple, Strength of stap'e, Short staple, and so on.

Q.—What are the points to be considered when testing Raw material (cotton)

A.—(1) Identification, (2) Staple, (3) Strength, (4) Elasticity, (5) Resistance and (6) Moisture.

Q.—Will the cotton grow in India from American seed be as good as that grown in America.

A.—If cotton is grown in India from American seed, the quality of the cotton grown in the former country will not be as good as that grown in America. Many reasons may be assigned for this difference, the chief of which are, that the atmospheric conditions in India are not as well suited to cotton growing and the systems of cultivation and all operations to and including ginning the cotton are often crude, neither do they receive the necessary care for the production of cotton equal to American. The heat in India during the growing period is too great, and the rainfall not sufficient, and when water is supplied by rainfall, the lands are more or less flooded. In addition, Indian cotton is adversely affected by the carelessness displayed in the majority of districts, especially in storing the cotton.

Q.—What effect has the climate conditions on producing a successful crop of cotton.

A.—Regarding the climatic conditions necessary to produce a successful crop of cotton, a fairly warm atmosphere say 65° to 70°F. containing sufficient humidity is required, along with enough rainfall to ensure satisfactory growth of the plants until the bolls are developed. Warmer weather, interspersed with showers, is beneficial from the time of thinning out the plants until their maximum size is reached. Increasing heat and sunshine with less rain are wanted during ripening of the cotton, and, when ready for picking, fine sunny weather is desirable. All the plants are not ready for picking at the same time; consequently, the fields are gone over several times to completely pick the cotton, and an occasional light shower is beneficial.

Q.—What is the difference between hard and soft cottons.

A.—The difference between hard and soft cottons, is that the former feels very harsh or comparatively rough, also that a handful of cotton is harder to the sense of touch.

One of the hardest cottons grown is rough Peruvian, in which, although the convolutions per inch do not attain the greatest number, the prominence of the convolutions is felt by the amount of pull required to draw out a pinch of fibres. The designation "Soft" cotton refers to cotton which is just the reverse, as regards the feel, to hard cotton.

A cotton that feels smooth, or of which a pinch of fibres can be drawn out fairly easily and without feeling harsh, may be termed a soft cotton. Typical soft cotton are: New Orleans, and Uplands.

Q.—What are the points to be considered in the correct sequence of their importance in judging a cotton for spinning qualities.

A.—In judging, a cotton for spinning qualities, the points to be considered in the correct sequence of their importance, generally speaking, are as follows :—

Length of staple, Strength, Cleanliness, and Colour.

Q.—State the first mechanical process to which the cotton is subjected and its action.

A.—The first mechanical process to which the cotton is subjected is that of ginning (The Saw Gin or The Macarthy Gin) which removes the seed and husks from the raw cotton on the field prior to it being made up into compact bales for transit on a Baling Press.

Q.—Give the opening process order of the machinery in a modern cotton Spinning mill and their use.

A.—(1) *The "Bale Breaker" and "Mixing."*—It is usually at the bale breaker that the first attempt to blend the cotton is made. As required this machine blends the various grades of cotton when fed to it in slabs, by hand or lattice, direct from the bale. It also cleans the cotton. The process of mixings and blending in a modern mill is done on the pneumatic principle, and arranged so that when the cotton, from the bale-opener, is delivered into the mouth of a large pipe, it is drawn along by a fan, and deposited in the various stacks, as required, through delivery boxes.

The "Hopper Feeder."—The hopper feeder's action is precisely the same as that of the bale breaker, the only difference being that the construction of the various parts is not as strong, and the settings, owing to the more open state of the cotton, are closer.

The function of the machine is to make uniform laps, cleans and opens the cotton, and makes the next process more effective.

The "Opening and Scutching" Machinery.—The objects of Opening and Scutching Machinery are : (1) To extract as much as possible of the many impurities which are to be found in all cottons, such as seed, leaf, stalk, dust, sand, etc. (2) To beat or "Scutch" the cotton into a very fleecy condition. (3) To form the loose cotton into a compact and uniform sheet and to roll it up into a lap ready for the next process and that is the Carding process.

Q.—State the process in which the fibre suffers the most.

A.—Apparently the fibre suffers the most damage in the porcupine type of opener, for after this machine there is no further deterioration in the maximum fibre length.

Q.—State why does short stapled cotton requires to be beaten more than the long stapled cotton ?

A.—As a rule the longer stapled varieties of cotton are cleaner than the short stapled cotton. It follows then that they do not require the same amount of cleaning necessary for the lower and dirtier grades. Apart from the difference in the number of times the cotton has to be beaten, other important factors have to be taken into account, chief of which are the character, size, and speed of the beater, the nature and shape of the bars, the settings of bars to beater and feed roller to beater, and the amount of fan draft.

Q.—What are the three prime agents at work in all opening machines.

A.—There are three prime agents at work in all opening machines, *viz.* Beaters, Bars, and Suction.

Q.—How many types of beaters are there ?

A.—Beaters are of three types (1) the spiked type as used on hopper feeders and bale breakers ; (2) The porcupine type, as used on the small porcupine opener, or lattice feeder, the Crighton opener, the horizontal exhaust opener, and the large horizontal opener ; (3) the bladed types are used only on the scutchers.

COTTON MIXING

Gossypium Barbadense

This plant reaches a height of fifteen feet, and is indigenous to the West Indies. From it long stapled cottons, such as South Sea Islands, and Egyptian are obtained.

Gossypium Herbaceum

This is an annual shrubby plant about three feet high indigenous in Asia and Egypt. From this plant the cottons of India, China, etc., are obtained.

Gossypium Hirsutum

The hairy American cotton grows to a height of about six feet. It is largely cultivated in North and South America.

Gossypium Religiosum

This species has a brownish yellow fibre, and is indigenous to India and China.

Q.—What would you do in case of slight difference in bales of cotton of the same consignment and same mark.

A.—It is often found necessary to mix bales of cotton having the same mark, and from the same consignment, owing to the slight difference between one bale and another together with the differences found in each bale. These slight fluctuations are caused by differences in cotton grown on the same or adjacent fields, even from the same seed, being baled under the same mark. There are slight variations in the character of the soil, methods of cultivating the different fields, differences in state of maturity when the cotton is picked, and other reasons. The mixing of such bales reduces the irregularity of the cotton passing through the mill, enabling the advantages of regularity in quality of supply to be atained.

Q.—What is the advantage of having a long combination of machinery for opening and mixing of cotton ?

A.—When the long combination of machinery is used to obtain opening and mixing of cotton, some of the advantages accruing may be enumerated as follows :—

The risk of fire is not so great as there is less amount of exposed cotton ; less floor space occupied ; the cotton is not allowed to consolidate as in the bin method or stack method ; the work is easier and more economical less money lying idle. On the other hand, this system does not produce yarn quite as regular and strong as the bin or old stack methods of mixing ; the cotton is not allowed to "age" or naturally expand and acclimatise itself ; "travelling fires" sometimes occur.

Q.—What are the causes of Laps Splitting ?

A.—Too much soft waste or short-fibre in the mixing ; damp cotton or atmosphere ; hopper bale breaker fed with thick layers of cotton, fan draught too strong, unsuitable division of air current in the cages.

Q.—What are the causes of bad selvedges ?

A.—Dirt on grate bars near machine sides ; cotton accumulating on stripping plate edges ; placing the lap roller very carelessly on the layer of cotton in such a manner as to dent the machine sides ; cotton adhering to the leather on the cage ends ; rough machine sides.

Q.—Give some of the causes of rich droppings ?

A.—Mixing an excessive amount of soft waste in at an earlier process at infrequent intervals; grid bars spaced too widely; air current too weak.

Q.—What is the purpose of opening machinery ?

A.—The purpose of opening machinery is to gradually open the cotton from the hard compressed state on arrival at the mills, into a soft fleecy mass, and while the cotton is being opened some of the heavier impurities are also removed. The machinery also assists in mixing the cotton. The cotton, after passing through all the necessary opening machinery, is delivered in the form of a lap.

Q.—Give the parts of a Scutcher which are stopped while a lap s being removed.

A.—The parts of a scutcher which are stopped while a lap is being removed are as follows: Feed lattice, feed roller, cages, stripping rollers, knocking-off motion, and smooth calendar rollers.

Q.—Describe the action of the evener lattice in the hopper feeder.

A.—The evener lattice in the hopper feeder acts in conjunction with the inclined lattice to open out the large masses of cotton brought up by the latter lattice. Masses of cotton small enough to pass and not touch the even lattice are, of course, little if any further opened out, but any larger pieces are acted on by both lattices, which move in opposite directions at closest proximity, and thus open, or reduce the size of, the masses of cotton, and some portion of them returned to the hopper. Further, the even lattice only permits an even and predetermined quality of cotton to pass over the top of the inclined lattice, thus effecting regularity in quantity of cotton delivered from the machine.

Q.—What is the advantage derived from cotton mixing ?

A.—The cotton is permitted to expand and resume its natural condition; the quality of the cotton in the mixing is more regular; a desired quality of yarn can be produced at less cost than is possible if mixing of cottons is not adopted.

Q.—State from what kinds of cotton would you produce 20s to 40s twist yarn.

A.—A good twist yarn from 20s to 40s counts can generally be produced from Texas cotton alone. If, however, it is preferred to blend cottons grown in different countries, a mixing consisting of suitable proportions of Hingunghat, Navasari, and Texas cottons will enable twist yarn of 20s to 40s to be spun.

Q.—What will be the result if the evener lattice is set further from the upright lattice.

A.—By setting the evener lattice further from the upright lattice in the hopper feeder, the cotton will not be open to the same extent as before, and this change of setting will also tend to reduce the amount of impurities removed from the cotton. In addition, the amount of cotton delivered from the machine will be increased, providing that the height of the cotton in the hopper is maintained the same as before the change.

Q.—Describe the action of the beater in a scutching machine.

A.—The feed rollers (or pedal roller and pedals in some scutchers) deliver the super-imposed sheets of cotton very slowly into the path of the beater blades which revolve very quickly. The result is that the sheet or fringe of cotton is bent partly round the bottom feed roller or the pedals, and each inch, say, of cotton is struck many times before being released by the feed rollers, or pedals and pedal roller. The cotton thus receives a rough combing action and is detached in small flakes. Some of the flakes are dragged over the grid bars by the beater blades and removed therefrom by the air current, while other flakes are carried along almost solely by the air current, as soon as they are detached from the lap. Some of the impurities drop between the bars of the grid, while other impurities are mechanically beaten through the grid. Whatever fibre is removed at this stage ought to be only that attached to impurities. The action of the beater along with the air current conveys the cotton onwards through the machine.

Q.—State briefly the difference between the methods of stack mixing and bin mixing.

A.—By adopting the method of mixing cotton in the mixing bins after it has passed through the hopper bale breaker much manual labour is saved and the cotton is mixed in a partially opened and cleaned condition. The operative ought, of course, to feed the hopper bale breaker with a layer of cotton from each of the bales available. This method of mixing compared to the old method of stack mix ng reduces the labour cost and the cotton is partially mixed as it is delivered from the hopper bale breaker, but the cotton is not allowed to expand, previous to being subjected to machinery, as naturally as in the stack method. Owing to the arrangement of lattices from the hopper bale breaker the cotton can be directed generally to any one of the large bins or to any portion of one bin. Mixing cotton by the old stack system involves arduous labour and there is not much guarantee as to the pulling apart of the masses of cotton, nor that a real good mixing is made.

Q.—What is of primary importance to an erector of Blow-Room Machinery ?

A.—Of primary importance to the erector of these machines is the floor position, because, before erection is possible, a hole must be cut in the floor to receive the exhaust pipe of the fan.

Q.—Supposing you were asked to put a scutcher in a certain position, without a pln what would you do ?

A.—I would measure from frame feet to the fan bearings of sides and make a chalked line on the floor across the frame, and half the width of the cross rails marked on the line made will give fan centre ; and then I will have the hole cut about 20 inches square.

CARDING

Q.—What are the causes of bad selvedges on the doffer web ?

A.—Lap guide plates not properly set on the cards ; finisher scutcher lap with bad selvedges ; waste gathered between the card framing and the ends of the taker-in or cylinder ; waste accumulated between the mote knives at the sides of the card. and also at the ends of the taker-in screen and cylinder screen ; too much oil on taker-in and cylinder bearings ; fly gathered under the screens near card sides.

Q.—Discuss fully whether a card is capable of removing the short fibres after the cotton has been treated in the blowing room.

A.—There is considerable elimination of the shorter fibres in the machines following the blowing room as the considerable improvement of the staple diagram of the fibres contained in the yarn suggests. Except for the fly on the ring-frame, the flyers and the draw frame, the only other occasion where this could happen is the card. It is the only machine, when no combers are used, which is designed to remove short fibres. The fact is that the settings of the different organs in the card and their speeds influence the sliver and the wastes to such an extent that it is very difficult to make comparisons with the right settings and speeds, it is certainly possible to reduce the amount of useful fibres in the waste and thus increase the percentage of trash in it.

Q.—What are the fault generally found in covering Cylinders and Doffers ?

A.—Tension exerted on clothing to excess, insufficient or varying too widely ; word plugs fitting too slack, too high, too low, or the timber itself too soft or not properly dried ; tail ends of clothing overlapping slightly, or not wound close enough ; tacks driven in crooked or too near the edge of the fillet ; too many wires removed from the inner edge of the tail ends ; spirals of fillet not tacked to sufficient wood plugs ; small lumps left on the bare srufaces after painting same ; clothing not properly seasoned before application ; slack tail-ends.

Q.—What are the causes of faulty Carding ?

A.—Defective teeth on taker-in, ~~clinder~~, and doffer at sides of card ; front knife plate gathering cotton at sides, loose tail-ends of clothing ; stripping brush wire badly worn down at th ends ; waste accumulating under screens near card sides, lap guide plates not properly set ; waste wedged between sides of card and ends of taker-in and cylinder ; bad selvedges on scutcher lap ; oil escaping from taker-in and cylinder bearings ; waste gathered between mote knives and sides of card, and at ends of taker-in and cylinder screens, faulty setting carding ; cylinder wire ground down at one side ; one flat chain longer than the other.

Q.—What are the majority of the causes of neppy webs ?

A.—Damp Cotton ; too high a speed of card ; under-casing too closely set ; doffer comb too close ; heavy carding and close settings ; dull wires ; hooked wires ; incorrect settings.

Q.—What are the main points of difference between a dead roller and a traverse grinder.

A.—The main points of difference between a dead roller and a traverse grinder are that the dead roller is a little longer than the width of the cylinder or doffer, but the roller is only given a very slight traverse. The traverse grinder is only about 3½ to 4 inches wide, but it has a traverse imparted to it to move from one side oi the cylinder or doffer to the other.

Q.—State the direction in which the flats should travel when grinding the cylinder on a card.

A.—When grinding the cylinder wire on a card, the direction in which the flat should travel is the same as when cotton is being carded. Those flats nearest the cylinder move towards the front of the card, whilst the rest of the flats travel towards the back of the card.

Q.—Give the causes of web sagging and following doffer?

A.—Doffer Comb too high or too low in position or too slow in speed; speed of calender rollers too slow; doffer comb too far from doffer wire, dirty, or insufficient length of stroke; doffer wire hooked, or hollow in places, too much moisture in atmosphere; excessive vibration in comb box, or driving band too tight.

Q.—How many times should a card be stripped daily.

A.—Three to five times according to quality of cotton being used. The cards should be stripped alternately. If stripping brushes are used, the fillet should be kept in good condition; a spare newly covered brush should always be kept ready for use. An occasional stripping of the cylinder and doffer should be carried out with the stripping brush bearings lowered so as to more completely remove the waste from the wire interstics. If vacuum stripping system is used, any reduction in vacuum by faulty pipes should be guarded against.

Q.—Give the various methods of grinding the cylinder and doffer fillet.

A.—There are various methods of grinding the cylinder and doffer fillet. (1) One hour weekly (2) two hours fortnightly (3) five to ten hours monthly. The flats are ground one day per fortnight. Light grinding in all cases. Grinding rollers require carefully settings to grind lightly and evenly all along. The emery grinding fillet requires renewal often enough to prevent it becoming so smooth as to only polish the wire.

Q.—Why is it essential to true up the surface of a cylinder or doffer before covering same with fillet.

A.—It is essential to true up the surface of a cylinder or doffer before covering same with fillet in order to ensure parallelism of the bare cylinder and doffer surface, otherwise, if these surfaces were higher at some parts than others and the clothing wound on, it would be necessary to grind down the high parts more than the remainder of the clothing. This would result in those parts of the fillet so ground down having a shorter distance between the point and knee of the wire, which would cause such parts to have a harsher action on the cotton.

Q.—Give some of the causes of cloudy carding ?

A.—Lap-licking, uneven laps, defective lap piecings; careless handling of laps; defective lap roller on cards; feed plate set too far from taker-in, damaged mote knife; neglecting to remove flat strippings from doffer cover; fillet slack at places, badly shaped tail-ends, or devoid of wires at intervals; rounds of fillet not wound close enough, or slipped to one side of card; bare surfaces not trued up; card not striped often enough, or at irregular intervals; excessive fly beneath undercasings; grinding of wire not properly attended to; driving band, for the flat brush, too slack.

Q.—What are the causes of neppy web ?

A.—Cylinder and doffer set too close; grinding of cylinder, doffer, and flats not accomplished often enough or very carelessly carried out; flats set too close to, or too far from, the cylinder; doffer comb set too close to the doffer; taker-in and cylinder under-casings set too near the card clothing; doffer not stripped before starting up after the doffer comb band has broken.

Q.—What is the reason for providing the doffer of a card with a slow motion ?

A.—The reason for providing the doffer of a card with a slow motion is to reduce the amount of waste made when breakage of the web occurs between the doffer and calender rollers. When the web breaks, the operative places the slow motion into gear, thereby reducing the amount of waste made, and allowing the end to be pieced up more easily.

Q.—Explain how is the cotton transferred from the cylinder to the doffer.

A.—The cotton is transferred from the cylinder to the doffer by means of a combination of circumstances, as follows :—

(*a*) The small distance between the cylinder and doffer at closest proximity.

(*b*) The adjacent surfaces of the cylinder and the doffer are moving downwards.

(*c*) The downward direction of the wires on the cylinder and the upward direction of the doffer wire teeth, when these two surfaces are at closest proximity.

(*d*) The slightly finer counts of card clothing on the doffer as compared with the cylinder card clothing.

(*e*) The greater surface speed of the cylinder as compared with the doffer, say, 2,200 feet, per minute of the former to 45 feet per minute of the doffer.

In addition to the foregoing important factors, there are several other points which do not always receive due consideration. All the fibres are not transferred the first time they are brought round by the cylinder; some fibres pass round on the cylinder two or more times before they are in positions to be taken hold of, or be deposited on, the doffer. It should also be clearly understood that, the interstices between the cylinder wires must be fairly well "filled" before any transfer takes place. To prove this, strip the cylinder and doffer wire very thoroughly, that is, deeper than usual, then start the card and feed in the ordinary way. Next, consider why the web removed from the doffer by the doffer comb is not immediately the full weight.

During the ordinary transfer of the fibres from the cylinder to the doffer, the doffer wires certainly assist in the transfer by arresting and taking off those fibres which are in positions to be removed from the tips of the cylinder wires. The cylinder teeth interstices can only accommodate a certain amount of "filling," then regular transference must take place if the various parts of the card are working properly, and this transference is accomplished by the combination of the circumstances mentioned, along with the effect of the centrifugal force of the cylinder and the clinging property of the fibre when once the transfer is normally commenced.

Q.—Find the cost of covering a card cylinder with wire. The cylinder is 50 inches diameter 42 inches wide, and the fillet is 2 inches wide and costs 10 annas per foot. Allow 6 feet extra for finishing off (ending).

A.—Circumference of cylinder $= \frac{22}{7} \times 50$

No. of wraps of fillet to cover cylinder $= \frac{42}{2} = 21$

Length of fillet $= \frac{22}{7} \times \frac{50}{12} \times 21 = 275$ feet.

Total length of fillet $= 275 + 6 = 281$

Cost $= 281 \times 10$ Annas $=$ Rs. 175.

Q.—Give one method which is adopted for the purpose of removing the dirt, short fibres, and other impurities from the cylinder and doffer wires.

A.—The method is brush stripping. The brush system consists of a wooden roller $5\frac{1}{2}$ inches in diameter made to the width of the cylinder or doffer, mounted on a hollow shaft, each end of which extends about 15 inches from the roller. This is covered with hooked or bent wire which is about $\frac{5}{8}$ inch in length from its foundation. The brush should also carry a tin dust cover, and an 8 inches rope pulley on each shaft end. When stripping is to take place the roller is placed with its shaft in the adjustable steps attached to the cylinder bends or sides. These steps are adjusted so that the brush wire take off the cylinder wire the impurities desired without doing any damage to the cylinder wire or foundation.

The correct way of setting the brush wire to that of cylinder or doffer is to place the brush in the steps turn it by hand whilst the cylinder or doffer is stopped. If set too deep it will be difficult to turn which means that the brackets require moving outwards. Then lift the brush clear and turn cylinder or doffer round a little so that on putting the brush back in position and turning it, a better guide as to depth is obtained. When the brush is fairly easy to turn lift it and notice if the strip is taken off the wire evenly ; if not, adjust one or both brackets until satisfied that the wires of brush are entering those of cylinder and doffer in an even manner. This may mean lifting the brush a few times and also turning the cylinder or doffer round slightly so as to make a test where the waste is on the wire.

When the setting is correct the adjustable brackets are locked in position to prevent disturbance and the above setting repeated on all the cards necessary. This operation is carried out when a brush of a different diameter is put into use, or periodically the setting on all cards should be checked. As will be observed, the system of setting is rather a tedious operation, particularly if a large number of cards have to be set to receive this brush, and a simple apparatus to get the desired setting of brush wire to that of cylinder or doffer is made by the firms concerned.

One consists of a shaft of suitable diameter to fit the brackets of cylinder and doffer, the length of the shaft being determined by the width of the card. On to the shaft a setting block is supplied that will slide along the shaft as desired. To the block a regulating screw which carries a very fine thread for accurate setting is fitted. This has a milled edge lock-nut so that when the screw is in the desired position it can be thus locked on turning the nuet by hand.

In block setting the brush brackets of the first card must be set very carefully with the brush so as to have the wires of the stripping brush entering those of the cylinder and doffer level and of correct depth. Then on removing the brush the shaft is placed in position and the screw of the setting block is regulated until it just touches the cylinder wire. If the brush has been set indifferently the screw may be away from, or otherwise hard on the wire when the block is moved from one side of card to the other. The brackets are then adjusted by averaging them and the brush tied in position again, which means that guess work has now been dispensed with. The screw of the setting block is thus secured in this position by its lock-nut and therefore all the cards on which it is desired to use the brush in question can have their cylinder brackets set quickly, level, and to a correct height by simply placing the shaft in the steps and adjusting them until the face of the screw just touched the wire at each of cylinder.

The method is repeated in a similar manner for setting the stripping brackets of the doffers by adjusting the screw of the block to the wire, after the brush has been set correctly on the first doffer. when stripping is taking place the brush is revolved at about 500 r.p.m., while the cylinder and then the doffer is turned slowly. Thus the greater surface speed of brush takes the waste on to itself. The brush, after stripping one card, has to be cleaned, which is done with a hand strickle, this being a piece of word about 24 inches by 4 inches carrying a handle in the centre and the whole of its surface on one side covered with short bent wire. Using it as a comb in the same direction as the bend of the stripping brush wires, the hand strickle cleans the brush wire which is then ready for the next card.

Q.—Give a method of setting the various parts to each other on a carding engine ?

A.—The method of setting the various parts to each other on any one card is to have the wires cleaned of fibres and impurities, by using either a vacuum or stripping brush cleaning arrangement. The card is then put in motion but without feeding in any cotton and remains so until the flats have been cleaned of fibres, this action taking about twenty minutes. Then for safety and convenience the driving strap is removed from the fast and loose pulleys of cylinder and the parts set to the following particulars :—

Licker-in teeth to cylinder wire, 7/1,000.
Feed plate to licker-in teeth, 10/1,000.
Flat wire to cylinder, 10/1,000.
Doffer wire to that of cylinder, 5/1,000.
Doffer stripping comb to doffer wire, 15/1,000.

Cylinder undercasing at its back edge is set to a 34/1,000 gauge from the cylinder wire, at the bottom or middle of casing to a similar distance or gauge, and at the front (*i.e.*, almost under the doffer), the undercasing is set to a 68/1,000 gauge from cylinder wire.

The back plate fits immediately above the licker-in and close to the cylinder wire and is held in position by two concentric brackets, these fitting on to the cylinder bends or sides. The brackets are adjustable, therefore after inserting a 10/1,000 gauge between the top edge of the plate and the cylinder wire (it may be convenient to take some flats off to do this), the concentrics are moved carefully until a good setting of the plates has been obtained. The bottom edge setting of the plate is about 5/1,000 wider than that of the top edge. If the back plate has been slotted to receive the nozzle of a vacuum stripping pipe then this close setting of the plate may be found impracticable, due to the fact that the plate has been weakened through being cut almost across its centre. To overcome this fault machinists are now converting each slotted back-plate into two plates by simply completing the slot and then supporting the plate by adding more screws to them and the brackets. This makes the plates perfectly rigid, and does not interfere with the settings given above.

The front plates are fastened to brackets known as front concentrics and the plates consist of a top stripping rail or plate, a door, and a bottom plate. The latter, which is screwed to the concentrics, is set to a 34/1,000 gauge at its top edge from the cylinder wire, by adjusting the brackets. These are shaped and fitted so that with the top edge of the bottom plate set as above, the bottom edge of the plate will just be clear of the wire. To test whether it is clear or otherwise, have the cylinder turned round slowly by hand and in its opposite direction to normal; then a gentle pressure by hand on to the bottom part of plate will indicate its position in relation to the wire.

With the front concentrics fixed in a correct position, the top stripping plate is adjusted by moving the setting screws until a 34/1,000 gauge fits between the cylinder and both top and bottom edge of the plate. This setting of the top edge, however, is only given as a guide, for it can be altered to suit the weight of flat strip required, *i.e.*, a closer setting of the top edge of plate to cylinder will give a lighter strip, a wider setting giving a heavier one. Usually when the front concentrics are moved and the plates set, the radial arms of the door which are centred on the doffer bends need adjusting so as to make the door a good fit with the two plates.

Another point concerning front plate setting, is that of the flat wire being regularly set to the wire or the cylinder as the length of each is reduced by grinding. This means that if the plate is not kept to a crorect setting, the flat wire, by being brought close to the plate, will eventually rub on it, particularly if the flat chains are slack or worn. If this is so the wires are soon spoiled, because this fault loosens them in their foundation ; then setting of flat wire to that of cylinder and their combing action on to the cotton become meaningless.

Various systems in regard to the time limit between setting of cards and what to set, etc., are in vogue, each mill having its own routine, this being due perhaps to the amount of duties performed by the card setter or to the ideas of the management. Therefore whilst it is difficult to give a definite period between setting of parts, yet each card should be completely overhauled at least twice a year, with additional setting of flat doffer and licker-in. As an example, the first setting, should consist of removing the licker-in, feed roller and plate, the cylinder undercasing then being taken out, and examined for broken or bent bars, cleaned with black lead, and then reset followed by setting licker-in, feed plate, flats and doffer comb. Having reset all the cards in this manner the next setting may consist of front and back plates to cylinder wire, then to the cylinder set the flats, doffer, and licker-in with feed plate set to the latter.

There are times when this system may be broken, as far example, when one or more cards have to be recovered with new wire, but, keeping as much as possible to the above, the setting will be of a high standard. Additions to the system given can always be made as desired. One point worth considering is that of an extra flat and doffer setting done in between. In a well conducted card-room a record book is kept so that the number of each card, and the parts set may be entered, the feature of this book being three-fold: (1) overlapping in setting is avoided; (2) setting may be arranged so as to be spread over the various preparations; and (3) in the event of yarn complaints concerning the amount of nep, leaf, etc., on a certain quality, the setting date of the card in question can easily be found. If stripping, grinding, setting, etc., are carried out systematically then there will be found very little fault in the quality of carding which will be favourably reflected in the yarn spun.

FLY-FRAMES

Q.—Describe with examples, the various change places for a bobbin and fly frame, giving reasons for their use.

A.—The principal change places on a bobbin and fly frame are:—

(1) Draft wheels; (2) Twist wheel; (3) Rack or ratchet wheel; (4) Lifter wheel. Other change places which is used to a much lesser extent are (*a*) the bottom cone wheel and (*b*) the taper wheel.

(1) The draft wheels comprise the draft change pinion which is fitted on the same stud as the crown wheel and the back roller wheel; both of these wheels may be used for changing the draft. Occasionally both wheels are changed together for the purpose of obtaining the required draft but it is better to keep to a fixed size of back roller; if possible, as this reduces the risk of errors. Increasing the size of the pinion speeds up the back roller relative to the front roller and therefore reduces the draft. The opposite effect takes place when the back roller wheel is changed.

(2) The twist wheel, is, as its name implies, responsible for the twist; it is secured to the inner end of the jack or frame shaft and drives the whole of the frame either directly or indirectly with the exception of the spindles. The latter insert the twist and with a definite spindle speed the twists inserted per minute are equal to the spindle revolutions in the same time. If, therefore, the twist wheel is increased in size the length delivered by the rollers is increased in direct proportion and the amount of twist per inch is therefore reduced. The opposite effect takes place when the size of the twist wheel is reduced.

(3) The rack or ratchet wheel forms part of the building motion or regulator and the number of teeth contained in this wheel determines the distance the cone belt shall move at each change of the building motion with a coarser hank the diameter of the bobbins

is increased to a greater extent per layer than for finer hanks the bobbins must therefore be reduced in speed to a greater extent and this can only be accomplished by allowing the cone belt to traverse a greater distance along the cone drums for each change of the motion. Coarser hanks require therefore rack wheels with fewer teeth and these wheels are made in a standard size by each maker, the pitch of the teeth varying.

(4) The lifter, or as it is sometimes known, the reversing shaft change wheel controls the spacing of the coils per inch of lift, generally a larger wheel gives a greater lifter speed and therefore a wider spacing of the coils. When changing from one hank to another the change in the twist wheel does not alter sufficiently the lifter speed so that this wheel requires changing. For small changes, say, 3 to 3.4 hank the lifter wheel is very often ignored without apparent defects.

The taper wheel is generally changed when starting new frames when it is found that the taper in the cone shaped ends of the bobbins is either too little or is too great. After the frames have been set to work and the taper found to be correct it is very rarely changed. The bottom cone wheel determines the speed of the empty bobbin and if the latter is changed to another diameter then this wheel will require to be changed; its size varies in direct proportion to the diameter of the empty bobbin.

Example of calculating the ordinary change wheels.

Hank Roving = 3, the wheels required are as follows :—

46 Twist ~~52~~, Draft Pinion 48, Rack 21, Lifter 20. Find the wheels for 4.5 hank roving.

$$\frac{46 \times 3}{4.5} = 30.7 \text{ practically 31 Draft pinion.}$$

$$\frac{52 \times \sqrt{3}}{\sqrt{4.5}} = 42.4 \text{ practically 42 Twist wheel.}$$

$$\frac{21 \times \sqrt{4.5}}{\sqrt{3}} = 25.7 \text{ practically 28 Rack wheel.}$$

$$\frac{20 \times \sqrt{3}}{\sqrt{4.5}} = 16.3 \text{ practically 16 Lifter wheel.}$$

Q.—Why is a good and regular roving most required for the production of a uniform yarn ?

A.—It is quite impossible to spin uniform yarns from rovings that are irregular, for the irregularity of the rovings will always be reflected in the yarn. Even though the drafting mechanism of the spinning machine may be perfectly efficient, the most that can be expected in this respect is that the uniformity of the roving would be maintained in the yarn. Since, however, no drafting arrangement is perfectly efficient, it follows that the yarn will always be less uniform than the roving from which it is produced. The most efficient machines produce the most uniform yarn.

Q.—If proper allowance is made for the contraction due to twist and if the gearing arrangements are all right in the roving frames and if short lengths occur then what are the causes ?

A.—The causes may be :—

(1) Defective hank-indicators (where these are used).

(2) Bottom roller diameters less than what they are assumed to be.

(3) Persnal error (*i.e.*, one doff taken rather early or the previous doff rather too late).

(4) Varying tension on the ends, or

(5) A combination of more than one of the above factors.

Q.—State what are the various forms of irregularity that are to be found in the yrn ?

A.—(1) Irregular "wrappings" on the same cop or bobbin.

(2) Thick and thin places in the yarn, although the wrappings may be considered quite regular.

(3) Different spindles of the same machine wrapping differently

(4) Wrappings varying with different machines.

Q.—What does the production of speed frames depend on ?

A.—The production of speed frames is depended on the following :—

(*a*) Speed of spindles.

(*b*) Twist per inch.

(*c*) The hank produced.

(*d*) The production factor.

Q.—Give the reasons of inserting more twist on the speed frames.

A.—More twist is inserted for following reasons: too high spindle speeds, shaky spindles causing soft rove, and rove stretched by tight winding. Excessive twist means loss of production.

Q.—Give the points to be considered while testing sliver and roving.

A.—(1) Uniformity ; (2) Twist and (3) Broken fibres.

Q.—How would you obtain best results from fly frames ? Discuss briefly.

A.—The greatest production compatible with the highest quality at the lowest cost should be one's endeavour in obtaining the best results from speed frame. The cost is naturally affected by capital charges often beyond one's control and so the frames must run as economically as possible by using the highest speeds and coarsest hanks possible while steel keeping the main object (greatest production and lowest cost) in mind.

Results are controlled by various circumstances which may be classified under the heading of either "the machine" or "the human element" ; these headings may be subdivided, the former into the construction of the machine and its erection and upkeep. Under the second heading there is the intelligent knowledge on the part of the official in charge of the various parts of the machine with regard to speeds, roller setting, drafting, twisting and winding. Finally, under this heading the part played by the tenters must also be included.

Good results are often adversely affected by the failure of any one of these points, over which one has sometimes little or no control ; for instance, a manager might have to change his spinning in order to obtain or capture a market.

To get the best results one must work the frames in accordance with what they were originally set out for. For instance, a roving frame originally intended to work 14 hank sakel with 4¼ inches spindle space, 1¼ inches, 1⅛ inches, 1¼ inches, bottom rollers, middle and back top rollers, self-weighted, spindle speed 1120 r.p.m. would be unsatisfactory for, say, 4 hank ordinary American. The result would be the rollers could not be set close enough, they would be too lightly weighted, the spindle speed would be rather high, the space would be so narrow that the full bobbin would be less than 80 per cent., the size of a satisfactory 4 hank bobbin thus resulting in much loss of time in extra doffing, and ultimately more creeling and piecing in the subsequent spinning machines.

Q.—What is drafting ?

A.—Drafting is the fundamental principle of cotton spinning by which the cotton is gradually attenuated from a bale form into a finished yarn which is sufficiently fine.

SPINNING

The ideal drafting should reproduce the conditions of regularity and evenness existing before entering the machines and should displace the fibres proportional to the amount of draft.

Q.—Find the average number of frames run per month when all the frames were not kept fully going during the month.

Example :—

Frames available = 80.

Number of hours the frames worked during the month = 240

Total working hours per month = 260.

A.—Multiply frames run by the number of hours worked and divide the product by the full working hours per month—

$$\frac{80 \times 240}{260} = 73.84 \text{ average frames run.}$$

Q.—What are the commonest properties that yarn ought to possess ?

A.—Strength uniformity in count over long and short lengths and general appearances of the yarn are some of the commonest properties that are desired.

Q.—What are the factors to be considered when testing yarn ?

A.—(1) Number or count ; (2) twist,; (3) ply ; (4) diameter ; (5) skein strength ; (6) single end strength ; (7) scrigraph strength ; (8) stretch ; (9) regularity and (10) fibre content.

Q.—State the appearance the yarn presents when first looked at and the cause of the defects that are found in them.

A.—Under the appearance of the yarn one understands primarily, the presence of the original impurities like small but of leaf, further, neps, slubs, excessive fluffiness, etc.

This is mainly a processing problem but of course the peculiarities of the raw material in the bale will influence the end product as well.

There are certain cottons which are notorious for the amount of trash, especially leaf, in it, and some othrs for the abundance of neps, or even both.

Q.—Give the various fancy yarns that can be produced on a Fancy Doubler.

A.—Snarl yarns, loop yarns, intermittent loop yarns, embroidery yarns, variegated yarns, 2-colour flake yarns.

Q.—The standard turns per inch for 36s is $22\frac{1}{2}$. Find the standard turns for 60s.

A.—$\dfrac{22.5\ \sqrt{60}}{\sqrt{36}} = \dfrac{22.5 \times 7.74}{6} = 29$ turns per inch.

Q.—If a ring frame is spinning 30s with a 40 change pinion wheel on, find wheel required to spin 40s.

A.—$\dfrac{30 \times 40}{40} = 30$ wheel required.

Q.—If a ring frame is spinning 30s with a 40 pinion and a 48 back roller, and it is required to change 48 for a 42 back roller wheel, find change pinion required.

A.—$\dfrac{42 \times 40}{48} = 35$ wheel required.

Q.—How would you find the yarn counts of the following kinds of yarn ?

A.—Cotton Count $= \dfrac{1000}{\text{Grains for 120 yards}} = \dfrac{\text{Inches of yarn} \times .2315}{\text{Weight in grain}}$

$= \dfrac{\text{Inches of yarn} \times .015}{\text{Weight in grains}}$

Worsted Count $= \dfrac{1000}{\text{Grains for 80 yards}} = \dfrac{\text{Inches of yarn} \times 3.475}{\text{Weight in grains}}$

$= \dfrac{\text{Inches of yarn} \times .0225}{\text{Weight in grains}}$

Woolen Run $= \dfrac{21.875}{\text{Grains for 50 yards}} = \dfrac{\text{Inches of yarn} \times .1215}{\text{Weight in grains}}$

$= \dfrac{\text{Inches of yarn} \times .0079}{\text{Weight in grains}}$

Silk Denier $=$ Grains for 638 yards $= \dfrac{\text{Weight in grains} \times 22{,}968}{\text{Inches of yarn}}$

$= \dfrac{\text{Weight in grans} \times 354000}{\text{Inches of yarn}}$

Q.—Give some of the factors that are likely to limit production in the spinning department.

A.—In yarn production the speed that the spindles will withstand, amount of twist that can be put in per minute, allowable speed of the front rollers without impairing drafting, allowance for stoppages, *i.e.*, time lost in cleaning, oiling, piecing up ends, doffings, etc., are the factors that are likely to limit the spinning production.

Q.—What percentage of warp and weft would you allow for weaving standard goods.

A.—It is customary to have 60 per cent. of the total yarns production as for warp supply and the balance for weft.

Q.—Give some of the defects that are found in the yarn ?

A.—(1) Uneven in diameter.

(2) Uneven in rotundity.

(3) Uneven in strength.

(4) Uneven in weight and hence uneven in counts.

(5) Full of slubs.

(6) Full of snicks.

(7) Full of neps.

(8) Insufficient in elasticy.

Q.—If a ring frame is spinning 32s with a 40 change pinion and 120 crown wheel and it is desired to change the 120 crown wheel, for 110 crown wheel, find change pinions required.

A.—$\frac{40 \times 100}{120} = 36.66$ wheel required.

Q.—If a ring frame is spinning 32s with a 40 ratchet wheel and you are required to change it to 40s. Find ratchet wheel required.

A.—Find sq. root of 32s which is $= 5.66$

„ „ 40s „ $= 6.32$

$$\frac{6.32 \times 40}{5.66} = 44 \text{ wheel required.}$$

Q.—What are the qualities of roller cloth used for drawing, slubbing, inter, roving and ring frame and how many ring frame rollers would 1 yard of roller cloth be sufficient for ?

A.—16 ozs. for drawing frame.

14 ozs. for slubbing inter, roving, and ring.

1 yard will make 330 rollers for ring frames.

For casablanka system.

20 to 22 ozs. for slubbing and inter.

16 to 18 ozs. for ring frame.

Q.—If you were given a roller skin $20'' \times 24''$ how many rollers would you make for drawing, slubbing, inter roving and ring frame.

A.—1 Skin will make 145 rollers for ring warp frame.

1	„	„	„	150	„	„ weft „
1 {	„	„	„	16	„	drawing
	„	„	„	9	„	slubbing
1 {	„	„	„	16	„	drawing and
	„	„	„	18	„	intermediate frame.
1	„	„	„	68	„	slubbing frame
1	„	„	„	84	„	intermediate frame
1 {	„	„	„	42	„	roving.
	„	„	„	92	„	slubbing.

Q.—What are the causes of count variations ?

A.—The causes of count variations are as follows :—

(1) Defective mixing due to not paying particular attention to the average staple length of cotton that is put in the mixing and worse still mixing waste without knowing its average staple length.

(2) Defective opening machinery, such as worn beater blades, broken grid bars, defective piano motion, improper and dirty air-flues and chambers.

(3) Defects in the carding engines, such as worn licker-in, worn fillets, worn main bearings, stripping the cylinders and doffers too often, defects in gauging different parts.

(4) Defects in the draw frames, such as dented fluted rollers and top roller, defects in drafting all the three heads, wrong setting of rollers.

(5) Defects in the speed or fly-frames, such as worn rollers, wrong setting of rollers, too much or too little drafts at some particular points, defective piecings.

(6) Defect in the ring frames, such as worn, dented and untrue rollers, too much drafts, band-slippage, worn and rusty rings.

(7) Careless workmen, poor supervision, too much heat, and unsatisfactory humidity.

(8) Mechanical defects should receive prompt attention and the machinery should be overhauled if the defects and variations in count of yarn are to be minimised.

Q.—If a ring frame is spinning 32s with a 44 twist wheel, and it is required to change it to 40s.

A.—Find the sq. root of 32s which is = 5.6

,, ,, 40s ,, = 6.32

$$\frac{5.66 \times 44}{6.32} = 39 \text{ wheel required.}$$

Q.—How would you find out what number of roving spindles will be required to keep going 2314 ring spindles ? When speed of roving spindles is 1150 r.p.m., hank roving 3.5 and the twist multiplier 1.35 working hours = 9.

A.—The twist in roving material is given by $1.35\sqrt{3.5} = 2.525$ and the consequent surface speed of front roller equals $1150 \div 2.525 =$ 455.4 inches per minute. From this the speed of front roller works out to be $455.4 \div 3.1416 = 145$ r.p.m. and $(455.4 \times 60 \times 9 \times 94) \div (36 \times 840 \times 3.5 \times 100) = 2.184$ lbs., net production pre spindle per day allowing 6 per cent. as stoppages. Hence to produce 8399 lbs. of roving material to be consumed by ring frames (8399÷2.184) = 3847 roving spindles will be required.

Q.—A ring frame spindle is making 900 revolutions per minute and the traveller when working on empty bobbin loses 202 revolutions per minute. Find revolutions of the traveller.

A.—900—202 = 8789 revolutions of traveller.

To find speed of spindles if speed of front roller turns per inch and diameter of front roller are given.

Example :—

Speed of front roller	=	152
Turns per inch	=	19.81
Diameter of front roller	=	$\frac{7}{8}''$

2.75×152 = 418

418×1981 = 8280 speed of spindles.

To find the speed of front roller from the speed of spindle turns per inch and diameter of rollers.

Example :—

Speed of spindles	=	4524
Turns per inch	=	8
Circumference of front roller	=	3.1416
4524÷8	=	565.5
565.5÷3.1416	=	179 speed of front roller.

Q.—What is the object of cross-reeled yarn ?

A.—When the yarn is wound into hanks a quick traverse motion is used. It is wound in a crossed condition—the object is to prevent entanglement in re-winding.

Q.—What is a hank ?

A.—A continuous thread that has been wound a revolving frame-work (= a reel having a known circumference = 1½ yards) to that a certain number of revolutions will give a known length of yarn is called a hank or a skein. A hank equals a length of 840 yards in the cotton trade.

Q.—How would you find the weight of traveller to be used when changing from one count of yarn to another count of yarn ?

Example :—

Count running = 20s.

Travellers in use = No. 2.

Weight of 10 travellers = 11 grains.

Counts required to be changed to = 10s.

A.—Multiply the counts of yarn being spun by the weight of 10 travellers being used, and divide the result by the counts of yarn desired.

$$\frac{20 \times 11}{10} = 22 \text{ grs. or No. 9 traveller (approximately).}$$

Q.—How would you determine weight of traveller ?

A.—$\frac{\text{Number of yarn being spun} \times \text{weight in grain of 10 of travellers being used}}{\text{Number of yarn to be spun}}$

= Weight in grains of 10 travellers to be used.

$\frac{30^s \text{ (yarn being spun)} \times 6 \text{ grs. (weight in grs. of 10 of travellers being used—6\%)}}{20 \text{ (yarn to be spun)}}$

= 9 grains (for 10 travellers) or 1/0 travellers.

Q.—If 60^s yarn is .0058 inch in diameter what will be the diamter of 32s yarn ?

A.—Diameter of $32^s = .0058 \times \frac{\sqrt{60}}{\sqrt{32}} = 00.58 \times \frac{7.745}{5.656} = .0079$ inch

Q.—If a 19s lifter wheel is required for 10 hank roving what will be required for 16 hank roving ?

A.—Wheel required $= 19 \times \frac{\sqrt{10}}{\sqrt{16}} = 19 \frac{3.162}{4} = 12.52$ or 13s wheel (approximotely).

Q.—Suppose that 60s and 40s single yarn are doubled toger,the what would be the resultant yarn ?

A.—1 hank (840 yards) of 60s $= \frac{1}{40}$ of a lb.

1 ,, (840 yards) of 40s $= \frac{1}{60}$,,

∴ 1 hank (840 yards) of doubled yarn =

$$\frac{1}{60} + \frac{1}{40} = \frac{40+60}{2400} = \frac{100}{2400}$$

∴ Resultant counts =

$$\frac{2400}{100} = 24\text{s equivalent to 48/2 fold yarn.}$$

Q.—How many breaks would you consider reasonable per 1 000 spindles per hour for the ring spinning.

A.—In the case of medium counts 30 breaks per 1 000 spindles per hour is considered the limit in U.S.A. If breaks begin to exceed this number steps are taken to bring about an improvement. The greater output per winder and warper, and the greater number of automatic looms per weaver in the United States is no doubt largely due to this difference.

Q.—Why is the control of atmospheric conditions vital in many industrial processes.

A.—In many industrial process the control of atmospheric conditions is a vital necessity and in a still greater number it is highly desirable and would be of great benefit. In the textile industries it is well known that many operations could not be carried on regularly unless steps are taken to increase the humidity of the air in the mills. Fine cotton spinning affords an example. Long before ventilation and air conditioning became accepted as definite branches of engineering crude methods of humidifying the air were adopted in mills in which yarns of fine counts were being spun. Though less trouble is experienced in the production of medium and coarse counts there is no doubt that in all branches of the textile industry the control of temperature and relative humidity proves to be of no small advantage, when the cotton material becomes electrified during its passage through the machines.

Q.—What is the consideration of first importance in sampling cotton ?

A.—The consideration of first importance in sampling cotton is that the sample be adequately representative of the bale. A good sample will enable the classer to determine the quality of the major portion of the lint making up the bale.

Q.—What are the characteristics essential in the case of a Ring Spindle.

A.—The following characteristics are essential.

(*a*) Long life and small replacement costs.

(*b*) Low power consumption.

(*c*) Ease of maintenance.

(*d*) When running at high or low speed there should practically be no vibration.

Q.—What do you consider the most important single adjunct in the mill necessary to the production of good yarn.

A.—The leather rollers play a greater part in the production of good or bad yarn as the case may be than all else in the mill.

Q.—How would you select skins for rollers for fly and spinning frames and both for coarse and fine yarns.

A.—(1) For low or "coarse counts" select a cheap quality of skin.

(2) For "medium counts" select a medium quality.

(3) For "fine counts" select only the best and finest Persian lamb preferably of small size and correspondingly fine grain.

(4) For "drawing" and "slubbing" frames large stout skins.

(5) For "intermediate" frames—medium size of medium substance.

(6) For "rovings" "mules" and "rings"—small size of thin substance.

It is a mistake to ask for a large-sized skin to be thin; skins are not grown thin on healthy sheep. If rendered thin by shaving, then the fibrous structure must suffer in strength.

In a lamb the fibrous structure is fine, thin, and delicate, and thus more suitable for the finer fibre with which it has to deal, whereas on a sheep it is thick, coarse and rough. Skins should be used in consonance with the class of cotton and counts spun—for instance, in spinning hard twist of say 6s counts it would be ridiculous to choose a thin, smoother grained skin; in this case a heavy roughish grained skin would do the work quite well and would last much longer, besides being considerably cheaper. It is always best to buy really good skins, *i.e.*, the bset of the grade necessary. As it saves both worry and money.

Q.—Why are rollers recovered?

A.—Because they wear hollow and are no longer capable of drawing evenly.

Q.—How are worn rollers classified?

A.—Worn rollers are classified in three sections, *viz.*, those which require (1) recovering with both cloth and leather, (2) recovering with leather alone, (3) simply grinding and varnishing and not recovering at all.

Q.—Give a recipe for making roller coverers' paste.

A.—The following is a very good recipe.

1½ lbs. best white flour.
½ gill boiled linseed oil.
2 ounces venice turpentine.
1 lb. amber resin.

Directions for preparing the paste.

(1) Put the flour to steep in 8½ gills of cold water for twenty-four hours before proceeding to make the paste.

(2) Grind up the resin into powder; place it in 8½ gills of boiling water, and continue to boil for 25 minutes.

(3) Then add the boiled oil and venice turpentine, and continue to boil for another five minutes.

(4) Now add 8½ gills of boiling water to the flour and mix all ingredients together, stirring well until the whole has boiled for half-an-hour.

All lumps, large and small should be removed.

Q.—Give a Cement recipe.

A.—A cement recipe should be composed of the following ingredients.

Isinglass or gelatine, either or both, in equal quantities dissolve in acetic acid.

Special cement for waterproof leather:

1 oz. best Russian isinglass.
½ oz. gum acacia.
4 ozs. acetic acids, 40% strength.

Dissolve the gum acacia in half the acid and the Russian isinglass in the other half. When both are dissolved mix together.

In hot weather add a little more isinglass as required. It is a mistake to use too much cement as a minute quantity ought to suffice if of proper consistency. An excessive quantity runs off the bevels and into the fibre on the flesh side of the skin, clogging it and causing a hard line on the surface of the roller.

Q.—Explain the principles of spinning?

A.—In the principles of spinning, it is explained that the thread or yarn produced consists of a collection of fibres, laid parallel during processing (carding, combing, and drawing) previous to the actual spinning, and then after further drawing out and by means of twisting the fibres around their axis, are transformed into yarns. These may be either for warp or weft, and the amount of twist in each is often the only differentiating factor. Two points in connection with this twist have to be taken into consideration:—(*a*) the direction of twist and (*b*) the amount of twist imparted.

In connection with the direction of twist there are two only. *viz.*, left and right. The latter—*i.e.*, the right-hand twist—is also technically known the warp twist, and the former—*i.e.*, the left-hand) twist—as weft twist.

Q.—Give a recipe for roller varnish.

A.—The following is a good recipe for roller varnish.

1 lb. chrome yellow.

¼ lb. lamp black.

¼ lb. rouge.

10 ozs. carpenter's glue.

Mode of preparation.

(1) Place altogether the chrome yellow, lamp black, and rouge, and pound well into powder.

(2) Boil the joiners' glue in two quarts of water, add in the above mixed powder, and let it simmer for half-an-hour, continually stirring it.

(3) If it should be thicker than ordinary paint dilute with warm water and then bottle. Before using, it will be necessary to heat the varnish slightly to render it liquid.

It should also be remembered that the care of the bottom fluted rollers has a distinct bearing upon the wear and tear of the leather covered rollers. A system of thorough and regular scouring of the bottom rollers eliminates the possibility of impurities adhering to the flutes and marking or damaging the leather top rollers.

It is generally speaking true to say that in the matter of leather covering of rollers the utilization of the best quality material is a real economy in the long run.

Q.—State (*a*) why good bevelling and secure piecing is essential in the case of roller covering (*b*) and the evils that may result from bad levelling and insecure piecing of leather rollers.

A.—(*a*) Good smooth piecing of the leather, and of the cloth at i's meeting line on the roller is absolutely essential if the good spinning of yarn is to take place (*b*) A projecting or uneven, piecing may cause :—

(1) A snarl; (2) A cut end; (3) By obstructing the passage of the fibres, a thick and thin place and a variation in the uniformity of sliver, yarn or roving.

It is, therefore, essential that the leather and the cloth be cut to a good "level." This can only be done by careful and accurate use of a bevelling machine. In the same way it is essential that reliable good quality adhesives should be used for attaching the cloth to the roller and for joining the leather. Flour paste, kept damp, is to be recommended for attaching the cloth to the roller and an adhesive made of isinglass and acetic acid cement is very reliable for the joining of the leathers.

Q.—What are the points that should be considered carefully with regard to carding operation that will help to produce good quality of yarn if the grade of cotton is suitable.

A.—The following points should be taken into consideration :

(1) Condition of the cylinder, doffer, and flat wires.
(2) Stripping.
(3) Grinding.
(4) Licker-in.
(5) Method and system of card setting.
(6) Constant observation.
(7) Strict supervision.

Q.—The floor space in the cotton godown is 155 feet by 88 feet How many bales of Egyptian cotton 3 feet high by 2 feet 7 inches wide by 1 foot 10 inches broad can be stacked in this godown, stood on end ?

A.—Floor space = 155 feet × 88 feet.
155 feet = 1860 inches.
2 feet 7 inches = 31 inches.

$\therefore$ Number in line down length of room $= \frac{1860}{31} = 60$

88 feet = 1056 inches.
1 feet 10 inches = 22 inches.

$\therefore$ Number of line $= \frac{1056}{22} = 48.$

$\therefore$ Total number of bales $= 60 \times 48 = 2880.$

Q.—State why is it necessary to take wrappings more than once during the day in the case of coarse counts of yarn.

A.—In the case of very coarse counts, from 4s to 12s, it is really necessary to have wrapping taken at least twice a day owing to the high production capacity of a frame doing this class of work, and this is especially so in the case of yarns that are being spun on a strength basis and when it is imperative that the strength be maintained at a constant figrue. Very often coarse yarns are spun direct from the slubber or intermediate bobbins and the defects in count of draw frame sliver are not reduced as is the case when roving bobbins are produced and fed to the spinning frame, therefore these irregularities soon find their way into the yarn, and only effective wrappings will reveal the extent of these. It is of extreme importance that the actual results of tests should be carefully recorded and it is necessary that the work of the wrapping boy or clerk should be checked at unexpected intervals to eliminate as far as possible the human error and insure reliable results.

Q.—State why is it of the greatest importance that the lubricants in a spinning mill should be chosen for the service they give.

A.—In the textile industry, as in other industries, it is the aim of managements to secure maximum production with true economy in operating cost.

To achieve that object it is necessary to employ all means whereby frictional and power losses on machinery will be reduced to the minimum.

The amount of friction to be overcome in driving a textile mill will be apparent when it is remembered that there may be from about 5,000 to 20,000 or more spindle bearings requiring lurbication in the spinning department alone.

Power consumption in a spinning department averages from 20 per cent. to 40 per cent. of the total power consumed by the entire mill, and poor spindle lubrication may increase the spinning load by as much as 15 per cent. compared with good lubrication.

Q.—Describe a ring spindle and the speed at which it operates.

A.—Ring spindles are carried on rails of deep section extending the full length of the frame. They are of self-contained type, and consist of a bolster or spindle bath carrying an inner tube in which the spindle runs, the whole being secured to the rail.

Although the bobbins are fitted to the spindles, with which they revolve, they do not move upwards and downwards in the winding of the yarn on to the bobbin, as in the case of flyer spinning. The lifter rail carrying the traveller ring is raised and lowered, thus feeding the yarn on to the vertical bobbin revolving in the axial centre of the ring races. As only rotary motion is required, a length of spindle suitable for the bearing and to accommodate the bobbin is all that is necessary.

Ring spindles operate at speeds varying according to the nature of the yarn spun. In cotton ring frames the spindle speeds range from 7,000 to 11,000 r.p.m.; but for silk and worsted spinning they do not exceed 7,000 r.p.m.

Q.—What are the principal parts of a ring spinning frame requiring lubrication and how is lubrication effected ?

A.—The parts requiring lubrication are the ring spindles, the draft rollers, the tin rollers, and the driving gears. On a ring spinning frame and on any other type where the spindles revolve in oil-baths, the spindles are of paramount importance from a lubircation point of view, as they are capable of absorbing as much as 55 per cent. of the power required to operate the frame.

The spindles operate at high speeds, and the clearances between the spindles and inner tbues are very fine. The rapid circulation of the oil through these small clearances when the spindles are running makes it essential that the oil in use shall have the maximum fluidity compatible with efficient lubrication, and be of such a nature that, it will not oxidize readily nor form gummy deposits with continued use.

The employment of an oil of the lightest possible body that will maintain at all times a complete lubricating film between the rubbing surfaces will result in minimum friction, low operating temperatures, minimum repairs and replacements and reduced power costs.

The bolster of each spindle is so arranged that the bottom part of the inner tube containing the spindle foot is immersed always in oil.

Lubrication is effected by the oil being drawn up on the revolving spindle, assisted by holes or slots in the inner tube, through which the oil overflows and finds its way back to the bolster; hence the oil is kept in continuous circulation over all of the bearing surfaces.

Make-up oil is added to the oil-bath, from time to time, this being easily accomplished by lifting out the spindle. In other cases the bolster is provided with an oil-cup which is readily detachable for the purpose of adding new oil.

The driving gears actuating the draft rollers and builder motions are hand-oiled, and it will be found that the oil used in the general lubrication of the frame is suitable and conducive to smooth running. The oil used in the oil-baths of the ring spindles is too light in body for the efficient lubrication of these gears.

Q.—When is yarn cross reeled and why ?

A.—Cross reeling is carried out when it is intended to dye, prepare, or bleach the yarn. In this form the yarn is left in somewhat open condition, and, therefore, can take dye better, and is at the same time more easily unwound without entanglement. Cross winding is obtained by a swift backwards and forwards movement being imparted to the thread guide rail by a crank or eccentric. Cross reeling is most used for the home trade, and open reeling for the foreign trade.

Q.—What should be the relative humidity from bale opening to yarn spinning.

A.—Yarn spun under ideal relative humidity conditions would be stronger than yarn spun under low relative humidities and then conditioned to the standard moisture regain. With increasing relative humidities both breaking strength and extensibility at breaking load increase.

Bale opening	70% R.H.
Mixing	70% ,,
Scutching room	65% ,,
Card room	60% ,,
Mule spinning	50 to 55% H.R.
Ring spinning	60% R.H.

As the moisture content of a textile fibre increases it swells and as the swelling increases, the plasticity increases and the fibre is more easily twisted and bent.

GREY WINDING

Q.—What quantity of warp will be required on ring bobbins allowing 2 per cent. for waste in winding and warping for a set of back beams containing a total number of 8,240 ends, 10,000 yards long of 20 counts ?

$$A.\text{—}\ \frac{8240 \times 1000}{840 \times 20} = \frac{13500}{7} = 1928 \text{ lbs. } 9.14 \text{ ozs.}$$

$$\text{Plus waste } 2\% = \frac{38 \text{ lbs. } 9.10 \text{ ozs.}}{1967 \text{ lbs. } 2.24 \text{ ozs.}}$$

Q.—A spindle is required to revolve 600 times a minute, and the proposed method is to drive it from a line shaft by a 16-inch drum to a 12-inch pulley, the latter being fixed to a 4-inch tin roller driving 2-inch wharfe on the spindle. At what speed will the line shaft have to revolve ?

A.—The drivers are 16 and 4

The driven are 12 and 2

$$\frac{600 \times 12 \times 2}{16 \times 4} = 75 \text{ speed of line shaft.}$$

Q.—What is yarn ? Define it.

A.—It is a term applied to one or more continuous strands, particularly to yarns in bulk spun or otherwise produced from natural fibrous substances uniformly disposed throughout its structure and having a certain amount of twist inserted for the purpose of enhancing its strength whether vegetable, animals or mineral as cotton yarn, woollen yarn, asbestos yarn. In other words yarn is the final product of the process of spinning, or the union of textile fibres into a single thread.

The yarn is defined as soft spun, medium spun, according to the amount of twist it has received.

Q.—The weight of 50 metres of yarn is found to be 10 grammes. What are the counts ?

A.—Divide the metres by twice the weight in grammes

$$\frac{50}{10 \times 2} = 2.55 \text{ counts.}$$

Q.—What should be the relative humidity of the preparatory processes and weaving.

A.—Weaving preparation .. 65%.

High speed beaming .. 75%.

Weaving .. .. .. 70 to 75%.

Q.—Give a brief account of processes the warp yarn has to go through ?

A.—The warp yarn is generally received from the spinning department or the spinner in the form of bobbins or cops and has at least four processes to go through before it becomes a part of the finished cloth, *viz.*, winding, warping, sizing and weaving.

(1) "*Winding.*"—The winding process is simply the winding of the yarn from the small spinners' cops, or ring robbins on to large

warper's bobbins, but this process has, of necessity, had to develop into a process for eliminating, as far as possible, the edfects in the yarn caused by defective cotton.

The yarn passes through slits or other contrivances in order that leaf or dirt still adhering to the yarn may be brushed off, and in order that thick places may be broken out. Further, the yarn is wound at considerable tension, so that weak places caused by irregular staple in the cotton may also break.

It will therefore be seen that in this process defects cannot be cured, but only removed by breaking the thread and replacing where possible the defective place in the yarn by a knot.

Further, the fact that yarn has to be wound at tension in order to eliminate certain faults creates another fault, insomuch as it takes a lot of the elasticity out of the yarn, which is so necessary for perfect weaving.

(2) "*Warping.*"—After being wound on to warper's bobbins the yarn is transferred from these bobbins in the beaming frame to warpers' beams to be ready for sizing. Here, with a yarn well spun from suitable cotton, there should be no breakages. It should be merely a transferring process from a collection of bobbins, one thread to a bobbin, to a line of threads wound on to a larger bobbin or beam.

Actually, the poorer the cotton the more the breakages. These breakages, as in winding, cause loss of production, waste, and trouble later with knots. The amount of waste for the above two processes varies from ½ per cent. to 1½ per cent., chiefly dependent on the cotton.

The wages for these processes are on piece rates, but it should be remembered that piece rates are fixed on average roduction. and if improved cotton can increase this production considerably the cost per lb. must be reduced.

(3) "*Sizing.*"—The yarn next goes through a machine which coats the threads with size or starch in order to strengthen them, and thus enable them to stand the strain of weaving. In this process all thick places, neps, and knots are apt to absorb more than their fair share of size, and thus a lump on the yarn emerges from the process with the defect exaggerated.

(4) "*Loom.*"—The yarn now goes into the loom for the actual process of weaving, and it will be noted that although in the preceding processes everything possible has been done to remove faults,

many of the remedies used against them have created other faults. such as knots, and it is far from a perfect warp which goes into the loom to undergo the process of weaving, where friction and tension upon the yarn cannot be avoided. The yarn has to pass through the dents of the reed, which are close set, and move constantly parallel to the run of the yarn. It has also to stand the friction of the lifting of the healds. Consequently, for successful weaving yarn must be even in strength, level of surface, and free from nep, leaf, lumps and knots, and the more elasticity the yarn possesses the greater will be the produce of the loom.

But in this process, weaving, there is also the weft yarn to deal with, as it is in the loom that the warp and the weft yarns meet. In the majority of cases the weft yarn goes into the shuttle ju t as it is delivered from the spinner, and the manufacturer has had no opportunity of taking out of the yarn defective places caused by defects in the cotton from which it is spun. Looms are generally so constructed that every time the weft thread breaks the loom automatically stops, and every time a warp thread breaks the weaver must stop the loom and repair the broken thread by ying a knot. Each breakage, therefore, whether of warp or weft, causes the loom to be brought to a standstill, and thus causes loss of production, and also, according to the skill of the weaver, each breakage has some effect upon the quality of the cloth produced.

In making an average quality of cloth, the loss in production caused by threads breaking, due to faulty yarn, is about 15 per cent., but in very high quality cloths the loss in production is often as high as 50 per cent. It is therefore obvious that if cotton can be produced free from faults, and a yarn could be spun out of it that would not break in the loom, weaving costs could be lowered very considerably, and, in some instances, even by 50 per cent.

Most fabrics, before being suitable for sale to the consumer, pass through some form of finishing process such as bleaching, dyeing, printing, calendering, and finishing. Many chemicals are used and there are various kinds of finishing. Different countries or markets have their own finishes, such as, India, China, and Persia.

The various kinds of finishes are: Pure, Filled, Firm, Soft, Mercerized, Schreinered, Back Filled, or Beetle Finishes.

The character of the cloth often indicate the kind of finish required, as there is a particular finish for each style.

Q.—Suppose a warper's bobbin has the capacity of holding 2 lbs. of yarn and you want to know how many yards of 20s warp can be put on it.

A.—Multiply the weight of yarn that the bobbin can hold when full, and multiply the weight by the counts of yarn and by 840.

$$2 \times 20 \times 840 = 33{,}600 \text{ yards.}$$

Q.—Find the counts in the metric system of cotton yarn of the present system of 60s counts.

A.—Multiply the counts given in the present system by the standard number of yard to the lb. in accordance with the system of cotton yarn counting and by .914 (metre in one yard) and divide the product by 907 (grammes in 2 lbs.)

$$\frac{60 \times 840 \times .914}{907} = 50.78 \text{ counts.}$$

Q.—A cotton yarn counted according to the metric system is marked 16s. Find the counts in the English system.

A.—Multiply the counts given in the metric system by 907 (grammes in 2 lbs.) and divide the product by the standard number of yards per hank in accordance with the English system ; (multiply by .914 = metre in one yard).

$$\frac{16 \times 907}{840 \times 914} = 18.90\text{s counts.}$$

Q.—Name some of the points to be considered while selecting bobbins.

A.—(1) The wood employed in the manufacture of bobbins should be highly seasoned.

(2) The bobbin should be perfectly uniform.

(3) The enamel put on the bobbins should be such as to render them perfectly impervious to water, steam or oil. It should be hard and elastic and should neither crack nor peel off. It should not be sticky and spoil the yarn.

(4) The bobbins should be smooth, clean and non-absorbent.

Q.—What are the counts in the ordinary system for cotton 80s bump yarn ?

A.—$\frac{80 \times 16}{840} = \frac{32}{21} = 1.52\text{s.}$

Q.—What are bump yarns ?

A.—Yarns of very low or coarse counts, spun from the waste of the spinning departments or from some low ma'erials are known as bump yarn.

Q.—What are counts, if 21 yards of bump yarn weigh 3 ounces ?

A.—The number of yards of bump yarn weighing one ounce is the count 21 yards ÷ 3 ozs. = 7 counts.

Q.—How are yarns classified ?

A.—Yarns are classified according to the method of their employment in weaving as warp or weft, also finds employment for sewing, knitting, according to the mode of preparatio , as bleached or unbleached, dyed or undyed, printed, etc., and by the way they are made up for use, in cops, pirns, bobbins, hanks, etc. Also according to the number of threads taken, two or three threads, twist and so on.

Q.—When is the spun thread perfect ?

A.—A spun thread is perfect when its diameter is regular throughout, *i.e.*, free from knots or weak places with the proper degree of twist and resistance to breakage, the surface being rough or smooth according to the material and its intended use.

Q.—Is the geographical name given to cotton yarn because it is grown in that country or spun ?

A.—The name refers to the country in which the cotton has been grown and not in which the yarn is spun.

Q.—What do you do to produce a 2/40s cotton yarn ?

A.—Two single yarn of 40s each are employed to produce a 2/40s cotton yarn.

Q.—Explain why does a 2/60s gassed yarn weigh nearer 2/62s and whether by weighing less the strength is affected.

A.—All yarns spun from cotton have the fibres projecting from the body of the yarn in all directions, as can easily be seen on examination through a counting or magnified glass. These fibres although giving weight do not give strength and when singed off the strength of the thread is not reduced. The thread is passed very rapidly through a gas flame, which burns off the projecting fibres and hence must reduce the weight a little, but if properly gassed the strength is not altered. Gassed yarns are generally of good quality and used for the most expensive fabrics—poplins, voiles, brocades, etc.

Q.—How many yards are there in a cop of 80s weighing 1 oz.?

A.—The nett weight of yarn $\times$counts $\times$840, divided by number of ends.

$$\frac{1 \times 80 \times 840}{16 \times 1} = 1575 \text{ yards.}$$

Q.—After twisting 20s and 40s together, what is the price per lb. of the folded yarn 20s cost 6 annas per lb. 40s 8 annas allow 1 anna per lb. for doubling.?

A.—Multiply count 20s by the price of 40s. Multiply 40s by the price of 20s.

20s at annas		8	= 160
40s	,,	6	= 240
60			400

$400 \div 60 = 6.66$ price per lb. +one anna.
for doubling = 7.66 or $7\frac{2}{3}$ annas per lb.

Q.—What is the price per lb. of a yarn obtained from twisting together 40s at 6 annas per lb., 60s at 8 annas per lb., 80s at 10 annas per lb., 100s at 12 annas per lb. ?

A.—Find (first) the resultant counts of 40s and 60s and the price per lb. of the two-fold yarn.

Thus :—

$1000 \div 40 = 25$ grs., $1000 \div 60 = 16.6$ grs.
$25 + 16.6 = 41.6$ grs.
$1000 \div 41.6 = 24$s counts.

The price per lb. of 40s and 60s, which when twisted together equals 24s—

40s at 8 annas		= 320
60s at 6	,,	= 360
100		680

$680 \div 100 = 6.8$ annas price of 24s.

Find (second) the resultant counts of 80s and 100s and the price per lb. of the folded yarn.

Thus :—

$1000 \div 80 = 12.5$ grs.
$1000 \div 100 = 10$ grs.
$12.5 \div 10 = 22.5$ grs.
$1000 \div 22.5$ grs $= 44.4$s.

The price per lb. of 80s and 100s, which when twisted together equals 44.4s.

80s at 12 annas	=	960
100s at 10 ,,	=	1000
180		1960

1960 ÷ 180 = 10.88 annas price of 44.4 counts two-fold.

Find (third) the price per lb. of 24s folded yarn which is 6.8 annas, the price per lb. 44.4s folded is 10.88 annas, what is the price price per lb. of the two combined ?

24s at 10.88 annas	=	261
44.4s at 6.8 ,,	=	301.9
68.4		562.9

562.9 ÷ 68.4 = 8.2 annas price per lb. of the four-fold yarn.

Q.—What difference is there between grandrelle and mock grandrelle yarns ?

A.—A grandrelle yarn is an expensive yarn made from two or more single yarns or threads doubled together and each thread of a different colour, such as blue and red, black-white, or blue and white.

The imitation or mock grandrelle is not a grandrelle yarn at all and should not have this term applied to it. It is simply a printed single thread printed in the above or other colours. The difference is very quickly seen by untwisting the thread.

Q.—Distinguish between sea-island cotton yarn and Egyptian yarn.

A.—The sea-island cotton yarn can be distinguished from the Egyptian cotton yarn, by the former being white in appearance, smooth and silky, while the latter is brownish in appearance and the fibres are very strong in proportion to their size and are long and silky.

Q.—State what is meant by doubled yarns and why are they used ?

A.—Doubled yarns are composed of two or more single yarns twisted together and are designated as 2/80s 5/80s etc., which indicate that the yarn is composed of 2 or 5 single yarns of 80s counts each.

The reasons for using folded yarns instead of single yarns are :—

(1) To impart strength.
(2) To add weight.
(3) To give a special handle and appearance.
(4) For fancy effects as in dhoty borders, etc.

Q.—What is one of the greatest problem in a 'Fancy Trade' to be faced ? Discuss it fully.

A.—In the fancy trade one of the greatest problems to be faced is the control of the yarn store, and the supply of yarn in time and in accordance with demand. The two great points to be considered are the control of the colours stocked and the disposal of the colours which have become obsolete and which if allowed to stand for a long time will cause loss or damage of thousands of rupees. It must be borne in mind that the control of the stock of yarn rests on the designer or the weaving master, as he (whoever may be responsible) chooses, arranges and fixes the shades and yarn to be used.

It also depends upon the salesman who should help in selling what is produced or bring samples that has a demand in the market.

The manufacturer that does not keep a strict eye on the yarn store is at a severe disadvantage in the matter of prompt deliveries, etc.

Q.—What do you understand by yarn being harsh, spongy, and uneven ?

A.—Harsh yarn means rough yarn. Spongy yarn means soft yarn. Uneven yarn means thick and thin.

Q.—Describe some of the defects caused by faulty yarn.

A.—Uneven diameter is one of the chief defects in yarns, caused by bad blending and too much stretch in drawing. This defect is also accentuated by the influence of twist which runs into smaller places, producing 'twists.' Irregular twist is also produced by spinning bands slipping, excessive vibration, badly fitting spindles, damaged bobbins and irregular drag in spinnihg. Mixed rovings also produce faulty yarn. Many of these defects arise from seeking to spin material to finer counts than should be practised, so that many breakages ensue, causing piecing, slubs, etc.

Q.—Describe briefly how defects in cotton are reflected into the fini hed cloth and cause the standard of quality to be lowered.

A.—"*Neps.*"—This is the cause of a lot of trouble in cloths of fine quality. Little neps on the face of the cloth caused by neppy cotton show up after dyeing darker than the rest of the fabric, owing to the fact that these places absorb more dye than the remainder of the yarn, and they give the finished fabric a most unpleasant spotted appearance. Neppy places in the yarn also collect more than their fair share of size in the sizing process, and thus produce thick and uneven places in the finished cloth.

"*Irregular Staple.*"—This causes thick and thin places in the yarn, and any uneveness in the thickness of the yarn gives the cloth a different coloured appearance when dyed, because though all the yarn may absorb the same amount of dye to the same depth, this unevenness causes a varied angle of incidence of light, and so gives what are apparently dark and light shades. The same effect is also produced by unevenness in weaving, which is caused by constant stoppages of the loom through yarn breakages.

"*Leaf, Sand and Foreign Matter.*"—The effect of leaf or foreign matter adhering to the yarn produces an effect in the finished cloth almost opposite to that of nep. The leaf or foreign matter resists the dye and prevents the dye getting to the fibres beneath it.

"*Lack of Lustre and Silkiness.*"—Generally speaking, the more silky a fibre is, the rounder and more compact yarn it produces, and a lack of silkiness and lustre in the fibre is reflected by a lack of lusture in the cloth, which becomes marked if either the yarn or cloth is subjected to the process of mercerising. Defects in the cotton do not disappear in either the spinning or weaving with a cumulative effect.

Q.—What is a mangle wheel ?

A.—A mangle wheel is used when it is desired to drive a shaft continuously and to reverse the direction of rotation regularly, as on a winding frame.

Q.—A spindle is required to revolve 800 times in a minute, and the proposed method is to drive it from a line shaft by a 16-inch drum to a 16 inch pulley, the latter being fixed to a 5-inch tin roller driving 1¼ inch wharve on the spindle. At what speed will the line shaft revolve ?

A.—$\dfrac{800 \times 16 \times 5}{16 \times 5 \times 4}$ =200 revolutions per minute.

Q.—Describe a bundle of yarn.

A.—All delivered cotton yarns being spun by cotton spinners are sent out in the form of a bundle which is being composed of hanks, so tied together as to prevent any unnecessary entanglement during the future processes. A bundle of yarn generally contain 10 lbs. and sometimes 5 lbs. of yarn.

Q.—What do the breakages during winding depend upon ?

A.—(1) The regularity of the yarn (2) the provision of satisfactory working condition.

Q.—State briefly what effect will a poor quality of yarn have in a weaving shed.

A.—The vicious practice of buying-yarn or manufacturing low priced yarns, because they are apparently cheap, is strongly to be reprobated. Because good weavers will not struggle with bad yarns, as they increase their work and diminish their earnings. They will take the first opportunity of transferring their services elsewhere. Therefore the mills that use poor quality of yarn will be left with a poor class of weavers and hence poor work will be the result.

There is no substitute for quality and no one knows so well what is required for his own particular standard as the man-in-charge of the mill. Yet there are men receiving handsome pay who substitute for their staple called for by the man in the mill, and in a majority of cases these inefficient experts are allowed a free hand, seconds or damaged cloth multiply so rapidly that the seconds or damaged cloth exceed the first quality or good cloth. The man in the mill should be given what they reasonably ask for whether in yarns or anything else required for the production of cloth, and they should then be held responsible for results.

Q.—(*a*) What is twist in yarn ? (*b*) How is the degree of twist indicated ? (*c*) On what factors do the extent of twist depend ?

A.—(*a*) The smoothness of the fibre, *i.e.*, the absence of protruding hair, so far as the nature of the fibre permits, is influenced by the twist increasing concurrently therewith.

(*b*) The degree of twist is indicated by the number of spiral turns imparted to the fibre within a given length.

(*c*) It depends upon the fibres of cotton whether long or short and hence soft or hard spun.

Q.—What is the speed of a universal winding machine if a 36-inch pulley on a main shaft making 135 revolutions per minute drives a pulley 20 inches in diameter on the centre shaft making 243 revolutions per minute, attached to the counter-shaft, there being a 14-inch pulley driving, a 7-inch pulley on the machine? The pulley on the machine drives a 3-inch pulley.

A.—$\frac{243 \times 14}{7} = 486$ speed of the shaft of the machine

$\frac{486 \times 7}{3} = 1134$ speed of the machine.

Q.—What is the direction of twist generally inserted in two-fold yarn as compared with that of the single yarn?

A.—The ply yarn is usually twisted together in the opposite direction to that in which the twist is inserted in the single yarn, *i.e.*, if the twist in the single yarn be inserted to the right, then the ply yarn will be twisted to the left and *vice versa*.

Q.—It is required to twist a thread of 20s with another thread, which together shall make equal to 8s. Find the count of the other thread.

$\frac{20 \times 8}{20-8} = 13\frac{1}{3}$s the count required to be doubled with 20s.

Or,

$\frac{1000}{8} = 125$ grains

$\frac{1000}{20} = 50$,,

75 grains difference.

$\frac{1000}{75} = 13\frac{1}{3}$ the count required to be doubled with 20s.

Q.—Suppose that a thread say of 20s yarn has 15 turns per inch, and it is required to produce a similar thread in 30s; what number of turns or twists per inch w ll give a sim ar thread?

A.—It will be as the $\sqrt{20} : \sqrt{30} :: 15 : x$

Or,

as $20 : 30 :: 15^2 : x^2$ which wil be

$\frac{30 \times 15 \times 15}{20} = 337$ the sq. root of which is 18.3: therefore a 30s, thread to be equal to 20s thread having 15 twist per inch, must have 18.3 twist per inch.

Q.—Give an example of 'mock twist' made in single cotton yarns.

A.—If a black end and white end are run together, it will make a black and white mock twist. Two ends of different coloured roving put together and spun into one thread.

Q.—Why is the setting of the traverse on the winding frame is very important.

A.—The setting of the traverse on the winding frame is of importance, for bad setting means that the warper's bobbins will have the threads falling down the flange at either top or bottom, resulting in far too much waste, and again if the bobbins are run too full the warper has to pull yarn off the bobbins to "ready" or prepare it fit for use.

Q.—Describe counts of cotton yarn.

A.—Count is a system of numbering whereby we are enabled to recognise the relative degree of finess or coarseness of yarn or thread which are denoted by the number of hanks of 840 yards in 1 lb. or 7000 grains. In other words the term counts of yarn, means the number of hanks (840) to the lb. which is known as he "Standard." The higher the count or number, the finer the yarn according to its diameter.

The letter S showing the counts of a single yarn is placed after the figure that represents the number or count of the yarn. For example, 20s shows that 20 hanks are contained in one lb. $20 \times 840 = 16{,}800$ yards to 1 lb.

Folded yarn counts are determined by the number of threads twisted together, such as 2/20s. Low coarse counts are denoted by yards per ounce.

Q.—What are the average counts of 60s and 40s combined ?

A.—$60 + 40 = 100 \div 2 = 50$ average counts.

Q.—What are the resultant counts of twisting 25s and 100s ?

A.—$1000 \div 25 = 40$ grains, $1000 \div 100 = 10$ grains

$40 + 10 = 50$ grains

$1000 \div 50 = 20$s

Or,

$$\frac{25 \times 100}{25 + 100} = \frac{2500}{125} = 20\text{s}$$

Q.—Find out the revolutions per minute of the spindle which has a wharve of 1¼ inches in diameter and it is driven by a tin-roller of 6 inches in diameter, which is making 125 r.p.m.

A.—$\frac{125 \times 6 \times 4}{5} = 600$ r.p.m.

Q.—What must be twisted with 25s to produce 20s ?

A.—1000÷25 = 40 grains, 1000÷20 = 50 grains

50—40 = 10 grains

∴ 1000÷10 = 100 counts.

Q.—What will be the resultant counts of 10s 15s and 20s twisted together ?

A.—1000÷10 = 100 grains 1000÷15 = 66.6 grains, 1000÷20 = 50 grains.

100+66.6+50 = 216.6

1000÷216.6 = 4.61s counts.

Q.—What are the average counts of 3 ring bobbins after wrapping if they weigh respectively 20, 30 and 40 grains.

A.—20+30+40 = 90 grains

∴ 3000÷90 = 33.33 counts.

Q.—What is the count of 4 yards of yarn the weight of which is 2 grains ?

A.—(7000 ×4)÷(840 ×2) = 16.66's counts.

Q.—What is the count of 120 yards of cotton yarn weighing 50 grains ?

A.—Multiply the length by 8.33 (7000 grains to the lb.÷840 yards per hank) and divide by the weight.

$$\frac{8.33 \times 120}{50} = \frac{99.96}{5} = 19.99 \text{ counts.}$$

∴ the constant = 120 ×8.33 = 999.60 per one lea,

999.60 (÷by the weight) = the counts.

Q.—A winder in a day winds 80 lbs. of warp yarn and makes 8 ounces of waste. Find the percentage of waste.

A.—80 : 100 : : ½ lb.

$$\frac{100}{80} \times \frac{1}{2} = .62\%.$$

Q.—What length of yarn is there in 4 grains of 20s yarn ?

A.—$\frac{840 \times 20 \times 4}{7000} = 9.60$ yards.

Q.—How would you set the traverse motion in a bobbin-winding machine.

A.—Count half the number of teeth in mangle wheel; set the mangle wheel opposite the pinion that drives it; count half the number of teeth in rack at side of machine; set the small side of eccentric wheel on mangle-wheel shaft in gear with full side of wheel that gears in rack; set the traverse halfway of bobbin.

Q.—Describe the formation of patches which is apt to cause damages in the weaving on yarn during the process of winding and state what means you would adopt to avoid it.

A.—During the process of winding cotton yarns, loose fibres detach themselves, and as a result a considerable amount of fluff, gather in various parts of the machine and is carried forward by the ends, forming patches. These patches being soft, take up the size very readily, and arrive at the looms in a very bulky state; they are the cause of ends being broken during weaving, and should they by any means get woven into the cloth, the appearance of the same is considerably spoiled. To avoid this, and also to clean the yarn at the same time, Haemig's Patent yarn-cleaning motion should be used. It consists of a roller covered with special plush revolving in a direction contrary to the course of the yarn.

The plush under these circumstances naturally cleans the yarn, and collects the loose fibres which in turn are taken up by a stripping card fixed in a suitable position behind the roller. The winder removes the fluff from the stripping card by means of a small metal comb such as weavers use.

Q.—How many hanks—for each colour—must be sent to the dye house in order to produce 50s warps, all striped to the following pattern, each warp to have 1280 ends and to be 110 yards long, after an allowance of $2\frac{1}{2}$ per cent, has been made for waste in working?

Pattern:—5 Red, 4 Indigo, 2 Blue, 4 Brown, 10 Red, 4 Brown, 2 Blue, 4 Indigo, 5 Red = 40 Ends Total.

Total of coloured Ends.

20	Red
8	Indigo
4	Blue
8	Brown
40	Ends.

A.—The number of hanks in one warp =

$$\frac{1280 \times 110}{840} = 167.62$$

$$167.62 + 4{\cdot}84\ (=2\tfrac{1}{2}\ \%) = 171.92$$

The total number of ends in the pattern = 40.

Therefore the number of hanks of the respective colours will equal to as follows :—

Red, 171.92÷40 Ends = 4.298 hanks per end × 20 Ends		Hanks
	=	85.960
Blue, there is 1/5 the weight of red	=	17.192
Indigo, there is twice the weight of blue	=	34.384
Brown, there is same weight as indigo	=	34.384
Total hanks for one warp		171.920

For 50s warps :—		Hanks
Red 85.96 hanks × 50	=	4298.0
Blue 17.192 hank × 50	=	859.6
Indigo 34.384 hanks × 50	=	1719.2
Brown 34.384 hanks × 50	=	1719.2
Total hanks for 50s warps	=	8596.0

Q.—How would you test yarn for counts and strength ?

A.—If it is ring bobbins or mule cops, then take 4 bobbins or cops either from the ring frames or the mule or from the middle of a skip containing them and place them on the spindles of the hand wrap reel. Reel off one lea or 120 yards, and a bell will ring as soon as 120 yards are wrapped ; but do not depend solely on the ringing of the bell for registering the length, the operator should notice the position of the handle at starting and commence to count the actual 80 revolutions required. Take off the leas separately and weigh on a pair of scales kept for the purpose. Divide the weight in grains of each separate lea into 1000. The result will be the counts. 1000 is 1/7 of 1 lb. or 7000 grains. A lea is 1/7 part of a cotton hank or 840 yards.

There is a machine by means of which the strength of one lea of yarn can be obtained by hand or power. The lea is placed on two hooks, one of which is stationary and the other movable. When the machine is operated it pulls the yarn downwrd until it breaks it and when few ends are thus broken it ceases from straining it any further than the breaking point can be read in lbs. on the indicator.

Q.—What is the weight in grains of 1 lea of 40s ?

A.—$1000 \div 40 = 25$ grains.

Q.—What length of yarn is there in $2\frac{1}{2}$ grains of 25s ?

A.—$840 \times 25 \times 2.5 \div 7000 = 7\frac{1}{2}$ yards.

Q.—What would be the counts of yarn if two hanks of yarn weighed 9 dwts. $2\frac{3}{4}$ grains.

A.—$\dfrac{2 \times 840 \times 7000}{840 \times 218.75 \text{ grs.})} = 64$s counts.

Q.—If $7\frac{1}{2}$ lbs. of waste was made out of a skip of bobbins weighing 240 lbs. net yarn. What would be the percentage of waste ?

A.—$\dfrac{7.5 \times 100}{240} = 3.1\%$

Q.—What would be the count of cotton yarn if $10\frac{1}{2}$ yards of a warp containing 2400 ends weighed $7\frac{1}{2}$ ounces.

A.—$\dfrac{10.5 \times 2400 \times 16}{840 \times 7.5} = 64$s, counts.

Q.—A bobbin is known to contain 840 yards of yarn and there are 42 to a lb. What is the count.

A.—$\dfrac{480 \times 42}{840} = 24$s.

WARPING

Bobbin

An implement round which thread or yarn is wound in order to be wound off again with facility, as required, in weaving. It takes the form of a wooden cylinder with a flange or rim at one or both ends.

Bobbin Creel

Any frame which holds bobbins supplying yarn such as warping frame. It is also known as warper's creel or warper's bank.

Q.—State the use of a beam warping machine.

A.—The use of a beam warping machine is to enable a sufficient number of threads to be gathered in one sheet for sizing purposes, say, 2,000 ; it is necessary to wind them first on a warper's beam. This is a round roller of wood about $4\frac{1}{2}$ inches in diameter having an iron flange 21 or 22 inches in diameter, at each end there being also an iron pivot. This will hold about 500 ends and may be 10,000 yards long or even more or less with regard to ends or length as it depends on the counts of yarn. For a cloth of 2,000 ends four or five beams will be required at the sizing machine.

Q.—Where are the bobbins from the winding machine placed ?

A.—The bobbins from the winding frame are placed in a creel, generally a V-shaped.

Q.—How is the beam driven on a warping frame ?

A.—The beam is driven by friction, resting on a large drum making about 46 revolutions per minute.

Q.—Name the causes of uneven beams.

A.—When the body of the yarn on the beam is not level but is larger or smaller in diameter at some parts than other, it is called ridgy or pitted surface which may be caused through (1) mixed counts of yarn ; (2) unevenly spaced and bent dents in the comb which is due to the coil spring being choked by dirt or lint ; (3) beaming a very small number of ends on large rollers ; (4) the driving drum not being sufficiently supported internally and thus allowing the timber to spring a little.

Q.—From 800 lbs. of 70s twist you are required to prepare a set of six warper's beams, each containing 15,854 yards, $1\frac{1}{4}$ per cent. being allowed for waste in winding and warping. What number of ends will you put on each beam ?

A.—800 lbs. less $1\frac{1}{4}$ per cent. (10 lbs.) = 790 lbs.

$$\therefore \frac{790 \times 840 \times 70}{15854} = 2930 \text{ Ends.}$$

$2930 \div 6 = 488$ and 2 ends over.

$\therefore$ 5 beams of $488 + 1$ beam of 490 ends = 2930 ends.

Q.—There are 190 bobbins each containing 12 ozs. of 16s twist, from which it is desired to make a warp of 2400 ends. What length can be obtained if the wasted material and that left on the bobbins equal 6 per cent. of the whole ?

A.—The weight of yarn equals 190×12 ozs. = 2280 ozs. less 6 per cent. (which equal 136 ozs.) equals 2144 ozs. or 134 lbs.

$$\frac{134 \times 840 \times 16}{2400} = 750.4 \text{ yards or 750 yards 15 inches.}$$

Q.—If a warp beam contains 600 ends 7200 long and weighs 365 lbs. (allow 65 lbs. for the tare of the beam). Find the hanks per lb.

A.—$\dfrac{600 \times 7200}{840 \times 300} = 177\frac{1}{7}$ hanks per lb.

Q.—What are hard and soft sides due to in beaming warps ?

A.—The hard side is due to in beaming, the ends being too near the flanges. The soft side is due to in beaming. the ends being too far away from the flanges.

Q.—In a beam warping machine, the measuring roller, 18 inches in circumference, is carried round by the friction of the yarn passing over it, on the end of the roller is a single worm driving a wheel of 70 teeth, on the same stud as the wheel of 70 teeth, is another single worm in gear with a wheel of 100 teeth when the wheel of 100 teeth has made one complete revolution, how many yards have passed the measuring roller ?

A.—$\dfrac{70 \times 18 \times 100}{36} = 3500$ yards.

Q.—What are the causes of sunk sides on a warper's or a back beam ?

A.—(*a*) One or both sides of the yarn sheet too far from the flange or flanges, that is the diameter of the yarn in contact with an adjacent to the beam flanges is smaller than the remainder of the narn on the beam ; (*b*) the extreme side ends too fine in counts ; (*c*) the comb dents too widely spaced or bent out of position at the sides ; (*d*) flanges bent ; (*e*) flanges not set square or lower.

Q.—What are the faults to be met with in the beam warping and what are the remedies ? Give also the timing and setting of parts.

A.—*Back Falling Roller.*—This roller should drop first to assist, add a small weight.

Bobbins too Full.—These will cause ends to slip off the side and wrap round creel peg and break. Bobbins should be placed in the creel to unwind from the top.

Centre of Creel.—Should be exactly opposite centre width of machine.

Crossed Ends.—May be due to broken ends running round the beam and the operative scratching the beam with the finger to find the broken end and crossing it under adjacent ends. When unwound at the slasher it will break at the crossed portion and cause a lapper. It may also be caused by turning beam back too many or not enough revolutions when trying to find broken end.

Drop Rollers.—If these do not work accurately will result in uneven tension and snarls. If the rollers are too light they cause the ends to be slack and entangle at the drop pins.

Hard Uneven Sides.—are due to the flanges being too close. The increased diameter will cause the ends to be slack when withdrawn at the slasher causing breakages and lappers to form.

Ridgy Beams.—These may be due to wrong denting or wires bent and unevenly spaced.

Measuring Motion.—Should be accurate to give all beams in a set the same length as the shortest beam gives the length capable of being run through the slasher the length on the other beams being waste. Wrong lengths may be due to measuring roller sticking due to fluff or dirt in the bearings.

Q.—A warping machine drum is 4 feet in circumference and makes 40 revolutions per minute. What is the circumference velocity ?

Rule.—Multiply the circumference in feet by the number of revolutions per minute.

A.—$4 \times 40 = 160$.

Q.—What is the length of a warper's beam weighing 10 lbs. of 50s counts and containing 420 ends ?

A.—$\dfrac{840 \times 50 \times 10}{420} = 1000$ yards.

Q.—You are required to prepare a set of warpers beams in the following order :—200 pieces 38 inches wide 50 yards long 32s twist 78s reed, cloth to contain 60 picks of 38s weft. What number of beams will you warp and of what length ? What weight of twist ought there to be on each beam ?

A.—Find first the weight per piece. Add 6 per cent. to width of cloth to obtain reed space. Add 6 per cent. to cloth length to obtain the tape length.

38 inches $+6\% = 40.28$ inches.

50 yards $+6\% = 53$ yards.

Reed 78×40.28 reed space $= 3141.84$ ends.

3141.84×53 yards (tape length) $= 166517.52 \div (840 \times 32) =$ 6.194 lbs. weight of warp in one piece.

Ends in the set $= 3141 \div 7$ (back beams) $= 400$ ends each beam and one beam of 341 ends.

∴ 7 beams of	400	each	=	2800 ends.
7 ,,	341	,,	=	341 ,,
Total				3141 ,,

The length of yarn per piece equals 53 yards.

∴ The length of yarn on each back beams $= 200 \times 53 = 10600$ yards.

Q.—Explain the passage of the yarn from the creel to the beam on a beam warping machine.

A.—The bobbins from the winding frames are placed in a V-shaped creel, each arm of the V being a frame containing tires of pegs to hold 250 (more or less) bobbins, the apex being nearest to the frame. The yarn passes through a reed under and over several horizontal rollers emerging in front through a guide comb, and thence to the beam.

Q.—What is 'mill warping,' and as it is more expensive than section warping, why is it used ?

A.—Mill warping is a system of making warps on a large revolving reel. The rest or circular mill is about 18 yards in diameter. The bobbins required for the warp are placed in a creel, the yarn passing through the eyes of the needles in a heck where the lease is made, then on to pegs in the circular mill and wound round the mill.

Short warps from 200 to 600 yards can be made by this system, the warps after removal from the reel being wound into a ball and then sized. For this reason the system is still used for the coloured trade and for fancy fabrics where only short lengths are required.

Q.—What are the causes of ends snarling at pins ?

A.—(1) The sheet yarn being short of tension ; (2) the bobbins over-running ; (3) snarls in the yarn as wound on the warper's bobbins ; (4) the swing and drop rollers must be set level, the former must be set high enough and the back drop roller to fall first when the stop motion acts ; (5) the machine should not be driven too fast.

Q.—If a beam warping machine, with 500 ends in bank or creel can produce an effective turn off of 1800 yards per hour of 32s cotton, find (1) the total weight of yarn warped in 48 hours and (2) calculate the number of weaver's beams that could be filled, if each contained 3000 ends of 1000 yards length—100 yards per cut or peace.

(1) Total weight in lbs. $= \dfrac{\text{Total length in yards}}{\text{yards per lb.}} =$

$$\frac{500 \times 1800 \times 48}{32 \times 840} = 1607\tfrac{1}{7} \text{ lbs.}$$

(2) No. of weaver's beams $= \dfrac{\text{total length in yards}}{\text{total yards of yarn on each beam}}$

$$= \frac{500 \times 1800 \times 48}{3000 \times 1000} = 14.4$$

SIZING

Calculations

Q.—How would you find the speed of a drag roller on a sizing frame ?

Rule :—

Revolution of line shaft × drum on it × speed wheel ÷ (drag roller wheel × pulley on the tape frame).

Example :—

If the revolution of line shaft be 77 per minute the drum on it $22\frac{1}{2}$ inches driving the tape pulley 13 inches and if the speed wheel be 12 and drag roller wheel 100, find the speed of the drag roller.

A.—$\dfrac{77 \times 22.5 \times 12}{100 \times 13} = 16$ revolutions per minute.

Q.—Find the number of yards per minute delivered by the drag roller on a tape frame.

Rule :—

Revolution of drag roller × circumference of drag roller ÷ 36.

Example :—

If the speed of the drag roller be 16 per minute and its circumference be $29\frac{1}{4}$ inches, find the number of yards per minute delivered.

A.—$\dfrac{16 \times 29.25}{36} = 13$ yards per minute.

Ammonia

One pint of liquid ammonia mixed in 2 gallons of water and 400 lbs. of farina (if a mixing is of this quantity otherwise in proportion) brightens the fast coloured stripes in cloth while being finished.

Apex

The tip or point, *e.g.*, of a cone or wedge.

Q.—For what purposes are anti-septics used? Give a list of the chief ones and state their good and bad points.

A.—(1) Chloride of zinc (advantage)—It is a powerful anti• septic. (Disadvantage)—Excess of it makes the yarn brittle and harsh.

(2) Carbolic acid—(advantage)—strong antiseptic. (Disadvantage)—Excess of it leaves stain and at times burns the yarn.

Back Beans

Warp or twist yarn supplied from beaming or warping on back beams which are composed of solid wood barrels 4½ inches in diameter, at both ends of which are fitted two cast or malleable iron flanges 21 inches in diameter and set approximately 54 inches apart. Such a beam will hold about 350 lbs. of unsized yarn and may have about 500 ends and the length as may be required or according to counts of yarn and number of ends being warped for instance 10,500 yards may be warped of 21 counts of yarn, 6,000 yards of 10 counts and so on.

Beams

Rollers with two flanges one on each side upon which the warp threads are wound side by side in a broad sheet before being put in the loom. Also used for a beam-warper. A weaver's beam holds on an average 1,088 yards barrel = 4½ inches diameter, flange = 17 inches diameter, counts of yarn = 20s.

Beaming

A process by which the ends that are warped grey or coloured are all run in one broad sheet in their particular pattern on to the weaver's beam.

Beam Creel

It is that part of the framing at the back end of the sizing machine in which the beams are placed.

Beam or Tension of Friction

A friction from which the weaver's beam is driven.

Becks

Wooden boxes or vessels used to mix the size ingredients generally 8 feet long × 4 feet broad × 4 feet high, or 4 × 4 × 4 feet.

Boiling Pan

A cast iron pan is used for boiling the weighting materials and softeners.

Q.—Why do you place back beams in this order ·.· ..., at the back of a sizing machine ?

A.—We place back beams as shown above because it takes less room than if we were to place the beams in a straight line. Also we could not have been able to put laces if the beams were in stright line.

Q.—Suppose you had a set of back beams, grey and coloured, and the colour beam had to go in first creel and was narrower than the rest. What method would you adopt to split the sides and produce each end separately at the front ?

A.—A wheel with an iron bar ¼ inch thick slightly bent on the top, fixed into the centre of it should be placed against the selvedge.

Q.—What are a limited number of ends on a back beam for ?

A.—Because it would be impossible to weave them as the end would be stuck together easily.

Q.—How is the weaver's beam driven ?

A.—The weaver's beam is driven by friction.

Copper Delivery and Squeezing Rollers

These are the rollers through which the yarn passes from the sow-box.

Creel

The creel or stand serves to hold the back beams of yarns to be sized.

Creeling

At the end of each set creeling takes place, namely removing the empty section or warper's beam from the creel and replacing them with full ones.

Cut

On the sizing machine the amount of yarn run spoken of is so many cuts or pieces. A cut indicates any number of yards—usually from 2 to 40 yards.

Cut Marker

Is the motion which applies coloured marks to the yarn at any required length ?

Cylinders

The cylinders are heated internally by means of steam. These cylinders are revolved with their outer surfaces in contact with the sheet of damp sized yarn and so evaporate the excess moisture.

Q.—What are the merits of a steam hated cylinder ?

A.—The merits of a heated cylinder machine are that the yarn dry better.

Q.—What are the merits of a cone driven machine from the ordinary driven machine ?

A. The advantage of a cone driven machine is that any speed may be acquired at any time, whereas this is not the case with ordinary driving machine.

Q.—Supposing you had a cone drum driving 2 belts, forks 6 inches wide. What width of a strap would you suggest and why ?

A.—I would suggest 5½ inches which is better than 6 inches strap which would then be full width and thus rub against the forks.

Q.—What is china clay used for in a size mixing ?

A.—China clay is used to give weight and a certain soft feel.

Q.—Why do you use copper roller piping and copper rollers in a size box ?

A.—Copper piping and rollers are used in sizing as they do not form rust.

Q.—How is it that the yarn goes over the big cylinder first ?

A.—The yarn goes over the larger cylinder first so as to allow it to go the other side up and helps the yarn to travel a greater distance and hence it will dry better.

Q.—What is the object of the cut piece marks on the warp yarn wound on the weaver's beam ?

A.—It is to provide some means by which the weaver may know the desired length has been woven.

Q.—How are cut marks produced on the sizing machine ?

A.—This is provided or by introducing on the sizing machine a mechanism known as a cut marker and that stamps on the warp yarn a mark at each required length by means of measuring roller and a train of wheels that drives a marking cam so arranged as to gradually lift and suddenly drop a hammer which strikes the warp against a block soaked in some colouring matter upon the threads about one inch in diameter.

Q.—Why is a cone drive adopted on the sizing machine ?

A.—The cone drive is adopted on a sizing machine in order to make it possible to change the speed of the machine more quickly and conveniently than by gears. For instance, when running a warp of a small number of ends that is to be sized lightly, the sizing has to be run quickly, while on the other hand, it is desired to run on a heavy sheet or warp or one that requires considerable size. the yarn will require a longer time for drying and consequently the machine must be run very slowly. It is necessary to run a sizing machine a little slower first thing in the morning when all is cold and also when getting near the finish so as to avoid jerking and over-running themselves.

Q.—Would you prefer to use one or two pairs of sizing rollers in the sow-box ?

A.—On a varied class of work it has been found that there is no advantage in the use of two pairs over one pair sizing rollers. If sufficient care is given to the cooking and preparation of size, with a good heavy top roller it will be found that one pair sizing roller is all that is required.

Q.—What are the various impurities in china clay ? Say what are the objections to each ?

A.—The impurities in china clay are :—(*i*) grit, (*ii*) iron, (*iii*) lime or chalk, (*iv*) magnesium.

(*i*) Grit is objectionable in china clay on account of its destructive action on healds and reeds.

(*ii*) The objection to iron in china clay is that iron stains present themselves in the cloth.

(*iii*) The objection to lime in china clay is that the cloth is given a harsh feel. Besides this, if there is any lime present in china clay, and a mixing is required to be prepared which requires deliquescent substance, such as calcium chloride, then the effect is, as calcium is increased, the yarn may become brittle.

(*iv*) The objection to magnesium in china clay is that when a mixing is required to be prepared where sulphate of magnesium is to be used as a weighty ingredient and if china clay is one of the ingredients that contain magnesium then the amount of magnesium is increased which will result in giving more weight to the cloth than desired.

Q.—Suppose a farina mixing stood too long, and the sized beam has come up too soft, what would you do to restore the firmness in the resultant woven cloth ?

A.—I would run the cloth through a mixture of 4 to 8 ozs. farina per gallon in the finishing mangle and dried on the drying cylinders.

It must be remembered that cloth shrinks in width during these operations and this must be counteracted as much as possible by passing the pieces over a Mycock's or similar expander at the time of drying. If a range is at hand in which a short stenter is fitted between the mangle and the drying cylinders, this machine could be used with advantage.

Q.—A sample of cloth is found to become tender and the cause is described to the size used. Discuss whether such a thing is possible and how would you prevent tendering in future ?

A.—Such a thing is possible owing to (*i*) deliquescent substances used in excess, (*ii*) quantity of softening material used being insufficient, (*iii*) excess of zinc or such other anti-septics, which should be avoided.

Deliquescent

Indicate chloride of magnesium which is a substance that tends to liquify in the air and to retain dampness and cause a fabric in which it is present to become moist.

Dhoty Marker

The motion which marks the place for the insertion of headings or coloured borders at any required distance between the cuts.

Distilled Water

It is used for making solutions of all the reagents, and for dissolving substances required to be tested, as most ordinary waters, are much too impure for these purposes.

Q.—Give the difference in diameter between drag roller and bottom roller in sow-box.

A.—There is no difference.

Q.—Describe the operation of drag roller. What is it wrapped for ?

A.—A drag roller is operated by the cone drum. It is wrapped for taking up the slackness of yarn.

Flange

A projecting rim that runs round a length of pipe at both of its ends to which it is attached by means of set screws.

Q.—What is the fermentation of flour ?

A.—The fermentation of flour is steeping of flour for several days if not months before using it.

The objects are :—(1) the prevention of mildew, (2) to give a softer feel to the cloth.

Q.—If you were about to start a new frame for sizing and no one else had manipulated it, what would you do and when would you be ready for your first set ?

A.—When the frame is ready pack all glands, wrap drag roller, prepare friction, run frame half an hour without running the fans and then oil the frame, run the fans, put water in sow-box, gait frame up and other things would take up a couple of days in all.

Q.—(1) How would you steep flour ? (2) How long ? (3) How is it that sago and farina are not fermented ?

A.—By mixing water and flour in a beck (wooden), zinc is added in this mixing to prevent mildew. Magnesium may also be added for convenience sake. (2) Flour is steeped at least ten days. But if flour is allowed to ferment for two months then very little zinc can be used. (3) Because the granules of sago and farina are larger than flour and does not contain the same amount of gluten.

Glucose

Grape sugar and potato starch.

Guide Rollers

The rollers round which the yarn is guided in any part of the machine.

Hammer

That part of the cut, dhoti or piece marker which strikes the yarn on a sizing or tape frame.

Head Stock

That part of the sizing machine at the front in which the drawing parts are arranged. Also for cooling the sized yarn after passing over the hot cylinders by means of two fans. The ends are separated by rods into loose open sheets, measured and marked off into required lengths termed cuts and finally wound upon the weaver's beam.

Q.—What is the difference between a Twaddle Hydrometer and a Hygrometer ?

A.—The former registers the specific gravity of the size ingredients and the latter registers the dew point, for instance, in the weaving shed.

Immersing Roller

The roller under which the yarn passes in the sow-box.

Last Cut

A term applied to the short length of yarn left on the beam.

Measuring Roller

Friction roller and draw roller are names given to the largest roller at the front end of the machine from which the yarn passes to the beam in a sizing machine. It gives motion to the copper delivery rollers in the sox-box.

Q.—Name the materials used for sizing cotton yarns, state their essential qualities and limitations, having regard to any after-process, other then weaving, which the yarn may have to undergo when in the cloth.

A.—The materials used for sizing cotton yarns may be divided into five classes.

(*a*) Adhesive substances which will form the body of the size and attach the size to the yarn.

(*b*) Materials for adding any required weight to the yarn.

(*c*) Materials to prevent the size becoming hard or brittle when dry on the yarn, thus keeping the yarn soft and pliable.

(*d*) Materials for preventing mildew, either on the weaver's beam or when woven into cloth.

(*e*) Materials for colouring or tintiug the yarn.

(A) The various flours, such as wheat, farina, rice, sago, or corn starch may be included in this class. For pure sizing the most usual to use farina or sago, or a combination of both. The condition of the shed, or the "feel" required must be considered when deciding whether to use farina or sago. In the writer's opinion farina gives a softer feel than sago, and has greater resistance to rubbing, but it is also dearer than sago. If a harsh feel is desired, then sago is better than farina, and if weaver's beams are likely to be in the shed a long time, two to three months, then it holds better than farina.

Whilst it is cheaper than farina, it is likely to cause more expense in healds and reeds. Wheat flour is used when it is desired to add a percentage of weight, but it should be well steeped.

(B) Wheat flour may also be included under this heading, but the usual materials for this purpose are china clay, sulphate of soda, sulphate of magnesia, and others.

(C) The most popular materials for this purpose are tallow, spermaceti and other waxes, castor oil, glycerine, coconut oil, and various kinds of soap. For ordinary purposes tallow is difficult to improve upon, but for fine yarns, where a sheen is desired, spermaceti wax gives good results, and is a help if the cloth is for finishing. On no account must paraffin wax be used if the cloth has to pass through a singeing process.

(D) If a mildew preventive is desired for pure sized fabrics, as dhootis or dhoties from 40s or 60s twist then use caustic soda, or glycerine or chloride of zinc, etc., but if heavy sized goods are being woven then chloride of zinc, along with chloride of magnesium should be used, but both these substances would be disastrous if the cloth had to pass through any subsequent process except finishing. They must not be used in even minute quantities if the cloth is for bleaching or dyeing.

(E) For tinting the cloth blue or "whitening" it, aniline or other blue are often used. Recently other colours have been used, and now cloth is tinted with many shades, the warp being sized with tinted size.

Q.—Supposing two pieces to be sized heavily, and the feel of size from one is smooth, whilst the feel of size from the other is gritty. What is the probable cause of the difference?

A.—Assuming that the same mixing has been used the gritty feel may result from oversizing. If, however, both samples are the same sized weight then it is very likely caused by insufficient preparation and cooking of the size. In heavy sizing a considerable amount of moisture must be left in the sized yarn in order to give the full soft feel, and also retain pliability in weaving. A frequent cause of rough unsightly cloth is the stoppage of the tape machine without care being first taken to reduce the heat of the drying medium—thus getting rough over-dried warps. In cylinder machines, owing to intimate contact of sized yarn with cylinder surface this reduction of heat is difficult to attain.

Q.—Would you advocate high temperature in drying ?

A.—No. I would not advocate it. The best results are got, especially if the elasticity of the sized thread is to be retained by using comparatively low temperatures, say from 100°Fah. to 130°Fah. and as a maximum 150°Fah. With high temperatures there is a grave risk of overdrying and burning, and there is also the deteriorating effect of temperatures of say 180°/200°Fah. on the starchy materials in the sizes to be considered.

Sizing

The application of a glutinous liquid on the warp yarn for the purpose of increasing the adhesiveness of the fibres and strengthening the threads for weaving.

Slasher

The slasher sizing machine.

Sow Box or Trough

The box through which the yarn passes and in which the immersing roller is contained.

Specific Gravity

By specific gravity is meant the number of times a substance is as heavy as the same volume of water.

Steeped Flour

Weight per bucket of 3 gallons at 30°Tw. =32 lbs., at 50°Tw. = 47 lbs.

Q.—Supposing you were required to mix two different kinds of china clay in a mixing in order to make it cheaper, the value of one is annas 12 per lb. and of the other annas 8 per lb., and the quantities of each are as 50 of the former to 30 of the latter ; find the value of the mixture.

A.—Multiply each quantity by its value and divide the sum of the products by the sum of the quantities.

Thus :—

$$\begin{array}{l} 50 \times 12 = 600 \\ 30 \times \ \ 8 = 240 \\ \hline 80 \qquad\quad 840 \end{array}$$

$\therefore$ $840 \div 80 = 10\frac{1}{2}$ annas will be the value of the new mixture.

Q.—In a sizing frame measuring motion, the measuring roller is 18 inches in circumference and it is carried round by the friction of the yarn passing over it, at the end of the roller is a single worm gearing with a wheel of 70 teeth and when this wheel has made one complete revolution, how many yards have passed the measuring roller ?

A.—$\frac{70 \times 18}{36}=35$ yards.

Q.—What is an overflow valve ?

A.—An overflow valve is fixed between the pump and the sizing machine. It is used in order to keep sufficient pressure on the size to enable it to reach the sow-box. When the sow-box is full and when the valve of the feed pipe is shut, the overflow or return valve opens and allows the surplus size to return to the beck from which it was pumped. If the lever is overweighted it causes unnecessary work to be placed on the pump and it might even burst the feed pipe.

Q.—What is the steam pressure gauge chiefly used, for, and also the fans ?

A.—A steam pressure gauge is chiefly used for indicating the amount of steam per square inch. The fan is used for drying the yarn.

Q.—How would you ascertain by practical way the percentage of size on a given warp ?

A.—Weigh the yarn before and after sizing and the difference will give the percentage.

Q.—What percentage of size remains upon the warp threads when in a plain fabric, if the piece weighs 12 lbs. and is constructed as follows :—

Thirty yards long, 44 inches wide, 14 × 14 ends and picks per quarter inch of 20s warp and 22s weft, full and true in every particular ?

A.—Find the weight of warp allowing 6% contraction in width, and 6% for contraction in length.

Weight of warp $=\frac{56 \times 46.6 \times 31.8}{840 \times 20}=4.93$ lbs.

$$\text{Weight of weft} = \frac{56 \times 46.6 \times 30}{840 \times 22} = 4.23 \text{ lbs.}$$

Warp = 4.93
Weft = 4.23

9.16 lbs.

Weight of piece = 12 lbs.—9.16 lbs = 2.84 lbs. which is size.
To find the percentage $2.84 \times 100 \div 4.93 = 57.6\%$.

Rod Rests

Are those brackets on sizing frame in which the lease rods rest.

Running a Set

It means slashing all the yarn in a set of section beams.

Sieve Tap

This is a tap fitted between the size beck and the pump. Its purpose is to prevent any substance likely to interfere with the working of the valves getting to them. The sieve should be cleaned out as often as necessary during the day in order to prevent it getting clogged up.

Size Box

The box in which the size is received from the mixing beck and is separated from the sow-box by a mid-feather.

Steam for Sizing

2 880 lbs. of steam = 288 gallons of water will be consumed by one sizing machine per day of 9 hours. Size of boilers = 24′ × 6″—120 lbs. pressure to be reduced to 30 lbs.

Q.—What method do you suggest for fixing the size on the warp thread and getting the maximum weight say 100% of size when yarn is sized, to give this result ?

A.—One may always expect a loss of sizing material at the loom and the proportion will vary according to the class of sizing and the kind of cloth being woven. With more ends, picks, and intersections per inch the loss will naturally be greater than with looser built cloths, even when adhesives of high quality in sufficient proportions are used, prepared and treated in the best possible way.

To retain 100% on the warp yarn, *i.e.*, 1 lb. size to 1 lb. warp yarn in 8 shaft cloths of say 70 ends and 50 picks per inch of coarse and medium counts, we should need to add at the tape frame from 125% to 180% on the weight of the warp yarn.

Q.—Would a reducing valve be a benefit or otherwise to overcome the differences in temperature in the heating chamber of the hot air machine ?

A.—Where the boiler pressure can be maintained reasonably constant there is no need for a reducing valve, but where owing to overloading there is likely to be considerable variation in pressure then it would be an advantage to use a reducing valve on the steam supply pipes to the chamber.

In this case, with boiler pressures of say 150 to 200 lbs. per square inch, one would reduce to 90 or 100 lbs. per square inch at the chamber. Every facility is given to the taper or sizer by means of thermometers and gauges to ascertain immediately any variation in steam pressure and chamber temperature.

Q.—What do you understand by concentration of the size and how would you test it ?

A.—The amount of size which is put on to yarn depends upon the concentration of the size. The lowest concentration used for pure cotton-yarn sizing is dry solids about 8% of the total weight of size, and this would usually put on about 12 to 15% size on weight of cotton warp. Sizing material of dry weight 12% when prepared into paste would give about 24% weight on warp. The concentration of size can be tested with a hydrometer.

Q.—Enumerate a factor which if present in the sizing room leads to bad sizing and give the evils that follow it.

A.—The presence of cold moisture in the atmosphere of the sizing room is the principal evil factor leading to bad sizing.

It is the cause of mildew, soft warps and the clogging of the cylinders, split rods and expansion comb, also the raining of condensed steam upon the sizer, on the machine and the floor.

Q.—When would you operate the slow motion arrangement on the sizing machine ?

A.—At times it is necessary to greatly reduce the speed of the sizing machine without stopping it entirely, for instance, when piecing up broken ends, a slow motion is introduced ; also used when laying new flannels on squeezing rollers, putting new cloth on drag roller, when putting a split rod, laying in lease bands behind the machine.

Q.—Distinguish between direct and indirect softeners.

A.—Direct softeners are those substances which have moisture in themselves to soften the size or yarn. Indirect softeners are called deliquescent substances. These substances act as softeners by absorbing moisture and so produce good weaving.

Q.—What is the object of using starch and not flour for giving adhesiveness to the yarn ?

A.—Flour is composed of gluten and starch. Gluten causes mildew and therefore the flour is not used for the purpose of giving adhesiveness by some sizers. But if flour is to be used in place of starch, an anti-septic must be used.

Q.—Stains appear in a cloth after weaving or during the process of weaving on the warp. To what causes are they due ?

A.—(1) Iron in china clay or in any of the ingredients used for a size mixing ; (2) over-moisture (if sized damp) or excess of moisture (if the ingredients are not used proportionately ; (3) if too much of softeners are used ; (4) if the weaver's beams (the flanges and particularly the barrels) are not painted or no paper is used, then stains are sure to present themselves ; (5) if excess of any acid antiseptic is present in size, then stains are sure to be found ; (6) if the flannels of the squeezing rollers are not soaked in water overnight, also if the squeezing roller is allowed to rust without painting it periodically.

Q.—Enumerate the object of sizing yarn.

A.—The object of sizing cotton yarns is to give the yarn sufficient strength in order to enable it to overcome the friction in weaving. The other objects are to give it a soft feel and put weight on it.

Q.—Find the contents of a sow-box (in gallons), which is 72 inches long, 36 inches wide and 24 inches deep.

A.—$72 \times 36 \times 24 = 62{,}208$ cubic inches.

There are 276.48 cubic inches in 1 gallon.

$$\therefore \quad 1 \text{ cubic inch} = \frac{1}{276.48}$$

$$\text{Then } 62{,}208 \text{ cubic inches} = \frac{62{,}208}{276.48} = 225 \text{ Gallons.}$$

Q.—Name some important defects in sizing that affect the weaving, therefore the quality of cloth, and how would you remedy them ?

A.—The defects are soft or insufficient sizing, and burnt or overdried yarn. In the former case beading takes place, that is, accumulation of fibres is formed upon the threads and reeds, eventually the beads become so large that they prevent the passage of the threads which then break, and by causing an entanglement with other threads generally lead to the formation of a float. The usual method of dealing with a soft warp is to apply a wax rod near the back bearer, increase the depth of the shed, and keep the warp as light as possible. Lack of elasticity and excessive thread breakages are the chief troubles when the warp is overdried. In this case a damp cloth is applied to the warp, and the tension reduced as much as possible.

Q.—State the various points that should be considered when laying a size-mixing.

A.—The points are: (1) the feel of the cloth (harsh or mellow); (2) the use of the cloth, whether it is for dyeing, printing, bleaching, etc.; (3) humidity of the weaving shed; (4) ply or two-fold yarn can be woven with very little size in many cases even without size. Single yarn of medium counts in a cloth of a coarse reed and pick can be woven with a minimum of size. A warp that has to be woven in a fine reed, or in other words one that contains a large number of ends or pick per inch requires a stronger size than one with a small number of ends or picks per inch, since, in the former case, the ends or picks are so close together that the friction on them is largely increased. A warp of fine, hard twisted yarn requires a stronger mixing (that is, containing a larger percentage of size ingredients in proportion of water) than a medium yarn, because it has not the same tendency to absorb size as a yarn of medium counts (soft twisted) a very coarse warp, being loosely twisted, tends to fray in the loom more easily than yarn of medium counts and twist and therefore needs stronger size.

Q.—How is gaiting up done with a set of back beams on a sizing machine?

A.—Every beam inside the first.

Q.—How is the side shaft (on a sizing machine) driven?

A.—The side shaft is driven by the drag roller.

Q.—Suppose you put a certain size on 12's yarn and the same size on 60's. Would the percentage of size be the same?

A.—Yes, it would be the same percentage.

Q.—Suppose you had to put 50% of size on 21's warp, and wrapping of the set of beams shows it to be coarser by two counts. Would the same per cent of size be put on the yarn ?

A.—No ; the difference of size would be made up by the difference of counts.

Q.—What classes of materials go to make up a size mixing ; state the use of each ingredient.

A.—(1) Adhesive and strengthening substance ; (2) softners, oily substances ; (3) in case gluten is a part of the adhesive substance, an ananti-septic is necessary ; (4) deliquescent substance, whenever there is an anti-septic, we must use a deliquescent substance ; (5) weighting materials.

Q.—Is the presence of cold moisture in the atmosphere of the sizing room advantageous ? If not, why ? What would you suggest for the sizing room—to be cold and dry, warm and dry, or hot and dry ?

A.—The presence of cold moisture in the atmosphere of the sizing room is the principal evil factor leading to bad sizing. It is the cause of mildew, soft warp and the clogging of the cylinders, split rods and expansion comb or wraith, also the drizzling of condensed steam upon the sizer, on the machine, and the floor. I would suggest about 100°Fah. if made perfectly dry.

Q.—Which of two sets of same length could be run sharpest 1,700 ends or 2,000 ends of 16's

A.—1,700 ends of 16's would run sharper than 2,000 ends of 16's as it will dry quicker.

Q.—What methods would you adopt in the sizing department to minimise the weaver's troubles as regards bad weaving ?

A.—I would see to the feel of the yarn (that is, it is neither sized too damp or too dry, the latter depriving it of the greater portion of its natural moisture) and the elasticy of the yarn is not taken out of it through too much tension. Also I would see that the size does not contain any ingredients that will cause bad weaving.

Q.—At the slasher sizing machine running 42 revolutions per minute, it takes $6\frac{1}{2}$ hours to run off a set of beams ; wishing to increase the production and to run off a similar set of beams in $5\frac{3}{4}$ hours at what speed must the machine run ?

A.—$5\frac{3}{4} : 6\frac{1}{2} : : 42$

$$\frac{13 \times 42 \times 4 \times 2}{2 \times 23} = \frac{1092}{23} = 47 \text{ revolutions practically.}$$

Q.—How would you find in percentage the strength that the size adds to the yarn ?

A.—Find the test of warp before and after sizing, that is, take 3 or 4 ring bobbins with yarn on either from the grey winding department or from the spinning department, wrap them and test them before sizing and run the same bobbins through the size on to an empty warper bobbin, to which a wharf of a spindle should be attached on one side and then it could be driven by the roller by a piece of string, one at a time on to four (or as the case may be) warpers bobbins which should be marked in the order of the wrapping of the ring bobbins. The yarn should be tested again after sizing. The difference will be the strength gained which should be worked out in percentage. 33% is reckoned to be a fair average.

Q.—Set out briefly the chief constituents of : (*a*) a light weaving-size for a cotton warp ; (*b*) a weaving-size suitable for a viscose rayon warp. Give reasons for the differences which you mention between the two sizes.

A.—A light weaving-size for a cotton warp would be suitable if built up from the following ingredients : farina or sago or half and half of each ; tallow, with one lb. of soft soap and one lb. of sphermacettiwax.

A weaving-size for a viscose rayon warp could be made from gelatine and gum tragacanth.

When sizing a cotton warp it is essential that strength be given to the yarn, and at the same time the fibres should be well bound together and pliability retained. The starch tends to strengthen the thread, the tallow gives pliability, the soft soap prevents the drying sized yarn from sticking to the cylinders, and the spermácetti wax helps to give "sheen" to the sized yarn.

The sizing of rayon yarns is not to give strength or pliability but simply to bind the filaments together so that the thread will be as near as possible a solid cylinder, and thus help to more easily overcome the friction which, however, small, cannot be altogether avoided as the yarn is processed from beam to cloth.

It might be mentioned that in a weaving-size for either cotton or rayon it is often advisable to add a little antiseptic to avoid mildew.

Q.—Name the principal object of sizing.

A.—(1) To coat each thread of warp yarn evenly, whether for weaving or weight with size in such a manner that it will partly penetrate and adhere to the thread without the threads adhering to one another; (2) to dry the sheet of warp after it has been sized; (3) to run the desired number of threads on a loom beam in an even sheet and in such a manner that the sheet will unwind at the loom without obstruction and pass through the healds and reeds without unnecessary breakage and with the least trouble to the weaver.

Q.—A set of taper's beams containing 200 ends of 62s twist, 20,000 yards, is taped with a cut mark every 100 yards. If the yarn is stretched $1\frac{1}{2}$% in going through the tape frame, what is the counts after taping, neglecting of course the size put on? Is one safe in saying that the number of cuts from a set of beams should be got always, and that really there is no waste to the manufacturer in taping?

A.—62s twist + $1\frac{1}{2}$% stretch = 62 + .93 = 62.93 counts after taping.

There should be 1,000 cuts of 10 yards each, from the above particulars. What is wasted has been gained in the stretch.

Q.—How much tape length would you allow if a piece of cloth contains 40 picks per inch, the counts of weft being 30s and the length of piece 50 yards from loom; show this in two ways.

A.—(1) Multiply the number of picks per inch by 3 and divide by the counts of weft.

The result will be percentage to allow for contraction.

$$\frac{40 \times 3}{30} = 4\% \text{ to be allowed for contraction.}$$

50 yards + 4% = 50 + 2 = 52 yards, tape length.

(2) Multiply the picks per inch by the length of piece of cloth and divide by the counts of weft. The result will be in inches.

Divide this by 36 (inches in a yard) and the result will be the length to be allowed for tape length.

$$\frac{40 \text{ (picks)} \times 50 \text{ (length of piece)}}{30\text{s weft}} = \frac{200}{3}$$

$$\frac{200}{3} \div 36 = 1 \text{ yard } 30 \text{ inches.}$$

Note.—It is impossible to standardize the contraction of warp and weft in woven fabrics, because they vary from being in the loom to becoming finished cloths, according to (1) the quality of raw material; (2) structure of yarn; (3) build of cloth; (4) amount of weight or tension put on the yarn on the loom.

It will be necessary by some means to obtain the amount of shrinkage from the sample of cloth that may be submitted for analysis.

During weaving the warp and the weft are in a perfectly straight condition but whilst being made into cloth the yarns have developed some curvature which indicates the amount of contraction of yarn developed. Thus, when the threads and picks taken from a finished sample of cloth are drawn straight and measured to the 1/32 part of an inch, the result will indicate the warp length and reed width to produce that particular size of finished cloth and by proportion the relative warp length and width in loom can be obtained for any required dimension of finished cloth.

Q. When from a sample $3'' \times 3''$ the threads and picks are drawn out, they are found to measure $3\frac{1}{4}'' \times 3\frac{1}{2}''$, what length of warp and width in loom will be required in order that the finished cloth will be 60 yards long and 56 inches wide ?

A.—As $3'' : 3\frac{1}{4}'' : : 60 : x$

$$\therefore \quad x = \frac{13}{4} \times \frac{60}{3} = 65 \text{ yards of warp.}$$

again as $3'' : 3\frac{1}{2}'' : : 56'' : x$

$$\therefore \quad x = \frac{7}{2} \times \frac{56}{3} = 65\frac{1}{3}'' \text{ loom width.}$$

Q.—How would you find the tension put on the yarn on a tape frame, supposing you had a set of 10,000 yards long and the tape length 30 yards long and the cuts obtained from the set 334, and the waste obtained 36 yards ?

A.—Multiply the number of cuts by the tape lenght which will show the actual length sized, minus the waste obtained from the grey length of the set. Then the difference between the actaul length and the grey length of yarn sized will give the gain per cent. Thus :—

$334 \times 30 = 10{,}020$ yards actual

Length of set $= 10{,}000 — 36$ yards (waste)

$= 9.964$ yards grey length of set

$\therefore$ 10,020—9,964 = 56 yards gain

$$\therefore \text{ the gain per cent} = \frac{56 \times 100}{9{,}964} = .56\%.$$

Uniform Drying

Keeping the whole of the sized beams in any one particular sort dried to the standard which experience has proved to be best adopted for it.

Q.—Suppose the volume of a solution at 72° twaddle is 4 gallons; what will be the volume if the solution is required to contain the same weight of solid substance at 64°Tw.?

A.—Multiply the degrees twaddle of solution at a usual density by the volume (4 gals.) known and divide by the degrees twaddle (64) of solution ot the required density.

$$\frac{72 \times 4}{64} = 4.5 \text{ gallons volume.}$$

Q.—When is wax largely used?

A.—It is largely used for sizing coloured yarns for dhoty borders because it lays the fabrics of the yarn rather better than tallow and as these yarns are generally sized with as small quantity of size as possible it enables them better to resist the rubbing of the healds and reeds.

Q.—State what features or qualities should a perfectly formed warp or weaver's beam possess?

A.—A warp or weaver's beam should be perfectly level across its width, that is of uniform diameter with the side threads evenly against the flanges.

Every thread should be separate and distinct from its neighbours and capable of opening easily from the base rods to the beam. The threads should occupy the same relative position on the beam that they do in the cloth. There should be no missing or dropped ends. The sizing should be such as will give the requisite amount of strength and smoothness to the threads which will enable them to withstand the strain and friction of weaving.

Q.—What are crossed ends in slashed warp due to?

A.—Crossed ends in a slashed warp are generally due to breakage at the dividing rods or too many lappers on the back beams.

Q.—Is condensed water better than ordinary water for size mixing?

A.—Yes, condensed water is water boiled, all hardness having been taken out, *Q.*—What is the weight of a set of a slasher beams which consist of five beams of 400 ends each and 10,500 yards long each of 40s counts ?

A.—$\dfrac{5 \times 400 \times 10{,}500}{840 \times 40}$ =625 lbs. weight of set.

Q.—What is the length on a warper's beam which contains 420 ends of 20s twist, and weighs 312.5 lbs. If you had to prepare for a set of "sizers" back beams, with a total of 2,520 ends and 17,500 yards in length of 32s twist, what weight of yarn would be required for the winding and warping, assuming that you allow 1.5% for waste.

A.—Length of yarn = $\dfrac{840 \times 312.5 \times 20s}{420 \text{ ends}}$ =12,500 yards.

Weight of yarn = $\dfrac{2{,}520 \times 17{,}500}{840 \times 32}$ =1,640.6 lbs.

1,640.6 lbs. + 1.5% =1,665.2 lbs.

Q.—There are five warper's beams put into the creel of the sizing machine, each beam containing 100 lbs. of 24s yarn ; what will be the total weight obtainable for weaving, allowing 1% for waste and adding 30% for size ?

A.—The total quantity of yarn will be 100 × 5 =500 lbs. less 1%, or 5 lbs. for waste leaving a balance of 495 lbs. To this weight must be added 30% for size so that the weight available for weaving would be—

$$\frac{495 \times 30}{100} = \frac{297}{2} = 148\tfrac{1}{2}$$

$\therefore$ $495 + 148\tfrac{1}{2} = 643\tfrac{1}{2}$ lbs. total weight.

Q.—On the weaver's beam there are to be 2,200 ends of 2/40s yarn. The length to be 1,000 yards. What would be the weight of the warp yarn used ?

A.—$\dfrac{\text{Ends} \times \text{Length}}{840 \times 2/40s} = \dfrac{2{,}200 \times 1{,}000}{840 \times 20}$

$= \dfrac{2{,}750}{21} = 130\dfrac{20}{21}$ lbs. or 131 lbs. practically.

Q.—At a slashing machine the weight of yarn on a weaver's beam is 100 lbs. After having been sized 30% the counts were 60, what length is on the beam, the number of ends being 2,000 ?

A.—Nett weight of the yarn without size would be—100—30 = 70 lbs.

as 1 lb. of 60s yarn contains $60 \times 840 = 50,400$ yards.

Then the beam would contain $\frac{70 \times 50,400}{2,000} = 1,764$ yards.

Q.—A weaver's beam weighs 100 lbs., having been sized 10% It contains 1,000 yards of 40s yarn. What number of ends are on it ?

A.—$100 - 10 = 90$ lbs.

$$\frac{90 \times 840 \times 40}{1,000} = 3,024 \text{ lbs.}$$

Q.—Give your reasons why sized warp during the course of weaving get soft and form into small balls and beads behind the reed.

A.—It is a hard matter to form an opinion on sizing without knowing all the conditions in the room. The trouble may arise from one or two things, that is, either the warps have been sized and left to stand for a long time before putting it on the loom particularly if it was sized with farina size, then there is every reason for it to go soft and form into beads behind the reeds. If the atmosphere is too dry in the weaving shed then it will cause the warp to dry up and dust off and also will cause the formation of little balls of fibre behind the reed.

Q.—If zinc is excessively used (1) what will be the result on the yarn if the temperature of the shed rises ; (2) how would you prevent it ; (3) how would you prevent it in the case of excessive temperature when no zinc chloride is being used ?

A.—(1) It will make the yarn brittle ; (2) to prevent this brittleness in the yarn, deliquescent substances such as chloride of magnesium, etc., must be used ; also humidifiers must be used ; (3) this can be removed by direct softeners and humidifiers.

Q.—What is the object of a zig-zag wraith ?

A.—The object of zig-zag wraith is to get better passage of yarn.

Q.—How would you prepare zinc and magnesium chlorides for size mixing ?

A.—If it is not used in the solids I would liquify them by placing the drums of either of the chlorides on two different vats which are lined with zinc sheet and steam out the contents from the drums into the vats.

Then bring the chloride of zinc to a density of 102°Tw. at which one gallon weighs about 15.10 lbs.

Cloride of magnesium is brought to a density of 58°Tw. at which one gallon weighs about 12.90 lbs.

In twaddling the liquid, it should be at a temperature of 60°Fah.

Q.—Give the essential qualities that an antiseptic must possess.

A.—(1) In order to obtain easy incorporation with the size, the antiseptic must be fairly soluble in water at the temperature of mixing.

(2) After being added to the size mixing or finishing mixing, the antiseptic must remain unchanged. If it is volatile with steam it will boil out ; and if it is decomposed by heat, its antiseptic properties may be lost.

(3) The colour of the size must not be altered by the addition of the antiseptic, unless the result happens to be favourable or can be counteracted easily by suitable tinting.

(4) The possession of an odour may be very objectionable if it is imparted to the cloth.

(5) Tendering of the yarn or fabric must not be produced, either by direct action owing to strong acids or oxidizing agents or by decomposition on heating, which is generally recognized as the objection to the use of zinc chloride.

(6) The dyeing and finishing properties of the yarn or fabric must not be affected.

(7) The antiseptic must have no action upon those parts of the machinery with which it is likely to come in contact.

(8) Safety in handling the antiseptic is essential.

(9) There must be no action on the constituents of the size which will affect the characteristic feel of the resulting fabric.

Q.—What are the practical points on slasher sizing that are required for producing a well sized warp.

A.—A well sized warp must be clean, smooth, non-sticky, and firm having a good feel and free from objectionable odour. A good sizing starch to have a high viscosity to give strength and elasticity to yarn, reduce breakages and droppage in weaving which is caused by overbaking on drying cylinders, injudicious use of ingredients, poor adhesives, insufficient boiling and application of size at a very low temperature, while tallow acting as a lubricant mitigate this evil of droppage to some extent. Starch should be used to paste down fibres, assisted in turn by addition of gums, waxes and viscous oils, size mixture in use should never be allowed to cool down to jelly state, it will then lose its colloidal properties and adhesiveness and be kept always hot, but repeated boiling be avoided. Fresh well cooked size should be added to the sow-box every hour or two or as the case may be to enable the warp to acquire stiffness, smoothness and resiliency so very essential to the fabric. Use of very high pressure steam in drying cylinders to work at a high speed and consequential high production lowers the quality of sized yarn whereas lower temperature practicable contributes stronger and more elastic warp. Fine yarns for thin fabrics require very light sizing whereas low counts for fabrics having a full appearance and feel require heavy sizing containing a good lubricant or fats with good oiliness and penetrating properties. To give hardness to fabric made with hard twisted yarn, the size should contain more starches and less fats, gums which are adhesive and soluble should be used.

Q.—Is it possible to substitute tallow in pure or light size by any other ingredient? If so, name it.

A.—In pure or light sizing it might be possible to substitute tallow by a small quantity of the very best china clay to give the desired weaving quality.

Q.—What is absolutely the safe quantity of chloride of zinc necessary to steep with flour to prevent any chance of mildew?

A.—One gallon or 15.10 lbs. of pure chloride of zinc at 102°Tw. to every 100 lbs. of wheat flour being used in the mixing particularly for heavy sizing. For light sorts, say under 50% 10 lbs. to every 100 lbs. of wheat flour, farina, sago, maize, or other gelatinous matter constituting the mixing is quite sufficient to make it safe from ordinary mildew, for there is not the same quantity of size on the warp as when it is weighed up to 100% and more. It must, however be remembered that the proportions named are only sufficient when the warps are run off reasonably dry and would not be sufficient to preserve the cloth from mildew if it was allowed to get wet and be packed damp, for then there is great doubt if any quantity of chloride of zinc would save the cloth under scuh extreme circumstances in a hot climate.

Q.—Is it correct to steep flour at once with chloride of zinc and prevent it from fermenting? Give your reasons.

A.—Yes, it is quite correct to steep flour and not ferment. Because (1) it prevents in the most effective manner any developments of mildew growths by at once stopping any putrefaction being set up in the raw gelatinous matter; (2) there is no possibility of loss of flour by the beck overflowing, as often occurs in the case of fermention method, for no gas is liberated by steeping, consequently 'barming over' never happens; (2) fewer becks and much less flour is required to be kept under water by steeping than by fermenting, as many used to 'age it' for three months with no better result than by steeping method.

Q.—How long would you require to break up the flour in the course of steeping?

A.—The time required to break up the flour varies somewhat with the nature of the flour, the amount of agitation that is employed on it, and the quantity of water which is added to it. Roller ground wheat flour should be used. The mixing should be agitated during the usual running hours of the mill and care should be taken not to put too much water in at first (usually the steeping is started with 10 gallons or 100 lbs. of water to every 100 lbs. of wheat flour in the mixing) then 10 days is ample time, particularly in a warm climate, to get the same in perfect condition for the work it has to do on the warp, the theory being that too much water at first thins down the chloride of zinc and thus dilutes the antiseptic powers on the wheat flour and it is quite easy to make all the right strength to suit the work in hand, when, it is added to a complete mixing, after its 10 days of steeping. Either fermenting or steeping is done more quickly in 90°Fah. in warm country than in 45°Fah. in cold country which is the reason why size becks are often put over the steam boilers in Lancashire.

Q.—Which do you think the better process—to add the magnesium to the clay pan and boiled with tallow just before admitting it to the finishing beck or to add it to the flour in the finishing beck?

A.—It is better to add both the chloride of zinc and magnesium to the water when starting the flour steeping, so that both chemicals at once come in direct contact with the substance they are put in to act upon, for they have no effect on any mineral or fatty matters, hence to boil the chlorides with them is of no advantage, but on the other hand there is distinct risk by not getting the full benefit of their use and the necessary effects on the wheat flour. When adding the wheat flour to the water and chlorides, not more than one sack of 184 lbs. or 196 lbs. should be added per hour, as then it allows the flour to become properly mixed much sooner than if there is no interval. Further it also avoids any excessive strain on the agitators and driving strap, than when, say, 10 sacks are put in as quickly as possible. During the first day or two after the flour is added to the water and chloride it is plainly evident the whole is not thoroughly blended, but each succeeding day the mixture lacks thinner and in a week has limpid appearance and splashes about the beck like thick cream when the agitators are working.

Chlorides of magnesium or zinc should never be used in goods which are to be singed previous to bleaching unless their presence is disclosed by the manufacturer to the bleacher. As little as possible should be used in goods meant for calendering to prevent caking on the bowls.

Q.—Why is it necessary that the man in charge of the sizing department should be an intelligent man ? Give your reasons.

A.—There must be an intelligent man in charge of sizing as it must be intelligently conducted to give the best results.

In sizing, the man in charge should have the active co-operation with those in authority and a manifestation of sympathetic interest in his experiments and investigations.

The importance of sizing cannot be overestimated. However good the yarn may be, indifferent sizing can detract from the value of the cloth made from it, and if the twist be of poor quality, it may be greatly improved by judicious treatment and excellent sizing.

Q.—Give one method of preparing starch that will last overnight.

A.—If a cold emulsion of starch and water be poured into hot water slowly and stirred at the same time, a paste is formed which requires no further boiling and which will stand for very much longer than one made by putting the dry farina into cold water and then boiling up. In the first case almost every granule is immediately burst, in the latter it is not so, as the warming is mainly done by conduction and not by convection, a properly cooked starch paste will easily last overnight —an incompletely cooked one will not.

Q.—Suppose the volume at 70° twaddle is 4 gallons; what will be the twaddle, maintaining the same weight of solid materials in solution if the volume is 4.5 gallons ?

A.—$\frac{72 \times 4}{4.5} = 64°$ twaddle.

Q.—How would you find the length marked on a tape sizing machine ?

Rule :—

For calculating the length marked by change wheels multiply together the circumference of the measuring roller in inches, the number of teeth in the bell wheel and in the stud wheel and divide by the number of teeth in the measuring roller wheel—the quotient will give the length marked in inches thus—

Example :—

Given measuring roller 14.4 inches circumference, with wheel on same of 108 teeth, bell wheel of 45 teeth, and stud wheel of 85 teeth, find the length of yarn in each mark.

$$\frac{14.4 \times 45 \times 85}{108 \times 36} \quad \frac{127.5}{9} = 14 \text{ yards } 6 \text{ inches.}$$

Q.—How would you find the measuring roller wheel required ?

Rule :—

Multiply 14.4 (circumference of measuring roller in inches) by number of teeth in the bell wheel, and the result by the number of teeth in the stud wheel, then divide by the length in inches of the mark required.

Example :—

Required a mark of 18 yards 18 inches with a bell wheel of 45 teeth, and stud wheel of 48 teeth. How many teeth must measuring roller wheel have ?

$$A.\text{—}\frac{14.4 \times 45 \times 48}{486 \text{ (18 yds. 18 ins.)}} = 64 \text{ teeth in measuring roller wheel.}$$

Q.—How would you find the stud wheel required ?

Rule :—

Multiply the number of teeth in the measuring roller wheel by the length of mark required in inches, and divide this by 14.4 (the circumference of measuring roller in inches) and the number of teeth in the bell wheel.

Example :—

Having a roller wheel of 108 teeth with bell wheel of 45 teeth, and wishing to make a mark of 11 yards 24 inches, what number of teeth should the stud wheel have ?

A.—$\frac{108 \times 420 \text{ (11 yds. 24 ins.)}}{45 \times 14.4}$ = 70 teeth in stud roller wheel.

The number of teeth in the bell wheel is constant 45 teeth, the circumference of the measuring roller is constant 14.4 inches and multiplied together they give.

$$45 \times 14.4 = 648.$$

648 gives "tin roller wheel." Length of mark in inches gives "stud wheel."

Example :—

What wheels, tin roller and stud must be used to mark every 20 yards.

20 yards × 36 inches = 720 inches.

$$\frac{720}{648} = \frac{60}{54} = \frac{35}{27}$$

∴ The wheels are 54 and 60 or 35 and 27.

Tin roller and stud respectively.

Q.—What stud and tin roller wheels must be used to mark every 36 yards ?

A.—648 gives tin roller wheel.

Length of mark in inches (36 × 36 = 1,296 inches) gives stud wheel or any two wheels which bear a ratio of 2 to 1, the stud wheel having double the number of teeth to the tin roller wheel, namely :—

27 tin roller wheel

54 stud wheel.

There are many lengths where the wheels are not so easily obtained.

Q.—What wheels, tin roller, and stud must be used to mark every 30 yards 21½ inches.

A.—30 yards × 36 inches = 1,080 inches + 21½ inches = 1,101½ inches.

648 gives tin roller wheel and 1,101½ gives stud wheel.

or any ratio of these two numbers, thus :—

Let 648 equal 1 then 1,101½ equals.

$$\frac{1{,}101.5}{648} = 1.7.$$

Therefore the ratio are tin roller wheel = 1 and stud wheel = 1.7.

For an example if the multiplier is 40.

Then tin roller = 1 × 40 = 40.

Stud wheel = 1.7 × 40 = 68.

In some cases the wheels are too large for practical purposes. It is usual then to use wheels that will give the nearest length, to the length of mark required.

Q.—What does the value of soap depend upon as a sizing ingredient ?

A.—It depends entirely upon the object for which it is used, and also upon the presence or absence of certain ingredients such as chlorides of magnesium and zinc, etc.

Q.—How would you analyse a sample of prepared size ?

A.—(1) I would weigh a quantity on a watch glass. Dry thoroughly in the steam oven and weigh again. The loss is mainly due to water.

(2) Then I would take some of this dried size and extract the fat by solution in ether. Filter, and allow some of the extract to spontaneously evaporate, then dry in a steam oven for several hours, and finally let it remain set for 2 or 3 days. Then determine the melting point of this fat.

(3) I would then determine the amount of ash by heating strongly, in a crucible over a Bunsen flame.

(4) I would take the residue on the filter paper from the ether extraction, and shake it up with hot water. Filter and test separate portions of the water extract as follows for :—

(*a*) Acidity—by litmus,

(*b*) Sugar—by Fehling solution,

(*c*) Starch—with iodine,

(*d*) A chloride (magnesium, sodium, calcium, zinc, etc.), by adding a little nitric acid and then a few drops of silver nitrate solution—a white curly precipitate shows the presence of a chloride.

To test for sulphate—add nitric acid and then a solution of barium chloride—a white precipitate is produced if it is present.

To the residue from the water "extraction" or the "ash" or both, add sodium carbonate (solid) and fuse the mixture in a crucible for 10 to 15 minutes. Boil this with water and filter. Test the filtrate for "acids." Dissolve the residue in dilute hydrochloric acid and test this solution for metals.

Q.—How would you analyse by a short method a sizing ingredient in a liquid state ?

A.—I would :—

(1) Evaporate some to dryness and examine the residue—taste, colour, smell, it gives to the Bunsen Flame when held in it on a platinum wire.

(2) Test the solution for free acid, free alkali, sugar, starch.

(3) Boil some (*a*) alone (*b*) with dilute acid—Note any gas given off.

(4) Test a portion for metals or bases, as follows :—

(*a*) Add a little dilute hydrochloric acid. A white precipitate = silver, mercury or lead salts.

(*b*) Filter (if necessary). Pass sulphurated hydrogen through the apparatus used to generate this gas ; a precipitate = mercury, lead, copper, arsenic, tin, etc.

(*c*) Filter off or (if there has been no result so far) take a fresh portion of the original solution. Boil with a few drops of nitric acid for a few minutes—add ammonium chloride solution and ammonia.

Brown ppt. = Iron.
White ppt. = Aluminium.
Green ppt. = Chronium.

(*d*) Filter off (if necessary) and again pass sulphuratted hydrogen—

Black ppt. = Cobalt and Nickel.
White ppt. = Zinc.
Buff ppt. = Manganese.

(*e*) Filter. Add ammonium carbonate solution. White ppt. = Barium, strontium, calcium (lime).

(*f*) Filter. Add sodium phosphate solution. White ppt. = magnesium.

(*g*) Sodium (to be tested for in the original solution) gives an intense yellow colour to the Bunsen flame.

Potassium gives a violet colour.
Lime gives a red colour.
Copper gives a green colour.

Ammonia, if present, is evolved as a gas if the original substance be warmed with caustic soda.

(5) Test separate portions for acids, as follows :—

(*a*) Add dilute hydrochloric acid. Carbon dioxide will be evolved if a carbonate be present, and chlorine (a yellow irritating gas) if it be a hypochlorite.

(*b*) Add dilute nitric acid and then silver nitrate solution—a white ppt. which turns purple in bright sunlight is produced if a chloride be present.

(*c*) Add dilute nitric acid and then a solution of Barium chloride—a white ppt. indicates a sulphate.

(*d*) Add dilute nitric acid, put a few drops of the mixture into ½ T.T. full of ammonium Molydate solution ; warm gently —a yellow colouration or ppt. means a phosphate is present.

(*e*) Add a little strong sulphuric acid ; cool, pour on the top a strong cold solution of Ferrous sulphate (green vitroil). A black ring is produced where the two liquids meet if a nitrate is present.

Q.—How would you treat water containing Organic Matter ?

A.—The water should be treated with a minute amount of chlorine. Chlorination is also being used extensively for the treatment of drinking water .The addition of less than half pint of chlorine pèr million parts has been shown to give a water freedom from organisms, such as bacillus coli, which are the causes of epidemic diseases.

Q.—How would you treat Acid and Alkaline waters ?

A.—Waters which are excessively acid or alkaline can be treated by simple methods. Acid waters should be neutralised by the addition of the correct amount of a suitable alkali such as lime, soda ash or caustic soda.

Excessively alkaline waters occasionally occur in deep wells, the alkalinity being due to sodium carbonate or bicarbonate formed by exposure to natural base-exchanging minerals. By treatment with lime and calcium chloride the alkalinity can be reduced to the figure required.

Q.—Why are disagreeable odours from chemicals, dirty and oily machinery, etc., objectionable in a factory.

A.—Disagreeable odours from chemicals, dirty and oily machinery, toilets, etc., while not usually harmful in the way of being poisonous, tend to lower the general physical efficiency of the operatives, and means should be adopted to eliminate them as far as possible. Vats or tanks containing liquids giving off odours of this kind should be provided with ventliating hoods. Machinery should be kept clean, and bearings so adjusted as to prevent all odour of hot or burning oil.

Q.—Explain briefly the advantage obtained from white enamel paints for interior painting in a textile mill.

A.—The textile industry above all others has tried and proved the value of certain white enamel paints for interior painting, and hence their use in some of the textile mills is very general. Whereas in some other mills limewash is more common. The chief reasons for their use are the high light-reflecting value and the permanence of their whiteness. The industry, having adopted this paint method, proves itself interested in the subject of saving all possible light in the plant. If white paint is good for the walls, ceilings, and posts, it is equally good for electric conduit, panel boxes, piping, shaft hangers, and all permanent building fixtures, including sprinkler piping. Just as white is good for overhead work, a light colour for dadoes should be adopted. A dust or coffee cream colour will not show dirt quickly, and has double the light-reflecting value of the dark-green or grey paint now so commonly used.

Q.—Explain the difference between the old and modern theory of ventilation.

A.—The older idea was that the discomfort experienced in crowded or poorly ventilated rooms was due to an excess of carbonic-acid gas, and to the presence of certain unknown poisonous substances given off in the process of resipiration, combined with a diminution of the oxygen content of the air. The remedy for this was to flood the room with large volumes of fresh outside air, thus diluting the harmful gases, and at the same time increasing the amount of oxygen.

Outside country air contains, on an average, about four parts of carbonic acid in 10,000, and it was supposed that this should never be allowed to rise above ten at the most. Efforts were made to limit it to six or seven parts in 10,000 in certain types of buildings. The whole matter of ventilation, under this method of reasoning, rested upon the chemical composition.

The modern theory of ventilation pays but little, if any, attention to the composition of the air, so far as it is affected by the respiration of the occupants of a room, and devotes itself to proper temperature and humidity control, air movement, and, under certain conditions, the removal of dust, odours, and bacteria, depending upon the type of building under consideration and the process carried on within it when no special means are provided for controlling the humidity, the air is usually too dry during the heating season, both for the comfort of the operatives and for the best results in certain manufacturing operations, except in special departments.

Too dry an atmosphere affects the respiratory passages and makes the operative subject to colds. Loss of production, due to absence by sickness on the part of the employees, is an important item during the winter months. Care should be taken, to see that the comfort and health of the operatives are well looked after.

Q.—A bottle holding 25 grammes of water at 60°Fah. held 37.575 grammes of chloride of zinc solution at the same temperature. Find (*a*) specific gravity (*b*) the degrees twaddle ?

A.—(*a*) $37.575 \div 25 = 1.503$ specific gravity.

(*b*) the degrees twaddle may be obtained by dividing the figures after the decimal point by 5. Thus :—

$$.503 \div 5 = 100.6°\text{Twaddle}.$$

Q.—Define matter.

A.—The word matter is used to include practically an infinite number of things. For physical purposes there are two classes: (1) solids ; (2) fluids, sub-divided into liquids and gases.

But the most important chemical classification is the one which divides matter ; (1) elements ; (2) compounds ; (3) mixtures, and every known substance can be placed in one or other of these three classes.

Q.—What is an element ?

A.—An element is a thing which has not by any known means been resolved into anything simpler—it yields nothing but itself, such as carbon, silver, gold, copper, tin, sodium, potassium, oxygen nitrogen, hydrogen, etc.

Q.—State the two sub-classes of elements.

A.—(*a*) Metals ; (*b*) Non-metals.

Q.—Give the characteristic properties of metals.

A.—(*a*) They are malleable ; (*b*) they are ductile ; (*c*) they possess a peculiar lustre ; (*d*) they have a high specific gravity ; (*e*) they ring when struck ; (*f*) they are good conductors of heat and electricity.

They also possess the property of intimately mixing with each other when melted together or compressed to form alloys. Some common alloys are : bronze, gun metal, solder, etc.

Q.—Do non-metal possess metallic properties ?

A.—Non-metals do not possess metallic properties, that is, they are not malleable, nor ductile, etc.

This class includes all the elementary gases and carbons, etc.

Q.—What are the stains that are caused in the cloth during the process of manufacture.

A.—The stains are generally due to the following causes :—

(1) Mildew stains.

(2) Oil stains.

(8) Paraffin wax stains.

(4) Iron rust stains.

Q.—Give the use of Diastase Ferments.

A.—Diastase preparations are now used for liquefying purposes, the best known product of this kind being diastafor, and similarly biolase, novo-fermasol, degomma, and activine. For all these prepartions, except activine, the best temperature for fermenting the starches is 60 degree. If the products are used at too high a temperature, *e.g.*, at boiling, they will be destroyed.

Biolase, however, can stand a temperature of 80-85 degrees, and has the advantage of giving the desired effect rather quicker. The action can be quickly stopped by boiling with an addition of acetic or formic acid. Activine on the other hand is used at the boil, but gradually exhausts itself, and consequently the quantity added must be watched.

The quantity of ferment added is usually not more than one per cent of the weight of the starch and the consistency of the starch can always be fully controlled.

Q.—Define compounds

A.—Compounds are things which contain two or more elements united together in certain definite proportions in the smallest piece of the substance which is capable of having an existence as such. A compound must be homogenous in structure, such as water, salt, glycerine, starch, chiha clay, zinc chloride, magnesium chloride, etc.

Q.—Define mixtures.

A.—Mixtures are the most commonly occurring of all things. In these there is no definite structure in their smallest particles. Such as coal, flour, soaps, and most oils and fats.

Q.—What are the distinguishable constituents of mixtures ?

A.—(1) Constituents can be distinguished by the eye, with or without the aid of microscope; (2) by solution and crystallization crystals of different kinds may be obtained; (3) in many cases particular solvent dissolves part of the mixture, leaving an insoluble residue; (4) they have no definite boiling or melting points.

Q.—State how would you distinguish pure substances.

A.—(1) The appearance should be uniform throughout, however minutely they are examined; (2) solution of crystallization should give crystals of one kind only; (3) substance dissolves thoroughly and uniformly; (4) exhibit invariable and definite melting and boiling points.

Q.—What is vapour and humidity ?

A.—A vapour is a body that at ordinary temperature is a liquid or solid, but when heat is applied becomes a gas, as steam. Humidity means dampness.

Q.—What are the two important tests necessary for the purpose of determining the quality of the various starches ?

A.—The first important test that is necessary is the determination of the amount of the moisture present, and the second is the determination of the quality of the paste when boiled with water.

Q.—Give the use of Glue and Gelatine if used in a size mixing.

A.—Glue and gelatine have the advantage of not dulling the fibre, but the vegetable gums, such as gum arabic, tragacanth, Iceland moss, etc., are not adopted for use alone, tragacanth giving a hard stiff effect, and the others not being sufficiently adhesive.

Q.—How would you find the humidity of air ?

A.—If the humidity of air is required at any time the simplest way is to find out how far the air is from being saturated. This can be done by cooling the air gradually down until it begins to deposit its moisture as dew. The temperature at which this occurs is called the dew point. The dew point is not a fixed temperature, it changes continually, as the temperature of the air and the amount of water vapour contained in it change.

On very damp days the dew point is only slightly below the temperature of the air. In dry weather the air needs to be cooled very considerably before the deposition of dew begins; therefore the dew point is much below the actual temperature. The difference between the two temperatures depends upon the dryness of the air; when the difference is great it indicates that evaporation is going on rapidly, and consequently that the air is dry and dew point relatively low, when the difference in temperature is small it indicates that but little evaporation is going on from the wet bulb, and the dew point is high relatively.

Q.—How would you distinguish between sulphonated oil and Liquid Soap.

A.—I would dissolve 6 or 8 grains of sample in 25 c.c. of distilled water, add 50 c.c. of concentrated hydrochloric acid, heat, transfer to a separating funnel, and draw off the acid water. Neutralize this with ammonia, using methyl orange indicator, add 1 c.c. of concentrated hydrochloric acid, make up to about 400 c.c. with distilled water, bring to the boil and add barium chloride solution in usual way. A precipitate of barium sulphate would indicate that the product was a sulphonated oil. Absence of a precipitate would indicate that the compound was a liquid soap. It may be necessary to use a little ether in order to give a clear separation in the funnel.

Q.—If a wet cloth hung up in air dries quickly on a warm summer day, while it takes a longer time to dry on a wet rainy day, where does the water that wets the cloth go? What is the difference due to?

A.—The wet cloth gets dry because the water disappears as invisible water vapour and mixes with air. The air of a summer day is intensely thirsty and so it quickly absorbs the moisture from the wet cloth. Whereas on the rainy day the thirst of the air for moisture is already quenched, and there is plenty of water all round to supply moisture, if required, nevertheless, the wet cloth gets dry but slowly to supply the moisture. This process of conversion of water into invisible water vapour is known as evaporation.

It is not only from the wet cloth that water is converted as water vapour to quench the thirst of hot dry air but the process of evaporation is going on slowly from all surfaces that are capable of yielding moisture or water vapour. In summer, lakes and rivers dry up, plants and leaves and in fact vegetation in general get dry, all to satisfy the thirst of dry air. One may ask 'Is the air so thirsty as to dry up all fresh moist things, and is there no limit for its thirst?' Yes, there is a limit, a certain quantity of air can take in or hold only a definite amount of moisture and no more. Moisture has to be supplied from all sources till the limit is reached. A natural question will be, 'On what does the limit for moisture depend?' It depends upon how hot the air is, or putting it technically its temperature is. We can feel the difference between hot and cold water by dipping our hands, but we cannot say merely by feeling how hot the water is. A sensitive instrument is required to indicate the degree of heat or coldness as stated above; the limit for thirst of hot air for moisture depends upon its temperature. The higher the temperature the greater the thirst. So the rate of evaporation depends upon a number of factors, the temperature, the nature of the surface, wind and the amount of moisture already in the atmosphere.

The state of atmosphere as regards its moisture content is known as its humidity. If the air were entirely free from moisture, which is never the case, its humidity is said to be zero. It is the moisture of the air that makes a summer day more uncomfortable and oppressive. It is commonly supposed that human body feels temperature only, while in fact wind, moisture, and temperature are felt by it equally. The reason for a moist day in summer being more oppressive than a dry day is that the atmosphere which already contains a considerable amount of moisture prevents free evaporation of perspiration from the body which cools it. It is this fact that makes the difference between the trying summer of coastal towns like Madras and Bombay and inland stations. In the coastal stations, the air is moist because of the evaporation of water from the neighbouring seas, while in inland stations the air is dry and permits free evaporation of perspiration from human body. There is a maximum limit for the air to hold moisture. A pint bottle can hold no more than a pint. If some more liquid than a pint is poured into a pint bottle the excess is spilt. Similarly, any excess moisture than the maximum that the air can hold has to come out and it does come out and is deposited as liquid on solid surfaces. The pint bottle can hold less than a pint, that is, a fraction of a pint. Similarly, air also can hold any amount up to the maximum it can hold. The moisture content can be expressed as relative humidity, the maximum is taken as 100 and the actual content as part of 100 and the relative humidity is expressed in cents. Thus, 70% relative humidity means the air contains 70 parts of moisture, while the maximum is 100. Hygrometer is the name of the instrument that indicates the moisture content of the atmosphere.

Q.—What are the objects of ventilation ?

A.—The objects of ventilation are to provide an atmosphere at reasonable temperature containing a minimum amount of products of respiration and combustion, and it is essential that the fresh air should be distributed over the building where required without causing draughts.

Or

Ventilation—when people collect together in buildings the impurities given off from their lungs and skin soon cause the interior air to be foul, the foulness being in proportion to the time they are together. Ventilation is the means by which these impurities are removed and the interior air is kept almost as pure as the outside air, without any draughts or air currents being noticeable.

Q.—What are the factors to be considered when designing a ventilating plant ?

A.—In designing a ventilating plant three factors present themselves—temperature, humidity and purity.

The ventilating and heating engineers hitherto have followed a great illusion in thinking that the main objects to be attained in dwellings and places of business are chemical purity of the air and a uniform draughtless summer temperature.

Life is the reaction of the living substance to the ceaseless play of environment. Biotic energy arises from the transformation of those other forms of energy—heat, light, sound, etc.—which beat upon the transformer—the living substance. Thus, when all the avenues of sense are closed the central nervous system is no longer aroused and consciousness lapses.

A sense organ is not stimulated unless there is a change of rate in the transference of energy and if this it to be effectual must occur in most cases with considerable quickness. If a weak agent is to stimulate, its application, must be abrupt. Thus the slow changes of barometric pressure on the body surface originate no skin sensations though such changes of pressure if applied suddenly are much above the threshold value for touch

A touch excited by constant mechanical pressure of slight intensity fades quickly below the threshold of sensation. Thus the almost unbearable discomfort which a child feels on putting on for the first time a natural wool vest fades away and is not longer noticed with continual wear.

It is not the wind which God tempers to the shorn lamb, but the skin of the lamb to the wind.

To find the density of solution

1 gallon zinc chloride at 102°Tw. or specific gravity = 1.51 weighs 15.10 (1.51 × 10)

1 gallon of water at 60°Fah. weighs 10 lbs.

Q.—If the prescribed volume of a solution say at 100°Tw. or specific gravity 1.50 be 5 gallons, what will be the volume of a similar solution at 102°Tw. or specific gravity 1.51 to contain the same weight of the solid substances ?

A.—It will only require a volume of 4.90 gallons of a similar solution at 102°Tw.

$$\frac{100 \times 5}{102} = 4.90 \text{ gallons.}$$

Q.—What temperature on the centrigrade scale is equal to 212° Fahrenheit ?

$$\frac{(\text{Fah.}—32) \times 5}{9} = \text{centrigrade.}$$

$$212\text{-}32 = 180$$

A.—*Rule :*—

$$\frac{180 \times 5}{9} = 100° \text{ centrigrade.}$$

Q.—What temperature on the centrigrade scale is equal to 0° Fahrenheit ?

A.—$0 - 32 = 32$

$$\frac{32 \times 5}{9} = \frac{160}{9} = 17.77°\text{C.}$$

Q.—Express 60° centrigade on Fahrenheits scale.

$$\frac{\text{C} \times 9}{5} + 32 = \text{Fahrenheit.}$$

A.—*Rule :*—

$$\frac{60 \times 9}{5} = 108 + 32 = 140° \text{ Fah.}$$

Q.—What are the sizing agents that are used to give the yarn a hard, soft or full effect.

A.—By judicious choice of sizing agents a hard, soft, or full effect can be obtained, and the usual method is to use ordinary starches, using in addition softening agents to produce the effect desired. The principal products for giving soft and smooth feel and add weight are oils, fats, soaps, glycerine, and the weighting agents are clay Glauber's salt, magnesium sulphate, etc.

For the softening of artificial silk an olive oil emulsion is principally used. Turkey red oil is added if a very soft feel is desired. Glycerine is both a softening and weighting agent owing to its affinity for water.

TAPE CHANGE WHEEL TABLES

Measuring Roller of 14.4 *inches Circumference Bell Wheel of* 45 *Teeth*

Tape Length		Wheels		Tape Length		Wheels		Tape Length		Wheels	
Yds.	Ins.	M.R.	S.	Yds.	Ins.	M.R.	S.	Yds.	Ins.	M.R.	S.
2	9	120	15	3	7	107	19	4	0	72	16
2	10¼	118	15	3	8	95	17	4	2	71	16
2	11	117	15	3	9	83	15	4	3	97	22
2	12½	115	15	3	10¼	104	19	4	4	70	16
2	14	113	15	3	11	87	16	4	5	87	20
2	15	119	16	3	12	81	15	4	6	95	22
2	17	109	15	3	13	91	17	4	7	103	24
2	18	108	15	3	14	85	16	4	8	81	19
2	19	114	16	3	15	79	15	4	9	72	17
2	20½	112	16	3	16	94	18	4	10	80	19
2	22	117	17	3	17	83	16	4	11	92	22
2	23	109	16	3	18	113	22	4	12	83	20
2	24	108	16	3	19	97	19	4	14	82	20
2	26	119	18	3	20	86	17	4	15	114	28
2	27	98	15	3	21½	100	20	4	16	77	19
2	28	110	17	3	23	84	17	4	18	72	18
2	29	109	17	3	24	108	22	4	20	75	19
2	30	108	17	3	25	112	23	4	21	102	26
2	32	112	18	3	26	87	18	4	22	78	20
2	33	105	17	3	27	96	20	4	23	66	17
2	34	98	16	3	28	81	17	4	24	81	21
3	0	90	15	3	29	104	22	4	25	69	18
3	2	106	18	3	30	94	20	4	26	80	21
3	3	105	18	3	31	84	18	4	27	106	28
3	4	104	18	3	32	111	24	4	28	64	17
3	5	86	15	3	33	101	22	4	29	101	27
3	6	108	19	3	34	73	16	4	30	93	25

TAPE CHANGE WHEEL TABLES—*contd.*

Measuring Roller of 14·4 *inches Circumference Bell Wheel of* 45 *Teeth*

Tape Length Yds.	Ins.	Wheels M.R.	S.	Tape Length Yds.	Ins.	Wheels M.R.	S.	Tape Length Yds.	Ins.	Wheels M.R.	S.
4	31	74	20	6	6	87	30	7	32	98	43
4	32	81	22	6	8	78	27	7	34	43	19
4	34	91	25	6	9	92	32	8	0	36	16
5	0	61	17	6	10	86	30	8	2	58	26
5	2	64	18	6	12	91	32	8	4	40	18
5	3	60	17	6	14	90	32	8	6	86	39
5	4	88	25	6	16	95	34	8	8	70	32
5	5	70	20	6	18	47	17	8	9	48	22
5	6	66	19	6	20	88	32	8	10	74	34
5	8	55	16	6	22	68	25	8	12	82	38
5	9	72	21	6	24	54	20	8	14	90	42
5	10	68	20	6	26	75	28	8	16	64	30
5	12	91	27	6	27	40	15	8	18	72	34
5	14	90	27	6	28	85	32	8	20	80	38
5	16	86	26	6	30	58	22	8	22	46	22
5	18	72	22	6	32	94	36	8	24	79	38
5	20	68	21	6	34	88	34	8	26	66	32
5	21	58	18	7	0	77	30	8	27	74	36
5	22	80	25	7	2	92	36	8	28	78	38
5	23	99	31	7	4	48	19	8	30	57	28
5	24	89	28	7	6	88	35	8	32	87	43
5	25	98	31	7	8	97	39	9	0	32	16
5	26	66	21	7	9	67	27	9	4	81	41
5	27	72	23	7	10	42	17	9	6	51	26
5	28	87	28	7	12	98	40	9	8	86	44
5	29	93	30	7	14	90	37	9	9	70	36
5	30	80	26	7	16	58	24	9	10	31	16
5	31	86	28	7	18	36	15	9	12	54	28
5	32	64	21	7	20	50	21	9	14	92	48
5	33	82	27	7	22	97	41	9	16	40	21
5	34	118	39	7	24	54	23	9	18	72	38
6	0	51	17	7	26	44	19	9	20	96	51
6	2	92	31	7	27	58	25	9	22	90	48
6	4	94	32	7	28	74	32	9	24	82	44
6	6	76	26	7	30	92	40	9	26	74	40

TAPE CHANGE WHEEL TABLES—*contd.*

Measuring Roller of 14.4 *inches Circumference Bell Wheel of* 45 *Teeth*

Tape Length Yds.	Ins.	Wheels M.R.	S.	Tape Length Yds.	Ins.	Wheels M.R.	S.	Tape Length Yds.	Ins.	Wheels M.R.	S.
9	27	96	52	11	24	91	59	13	22	74	56
9	28	92	50	11	26	89	58	13	24	58	44
9	30	75	41	11	27	46	30	13	26	42	32
9	32	80	44	11	28	52	34	13	27	55	42
9	34	67	37	11	30	70	46	13	28	94	72
10	0	90	50	11	32	56	37	13	30	91	70
10	4	48	27	11	34	98	65	13	32	35	27
10	6	46	26	12	0	42	28	13	34	40	31
10	8	67	38	12	4	61	41	14	0	27	21
10	9	58	33	12	6	74	50	14	8	76	60
10	12	61	35	12	8	84	57	14	9	91	72
10	14	71	41	12	9	47	32	14	10	63	50
10	16	62	36	12	10	88	60	14	12	64	51
10	18	72	42	12	12	92	63	14	14	35	28
10	20	99	58	12	14	93	64	14	16	81	65
10	22	78	46	12	16	81	56	14	18	72	58
10	24	27	16	12	18	72	50	14	20	73	59
10	26	99	59	12	20	43	30	14	22	64	52
10	27	77	46	12	22	77	54	14	24	92	75
10	28	102	61	12	24	71	50	14	26	77	63
10	30	98	59	12	26	99	70	14	27	94	77
10	32	91	55	12	27	48	34	14	30	91	75
10	34	92	56	12	28	62	44	14	32	87	72
11	0	36	22	12	30	73	52	14	34	59	49
11	4	34	21	12	32	88	63	15	0	72	60
11	6	58	36	12	34	82	59	15	8	84	71
11	8	77	48	13	0	72	52	15	9	72	61
11	9	48	30	13	6	41	30	15	10	66	56
11	10	67	42	13	8	94	69	15	12	74	63
11	12	27	17	13	9	87	64	15	14	69	59
11	14	98	62	13	12	50	37	15	16	92	79
11	16	66	42	13	14	82	61	15	18	72	62
11	18	72	46	13	16	87	65	15	20	74	64
11	20	81	52	13	18	72	54	15	22	83	72
11	22	62	40	13	20	73	55	15	24	93	81

TAPE CHANGE WHEEL TABLES—*contd.*

Measuring Roller of 14.4 *inches Circumference Bell Wheel of* 45 *Teeth*

Tape Length Yds.	Tape Length Ins.	Wheels M.R.	Wheels S.	Tape Length Yds.	Tape Length Ins.	Wheels M.R.	Wheels S.	Tape Length Yds.	Tape Length Ins.	Wheels M.R.	Wheels S.
15	26	71	62	18	9	70	71	20	14	88	94
15	28	78	64	18	10	66	67	20	16	81	92
15	30	88	78	18	12	55	56	20	18	86	98
15	32	85	75	18	14	90	92	20	20	92	105
15	34	61	54	18	16	79	81	20	22	76	87
16	0	90	80	18	18	74	76	20	24	81	93
16	9	93	84	18	20	95	98	20	26	86	99
16	10	94	85	18	22	88	91	20	27	85	98
16	12	75	68	18	24	80	88	20	28	84	97
16	14	89	81	18	26	74	77	20	30	70	81
16	16	92	84	18	27	72	75	20	32	81	94
16	18	96	88	18	18	94	98	20	34	67	78
16	20	99	91	18	30	85	89	21	0	72	84
16	22	77	71	18	32	81	85	21	9	61	72
16	24	94	87	18	34	94	99	21	10	77	91
16	26	84	78	19	0	90	95	21	12	81	96
16	27	87	81	19	9	87	93	21	14	69	82
16	30	92	86	19	10	85	91	21	16	68	81
16	32	82	77	19	12	81	87	21	18	82	98
16	34	68	64	19	14	90	97	21	20	81	97
17	0	90	85	19	16	87	94	21	22	80	96
17	9	96	92	19	18	84	91	21	24	64	77
17	10	75	72	19	20	81	88	21	26	82	99
17	12	81	78	19	22	90	98	21	27	72	87
17	14	88	85	19	24	86	94	21	28	76	92
17	16	99	96	19	26	83	91	21	30	80	97
17	18	74	72	19	27	62	68	21	32	74	90
17	20	81	79	19	28	81	89	21	34	82	100
17	22	94	92	19	30	88	97	22	0	81	99
17	24	56	55	19	32	76	84	22	9	76	94
17	26	67	66	19	34	74	82	22	10	80	99
17	27	75	74	20	0	72	80	22	12	75	98
17	28	84	88	20	9	88	99	22	14	78	97
17	30	106	105	20	10	87	98	22	16	77	96
18	0	58	58	20	12	85	96	22	18	76	95

TAPE CHANGE WHEEL TABLES—*contd.*

Measuring Roller of 14.4 *inches Circumference Bell Wheel of* 45 *Teeth*

Tape Length Yds.	Ins.	Wheels M.R.	S.	Tape Length Yds.	Ins.	Wheels M.R.	S.	Tape Length Yds.	Ins.	Wheels M.R.	S.
22	20	75	94	24	26	67	92	26	30	55	82
22	22	74	93	24	27	64	88	26	32	77	115
22	24	77	97	24	28	69	95	27	0	50	75
22	26	61	77	24	30	71	98	27	9	70	106
22	27	76	96	24	32	68	94	27	10	64	97
22	28	68	86	24	34	70	97	27	12	52	79
22	30	78	99	25	0	54	75	27	14	46	70
22	32	70	89	25	9	67	94	27	16	59	90
22	34	69	88	25	10	52	73	27	18	55	84
23	0	72	92	25	12	59	83	27	20	64	98
23	9	72	93	25	14	61	86	27	22	60	92
23	10	75	97	25	16	70	99	27	24	54	83
23	12	71	92	25	18	60	85	27	26	63	97
23	14	70	91	25	20	62	88	27	27	61	94
23	16	66	86	25	22	52	74	27	28	57	88
23	18	72	94	25	24	68	97	27	30	64	99
23	20	68	89	25	26	63	90	27	32	60	93
23	22	61	80	25	27	58	83	27	34	58	90
23	24	73	96	25	28	67	96	28	0	63	98
23	26	66	87	25	30	69	99	28	9	58	91
23	27	72	95	25	32	57	82	28	10	63	99
23	28	56	74	25	34	68	98	28	12	61	96
23	30	74	98	26	0	63	91	28	14	52	82
23	32	61	81	26	9	61	89	28	16	50	79
23	34	88	117	26	10	63	92	28	18	60	95
24	0	72	96	26	12	67	98	28	20	58	92
24	9	72	97	26	14	60	88	28	22	56	89
24	10	66	89	26	16	66	97	28	24	54	86
24	12	71	96	26	18	55	81	28	26	52	83
24	14	62	84	26	20	61	90	28	27	62	99
24	16	67	91	26	22	48	71	28	29	60	96
24	18	72	98	26	24	54	80	28	32	43	69
24	20	66	90	26	26	66	98	28	34	51	82
24	22	60	82	26	27	74	110	29	0	54	87
24	24	62	85	26	28	43	64	29	9	56	91

TAPE CHANGE WHEEL TABLES—*contd.*

Measuring Roller of 14.4 *inches Circumference Bell Wheel of* 45 *Teeth*

Tape Length Yds.	Tape Length Ins.	Wheels M.R.	Wheels S.	Tape Length Yds.	Tape Length Ins.	Wheels M.R.	Wheels S.	Tape Length Yds.	Tape Length Ins.	Wheels M.R.	Wheels S.
29	10	59	96	31	20	65	114	33	27	40	75
29	12	54	88	31	22	45	79	33	28	57	107
29	14	60	98	31	24	54	95	33	30	50	94
29	16	55	90	31	26	42	74	33	30	25	47
29	18	47	77	31	27	55	97	33	32	51	96
29	20	53	87	31	28	51	90	33	34	35	66
29	22	48	79	31	30	56	99	34	0	45	85
29	24	54	89	31	32	35	62	34	9	41	78
29	26	43	71	31	34	40	71	34	10	42	80
29	27	49	81	32	0	54	96	34	12	43	82
29	28	52	86	32	9	48	86	34	14	45	86
29	30	38	63	32	10	53	95	34	16	46	88
29	32	56	93	32	12	54	97	34	18	48	92
30	0	48	80	32	14	50	90	34	20	50	96
30	9	50	84	32	16	66	119	34	22	39	75
30	10	44	74	32	18	41	74	34	24	27	52
30	12	54	91	32	20	47	85	34	26	42	81
30	14	45	76	32	22	53	96	34	27	43	83
30	16	55	93	32	24	54	98	34	28	44	85
30	18	49	83	32	26	44	80	34	30	31	60
30	20	53	90	32	27	50	91	34	32	49	95
30	22	50	85	32	28	39	71	34	34	43	66
30	24	54	92	32	30	51	93	35	0	36	70
30	26	58	99	32	32	52	95	35	9	48	94
30	27	55	94	32	34	47	86	35	10	50	98
30	28	38	65	33	0	54	99	35	12	27	53
30	32	60	103	33	9	46	85	35	14	30	59
30	34	57	98	33	10	53	98	35	16	33	65
31	0	54	93	33	12	54	100	35	18	36	71
31	9	57	99	33	14	55	102	35	20	40	79
31	10	61	106	33	16	43	80	35	22	48	95
31	12	54	94	33	20	37	69	35	24	52	103
31	14	43	75	33	22	53	99	36	0	49	98
31	16	67	117	33	24	54	101	36	12	52	105
31	18	40	70	33	26	63	118	36	14	46	93

TAPE CHANGE WHEEL TABLES—*contd.*

Measuring Roller of 14.4 *inches Circumference Bell Wheel of* 45 *Teeth*

Tape Length Yds.	Ins.	Wheels M.R.	S.	Tape Length Yds.	Ins.	Wheels M.R.	S.	Tape Length Yds.	Ins.	Wheels M.R.	S.
36	16	40	81	38	30	51	110	43	0	36	86
36	18	37	75	38	32	37	108	43	12	27	65
36	20	33	67	38	34	55	119	43	18	36	87
36	22	30	61	39	0	48	104	44	0	36	88
36	24	27	55	39	9	50	109	44	9	48	118
36	26	25	51	39	12	54	118	44	12	41	101
36	27	28	98	39	14	53	116	44	18	36	89
36	28	47	96	39	16	47	103	44	27	37	92
36	30	43	88	39	18	36	79	45	0	20	50
36	32	40	82	39	22	40	88	45	9	37	93
36	34	38	78	39	24	54	119	45	12	27	68
37	0	36	74	39	26	29	64	45	18	26	91
37	9	43	89	39	27	48	106	45	27	24	61
37	10	42	87	39	28	43	95	46	0	36	92
37	12	27	56	39	30	47	104	46	18	36	93
37	14	39	81	39	32	51	113	46	26	42	109
37	16	50	104	39	34	41	91	47	0	18	47
37	18	36	75	40	0	54	120	47	9	24	63
37	20	35	73	40	9	38	85	47	12	27	71
37	22	45	94	40	12	28	65	47	18	36	95
37	24	43	90	40	14	41	92	47	27	23	61
37	26	42	88	40	18	44	99	48	0	18	48
37	27	31	65	40	22	43	97	48	10	22	59
37	28	51	109	40	24	50	113	48	12	35	94
37	30	39	82	40	26	42	95	48	18	36	97
37	32	38	80	40	27	38	86	48	27	24	65
37	34	37	78	40	30	41	93	49	0	36	98
38	0	45	95	40	34	40	91	49	9	38	104
38	9	40	85	41	0	36	82	49	12	27	74
38	12	31	66	41	9	48	110	49	18	40	110
38	14	45	96	41	12	27	62	49	27	38	105
38	16	44	94	41	18	49	113	50	0	36	100
38	18	43	92	41	27	50	116	50	9	24	67
38	22	48	103	42	0	36	84	50	14	15	42
38	24	27	58	42	9	46	108	50	18	41	115
38	26	53	114	42	12	37	87	50	28	28	79
38	27	46	99	42	18	36	85	51	0	18	51
38	28	52	112	42	27	48	114	51	10	33	94

TAPE WHEELS

For W. Dickensons Dhootie Marker.

Cam Shaft Wheel	Cross Shaft Wheel	Gives Marks Per Cut
100	20	2
100	30	3
100	40	4
100	50	5
100	60	6
100	70	7
100	80	8
100	90	9
100	100	10

Up to 10 marks to the cut the 20s bevel wheel gears into the 90s Bevel wheel. Over 10 marks to the cut the 20s bevel wheel gears into the 45s Bevel wheel.

and other wheels are as follows :—

Cam Shaft Wheel	Cross Shaft Wheel	Gives Marks Per Cut
100	55	11
100	60	12
100	65	13
100	70	14
100	75	15
100	80	16
100	85	17
100	90	18
100	95	19
100	100	20

For marks over 20 to the cut the following wheels are required with the 20s bevel wheel geared into the 45s bevel wheel.

Cam Shaft Wheel	Cross Shaft Wheel	Gives marks Per Cut
20	20	20
20	21	21
20	22	22
20	23	23
20	24	24
20	25	25
20	26	26
20	27	27
20	28	28
20	29	29
20	30	30

BEAM DRAWING

Bitting

Drawing-in additional ends at the side of healds and reeds in case of a wider warp having to be used.

Cumber Board

A perforated frame of one length of wood or a number of wood slips for the guidance of the harness in the jacquard or some dobby shedding motion (particularly dhoty borders).

Dent

A space between the wires of a reed, otherwise split.

Drffing or Loomer's Comb

See striking reed or comb.

Draft

A plan showing the order in which the ends are drawn through the healds. The ends are imparted to the drawer-in by the reacher.

Drawing-in

A term employed to indicate the drawing-in of the warp threads, from a weaver's beam, through the eyes of the healds and dents of a reed in the order indicated by the draft and denting plan supplied by the fancy jobber or the weaving master.

Double Reed

It consists of two sets of wires with the dents of one set opposite the spaces of the other. Suitable for warps with a large number of ends per inch, prevents choking of the reed and 'beading' due to fibres forming into small lumps or beads.

Dresser Reeds

Made with strong wires and baulks open spaced. Used for dividing the threads in warp dressing.

Entering Draft

The system of drawing the warp through the healds.

Expanding Reeds

The dents are arranged between the coils of a spiral spring arranged on a screw. By drawing out or contracting the spring the dents may be adjusted to any desired width. Used for adjusting the width of yarn in various winding and beaming machines.

False Reeds

A false reed is placed on the loom in addition to the ordinary sley with the idea of opening out the loose fibres of a fibrous warp. It is composed of small wires about 7 inches long, with a loop at the top ; these wires being threaded on band or wire, the latter being preferred. These wires are passed through the warp behind the ordinary sley, and divide the warp into groups of three or four reeds as desired. The band or wire supporting the false reed is suspended from looped wires behind the top shell or hand rail, and looped wires are also placed behind the sley rack. For the latter a heald shaft is placed in to keep all the wires composing the false reeds in position. The wires of the false reed have a certain amount of horizontal freedom which is limited by the tension on the warp.

Observation has to be made to see that no false reed wires are rigidly held by nuts or bolt ends behind the sley rack, as this may make a reed mark in the fabric.

Flexible Reeds

In this type the wires or dents are kept in place at one baulk by pitch band and at the other baulk by fine wire. This allows the dents to "give'' and easily pass knots and lumps. They are used for weaving fancy warp-yarns such as 'spiral,' 'slub,' 'knop,' and other varieties. These yarns having irregular surfaces, an ordinary reed would tend to destroy the special effect and also cause breakages. These reeds are also employed to advantage for ordinary warp yarns with a large number of knots and slubs.

Fly-Reed

For loose reed.

Gauze Reed

A reed twice the ordinary depth and arranged with eyed half dents midway between ordinary dents. Used in Madras muslin gauze weaving, the crossing ends being drawn through the eyes of half dents.

Gimp Reed

These are coarse pitch reeds with fine wires allowing more space for the warp threads. Used for gimp, spiral and fancy yarns.

Healds

An arrangement for effecting the separation of the warp threads, so that the shuttle carrying the weft can be passed between them. The heald consists of a series of cords having an eye in the centre, and attached at each extremity to a flat piece of wood, called 'heald shaft' or "stave,' the warp thread being passed through the eye of the heald. Whenever the heald shaft is raised or depressed, the warp threads are also raised and depressed, and so the warp is separated into two portions for the shuttle to pass between, or, in other words, they are the most important feature in a loom, and, consequently, the resultant style of interlacing, according to drawing-in and denting plan supplied by the designer.

Heddle

Another word for heald. Also gears, combs, leaves of the caulm (harness in America).

Leasing Reed

Consists of a deep reed with alternate dents soldered. Can be moved vertically to obtain a lease. Used in section warping.

Ordinary Reeds

Consisting of rustless wire or brass, the wires being kept in place by pitch band at each baulk. Suitable for all ordinary classes of cotton goods.

Shaft

Heald.

Striking Reed or Comb

A half reed or comb, the wires being pointed. Used to evenly divide the warp to allow the threads to be picked out straight in drawing-in or twisting. May be used on any warp where a definite lease is not made at the beaming process.

V-Reed

A reed arranged in the form of a V hinged at the point. Used on a section warper to adjust width of yarn.

Warp Ondule Reed

These reeds may have the wires converging towards the top to give shaped fabrics as slippers, uppers, or the wires may converge in groups alternately towards top and bottom to give wavy lines during weaving. The reed is raised and lowered during weaving at some definite rates.

Weft Ondule Reeds

The dents are parallel but set in advance of each other front and back to give a wavy beat up to the weft.

Zig-Zag Reed

Used on a slasher sizing machine and dry tape to adjust the width of yarn.

Q.—State which of the three kinds of varnishes would you prefer that healds should be treated with and why? (1) Medium Varnish, (2) Soft Varnish, (3) Hard Varnish.

A.—Whilst the strength of the healds is an important factor, it is not advisable to obtain the maximum strength at the expense of other qualities that are more essential. For example, a single heald 18 inches length made from good quality 16/17s, yarn, and with a medium varnish finish, will break under a uniform pull of 12 lbs. whilst the same heald with a soft varnish finish will break under a pull just over 12 lbs., and with a hard varnish finish will break under a pull just under 12 lbs. Thus the hard varnish finish produces a heald with the least tensile strength, but has the advantage in respect to the abrasion that it will stand during the process of weaving. For that reason it is advisable to test healds periodically, and make comparisons, in order to check the quality of heald yarns used, and not to obtain the maximum strength regardless of other features that are required.

Q.—State the number of ends if the reed is 80s, two ends in a dent and the reed space is 42 inches. Allowing 20 ends extra for selvedges.

A.—80s Reed × 42″ R. Space = 3,360 ends + 20 ends (extra for selvedges) = 3,880 total ends.

As the selvedges are drawn 4 ends in a dent and 5 such dents are commonly drawn, 20 ends that is 10 ends for each side should be taken extra otherwise the width of cloth will be proportionately narrower.

If the denting of the cloth is 4 in the reed then nothing should be allowed for the selvedges.

Q.—What is the chief function of the healds ?

A.—The chief function of the healds is to determine the particular order in which the warp threads should be placed side by side and interlaced with the weft to form a weave or design.

Q.—What would you recommend a 20/60s or 12/60s healds for 60s reed 6 shafts, and why ? Discuss fully.

A.—I would recommend a 12/60s. It is a well known fact that a soft yarn will take more size than one hard twisted, and just so will a twelve-fold yarn drink in more varnish and cement itself to the fibres than a sixteen or twenty-fold. It reasons to theory that it will be rougher, and that extra chafing on the yarn takes place, but it is not so in practice—conditionally upon the varnishing to the same amount being placed on at four times instead of at two or three times. It is a great mistake that each of the yarn receives a coat of varnish ; it is taken into a very hot room to dry, and then packed up and delivered straight out of the hot place into the cold and very damp atmosphere, where they remain, say for one day. By the time the healds have reached the mill the varnish has gone soft. Therefore when the healds are placed in the loom and the just few inches of cloth woven, this soft varnish is rubbed off by the yarn from the warp by chafing, and the heald eye is afterwards left naked of varnish. The varnish should be allowed in such a case to reset in a dry, cool room at the mill, by staving them and hanging them on stands to meet the various width and arranged according to their counts. There is such a thing as the healds being over-varnished and remaining too long in stock, so that they become very hard and wiry. The eyes get half twisted and if the healds, are too short in depth, say 10 inches, and very tightly strung up there we must expect the warp threads will be treated very unkindly and it pays to use the knife to them rather than tolerate the consequences.

Q.—A 100s set of healds is required to be used for a cloth to be woven in an 80s Reed. Give the rate of dropping.

A.—$80 \div (100 - 80) = 80 \div 20 = 4$.

Then 4 repeats of the pattern be drawn-in and one missed all across the warp. As this is rather a small number, 8 repeats drawn-in and then 2 missed would be quite satisfactory.

Q.—If a cloth 40 inches wide, 2 ends in each dent of a 60s Stockport reed, how many heald eyes will be required.

A.—Rule :—

Ends per dent $\times$ dents per inch $\times$ inches wide $=$ total healds. Then $2 \times 30 \times 40 = 2{,}400$ total healds. And if the healds per stave are required it is only necessary to divide the total healds by the number of heald staves being used, so if the above example is plain cloth woven on 4 staves then $2{,}400 \div 4 = 600$ heald eyes per stave, and if the heald eyes per stave per inch is required then $600 \div 40 = 15$ healds per stave per inch.

Q.—A five stave satin or twill weave is to be woven in a 60s Stockport reed. What counts of healds will be required ?

A.—$60 \div 5 = 12$ heald eyes per inch, and $12 \times 4 = 48$s healds then five staves of 48s counts of healds are required.

Heald drafts may be other than straight or skip shaft. They may be centred or mixed, and it may be considered advisable, on the point of economy, to make up the set required from healds already in stock, and it is therefore necessary that the counts of each stave be calculated separately.

Q.—A 4-end twill pattern has to be woven with 60 threads per inch, what number of healds per inch upon each heald shaft is required ?

A.—Since 4-heald shafts are necessary to weave the 4-end twill design, the number of healds per inch, upon each heald shaft would necessarily be

$$\frac{60\text{ (ends per inch)}}{4\text{ (heald shafts)}} = 15\text{ healds per inch per shaft.}$$

Q.—What is your method of spacing healds, if the reed has 2/60s counts and you had 5 staves ? How would you determine counts ?

A.—$4 : x : \; : 5 : 60$

$$\therefore x = \frac{60 \times 4}{5} = 48\text{ Counts.}$$

Or

$60 \div 5 = 12$ in one inch.

$12 \times 4 = 48$ Counts of healds.

Q.—A set of healds knitted for a 78 reed has to be used with a 64 reed. How many eyes must be left empty, and in what order ?

A.—The difference between a 78 reed and a 64 reed gives 14 heald eyes per inch, or 28 on 2 inches. So as to miss an equal draw through on four staves, miss after the first inch 12 heald eyes, miss after the second inch 16 heald eyes, and so on repeating.

Q.—Suppose you wanted to weave 200 counts (= 4 staves) of healds in a plain loom and had only 100s counts, what would you do ?

A.—I would take two healds of 100s each.

Q.—What is the reed space of warp containing 3,400 ends which is drawn two ends in a dent in a 60s reed allowing 20 ends for selvedges extra ?

A.—3,400 ends — 20 (for selvedges) = 3,380 ends.

3380 ÷ 60 (reed) = $56\frac{1}{3}$ inches reed space.

Q.—How many healds per inch will be on each stave weaving the following pattern ? A centred draft 1.2.3.4.5.4.3.2. all across, 40 inches wide in a 72s stockport reed.

A.—A 72s reed equals 72 ends per inch. Taking the draft as given above, there are 8 ends or 8 healds in one repeat, then 72 ÷ 8 = 9 repeats per inch. Staves 1 and 5 = 9 repeats × 1 heald per repeat = 9 healds per inch and thus taking 4 to a set gives staves 1 and 5 = 36s counts, with 40 inches wide = 40 × 9 = 360 total healds on each stave. Staves 2.3.4. = 9 repeats × 2 healds per repeat = 18 healds per inch, and 18 × 4 = 72s counts for each of these three staves, which 40 inches wide gives 40 × 18 = 720 total healds on each stave.

Q.—State how is the heald eye made and how does it influence the weaving qualities of a warp.

A.—The eye of the heald is made during the process of knitting, and is formed by the loop of the top heald cord passing around a shaped rod, which forms the loop or design of the eye, a knot is formed to close the eye at the top, and the bottom heald cord is passed through the eye and forms a link with the eye. The design, size and angle of the heald eyes in a set of healds are factors which influence the weaving of a warp considerably.

WEAVING

Manufacturing Particulars.

The following facts should be noted when a piece of cloth is presented for manufacturing purposes :—

(1) Construction of a fabric, that is the manner in which the warp and weft are combined (weave, draft and pegging plan); (2) external appearance of the individual threads. Determination of finish, alterations introduced into the goods by the process of dyeing, bleaching, etc.; (3) kinds, sizes (examine the cloth carefully to ascertain if warp is all one count, and if weft is all one count) and twists of yarn; (4) diameters of yarn; (5) reed to be used; (6) picks per inch; (7) reed space; (8) tape length; (9) ends in the warp; (10) number of patterns in the warp; (11) warp pattern or design; (12) weft pattern or design (if any); (13) weight of warp; (14) weight of weft; (15) weight of size; (16) weight of piece (warp and weft); (17) size per cent on warp yarn; (18) size retained on cloth; (19) should be (weight of warp yarn and weight of size + 5 per cent allowance for droppages on the total weight of warp and size.

Example of Cloth Manufacturing Particulars :—

HEAVY SHIRTING
54″ × 32 yds. × 15½ lbs.

58 Reed	29s Warp	57½ Reed Space
56 Pick	18s Weft	34¾ Tape Length
	Ends 3,350	

Warp =	7.29
Weft =	7.21
	15.40
Size	1.00
	15.50

$$\frac{18.85}{7.17} = \frac{\text{Ret. on Warp}}{\text{Ret. on Weft}}$$

To Find Reed.—Count the number of threads of twist on the pick counter always to one inch on the cloth. If the cloth is calendered, minus four threads to the inch from what is actually counted in the sample piece to arrive at the actual reed used. If uncalendered minus two threads to the inch. If the cloth is fully bleached minus eight ends or threads to the inch.

To Find Picks.—Count the number of picks on the pick counter to one inch. In case of fully bleached cloth, add 4 picks to the inch over and above what is actually counted in the cloth.

Determination of the "Warp and Weft."

Before ascertaining the counts of warp and weft it will be as well to note the following guiding factors which assist in distinguishing warp from weft in the cloth.

(1) If the sample of cloth submitted for analysis shows the reed marks or contains a selvedge, the warp direction is at once obvious.

(2) If one set of threads be two-fold and the other single, the two-fold usually represents the warp.

(3) The direction of the twist in the warp threads is usually from right to left.

(4) If one set of threads be harder twisted than the other the hard twisted threads represent the warp.

(5) If the cloth has a dressed face finish, the direction of the nap indicates the warp.

(5) If the cloth has a dressed face finish, the direction of the nap indicates the warp.

(6) When the yarns are of unequal thickness, the finer and better quality usually represents the warp.

(7) If one set of threads be cotton and the other woollen, worsted, or linen, the cotton threads usually indicate the warp.

(8) If one set of threads has been sized and the other has not, the former represents the warp.

(9) This method, though somewhat crude, is yet simple and ready, and therefore frequently resorted to in practice for low and medium counts of yarns, which, when compared in a practised hand and with an experienced eye yield fairly accurate results. It is performed in extracting a few threads from the cloth, which are crossed and folded over a few threads of some known count, the two ends of each respective group of threads being taken and held between the fingers—the group of the unknown in one hand, and the known in the other. The two groups are then simultaneously twisted so as to compare their relative counts. By the simple act of twisting, we necessarily make a comparison of the areas and solidities of the threads, and since areas and solidities of threads are represented by the equivalent term "counts of yarns" it follows that when the number of threads of some known counts is of equal thickness to some other number of known or unknown counts, these numbers bear a simple and direct proportion to each other. During comparison, threads are added or taken from one or other of the sets and again twisted as above and compared until the two sets appear to make a similar thickness of thread.

To Find the Counts of Yarn.—This is done after cutting a small piece to the size of a template supplied with a yarn assorting balance. The small cutting is then boiled with a little soda ash and all size removed. Few ends are then extracted of both warp and weft separately, and balanced on the scale. The number of ends that are thus balanced indicates the counts.

In dissecting cloth, $12\frac{1}{2}\%$ must be deducted from the actual counts obtained on balance to allow for shrinkage. 6% is enough for coarsely woven cloth.

How to Find the Size of Template for Cotton Yarn :—

840 yds. $\times$ 36″ = 30,240″ in 7,000 grains.

$$\frac{30{,}240}{7{,}000} = 4.32'' \text{ size of template}$$

$$\frac{7{,}000}{302{,}400} \times \frac{4.32''}{1} = 1 \text{ grain.}$$

Weight in grain		Size of templates
1	=	4.32″
2	=	8.64″

The number of ends that balance the weight indicates the count. For this purpose a good wrapping scale or better still a chemical balance will serve the purpose as well.

Templates for :—

		Inches	Weight in grain
Linen	=	1.543	$\frac{1}{2}$
Woollen	=	1.315	$\frac{1}{2}$
Worsted	=	2.88	$\frac{1}{2}$

Another method is to take out a given length of yarn, according to the size of sample is available, weigh the material very carefully and calculate the count.

Thus :—

$$\frac{\text{Length taken} \times 7{,}000}{840 \times \text{weight in grains}}$$

Example :—

$$\frac{3 \text{ yds.} \times 7{,}000}{840 \times 0.53} = 47.17 \text{ count.}$$

Three yards weighing	0.50	grains	=	50.00	count
,, ,, ,,	0.51	,,	=	49.01	,,
,, ,, ,,	0.52	,,	=	48.07	,,
,, ,, ,,	0.53	,,	=	47.17	,,
,, ,, ,,	0.54	,,	=	46.30	,,
,, ,, ,,	0.55	,,	=	45.45	,,
,, ,, ,,	0.56	,,	=	44.64	,,
,, ,, ,,	0.57	,,	=	43.86	,,
,, ,, ,,	0.58	,,	=	43.10	
,, ,, ,,	0.59	,,	=	42.37	,,

Still another method is as follows :—

$$\frac{\text{Yards} \times 100}{\text{Grains} \times 12} = \text{count.}$$

Example :—

60 threads of 30 inches each = 12.2 grains

$60 \times 30 = 1{,}800$ inches

$1{,}800 \div 36 = 50$ yards

12.2 grains $\times 12 = 146.4$

$$\text{Now} \frac{50 \times 100}{146.4} = 34.1 \text{ count.}$$

5,315 ÷ Denier = Cotton counts.
4,500 ÷ Denier = Metric system.
7,972 ÷ Denier = Woollen counts ; British system.
17,439 ÷ Denier = Worsted ; English system.
14,882 ÷ Denier = Jute and Linen.

To Find the Number of Ends :—

Rule :—

Read width of warp in loom × Ends per inch in reed.

Or

Cloth width on counter × Ends per inch in cloth on counter.

(*a*) Reed = 40, width = 30″ (after calendering).

Plus to the width of cloth 1 inch or more, as the case may be, if the cloth is required to be calendered if dyed 2 to 3 inches, if bleached or finished 2 to 3 inches.

Then add to the width of the cloth after allowing for calendering, etc., 7 to 8 per cent. for shrinkage.

30″ + 1″ for calendering = 31″

31″ + 3% = $33\frac{1}{2}$″ reed space.

40 × $33\frac{1}{2}$″ = 1,340 + 20 (for selvedges extra) = 1,360 ends.

(*b*) Reed = 40, width of cloth = 30″ (after calendering)

30″ + 1″ for calendering = 31″

40 × 31 = 1,240

1,240 ÷ 12 (constant) = 100 ends to be allowed for the purpose of shrinkage

1,240 + 100 = 1,340 — 20 (for selvedges) = 1,360 ends.

(*c*) Reed = 40, width = 30″ (after calendering).

30″ + 1 (for calendering) = 31

40 + 4 (for shrinkage if for calendering otherwise 2) = 44

44 × 31 = 1,364 Ends.

To Find Reed Space.—To estimate the shrinkage accurately measure in centimetres the piece of cloth, then remove a thread, place on a metric rule, and carefully press out the waves with the finger the difference in length gives the shrinkage in weaving, and thus the percentage can be worked out. Take care that the thread is not pulled, and treat both warp and weft threads alike. The warp measurements show the shrinkage from warp length to cloth length, and the weft measurements shrinkage from reed width to cloth width. It is better to use centimetre as it gives ease in calculating the percentage because the measure is in multiple of 10.

Ends ÷ Counts of Reed = Reed Space.

3,350 ÷ 58 = $57\frac{1}{2}$ reed space.

Before dividing the total ends by the reed used, the extra ends for selvedges, should there be any, must be deducted for the sake of accuracy.

To Find Tape Length :—

Picks 56, lenght = 32 yards, counts of weft = 18s

$$\frac{\text{Picks} \times \text{length}}{\text{Counts of weft.}} = \text{length to be allowed.}$$

$$\frac{56 \times 32}{18} = 99 \text{ inches or } 2\tfrac{3}{4} \text{ yards.}$$

$\therefore$ $32 + 2\tfrac{3}{4} = 34\tfrac{3}{4}$ yards.

If the cloth is meant for calendering, the gain after calendering in length should be deducted from tape length otherwise the finished cloth will be longer than the nominal length.

It is generally agreed that a twill, a satin, or any weave other than plain requires less warp length to give a required length of cloth than does a plain weave. and it should follow that the same applies to the weft. Less length will be required in the case of cloth being calendered with excessive tension being put on it.

To find the quantity of warp necessary to make a required piece of cloth from the following particulars.

Rule :—

$$\frac{\text{Ends} \times \text{Tape Length}}{840 \times \text{counts of warp}} = \text{weight of warp.}$$

$$\frac{1{,}360 \times 30}{840 \times 19} = 7.29 \text{ lbs. weight of warp.}$$

To find the quantity of weft to make a required piece of cloth from the following particulars.

Rule :—

$$\frac{\text{Picks} \times \text{reed space} \times \text{length of piece}}{840 \times \text{counts of weft}} = \text{weight of weft}$$

$$\frac{56 \times 57.5 \times 32}{840 \times 17} = 7.21 \text{ weight of weft}$$

To Find the Size per cent.

$$\frac{\text{Weight of size taken in the piece} \times 100}{\text{Weight of warp}} = \text{size per cent on warp.}$$

$$\frac{1 \text{ lb.} \times 100}{7.29} = 13.85\,\% \text{ size put on warp.}$$

To Find Size Retained on Cloth :—

$$\frac{\text{Weight of size} \times 100}{\text{Total weight of yarn (Warp and weft)}} = \text{size retained on cloth}$$

$$\frac{1 \text{ lb.} \times 100}{14.50} = 7.17\,\% \text{ size retained on cloth.}$$

To Find Should Be :—

Weight of warp + weight of size + 5% for droppages = should be weight.

7.29 + 1.00 = 8.29 + (5% = .41) = 8.70 should be weight.

The calculated weight of a piece of cloth does not allow for waste unless, in calculating, the standard hanks be taken as 800 instead of 840, otherwise, the quantity of waste, as the case may be, is calculated, while working out the manufacturing cost of the piece of cloth.

Or,

Lower the nominal counts by one number that is if the counts of yarn for warp is 20s then take 19s for the purpose of finding out the weight of yarn whether warp or weft and the spinner must be strictly instructed to keep his counts a little finer and not coarser than the counts taken for calculation. The counts must constantly be watched and adjustments made if necessary.

To Find Production.—Multiply the speed of loom or picks per minute by 60 (minutes in an hour) and then multiply by 9 the number of working hours per day. Divide the result by picks per inch × 36 (inches in 1 yard). The answer thus obtained will give you the production in yards at 100% efficiency.

Speed of loom or picks per minute	=	200
Minutes in an hour	=	60
Number of working hours per day	=	9
Picks per inch	=	40
Inches in one yard	=	36

$$\frac{200 \times 60 \times 9}{40 \times 36} = 75 \text{ yards at } 100\% \text{ efficiency.}$$

Now to find what will be the length at 80% efficiency from the above particulars.

Multiply 75 × 80 and divide by 100 = 60 yards.

Or Multiply by 4 and divide by 5

$$\frac{4}{5} = \text{of } 75 = 60 \text{ yards.}$$

Example of Cloth Manufacturing Particulars :—

9/16″ Plain Border Dhoty

$$81'' \times 8 \text{ yds.} \times 1\frac{8\frac{1}{2}}{16} \text{ lbs.}$$

36 Reed	22s Warp	34¼ R. Space
32 Pick	26s Weft	8¼ T. Length

Ends.

90 Col. 2/42s	= 0.04	
12 Cord 2/20s	= 0.01	
1,194 grey 22s	= 0.55	
1,296	Warp 0.60	
	Weft 0.40	
	1.00	
	Size 0.22	
	1.22	
		40.00
		22.00

In proceeding to calculate for a dhoty border or sarees or chaddars: (1) deduct the width of the border from the width required in the finished state; (2) add to the width as left for the body of the cloth the allowance to be made for calendering, or as the case may be; (3) find the number of ends; (4) find out the number of coloured ends or whatever it may be for the two borders and the cords (if any), and the proceed in the ordinary way.

In case of dhoty borders or chaddars on account of compactness of the border and the size of the borders, a little less may be allowed for shrinkage in the width.

Check Shirting (for Bleaching)

$\frac{35}{82} \times 20$ yds. $\times \frac{3\ 3}{16}$ lbs.

48 reed	32s, 2/40s warp	38 R. space.
48 pick	40s, 2/40s weft	20¼ T. length.

Ends.

602 blue 2/40s	= 0.72	Col. weft = 0.72
1,240 grey 32s	= 0.93	
1,842 Warp	= 1.65	Grey weft = 0.72
Weft	= 1.44	Weft = 1.44
	3.09	
Size	= 0.10	
	3.19	

40 Ends grey
For selvedges
Design
2 blue
4 grey

6

300 Patterns.

10.75	
3.26	

To arrive at the above results, proceed as follows :—

(1) Find the number of ends in the width of the cloth—48 × 35 = 1,680 ÷ 12 (const.) = 140, 1,680 + 140 (for shrinkage) = 1,820 + 20 (for selvedges) = 1,840 ends.

(2) Now find the number of patterns :— 1,840-40 (selvedges) = 1,800, 1,800 ÷ 6 (ends in a pattern) = 300 patterns.

300 × 2 (ends of blue in a pattern) = 600 + 2 (for the repeat) = 602 total ends of blue.

300 × 6 (grey ends in a pattern) 1,800 + 40 (ends for selvedges) = 1,840 total ends grey.

(3) Find reed space; (4) find tape length; (5) find the weight of warp; (6) find the weight of coloured and grey weft.

$$\frac{48 \times 38 \times 20 \times 2}{840 \times 20 \times 6} = 0.72 \text{ weight of coloured weft.}$$

$$\frac{48 \times 38 \times 20 \times 4}{840 \times 40 \times 6} = 0.72 \text{ weight of the grey weft.}$$

(7) Find the weight of size and the size, per cent, etc.

Mosquito Net (Square Holes) for Bleaching and Finishing

$54\frac{1}{2} \times 23 \times 7$ lbs.
49 24

48 reed	18s warp	$57\frac{1}{4}$ R. Space
52 Pick	26s weft	$24\frac{1}{2}$ T. Length

Ends 2,078.

Warp	= 3.26	
Weft	= 3.27	
	6.63	
Size	= 3.37	
	7.00	11.01
		5.58

Rayon Cloth Calculations

To find weight in a piece of rayon cloth.

Rule I *:—*

$$\frac{\text{Ends} \times \text{length (in metre)}}{450} \times 0.05 \times \text{Denier} = \text{weight in grammes}$$

$$\frac{2{,}650 \text{ Ends} \times 52.5 \text{ yds. T.L.}}{450} = (48.00 \text{ metres}) \times 0.05 \times 120$$

$$= \frac{1{,}696}{453 \text{ grammes in 1 lb.}} = 3.739 \text{ lbs}$$

Rule II *:—*

$$\frac{\text{Ends} \times \text{length in metre} \times 1 \times \text{Denier}}{9{,}000^{*}} = \text{grammes.}$$

$$\frac{2{,}650 \times 52\text{-}5 \; (= 48 \text{ metre}) \times 1 \times 120}{9{,}000^{*}} = \frac{8{,}480}{5} = 1{,}696 \text{ grammes.}$$

$$1{,}696 \div 453 \text{ (grammes in 1 lb.)} = 3.739 \text{ lb.}$$

$$^{*}\; 9{,}000 = (450 \div 0.05)$$

Rule III *:—*

$$\frac{\text{Ends} \times \text{length}}{840 \times \text{cotton counts}} = \text{Weight in 1 lb.}$$

Rule IV *:—*

$$\frac{\text{Ends} \times \text{length}}{37{,}203 = \text{yds. in 1 lb.}} = \text{Weight in 1 lb.}$$

Abrasion Machine

An instrument for testing the surface wear of fabrics, especially carpets, blankets, overcoating, and suiting, by controlled rubbing of surface.

Actual

A term used in the cotton trade to indicate the particulars given are to be "actual" and not "nominal" 40-inch wide may mean "nominal" or "actual" 39½ or 40 inches. To ensure the required cloth being quoted for, a buyer should send his enquiry onto the manufacturer as follows :—

40-inch full × 40 yards (36 inches to the yard)
52 × 52 (Reed and Pick) full.
36s × 40s (counts of yarn) actual.

Adulteration

To deteriorate by admixture of baser materials.

Adhesives—for Pasting Cloth

Solutions of gum arabic, or of dextrine mixed with acetic acid, are frequently employed in the case of paper.

Flour or starch mixed with water containing a little alum, so as to form a thick cream, which is then heated to boiling and when cold mixed with oil of cloves, thymol, phenol, or salicylic acid so as to preserve it, makes an effective adhesive for cotton goods. A transparent paste may be made by the use of rice starch instead of ordinary flour.

Alaska

The Alaska yarn is composed of undyed wool and cotton fibres mixed together by carding or combing or drawing processes. The two materials are mixed in various proportions of each according to requirements. As the two materials possess different dye-taking properties this type of yarn provides means of economically obtaining a mixture coloured effect of either an all-over effect or in character of stripe or check in piece-dyed fabrics.

Albatross Cloth

A lightweight, plain woven fabric in imitation of the worsted fabric of the same name. It gets its name from the fact that its soft finish resembles the downy breast of the albatross. It is generally sheared, singed, bleached or dyed, and finished by a light pressing without applying any size. It is used as dress goods.

Alhambra Quilting

A cotton cloth made from fairly hard spun warp and soft condenser waste weft yarn. The figuring is large, often only one repeat to a quilt. Very soft finish.

Alligator Cloth

A coarse, plain-woven cotton or jute fabric, coated with varnish and finished to imitate alligator leather. It is used for cheap suit-cases and upholstery.

Anchor Bobbin

A large bobbin having flanged heads, which are grooved to hold tension cords. Used to wind the edge or border or selvedge upon.

Angled Draft

A method of drawing the threads into healds from front to back and then back to front, so that a species of herring bone design will be produced.

Angle of Twill

The angle which a twill forms with the weft or warp.

Angola Yarn

A yarn composed of a low quality of shoddy wool and cotton mixed as required together, the cotton being chiefly employed to improve the spinning property of the shoddy wool fibre, and thus produce a finer count of yarn.

Animal Fibre

Wool, alpaca, mohair.

Anti-Crease Process

Chemical treatment of cotton or linen sheers and rayons with a synthetic resin, tends to decrease slippage in rayons. Process increases resistance to wrinkling. Product require careful laundering.

Anti-friction Bowls

Small rollers fitted into levers on many textile machines to reduce friction (such as, treadle bowls).

Artificial Silk

A very lustrous, manufactured, textile fibre made from gummy solutions of cellulose expressed through capillaries into fine filaments which are subsequently solidified and combined.

Artificial Wool

This is known by the trade name of "sniafil" the product of Snia Viscose Co., Italy, spun with wool.

Asbestos

Also known as amianthus, mountain flax, and mountain silk, is disintegrated (by weathering) hornblende or serpentine, and it is marketed as hornblende asbestos and serpentine asbestos. It is found in Europe and North America in the form of a mass of entangled crystaline fibres. Italian asbestos is in the form of long, white, lustrous, strong fibres, whilst the Canadian is somewhat softer and less entangled. Asbestos consists of magnesium calcium hydro-silicate contaminated with iron oxide and alumina, serpentine asbestos (chrysotile) is the most important variety; it is found as veins embodied in serpentine rock and is in much demand. Hornblende asbestos fibres are more brittle than those of serpentine asbestos so that this variety is not much spun into thread or cord.

The manufacture of asbestos is carried out in two stages. The natural product is first freed from rock and made into a slime by crushing in rolling mills, and then follows a separation of the fibre and conversion from its hard fibre-bundle form into a soft mass. Subsequent working up of the asbestos follows the general methods used in spinning and weaving, the long fibres being spun either alone or in admixture with cotton into threads. Usually it is necessary to add cotton to produce especially fine threads. Asbestos yarn is woven into many kinds of fabric. The short fibre and waste obtained in asbestos yarn production is used partly as a packing material and partly in the manufacture of asbestos paper or sheets.

The most important property of asbestos is its resistance to fire and it was this which first made asbestos valuable. Its resistance to acids is also a useful property ; its fineness is of more importance than its lustre.

Average Counts

Counts of yarn that will be of the same weight as the yarn of unequal counts that are used in warp, if the same number of ends are used.

Awning Stripes

Usually heavy fabric (duck), plain weave with woven, printed, or painted stripes, beach chairs and steamer chairs, hammocks, etc.

Q.—Define 'Art.'

A.—It means "skill in the use of knowledge."

Q.—How can knowledge be obtained, and what is the best method by which we can develop the reasoning faculties, so as to apply our knowledge to definite purposes, for the improvement of the amenieties of life and consequent development of our industries ?

A.—By making the fullest use of education and not the rule of thumb education obtained by imitation and a narrow experience of a particular phase of life, but the broader system which, by combining theory with practice, brings a trained understanding to help the practical experience obtained by contact with the world.

Q.—How would you find the reed width from the following particulars.

Picks, = 40 ; Length of piece = 40 ; Hanks = 840 ;
Counts = 20 ; Weight of weft = 2.

A.—$\dfrac{840 \times 20 \times 2}{40 \times 40} = 21$ inches.

Q.—How would you find the picks per inch from the following particulars.

Reed width = 21 ; Length of piece = 40 ; Counts of weft = 20s ; Weight of weft = 2 ; Hanks = 840.

A.—$\frac{840 \times 20 \times 2}{21 \times 40}$ = picks per inch.

Q.—Find the cloth length from the following given particulars. Reed width = 21 ; Picks = 40 ; Counts of weft = 20s ; Weight of weft = 2 ; Hanks = 840.

A.—$\frac{840 \times 20 \times 2}{21 \times 40}$ = 40 length of cloth.

Q.—What are the two principal factors which all producers strive to obtain in the manufacture of cloth.

A.—In the manufacture of cloth there are two principal factors which all producers strive to obtain : firstly, a perfect cloth ; secondly, cheapness of production.

Q.—Can yarn that is used by a manufacturer be perfect and free from defects. If your answer is in the negative then state briefly what effect has the dfective yarn on the manufacturing of cloth and its cost ?

A.—It might easily be thought that cotton yarn, when it reached the manufacturer or weaver, was free from defects, but such is not the case.

The character and the defects of the raw cotton are reflected definitely into the yarn which the manufacturer has to use, and every deviation from what might be considered the perfect standard of cotton has its direct effect upon weaving and causes imperfections in the finished cloth and a loss of production at the loom, which of course increases production costs, and therefore increases the price per yard, or lb. or piece of the cloth to the public.

Q.—What are the points to be considered when a sample of cloth is presented to you for the purpose of testing.

A'—(1) Construction ; (2) Counts of yarn ; (3) Yarn twist ; (4) Weight, width and length ; (5) Moisture ; (6) Strength ; (7) Stretch ; (8) Tearing resistance ; (9) Bursting resistance ; (10) Thickness ; (11) Porosity ; (12) Wear ; (13) Fibre content ; (14) Crimp ; (15) Heat transmission ; (16) Sizing and finishing (quantity put on) ; (17) Yarn slippage ; (18) Adhesion ; (19) Stress and (2) Cloth defects.

Q.—State what is one of the greatest impediments to the successful weaving of artificial silk ?

A.—The greatest impediments to the successful weaving of artificial silk is the fact that, with but very few exceptions, manufacturers have not the advantage of personal supervision and control in their own mill of the various operations and processes involved in the preparation of the raw material as warp and weft ready for the loom, but are more or less dependent for their warps and weft upon some external source over which they have no jurisdiction, and cannot, therefore, give the necessary care and vigilance which they exercise in the preparation of cotton yarn.

Q.—State briefly what is the advantage in using larger loom beams.

A.—One method of attaining greater production and efficiency in the weaving shed is through the use of the larger loom beam head or flange that will contain a greater amount of warp yarn. When there is more yarn on the beam, it will run longer before a new warp must be tied in the loom. This increases the production of the loom as there will be less gaiting up of the loom and thus some hours are saved thereby due to the loom waiting less for a beam and the jobber to come and gait it up.

The following percentages of gain that can be affected when changing from one size beam head or flange to another, using different diameter beam barrels, are as follows:—

From 18 inches flange, 5 inches barrel to 20 inches head, 5 inches barrel increase 25.4 per cent.

From 18 inches flange, 5 inches barrel to 20 inches head, 6 inches barrel, increase 21.8 per cent.

From 20 inches flange, 6 inches barrel to 22 inches head, 6 inches barrel, increase 23.0 per cent.

From 18 inches flange, 5 inches barrel to 22 inches head, 6 inches barrel, increase 49.8 per cent.

Q.—Give the reasons why the automatic loom has made little headway both in Europe and in England ?

A.—The reasons are : (1) Better yarn is required for the automatic loom ; (2) difficulty of weaving headings on automatic looms ; (3) weft is not entirely used up ; (4) initial cost is too heavy ; (5) intricate technical parts ; (6) automatic looms can only be used for plain goods or warp stripes.

Back Rest

The back cross rail or roller of loom over which the warp passes in a horizontal direction to the healds and reed to give elasticity to the tension.

Back Reed or False Reed

A reed placed in a loom behind the regular reed and made of a frame carrying movable wires, or threads, which helps to separate the warp threads and keep back lint, etc.

Bad Reed

May be caused by a Shuttle trap or bits of beather flying into the shed which may cause a few dents to be bent back or spaced irregularly. If the reed cannot be properly straightened, then there will be a lengthwise line in the cloth unevenly spaced.

Bad Selvedges

These are caused by snarly weft, excessive tension on weft, selvedge end, too soft, or they may be cut or chopped by the press roller at the calendering machine, selvedge ends wound on the beam too slack, or not properly drawn through the healds and reed, sheds unequal in size, etc.

Baize

Loose, plain-woven, napped, and finished to imitate felt. Card-table covers, lining for instrument and jewellery cases.

Bale

A package of cotton cloth averaging about 350 lbs. in weight, and 33 cubic feet in bulk.

Bandana

A plain-woven cloth with white or bright coloured spots on a dark ground. Used for handkerchiefs.

Ball Warps

Warps which, after being wound on the warping mill, are bunched together in rope shape and wound up in a ball, or similar form. Cotton warps are frequently handled in this manner.

Banking-up

Arranging in their proper places, the bobbins on a warp creel.

Banging Off

Indicates that the blade of the stop rod is not lifted sufficiently to clear the frog when the sley is beating up ; hence there is a characteristic bang, and the loom is very suddenly stopped.

Bar

A term applied to a stripe of coloured weft, used as heading or cross border.

Bare Cloth

That is bare-looking in appearance or lacking in cover. The causes are : Shedding too late, warp and weft twisted more than necessary, warp line in loom too near absolutely horizontal.

Basket-weave Cloth

Plain woven, several threads drawn together in both warp and weft, producing the plaited effects of a basket.

Batten

A timber merchant's name for timbers measuring from 18 to 32 inches long by 1½ inches broad, and ½ inch thick used on the outside four corners of a cloth bale to keep the tability of the bale. At times ordinary bamboos divided into two pieces are used instead of battens.

Beach Cloth

A light weight, plain woven fabric with cotton warp and mohair weft. Used for men's summer suits .

Beam Apron

A coarse, strong cloth, one end of which is attached to the beam, the other end hammed, and slit at intervals, and an iron rod passed through, to which the warp is tied for beaming.

Beating Up

The third primary movement of a loom. The forcing or bumping up of weft after it is carried across through the warp by the shuttle. It is accomplished by the loom crank, sley and reed.

Bedford Cord

Fabrics having cords or ribs in the direction of warp produced by interweaving the weft in plain or twill order, with alternate groups of warp threads. The ribs may be emphasised by stuffing warp threads.

Beer

Twenty dents or splits in a reed also 40 ends, *i.e.*, two ends to each split or dent. Sometimes a warp during the warping process will be split up into beers or bunches, so as to facilitate counting off. In other cases, they are used to assist in spreading out the warp threads by passing through a wraithe during the beaming process.

Beetling

A pounding process which gives round-thread linen cloth a flat effect. When beetled, linen damask has a leatherlike texture and increased lustre.

Belt-fork or Strap-fork

The pronged lever which shifts the driving belts of any machine from the fast to the loose pulley.

Bemberg

Brand name for synthetic yarns made by cuprammonium process. Applied to knitted and woven fabrics made from these yarns.

Binding in Cloths

The securing together in the process of weaving two separate cloths, or extra materials used for figuring or other purpose in an ordinary single cloth.

Blankets (Cotton)

Plain or twill weave cotton cloths, 60 inches and upwards in width, and 80 inches and upwards in length. Made from coarse yarns. Very coarse reeds are used. A soft spun coarse weft from 1s to 8s counts is usual; sometimes a "bump" yarn weft. Special shuttles are used to take the large cops. Coloured weft headings are put in at each end. The fabrics are raised on both sides by passing several times through the raising machine either in the grey or dyed state.

Blending

Blending has three different applications : (1) to the mixture of two or more qualities of materials ; (2) to the mixture of two or more colours of material; (3) to the mixture of several qualities and colours of material.

Blending

This term is used to denote a change in the appearance of the fibre during the dyeing process. Viscose appears to lose lustre and change shade, and it becomes more opaque in appearance. Also caused by an excess of developer when using ice colours.

Boiled-off Silk

Undyed thrown-silk with the gum boiled out. The boiling is done with soap and water.

Bone Pick

A tapered, smooth bone, about 3 to 5 inches long, used to separate sections and find lost ends while warping.

Borders

The stripes running along each side of a piece of cloth formed either by different colour counts of yarn, or weave from the centre or body of the cloth.

Box-motion

An arrangement for operating the shuttle boxes in check weaving.

Bracket

An attachment bolted to a framing for the support of other apparatus.

Brake

An appliance for aiding in the stoppage of a loom.

Breaking Strain

The point at which a sample of cloth or yarn breaks owing to the weight put upon it.

Breast Beam

The front cross rail of loom over which the cloth passes to the cloth roller.

Bright Silk

A name applied to thrown silk completely boiled off and dyed.

Brocade

Elaborate jacquard woven designs, appearing in relief against a satin or twilled background.

Broken Ends

Ends in the warp which has broken owing to weakness, or being too heavily tensioned, etc.

Broken Twill

A weave in which the twill line running from right to left or left to right, is broken by departure from the regular or non-continuous order. The best type of broken twill is the sateen weave.

Broken Picks

A defect in weaving caused by the weft breaking as it passes from edge to edge of the piece.

Buckram

A coarse, heavy, and very stiff cotton or linen material. Sometimes made of two fabrics glued together. Used for the stiffening in women's hats, men's coats, etc.

Buff Shades and Dark Cream

For imitating the colour natural to Egyptian cotton for this purpose, mixtures of auromine yellow and crysordine orange yield any shade of cream which may be desired. These two colours, when mixed in suitable proportions, produce a shade which is very good imitation of Egyptian cotton.

Buffalo Pickers or Plain Pickers

On receiving a consignment of pickers they must be allowed to dry up either in a dry place or in the engine room, before they are allowed to enter the oil. Bear in mind, a damp picker should never be put in oil, because it is bound to swell out and be rendered useless to be utilised.

Steep in sperm oil at least for two months, and then hold a picker to sun light and if it is found to be transparent, then it can be allowed to be hung up for dripping purpose. If it is not found to be transparent, it should be put back again in the oil to be steeped further.

When the picker is sufficiently steeped and dripped for about two months, it must be put out in a dry place, or in the engine room before it is used as it must be given sufficient time to harden up.

The steeping vat should have a perforated false bottom, so that any water, which settles from the oil, can get away, otherwise the lower strata of the pickers may be steeping in water instead of in oil.

Trouble with pickers is caused in most mills owing to the fact that they do not know that there is a right side and a wrong side, also a front and a back to a picker.

The method of manufacturing of Round Foot Pickers makes it imperative that they are put on the right side of the loom to commence with, otherwise they will only give a very short life.

Front side is the closed side because one piece bar for band and it is stamped. On the striking side one piece of wire is shown.

Burlap

A plain, coarse, rough material made from jute. Cheaper grades used for gunny sacks. Better grades dyed or printed and used for draperies. Used for bags, bale coverings, etc.

Q.—What is the breast beam and back rest or back bearer for ?

A.—The breast beam is used for the cover. It should be an inch and a half above the shuttle race board. The back rest or back bearer is used for the cover to keep the yarn in a line with the shuttle race.

Q.—What is the most convenient time to change the boxes in a dropbox loom ?

A.—When the crank arm is between the top and the front centre.

Q.—What is the best time to turn the card barrel in a drop box loom ?

A.—When the crank arm shaft is at its front centre.

Q.—Explain why is a brake a necessary adjunct in a loom.

A.—In most looms an effective brake is a necessary adjunct to the driving motion, its function being to prevent the loom from over-running when thrown off.

Q.—Explain bundling cloth.

A.—Bundling is the tying together of 5 or 10 pieces of cloth together of folded pieces by means of a cotton band on a bundling press at both the ends of the pieces, in order to facilitate the pressing of a neat bale.

Q.—Define the process of baling.

A.—A sufficient length (not one inch more) of hessian cloth is spread on the table (of a baling press) on which a piece of tarpaulin sufficient to cover both of the pieces sides up to half the pile of the cloth is to be placed on the table. Another piece of the hessian cloth equal in size of the tarpaulin is placed on it. Then two or three papers (white) are placed on the top of the hessian cloth. The bundles of pieces are then placed on the top of the papers. The pieces are again covered on the top with papers, hessian cloth, tarpaulin or mates and last with hessian cloth. On the sides, papers are placed, and then a piece of tarpaulin. After doing all these, the press should be set in motion, that is, the table starts rising until it presses the pieces against the top to the necessary pressure generally one to one and a half ton. The hessian cloth drawn up from the bottom and down from the top so as to overlap each other, and then the edges are sewn together. Four pieces of battens are placed on each of the four corners of the bale. The hoop irons of suitable length are passed through the grooves and secured by means of buckles and pins around the bale, and the table allowed to descend. The bale is then removed and marked by means of stencil (copper or tin) with number of bale, description of its contents, such as width, length, quality number, mill mark, year (which isindicated by an alphabetical letter, as, for instance, M. for 1943, and so on). At times papers are only used for covering the bundles and not tarpualins and hessian cloth, that is, hessian cloth is used for the outer part of the bale only. Bamboos are used instead of battens.

Q.—What are the casues of barry places in a piece of cloth ?

A.—Barry places across the piece arise from three main sources in the loom, these being (*a*) the letting-off motion (*b*) the taking-up motion, and (*c*) the holding of the warp beam flanges. The friction letting-off motion, which consists of chains and ropes, passing round the warp beam pulleys, gives very satisfactory results, so long as they allow the warp beam to slip evenly when the sley beats up the weft against the fell of the cloth. The bump there given unwinds a slight portion of the warp from the beam almost every pick.

The amount of let-off depends upon the diameter of the warp on the beam, for the greater the diameter the less it moves, and the smaller its diameter the faster it travels .The amount is also regulated by the picks per inch and the diameter of the weft. In this kind of letting-off motion there should never be any jerkiness of movement, for it is this which imparts a barry character to the cloth.

It is an almost invariable rule that where two metal parts work together, the place where the friction occurs should be oiled. The chains, however, which go round the warp beam pulleys are one of the exceptions to the rule. Experience teaches that if the chains and pulleys are free from rust, they give much better results without oil than with it, and that the pulleys soon possess a glassy surface. Oil mixed with metal dust retards the slipping action, whereas the non-oiled surface lets the metal dust fall away.

If anything is needed at all, as when weaving the last cut and when the warp beam must travel at its highest speed, powdered black lead will supply the best slipping agent.

In the worm letting-off motion employed in one loom, two catches are used to work the letting-off wheel, one catch working half a cog ahead of the other. This ensures evenness of letting-off, whereas, if they work both together, the wheel remains stationary too long, and when the catches do begin to move the wheel, they do so with so much vigour that the warp is let off too fast, and in this way heavy and light places are made in the fabric alternately.

When catch points become rounded off they slide over any of the zeeth in the letting-off wheel which have become blunted. Marks made in this way are usually further apart than those made by the catches working together or almost so. If the letting-off wheel has its teeth worn more in one place than another, the defects shown in the piece coincide with each revolution of the letting-off wheel.

Q.—Explain the function of a balance wheel in a loom.

A.—A balance or hand wheel is usually fixed on to the end of the crank shaft as an appendage to the driving motion ; this enables the weaver or tuner to manipulate the loom by hand when necessary. A minor advantage in the form of kinetic energy is also derived from this wheel, which assists, although in a small degree, to overcome the variable resistance encountered by the driving motion in turning the crankshaft one revolution. If the weight of this wheel and the consequent amount of accumulative work were too excessive, more effective braking power would be required.

Cabled Yarn

These are folded yarns again folded together. Thus, in a six-fold cabled yarn a two-fold yarn could be used, and three threads of this two-fold yarn folded or doubled together.

Calico

Coarse and fine, plain woven, printed on one side and highly sized.

Cam

A plate revolving on a shaft, having its circumference other than circular thus giving reciprocating motion to any level actuated by it—applied to the shedding and picking plate.

Cambric

Plain close woven of medium counts of yarns, similar to muslin, but glazed and polished. Heavily sized and stiffened when used for linings.

Cashmere

A fine plain or twill fabric originally woven from the wool of the cashmere goat. Soft finished.

Caste Tulle

Fabric produced from viscose liquor without weaving, in the form of net.

Catch Cord

A strong cord used on the edges of the cloth while weaving, to prevent the weft from pulling in or cutting the edges.

Caterpillar

A thread, part of which breaks an curls around the unbroken part in the shape of a caterpillar, caused by a weak spot in the thread catching in a dent of a reed.

Centimetre

One-third of an inch.

Challie

Soft, plain weave, lightweight, printed or plain fabric similar to voile but not as fine or smooth.

Chardonnet Silk

Named after its inventor, Count Hilaire de Chardonnet, a Frenchman, who first invented the process in 1884.

Charmeuse

Light-weight, rich-looking sateen weave with a dull back. May be described as very soft sateen subdued lustre, due to spun silk weft. Piece-dyed, width 40-inch.

Chacilaine

A wooly fibre like natural wool, the product of La Soie de Chatillon.

Checks

Fabrics having formed by crossing the threads of a striped warp with coloured weft threads of the same order or otherwise.

(Mock) are produced by combining weave effects.

Checking Motion

A mechanism for automatically changing shuttle boxes on a loom, so that shuttles containing different colours of weft may be brought into action to give any desired colouring or check effect. Two distinct systems are in use : (1) rising and falling boxes (2) revolving boxes.

Chiffon

Dull, soft finished, open-weave fabric of fine hard-twisted yarns.

Chiffon Twist

Hard-twisted, single, raw-silk threads, having from about 50 to 100 turns of twist per inch, more or less, used for making chiffons, mosseline de soie, etc.

Chintz

Plain, brightly printed, glazed fabric, woven of hard twist warp and coarse slack twist weft.

Chocking the Shade

When the warp threads are so numerous of so rough character that they will not pass through between each other and separate readily into two portions between which the shuttle may pass.

Choving

The damp size would rub off as it passed through the healds, thus causing the eyes of the healds to become made up.

Cloth Hessian

The standard width of all hessian cloth is 40 inches. But the width ranges from 30 to 76 inches. The standard qualities are two in number namely (1) 9 Porters 10 shots—40″ × 8 ozs. (2) 11 Portres 10 shots—40″ × 10½ ozs.

Cloth

The technical name of woven cotton fabrics, although "cloth" is the popular name for woollen and worsted fabrics, and cotton is usually called "calico" or some such name, yet in the trade, the name of cloth is always given to cotton goods.

Cockling

When the cloth, instead of presenting a smooth, even surface, is irregular, some portions standing up in bubbles, caused by uneven tensioning.

Cockspurs

Two long steel hooks on which the cloth is folded backwards and forwards on itself by hooking one selvedge of the cloth first on one and then on other. The hooks are made to slide outward and inward to the requisite length of the fold or plait required.

Cocoon

The covering that the silk worm spins around itself, which, when unwound, becomes raw silk.

Compass Board

Another name for the cumber board which is a short and narrow perforated sections or pieces of hard board, or one long one, extending f om one side of a jacquard loom to the other. The object of the cumber board is to spread and guide the harness threads, which pass through the holes in the board.

Constants

Are used to shorten calculations connected with machinery, that is, not newly started. When certain wheels for a new machine must be calculated it is necessary to first employ the ordinary long calculations, or ascertain the constants, and then the change wheels to use. The real benefit from using constants, therefore, is derived when it is required to calculate a certain change wheel or draft during the ordinary working of machinery, and not when new machinery is being started.

Contraction or Milling-up

This takes place during the process of weaving. If a thread is removed from a piece of cloth, it will be found slightly wavy, because it bends round the weft to a small extent and, of course, in that form occupies a shorter length than would a straight thread. It is difficult to give a hard and fast scale for contraction, which along with the allowance for the extra ends, varies greatly with the class of cloth made.

The percentage of contraction will vary for the following reasons from a 2 to 12 per cent—varying degree of tension imparted to the warp in the loom, thickness of weft yarn, hardness or softness of the weft yarn, the intersections of warp threads and weft picks, the hardness or softness of the size, rebounding of the shuttles, temple roller wrongly set, the class of looms employed, and the weather.

Cop

The cylindrical coil of yarn with cone-shaped ends formed at the mule. The lower end being called cop bottom and the upper end cop nose. It is either self-contained or built on paper tube short or long.

Cord

The bands used in attaching the healds to the heald rollers, or lamb rods, *i.e.*, heald cords, also a very coarse thread, used as heading or striped border as in dhoty border. Simple cords are produced by running several threads of either warp or weft together in the weave.

Corduory

A form of weft pile weaving for the heavy cloths, suitable for men's wear, which give a rib longitudinally in the cloth. After weaving it is cut, sheared and finished, often dyed.

Cotton

Amongst the vegetable fabrics, the first place must be assigned to cotton. It is a product of the cotton, a shrub of the malvacæ genus, gossypium class. There are several varielies of this plant, but the growth of the raw material in each case is the same. The cotton seed pods are divided by memberaneous walls into three parts each containing three or four seeds, covered with fibres attached by one end of the seed. The fibre during growth consists of a hollow tube gradually tapering to a fine point, the internal channel which supplies the nutriment to the growing cells narrows, as it approaches the end of the fibre, leaving a solid portion. When the fibre is ripe, the supply of sap through the channel ceases, and as the residual sap is absorbed, a vacuum is created in the channel, causing the walls of the fibre to collapse, and during drying and contraction, the fibre twists itself into spiral form. Wax, seed oil, and natural colouring matter are the chief impurities of the cotton fibre, and are evenly distributed over its surface, When the external impurities have been removed the chemical composition of the cotton is pure cellulose.

Cotton Flannel

A strong heavy plain or twilled cloth, in either grey coloured or bleached condition, and raised or napped on one or both sides. It is woven with coarse soft spun weft.

Cotton Shoddy Yarns

Made from hard waste, from cop bottoms, remnants of warps, etc. They are passed through a hard waste breaker, which destroys all vestiges of thread structure. This machine breaks many of the fibres, because of the spinning process twisting and holding the fibres firmly together. The fluffy mess obtained is subjected to a soaping. Many modern machines have a soaping attachment. When without, this fibrous mass is spread thinly in layers one above the other, and on each separate layer a strong solution of soap and water is sprinkled. A stack is thus built up, and allowed to stand for several days, so that the solution can flake together. In this flaky condition it can be carded and spun into very coarse yarns for weft. Used for candle wicks, in the manufacture of cotton blankets, as weft in waste sheetings, etc. This material is very low in quality, but very useful. It differs from ordinary waste.

Counter or Magnified Glass

A brass or nickel arrangement with lens, which folds into three parts, and when opened for use has the appearance of three sides of a box. One side serves as a stand, this has a square hole cut in the centre, which is exactly $\frac{1}{4}$, $\frac{1}{2}$, or 1 inch in diameter either independently or the three combined together in one, or distinguished from one another by marks. The second side acts as a piller to support the third, in which an ordinary glass lens is set opposite to the hole in the lower side. This arrangement is put on the piece of cloth to be tested, and the eye of the operator is placed above the lens, which magnifies the threads, and so enables him to count the number of threads which are in the space that the square hole includes, thus he is able to tell how many picks or threads of warp and weft the cloth contains to the quarter inch. It is always best to count to the inch to get the best and accurate result.

The counting depends upon the position of the first thread under the glass. Some people count every thread that can be seen, whilst others start with the first full thread. It is also used for designing, for finding out the position of each thread in the pattern.

Counting Glass—Microscope

It is fitted with a strong magnifying eye-piece adjustable to any sight, combined with a fine pointer which is traversed along a divided plate by means of a thumb-screw. The plate is marked on one side in inches and divisions, and on the other in millimetres.

Count of Yarn

The number of a yarn indicating its size, from which its length per lb. can be ascertained. The cotton system is based on 840 yards to the hank, and the number of hanks that weigh 1 lb. equals the counts thus 20s counts cotton = 20 × 840 yards per lb.

Couplings

An attachment to a jacquard harness. It is suspended from the neck cords, and consists of sleeper cord, mail and lingoe. One coupling is required for each separate warp thread in the width of cloth.

Crack

The term, crack, denotes a more excessive distance between the successive picks, than ordinarily exists between adjacent picks. Or, in other words, a fault in cloth caused by the sley beating up when no weft has been inserted.

Crammed Stripes

Striped fabrics in which one section contains more warp threads as compared with the other sections of the stripe.

Crepe

The crepe fabric is plain woven from hard twisted yarns. The nature of the latter together with subsequent finishing operations causes a considerable contraction to take place whereupon an uneven crinked surface results.

Crepe de Chene

A fabric produced from a fine silk warp and a right and left (open band and cross band) tightly twisted worsted weft, this latter during the finishing operation disturbing the straightness of both itself and the warp, and thus creating a crepe effect.

Crepe de Chene Twist

Hard twisted yarn, in both right and left-hand twist, usually from 40 to 100 turns per inch, and generally made from three to five raw-silk ends used for the weft of crepe de chene

Crepe Georgette Twist

Generally made of two threads of 13/15 denier raw silk, with 50 to 90 turns per inch, right and left-hand twist, used for both warp and weft of crepe Georgette.

Crepe Weave

An interlacing of threads and picks in a more or less mixed or indiscriminate order to produce an appearance of a finely broken character, usually associated with crepe cloths.

Crimoline

Open weave, hard-twisted warp, heavily sized fabric, dull finish. May be twill or satin weave, has horse hair weft.

Crimp

The fabric should be well balanced in the direction of warp and weft. To regulate this quality it is desirable to measure the crimp on "crimp testers." This is quite important in mechanical fabrics, where equal strength, both warp and weft way, is necessary.

Cross Dyeing

Cloth containing fibres of different characteristics dyed in the same bath and producing varying colours according to the affinity of the fibres for particular dyes.

Cross-over

A fabric of a stripe character in which the stripes are produced in the weft, generally the stripes are coloured.

Cross Border

A heading to a piece of cloth or handkerchief, either formed by coloured or other weft, or by a change in the pattern.

Cut

The mill term for a single piece of cloth of varying length. A warp is made up of many cuts.

Q.—How would you analyse cotton cloth for filling and moisture?

A.—To find the amount of fibres contained in a piece of cotton cloth it is necessary to disect it of moisture, and any filling or weighting material which may have been added to in the finishing.

Separate tests may be taken of each addition by itself, or a test may be used to determine the total amount of fibre.

(*a*) *Test for Moisture.*—Take a piece of cloth weighing 20 gm. and dry in hot oven. Dry it till the heat effects no change in the weight. Then weigh it carefully, and the difference obtained is the amount of moisture in the cloth.

(*b*) *Testing for Mineral Matters.*—Burn a piece of cloth weighing, say, 10 gm. in a crucible till the ash is quite white. Weigh the ash. Allow one per cent for the ash of the fibre, the rest is filling.

(*c*) *Test for Amount of Pure Fibre.*—Take a piece of cloth weighing 20 gm. and treat it as follows : Soak it in water and squeeze out as much of the filling as opssible. Boil it in water containing one per cent of caustic soda for over an hour. Wash it in water. Boil it in water containing one per cent of hydrochloric acid, was it clean. Boil it in pure water for an hour. Dry it in a hot oven. The weight of cloth remaining is the amount of pure fibre.

Q.—What do you understand by cloudy and uneven cloth ?

A.—Cloudy cloth is generally the result of using an uneven weft, and can only be cured by a better and more even spun yarn. But uneven cloth is also caused by so many faulty settings such as : (1) Uneven let-off of yarn from the weaver's beam. This may be because the "pike" at the end of the beam is not true, or that it is binding, or that the let-off motion is not acting in an efficient manner. If binding is the cause, a liberal use of French chalk will be found useful, and in very bad cases black lead is used. (2) The uneven cloth may be, and very often is, the result of a faulty take-up motion. The beam roller (often called emery roller, or sand roller, or tin roller, or take-up roller) may not be exactly cylindrical, hence the picks per inch will vary according to which part of the roller is acting on the cloth. Again, any one or more of the wheels of the take-up train may be bored out of centre, or a small piece of dirt may be wedged in the rack wheel causing two teeth to be taken up as the wheel is pushed over. This may occur occasionally and is often difficult to trace. If one heald stave is lifting too high, one may get uneven cloth, or a faulty setting of the reed in the reed casing will give the same effect. If the heald staves are lifting higher at one side than at the other, uneven cloth may result at one side of the loom. Quite often a belt too tight will give uneven cloth. Also if the back rest is not set exactly straight, or one side of the beam is higher than the other, the same fault will occur. If one temple is set higher than the other one may get uneven cloth at one side of the loom.

Q.—Suppose you had a white plain cloth in a dobby loom and you had the advantage of an extra 2 shafts. What ornamentation could you produce ?

A.—Stitch effect, stripes 2 up and 2 down, 3 up and 3 down, or 4 up and 4 down with various coloured ends.

Q.—A finished piece is required to be 55 yards in length, $20\frac{1}{2}$ ozs. per 36-inch yard, what length and weight must the piece be out of the loom on an estimated loss of $12\frac{1}{2}\%$ in weight and 8% in length.

A.—Length out of the loom—the 8% loss in length must be reckoned on the length out of the loom, *i.e.*, a piece 100 yards long (grey length) becomes 92 yards when finished. So that 92 yards finished was 100 yards out of the loom.

Then 1 Yard finished was $\frac{100}{92}$ =out of the loom

" 55 " " " $\frac{100 \times 55}{92}$ " " "

Length of piece out of the loom = 59.78 yards. or $59\frac{3}{4}$ yards practically.

Suppose the weight required = X lbs. loss in finishing = $12\frac{1}{2}\%$ = $\frac{1}{8}$ weight of piece finished = X-$\frac{1}{8}$X = $\frac{7}{8}$X the finished weight

$$= (20\tfrac{1}{2} \times 55) \text{ ozs.} = \frac{20\frac{1}{2} \times 55}{16} \text{ lbs.}$$

$$\text{Hence } \tfrac{7}{8}\,X = \frac{20.5 \times 55}{16}$$

$$X = \frac{41 \times 55 \times 8}{2 \times 16} = 80.53 \text{ of } 80\tfrac{1}{2} \text{ lbs. weight of cloth out of loom.}$$

Q.—Describe coarse counts which you think would produce a pleasing effect.

A.—21s warp 27s weft, 44 reed 44 picks per inch, end and end 25 blue and white stripe.

Q.—Say as to how you would prevent cops from flying off.

A.—By adjusting the check strap, the picking and the shuttle tongue.

Q.—The weight of a piece of cloth is required to be 128 lbs. The warp contains 1,920 ends of 40s counts and is 105 yards long. Width of warp in reed is 42 inches, picks per inch are 60, cloth length

100 yards. What counts of weft would be required to produce the desired weight of piece, assuming that the yarn retained $12\frac{1}{2}\%$ of size ?

A.—Weight of warp $= \dfrac{1,920 \times 105}{840 \times 6} = 6$ lbs.

Warp $= 6$ lbs. $+ 12\frac{1}{2}\%$ size retained $= 6 + .75 = 6.75$ lb.
$12.75 - 6.75 = 6$ lbs. of weft.

Counts of weft $= \dfrac{60 \times 42 \times 100}{840 \times 6} = 50$s counts.

Q.—What is the average count of material in one square yard of fabric composed of 56 ends per inch of 18s twist and 160 picks per inch of 38s weft ?

A.—The weight of warp and weft without allowing anything for contraction, equals :—

$$\text{Warp} = \frac{56 \times 36 \times 7,000}{840 \times 18} = 933.3 \text{ grains.}$$

$$\text{Weft} = \frac{160 \times 36 \times 7,000}{840 \times 38} = 1,268 \text{ grains.}$$

$933.3 + 126.3 = 2,196.3$ total weight in grains.
The total length in yards of warp and weft equals :—
Warp $56 \times 36 = 2,016$ yards.
Weft $160 \times 36 = 5,760$ yards.
$\therefore$ $2,016 + 5,760 = 7,776$ yards.
The average counts equals :—

$$\frac{7,776 \times 7,000}{2,196.3 \times 840} = 29.5 \text{ counts.}$$

Q.—What is the heald space of a loom ?

A.—The heald space of a loom is the distance from the top shaft or counter shaft to the sley when the loom is at back centre. The heald space varies from $9\frac{1}{2}$ inches on a narrow dobby loom to 15 inches on a heavy woollen loom, on a medium loom of 60 inches to 72 inches heald space is 13 inches to 14 inches.

The heald space limits the number of shafts which can be accommodated, hence if 20 shfts were required on a narrow loom with $9\frac{1}{2}$ inches heald space, the staves would require to be $\frac{1}{4}$ or $\frac{3}{8}$ inch thick.

Q.—Which would weave the best, a cloth that is wider in reed than healds, a cloth that is narrower in reed than healds, or a cloth that is the same width in reed as the healds ? State the order you put the three in.

A.—A cloth that is same in reed as in heald work the best, second wider in healds than reed, third wider in reed than healds (very poor). Also every attention must be paid in the case of fancy healds, that is, a set of healds that has to be cut or spaced according to the pattern in the cloth, and not cause the ends to be crossed, as this will result in breakages of yarn, and thus harass the production. When the ends are separated between the healds and the reed, they must present a clear line otherwise the healds are wrongly spaced or cut.

Q.—If a heavy clothy feel is required in a piece of cloth, how would you do it ?

A.—A white dextrine mixing containing a large proportion of finishing soap is suitable for the purpose.

Q.—If a very high glaze is required in a heavy check cloth how would you acquire it ?

A.—Heavy check cloth will take on a very high glaze by passing the goods through the friction starch mangle in a mixture of farina and Japan wax (this mixing must be used hot) and then passing through the friction calender.

Q.—Give some of the defects that are found in yarn or cloth that are clearly due to faulty spinning or faulty manufacturing.

A.—In many cases of dispute between spinners and manufacturers it has been found that the defects in yarn or cloth were clearly due to faulty spinning or faulty manufacturing.

(1) Taking tenderness, or rather weak resistance in cloth, this must be ascribed to faults either in the raw material or in the manufacturing processes.

In the first category (*i.e.*, defects due to the raw material), tenderness is caused by the presence of neps in raw cotton, presence of dead cotton, pieces of seed coat particles, or fuzzy hairs of seeds, etc.

In the second category tenderness may be caused by any of the following :—

(*a*) Faulty mixing of cottons, trying to spin yarn from cottons of different characters (lengths of staple, resistence of fibres, etc.)

(*b*) Faulty settings of machines in any of the different processes of spinning.

(*c*) Presence of excess of chemicals such as chlorine preparations, magnesium sulphates, free acids, etc., which attack and weaken the cloth.

Goods are frequently tendered in the singeing process owing to the presence of magnesium chloride in the grey cloth. A relatively small amount of magnesium chloride in a cloth will cause it to literally fall to pieces on singeing. Sometimes we find that when magnesium chloride has been used in sizing, the warp is seriously tendered, whilst the weft is scarcely affected.

The tendering of bleached goods is frequently attributed to imperfect removal of acid liquors, and it is taken for granted, so long as any mineral acid can be found in the cloth. that is the cause of damage.

Prints in which a portion of the design is in black are particularly liable to be tendered in the black portion, and it is common to find in such cases, that free mineral acid has been present in the black dye used in printing.

(*d*) Faulty calendering, which has been too severe for the class of weft yarn used.

(*e*) Calendering the material in a creased condition.

(*f*) Excessive pressure in finishing.

(*g*) Faulty mixtures of dyeing stuffs.

(*h*) Making cloth from yarn of the same counts but from different cottons, etc., etc.

(2) Taking stains and specks as being the cause of tenderness, they may be due to the raw material or to faults in the manufacturing processes.

From raw material the causes are presence of seed coat particles, etc.

From spinning and manufacturing the causes may be :—

(*a*) Presence of dirty oil or grease which has come into contact with the yarn prior to or during the weaving of the cloth and it will be particularly troublesome if it contains particles of finely-divided metal from the brasses or shafting.

(*b*) Irregular mercirisation, giving rise to irregular dyeing stained by unsaponified oil.

(*c*) Stains of mildew.

(*d*) Yarn stained from iron mould.
(*e*) Dye spots due to imperfect dyeing materials.
(*f*) Dirt and oil not removed in bleaching.
(*g*) Stains from salt water, etc.

From dyeing and bleaching.

(*a*) Paraffin wax on the cloth is exceedingly difficult to remove in scouring or bleaching, and the presence of traces of this substance usually results in either a poor colour in bleached goods, or light patches in dyed cloth.

(*b*) Dyed cloth sometimes exhibits marked streakiness similar to that consequent upon the use of uneven yarn, but where no unusual irregularity in count or twist is apparent. On stripping the colour from such cloth, and re-dyeing, it is often possible to produce level shades. The defect in this case is frequently due to insufficient scouring prior to dyeing, although it may also be due to irregular dyeing.

Q.—Supposing a piece of cloth is to be made 3,030 ends and 40 yards long with a pattern arranged as follows :—

Find the number of ends and weight of each colour allowing 40 ends grey for selvedges.

Design for the pattern in the cloth.

2	blue	2/40s
2	grey	30s
2	blue	2/40s
40	grey	30s
46	total ends in a pattern.	

A.—3,030 ends — 40 ends for selvedges = 2,990 ends.

2,990 ÷ 46 = 65 patterns.

65 × 4 (ends of blue in the pattern) = 260 ends of blue

65 × 42 (ends of grey in the pattern) = 2,730 ends grey + 40 (ends grey for selvedges) = 2,770 ends.

			Lbs.	Ozs.
Now there are	260 ends blue 2/40s	..	0	9.90
Now there are	2,770 ends grey 30s	=	4	6.34
Total ends	3,030		5	0.24

Q.—Suppose you are supplied with samples of two cotton cloths, one of which has been woven from a sized bleached warp and bleached weft, and sold as it came out of the loom, whilst the other has been woven in the grey, bleached, and finished with a thin starch paste; how can you distinguish the one from the other?

A.—The first and simplest test is to examine the cloth for reed marks. All fabrics woven with cotton yarns have a tendency to reediness, and no matter how well covered the cloth may be, if examined in the loom state, especially by holding up in front of a window or light and trying to see through it, some reed marks will show.

If the cloth has been bleached, and whether or not finished by a thin starch paste, then the wetting of the cloth will have caused the warp threads themselves out evenly over the face of the cloth, hence a bleached cloth should be fully covered. Again, if a cloth is woven from bleached warp and weft, then the warp only will be sized and weft threads pulled out of the piece will have protruding short fibres jutting out from its surface, whereas if the cloth has been finished with a thin starch paste, then this paste will be on both the warp and the weft.

Q.—What would be the average counts of weft used in a weaving shed, if under the following conditions?

Shed of 600 Looms

150	looms on	20s	weft
60	,,	30s	,,
30	,,	10s	,,
120	,,	40s	,,
240	,,	60s	,,
600			

A.—All calculations relating to average counts are best solved by treating the number of looms, beams, or whatever is being used as hanks. Take the question above.

150 hanks of 20s weft .. .. .. $\frac{150}{20} = \frac{15}{2}$ lbs.

60 hanks of 30s weft .. .. .. $\frac{60}{30} = \frac{2}{1}$ lbs.

30 hanks of 10s weft .. .. .. $\frac{30}{10} = \frac{3}{1}$ lbs.

120 hanks of 40s weft .. .. .. $\frac{120}{40} = \frac{3}{1}$ lbs.

240 hanks of 60s weft .. .. .. $\frac{240}{60} = \frac{4}{1}$ lbs.

Total is equal to 600 hanks weight $\frac{15}{2} + \frac{2}{1} + \frac{3}{1} + \frac{3}{1} + \frac{4}{1} = 19.5$ lbs

Then if 600 hanks weigh 19.5 lbs. $\frac{600}{19.5} = 30.76 =$ average counts.

Q.—A warp 840 yards long contains 2 ends of cotton to 1 of worsted. The cotton yarn is 24s counts and weighs 30 lbs. and the worsted yarn weighs 20 lbs. What is the worsted counts ?

A.—$\frac{840 \times 24 \times 30}{2} = 302{,}400$ yards.—length of one thread of cotton and, therefore, length of one thread fo worsted.

$\frac{302{,}400}{560 \times 20} =$ 27s worsted counts.

By length of one thread is meant the total length, if all the threads of that fibre and counts were tied together to make one long thread.

Q.—Name some of the causes that produce cracks, thick and thin places.

A.—Faulty let off motion, defective action of weft fork, the brake acting incorrectly, taking up motion not properly accomplishing its objects in restarting of the loom, such as, after repairing broken, warp ends or replenishing the weft, broken weft, defective weft, and incorrect shedding.

Q.—Give some method by which the appearance of the cloth can be altered.

A.—(1) By introducing coloured warp.
Example :—Striped cloths with two or more colours.

(2) By introducing coloured weft.
Example :—Check cloth with two or more colours.

(3) Denting in different orders that is passing one or more threads through a dent.

Example :—10 ends taken through the reeds, one in a dent, nexe 20 ends taken 4 in a dent, and next 30 ends taken two in a dent.

(4) By putting tension on a weaver's beam in the case of two weaves.

Example :—Repp cloth.

Q.—Give some method by which you can change the weight of cloths.

A.—(1) They may be woven opener or closer, thereby giving more or less weight, that is, by putting few or more picks per inch. This is common method in producing range of qualities.

(2) They may be made thinner or thicker, that is, by employing thinner or thicker warp or weft yarn.

(3) Varying the set, that is, putting in fewer or more threads per inch.

Q.—How would you inspect a piece of cloth ?

A.—I would inspect it either: fold by fold, after it has been folded by a folding machine and laid flat on the table ; (2) or on a slanting inspecting table over which the cloth is drawn by means of revolving roller that can be readily stopped, in case a defect is noticed.

Q.—What are the causes for bad cover or reediness ?

A.—Back rest being slightly low or not level. Non-adjustment of lease rods. Back rest making contact with the rim of the beam flanges. One side of the heald being higher or lower than the other side. Bad shedding.

Q.—Why are the pieces of cloth stamped ?

A.—The object of stamping pieces of cloth is to give information or what you might say is an advertisement for the manufacturers, that is, it shows in which mill the piece is made, the trade mark, the number of piece which serves the purpose of obtaining similar piecse without any trouble either from mills or their agents, and the length of piece. Blue or red ink is generally used, and the piece is stamped on one half of the outside fold of the cut.

Q.—What is cover ?

A.—A term used to indicate that the warp threads are spread in the cloth at equal distances, so as to destroy any row or naked appearance which may arise by the threads passing in pairs or more through the splits in the reed. A well covered cotton cloth is worth more in the market than cloth which has been made of a higher grade of material but is poorly covered. The foundation for a good cover on cotton fabrics is based upon the efficiency of the processing from the carding of the raw material to the finishing of the pieces. A well-covered cloth would be one with the warp and weft evenly spread, presenting a uniform surface to the eye, and having a soft full feel with good clothing properties. In a cloth of this description it should be expected to have the weft prepondering, as weft yarns are usually spun with a less amount of twist, giving a softer and fuller yarn, and the warp yarn should not receive more size in slashing than is necessary to good weaving. Ring yarns being more compact and solid are utilized as warp, as they are able to withstand the friction of the weaving processes better. The two main factors in getting cover in cloth in the loom are the shape and setting of the shedding tappets, and the arranging of the warp line—the relative position of the front rest, heald eyes and back rest, but there are host of other details that have their influence, and either add to or detract from the cover effect, among which it may be mentioned position of lease rods and manner of leasing, position of temple bar, the manner of tensioning the warp, which is of considerable importance. If variation of tension in the warp threads causing some threads to be tight, and some comparatively slack, when the reed is beating a pick of weft up to the already woven cloth, could be avoided or rather regulated, good cover must follow or can easily be effected.

The threads composing the texture must be equally spaced and free of gaps, coarse ends, miss-picks, and imperfections that commonly impair the surface of any cloth.

Q.—A card measures $16\frac{5}{8}$ inches long by 2-7/16 inches wide. Find the number of square inches in it, and the weight of 12 such cards, if 100 cards weight $3\frac{1}{2}$ lbs.

A.—$16\frac{5}{8} \times 2\text{-}7/16$

$$\frac{131}{8} \times \frac{39}{16} = \frac{5{,}109}{128} = 39.91 \text{ square inches.}$$

$$\text{Weight} = \frac{12 \times 3.5}{100} = \frac{2.1}{5} = .42 \text{ lbs.}$$

Q.—Give the process as to how you would produce cover on a plain and drill cloth.

A.—*Plain*—(1) shed early; (2) healds level before the crank comes to the top centre; (3) get back rest as high as possible; (4) healds away as to get a small shed; (5) lease rods well back and heads slack; (6) pick early before crank gets to bottom centre.

Drill.—(1) shed late; (2) two healds, that is, No. 1 and 3, or 2 and 3, or 1 and 2 level when crank shaft is between top and front centre, that is, when the reed is $1\frac{1}{2}$ inches from the fell of the cloth; (3) get back rest as low as possible; (4) healds as near as possible towards the sley, so as to get big shed; (5) pick late before crank gets to back centre.

Q.—Sometimes woven goods dyed with congo red, have turned black, owing to lying in an acid atmosphere, or from coming in contact with acid in some shape or form. What would you do to restore the colour?

A.—The red colour can be restored by passing the pieces of cloth through a mangle containing a solution of soda ash from $\frac{1}{2}$ to $1\frac{1}{2}$ ozs. per gallon, and drying over the drying cylinders.

Q.—State the effect (1) too much tension; (2) too little tension put on the cloth in the folding machine.

A.—(1) It will make the folds uneven, and perhaps, pull it from the jaws. It will also show more folds in the piece though the length may actually be short.

(2) The cloth will be very loose and will flap considerably in being folded. It will also have the effect of making the length of the fold uneven.

Q.—In analysing cloth, how would you gauge the counts, nature and quality of the yarn requisite for its production?

A.—A ready method of gauging counts is to take out as much length of yarn as possible from the sample, then weigh it and test in the usual way. Another method is to compare the threads, with standard threads of known counts

Q.—If a folder operates at the rate of 80 yards per minute, how many hours will be required to fold 12,000 yards of cloth, allowing 50% for stoppages, etc.?

A.—80 yards in $\frac{1}{60}$ hour.

$\therefore$ 1 yard in $\frac{1}{60} \times \frac{1}{80}$ hour

$\therefore$ 12,000 yards in $\frac{1{,}200 \times 1 \times 1}{60 \times 80} = \frac{5}{2}$ or $2\frac{1}{2}$ hours.

In 60 minutes or 1 hour is allow $\frac{50}{60}$ hours.

$\therefore \frac{5}{2}$ hours ,, ,, $\frac{5}{2} \times \frac{50}{60} = \frac{25}{12}$ hours $= 2.08$ hours.

2.5 plus 2.08 is equal to 4.58 hours.

Q.—If the counts of yarn that a piece of cloth was composed of and the width, the length and the weight were known, how would you find the reed and pick? Assume that the counts of yarns were 20s both warp and weft, width and length being 45×33 respectively.

A.—Multiply the width by length and divide by 36 inches and the weight of piece. Then the result is to be divided into counts of yarn.

$$\frac{45 \times 33}{36 \times 11.5} = \frac{485}{138}$$

$$485 \div 138 = 3.51$$

$20s \div 3.51 = 56.04$ practically 56 threads to the inch.

$\therefore$ the reed $= 52$ and the picks are generally 4 less than the reed that is 48 picks.

Q.—If a piece of cloth is 40 yards long and 36 inches wide, how many cuttings can be obtained of 648 square inches each?

A.—40 yards long $\times$ 36 inches wide.

40 yards $\times$ 36 inches (to the yard) $=$ 1,440 inches.

1,440 $\times$ 36 $=$ 51,840 square inches.

Divide 51,840 by 648 and the result will be 80 cuttings.

Q.—If a piece of cloth triangular in shape has the length for its sides, 4, 6 and 8 yards how many square yards does it contain?

A.—Add all the sides together $4 + 6 + 8 = 18$.

From one half the sides subtract each of the side separately, $18 - 2 = 9$, $9 - 4 = 5$, $9 - 6 = 3$, $9 - 8 = 1$.

Multiply the remainders together and by one half the sum of the sides, the square root of the product will be the area of the triangle.

$5 \times 3 \times 1 \times 9$ is equal to 135.

		$\sqrt{135{,}000}$ (11.61 square yards)
$1 \times 2 =$	21	35
		21
$11 \times 2 =$	226	1,400
		1,356
$116 \times 2 =$	2,321	4,400
		2,321
		2,079

Q.—A sample length of grey cloth weighs 4 ozs. to the yard. Supposing you have made similar cloth before and found that 20 lbs. of grey cloth weighed 18 lbs., after bleaching what weight would you make the sample ?

A.—Assuming that 20 lbs. of cloth lost 2 lbs., in finishing and bleaching, that is equal to 10 per cent., and the cloth was made 4 ozs., to the yard, if it is desired to make a cloth to weigh 20 lbs. for a given length, the samples must be made 10 per cent. heavier, namely 4.4 ozs. per yard.

Q.—Suppose you had a crank wheel of 36 teeth. How many teeth would be missing before you condemn it ?

A.—Three teeth.

Q.—A piece of cloth 3 inches by 2 inches weighs 12 grains. What will be the weight of a yard, and also the weight of 38 yards piece 40 inches wide ?

A.—Multiply the weight in grains of the small sample by the number of square inches in a yard of the required cloth, and divide by the number of square inches in the same and 437½. The answer is the weight in ounces of one yard of the required cloth.

Width—40×36 inches (in a yard) $=$ 1,440 square inches.

The number of square inches in the pattern is $3 \times 2 = 6$

$$\frac{1{,}440 \times 12}{6 \times 437.5} = \frac{576}{87.5} = 6.582 \text{ ozs. weight of 1 yard.}$$

$6.582 \times 38 = 250.116$ ozs.

$250.116 \div 16$ (ozs. in a lb.) $= 15.632$ lbs. $=$ weight of 38 yards piece.

Q.—What is the count of 420 ends weighing 10 lbs. and 1,000 yards long ?

A.—$\dfrac{\text{Ends} \times \text{length}}{840 \times \text{weight}} =$ counts

$$\frac{420 \times 1{,}000}{840 \times 10} = 50\text{s counts.}$$

Q.—A warp contains 3,200 ends. It is 730 yards long. It is sized to the extent of 24 per cent., and weighs 150 lbs., what is the count of pure yarn ?

A.—Weight of the pure yarn before sizing equals :—

$$\frac{150 \times 100}{124} = 121 \text{ lbs. (nearly).}$$

$$\therefore \quad \frac{3{,}200 \times 730}{840 \times 121} = 23\text{s counts (nearly).}$$

Q.—A piece of cloth 40 inches wide and 40 yards long, containing 50 ends and 50 picks per inch, weighs 15 lbs. On being analysed it is proved to be one third size, and the warp and weft threads are found to be similar counts. Find the counts of yarn.

A.—The weight of sizes is $\frac{1}{3}$ of $15 = 5$ lbs.

The weight of yarn in the piece is, therefore, 10 lbs.

The threads and picks are $50 + 50 = 100$.

$$\therefore\ 10 \text{ lbs.} \div 100 = .10$$
$$50 \times .10 = 5.00$$
$$50 \times .10 = 5.00$$

$$\text{Total weight} \quad 10.00$$

$$\frac{\text{Width of cloth} \times \text{threads per inch} \times \text{length}}{840 \times \text{weight}} = \text{counts of warp}$$

$$\frac{40 \times 50 \times 40}{840 \times 5} = 19.47 \text{ counts of warp.}$$

$$\frac{\text{Width of cloth} \times \text{picks per inch} \times \text{length}}{840 \times \text{weight}} = \text{counts of weft}$$

$$\frac{40 \times 50 \times 40}{840 \times 5} = 19.47 \text{ counts of weft.}$$

Q.—Give an instance when a thick and thin place can be formed.

A.—A thick or thin place is often made after a weaver has been 'pulling back' owing to a 'float,' and then not rewinding the correct amount of warp on the beam, if too much yarn be rewound on the beam, a thick place will inevitably result when restarting the loom. If the fell of cloth not be near enough to the reed, when recommencing weaving, a thin place will appear in the cloth.

Q.—Four square inches of cloth is found to weigh 10 grains. What are the yards per lbs. if the cloth is 40 inches wide ?

A.—Multiply 7,000 by the number of square inches weighed, and divide the result, thus obtained, by the product of the weight in grains, of the piece weighed, the width of cloth, and 36 inches in a yard.

$$\frac{4 \times 7{,}000}{10 \times 40 \times 36} = \frac{35}{18} = 1.94 \text{ yards per lb.}$$

Q.—What is composition of fabric, and state what determines the structure and character of cloth ?

A.—The substance of a fabric consists of fibres which have been spun into yarns. The method, by which the yarns have been combined, determines the structure and character of the cloth or fabric.

Q.—What is the more pointed end of a cop from which the yarn is unwound called ? What is the opposite end called ?

A.—It is called the nose, the opposite end is called the cop bottom.

Q.—What would you do in case the cops or pirns are softly built and liable to slip off the nose of the peg ?

A.—When the loom is running very fast and the cops or pirns are softly built and liable to slip off the nose of the peg, it is often advisable to time the picking a little earlier, because by so doing, more time is allowed for the traverse of the shuttle, and the pick can be made a little weaker.

Q.—If you are asked to weave a piece of plain cloth (2 ends and 2 intersections in the pattern) on a loose reed loom with the following particulars, would you weave it ? If not, why ? What reed and pick would you suggest reed, 60, pick 60 warp 10s weft 8s ?

A.—No because the reed and pick are too fine for the counts of warp and weft given, I would suggest 40 reed or 44 threads and 34 picks per inch.

Q.—A piece of cloth is made with 80 threads per inch, 16s yarn, it is changed to 9s. What number of threads per inch will be required?

A.—Multiply threads per inch in given cloth by the square root of the counts of the required cloth, and divide by the square root of the counts of the given cloth.

Square root of $16 = 4$; square root of $9 = 3$

$\therefore$ $80 \times 3 = 240$, $240 \div 4 = 60$ threads per inch.

Q.—What counts must be used in changing from 72 threads per inch of 36s yarn to 48s threads per inch ?

A.—Multiply the threads in the required cloth by the square root of the counts of the given cloth, and divide by threads in the given cloth, square the result for the answer.

Square root of $36 = 6$

Therefore, $48 \times 6 \div 72 = 4$

Square of $4 = 16 =$ counts.

Q.—Describe the most effective form of a checking motion in a loom.

A.—The most effective form of a checking motion is found in looms where the picking takes place from each side alternately.

This consists of a strap run along the front of the going part, extending from one box to the other. The strap is first secured, in buckle form, to leather tags which fit on the spindle behind the picker. The ends of the strap are fixed to the other end of the shuttle-box by means of the spindle spring or by a set-screw. The check strap is left of such a length that when the shuttle enters either box, the strap will be drawn in the same direction, and so draws the picker forward at the opposite side ready to check the shuttle as it is returned. With this method the length of the check can be easily regulated, whilst the checking of the shuttle is not influenced by any variation of the pick.

Q.—Calculate the weight of each kind or warp in a piece of cloth 100 yards long made to the following particulars. Total length of warp 105 yards. Two selvedges each 20 ends of 2/40s.

Pattern of Warp

30 ends white 30s
4 ,, blue 24s
4 ,, white 30s
4 ,, blue 24s
4 ,, white 30s
4 ,, blue 24s

50 ends in a pattern.

Patterns repeat 48 times and in addition there are 30 ends, white of 30s and selvedges. Total ends 2,470.

A.—Total white ends in one pattern = 38
,, blue ,, ,, ,, = 12
,, white ,, $= 38 \times 48 + 30$ = 1854
,, blue ,, $= 12 \times 48$ = 576
Selvedges of 2/40s = 40

Total ends = 2,470

$$\text{White} = \frac{1{,}854 \times 105}{840 \times 30} = \frac{309}{40} = 7.725 \text{ lbs.}$$

$$\text{Blue} = \frac{576 \times 105}{840 \times 24} = 3.01 \text{ lbs.}$$

$$\text{Selvedges} = \frac{40 \times 105}{840 \times 20} = .25 \text{ lbs.}$$

White = 7.725 lbs.
Blue = 8.000 ,,
2/40s Selvedges = .250 ,,
Total 10.975 ,,

Q.—Plain cloth is made from 80 threads per inch; it is changed to a 4-end twill, two up, two down. How many threads and picks will be required?

A.—Multiply the threads per inch in the given cloth by the ends plus intersections in the given pattern, and divide by the ends plus intersections in the pattern of the required cloth.

There are four ends plus 4 intersections in the given cloth.

There are 4 ends plus 2 intersections in the required cloth.

Therefore, $80 \times 8 \div 6 = 106.6$ threads and picks per inch required.

Q.—What is it that determines the closeness of the warp threads in a piece of cloth?

A.—The closeness or otherwise of the warp threads in an piece of cloth is determined by the reed and healds.

Q.—State the attention necessary when changing over from plain weaving of staples to finer cotton.

A.—The machinery should be properly tuned on its mechanical efficiency which the finer work necessarily demands.

The operatives engaged for finer work should be trained and be efficient in their work. Worn out race boards should be removed. Attention should be paid to the worn out shafts. Treadles and treadle bowls should be removed if found necessary. Box backs should also be replaced if found necessary. The box backs should accurately be fitted. Right type of temples should be used. The emery roller pivots and collars must be thoroughly examined. The ordinary tin with which these rollers are usually wrapped should be covered with fine emery papers or some other material to guard the cloth from damage. In some cases straps are fixed on cloth levers brought over the emery-roller and weights hung to them. Finer fabrics necessitate greater care and accuracy in shedding, if fraying is to be reduced to the minimum. All tendencies to side—movements of the reed and the sley must be eliminated. Picking motion must be set correctly and the shuttles used must be of the type most suited to the fabric to be manufactured.

Proper alignment of reed with box-backs, bevel of shuttles and reed coinciding and a good race board in combination with the proper setting of pick and boxes will ensure the travelling of the shuttle with the least strain on the yarn.

The weft fork motion should be correctly set and attention must be given to the brake and belt fork to avoid those thin or thick places that mar the cloth. The weft fork should not protrude more than quarter of an inch through the grid when the reed is at the fell of the cloth. The healds and reeds should be specially prepared for fine counts.

Q.—What is understood by a perfectly balanced cloth?

A.—The ends and picks are in close contact with each other, any additional ends or picks will cause them to crush each other, and any less ends or picks will be the means of leaving spaces between them.

Q.—What precautions should you take to get good borders and cover when weaving plain dhoties.

A.—When weaving plain dhoties, special precautions should be taken to avoid the faults of reediness, bareness, and bad selvedges, by suitably adjusting the necessary parts of the loom according to the cloth being woven. The back rest should be set high for these cloths, and the healds should be timed to cross soon. These settings will give a well-covered cloth, but if care is not taken faulty edges are produced. If the back rest is raised too high, it throws the top shed slack and allows certain ends to hang; these ends catch the weft and do not allow the shuttle to pull it tight enough, thus causing uneven selvedges, and loops of grey weft to protrude. To get the best effect, the coloured yarn in the selvedges is brought over the bottom bar of a two-bar back rest and under the top bar, while the grey yarn passes over both bars. By this arrangement, the coloured-yarn portion of the top shed is made more equal in tension to the bottom shed. When the off-side selvedge is at fault, this has often been remedied by shedding on the opposite pick, by turning the shedding tappets round half a revolution relative to the shaft. Faulty edges of coloured borders can be remedied by denting the first two dents two in a dent in the reed instead of four in a dent.

Damask

Fabric in jacquard designs, the pattern and ground in satin weave.

Denim

Twilled fabric of coarse, single, hard-twisted yarns. Usually coloured warp and white or mock-twist weft, may be piece dyed. A coarse grade is known as Dungaree.

Denier

A weight equal to 1/20 gramme; used in determining the size, or count, of raw silk. The number of deniers which it takes to balance the weight of a reeling of the silk 450 metres long, is the denier, or size of that silk. The two-part filament from the silk worm, 450 metres, or approximately 500 yards in length, weighs about $2\frac{1}{2}$ denier. Since raw silk usually comes from 5 or 6 cocoons, the weight is computed $5 \times 2\frac{1}{2} = 12\frac{1}{2}$ (or $6 \times 2\frac{1}{2} = 15$).

Dent

A space between the wires of a reed otherwise a split

Dhoty

A grey shirting fabric, with fancy edges used by Hindus as well as Mohammadans for loin cloths made of both coarse and fine yards. The grey dhoty has merely plain borders made by cramming grey or bleached yarn at the selvedges. The coloured dhoty has plain or figured stripes of extra warp threads, varying from half inch to several inches in width, at the selvedges, and sometimes at intervals across the width of the piece, such as, three borders saree, etc.

Diagonol

The name applied to weave of diamond shape.

Diaper Cloth

Soft-twill weave of ply or single warp and single-weft yarns in a birdseye or diamond pattern.

Dimity

Sheer white or printed fabric made with warp cords or warped weft cords.

Dirty Picks

There is really no excuse for this taking place, because the soiled yarn is nearly always the outer coils on the bobbins and quite visible. Occasional dirty bobbins are used by full bobbins being dropped on the floor and rolled about on it.

Dividend

Dividend is a number, which is divided by picks per inch or per $\frac{1}{4}$ inch, to find the size of the change wheel.

Dobbie or Dobby

A machine which takes the place of a tappet, and produces more elaborate weaves. Its capacity for pattern production is also much greater. There are numerous types, some of which are positive and others negative in their action. Upto 40 shafts can be used ; that means fancy designs with 40 different lifts can be woven with a dobby.

Domestics

A class of grey cloths plain woven of medium and heavy weights

Doria Stripes

Fabrics having stripes formed by cramming the warp in the reed dents.

Double Cloths

Two separate fabrics woven and fastened together in the process of weaving.

Double cloth is woven with two sets of warp and one weft, or one warp and two weft, or two weft and two warps, or with a fifth set of binding yarns to unite the two cloths.

The cloths woven are—ribbon, double-faced coatings, and jacquard blankets. Both sides may be alike or show a pattern reversed in colour weave—twill, satin, jacquard, combined in various ways with various finishes.

Double Ends

Two ends weaving as one in a cloth. This may be due either to a fault caused by a weaver, etc., or it may be that the cloth is specially arranged with double ends.

Double Warp

The name indicates a good quality of various cloths made from a twofold yarn.

Doups

A special arrangement of healds used for gauze weaving and so arranged that they may cause the warp threads to cross each other.

Dram

A weight equal to 1/16 of an ounce, Av., used in determining the size, or count of thrown silk, based on the weight in drams of 1,000 yards. A 1-dram silk has 256,000 yards per lb., 2 dram silk = 128,000 yards per lb., and so on. Dividing 256,000 by any dramage gives its yardage per lb. Dividing it by the yardage per lb gives the dramage.

Drills

Strong heavy fabrics woven with three, four and five shaft twill and sateen weaves, warp face. They are sold in the grey with heavily sized warps, also bleached, dyed, and in stripes.

Drop Box

A type of power loom in which the shuttle boxes have a vertical up and down movement.

Duck

A strong heavy fabric. One class of duck cloth is used for sails and is plain woven from double warp and weft. Another class is used for men's wear particularly in hot countries, and is woven by the mat or hopsack weave.

Duvetyn

Soft velvety twill effect, fine nap, and of mercerized yarns. Cotton or wool warp and silk weft.

Dynamited Silk

An expression for silk weighted with tin salts, owing to the destructive effects sometimes experienced.

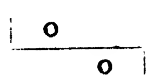
Q.—What is the diameter of a thread of 46s yarn.

A.—Number of yards in 1 lb. = 840 × 46 = 38,640 yards.

	38640.00(196.5
	1
1 × 2 = 29	286
	261
	2,540
19 × 2 = 386	2,316
	22,400
196 × 2 = 3,925	19,625
	2,775

∴ 196.5 less 10% =
19.6

177.0 diameter of 46s or 177 threads side by side will stand on one inch of space; and to produce a perfect plain cloth with 46s warp and 46s weft, 88½ threads and picks per inch will be required. This is obtained by multiplying the diameter by the ends in the pattern, and dividing by the ends, plus intersections Below is given a section of plain cloth, the circles = ends, the interlacing line the weft.



Two ends in the pattern, and 2 intersections. Therefore 117 × 2 ÷ 4 = 88½ ends and picks required. The number of threads and picks per inch in plain cloth equals half the diameter of the yarn used. Diameters of yarns vary as the square root of the counts.

The rule is a sort of general principle, however, rather than a definite guide, for it holds good in no particular case. For example 46s counts of cotton yarn gives 38,640 yards to the lb., the square root of 38,640 is 196.5. By no manipulation can 196 threads of 46s cotton be got to lie in one inch of space. It is quite possible that the actual diameters of the threads are given by the rule, but on every spun thread, there are infinite small hair protruding which hinder them from lying close. For that reason, we have to make deductions which vary considerably according to the nature of the yarns. For a hard spun cotton, 5 per cent is quite enough, for a medium cotton 8 per cent. may be allowed. Also deduct 8 per cent. for silk and linen yarns, 10 per cent. for worsted yarns and 15 per cent for woollen yarns.

Therefore 196.5 less 8 per cent. = 180.8 diameter of yarn, that is 180.8 or 180 (practically) threads will stand side by side in one inch of space.

Q.—Describe the merits of a dobby loom ?

A.—The merits of a dobby loom are, that a pattern, which is beyond the range of a tappet in the number of shafts to be manipulated or in the picks to a repeat of the pattern, can be worked by a dobby.

Q.—What do you understand by a good drive in a weaving shed ?

A.—A large drum (16-inch), little pulley (9-inch) strap long 8 or 10 times as long as distance round drum and pulley.

Q.—What is dwell in a tappet ?

A.—Dwell is the time which is given to allow for beating up, picking and shedding for a single pick of yarn.

The common practice is, for narrow looms, to have $\frac{1}{3}$ pick dwell, broad looms getting, and in some cases, even exceeding $\frac{1}{2}$ pick dwell on tappets, etc. It must be mentioned here that the time occupied by the dwell of the healds is time that could very well be employed in moving the healds for the next pick of weft, as it is also desirable for good weaving that the healds should move as slow and steadily as possible. Therefore it stands to reason that a middle course must be chosen to get all the time for shedding while retaining sufficient dwell on tappets to give the desired cover. It is also desirable that the front rest should be a fixture after having arrived at the correct height, taking into consideration the bottom warp line, and its relationship to the sley. The temple bar, if under the cloth, really acts in the same way, as the front rest. It should, as a rule, be set as close to the sley as possible but, if raised, would tend to tighten the bottom shed, and thus give cover. But it would also lift the bottom warp-line off the sley, and this would cause bad running of the shuttle.

Lease rods tend to detract from the cover effect, particularly if they be placed near to the healds and the lease an end and end one, the reason for this being that the tight threads will assume a more direct line facing the slacker threads to bend round lease rods more.

The two and two is much better in this respect as the lease rods retain in their position owing to the threads from both sheds being over or under the same rod.

Q.—What is the best time to push the star wheel forward a tooth in a dobby loom ?

A.—When the crank arm is at its front centre.

Q.—The diameter of 36s is 157 ; what is the diameter of 16s ?

A.—Square root of 26 = 6. Square root of 16 = 4
therefore 157 × 4 ÷ 6 = 104½, diameter of 16s.

The diameter of 36s = 157, threads and picks per inch required in plain cloth = 78½.

The diameter of 16s = 104½. Threads and picks per inch required in plain cloth = 52¼.

Q.—A piece of cloth is made with 78½ threads per inch, 36s yarn ; it is changed to 16s yarn ; what number of threads per inch will be required ?

A.—In changing from one count to another, to find the ends and picks required—Multiply threads per inch in given cloth by the square root of the counts of the required cloth, and divide by the square root of the counts of the given cloth.

Square root of 36s = 6 square root of 16s = 4.
Therefore 78½ × 4 ÷ 6 = 52¼ threads per inch required.

Q.—What counts must be used in changing from 78½ threads per inch 36s yarn, to 52¼ threads per inch ?

A.—To find the counts, in changing from one number of threads per inch to another number of threads per inch.

Multyply the threads in the required cloth by the square root of the counts of the given cloth, and divide by the threads in the given cloth, square the result for the answer, Square root of 36s = 6. Therefore $52\frac{1}{4} \times 6 \div 78\frac{1}{2} = 4$ and 4 squared = 16s counts.

Q.—A plain cloth is made with $88\frac{1}{2}$ threads per inch; it is changed to a 4-end twill, two up. two down; how many threads and picks will be required.

A.—In changing from one pattern to another, to find the ends and picks per inch to use—carry both patterns out until they repeat on the same number of ends. Multiply the threads per inch in the given cloth by the ends, plus intersections, in the given pattern, and divide by the ends, plus intersections, in the pattern of the required cloth.

Given cloth
o   o
  o   o
4 ends 4 intersections = 8.

Required cloth
o o
    o o
4 ends plus 2 intersections = 6.

Therefore $88\frac{1}{2} \times 8 \div 6 = 118$ threads and picks per inch required.

Q.—Can you give the years when the import duty on cotton cloth coming into India were increased?

A.—Upto 1917, the import duty on cotton cloth coming into India was $3\frac{1}{2}$ per cent., with an excise duty also of $3\frac{1}{2}$ per cent., lint in 1917 the import duty was raised to $7\frac{1}{2}$ per cent., the excise duty being untouched. In 1921, the import duty was raised to 11 per cent., the excise duty not being altered. In 1925, the excise duty was taken off. and this is the position at present.

Q.—At what time is the dwell operated by the crank?

A.—When the crank is at its back and front centre.

Q.—A piece of cloth 40 inches wide is wrapped twice round a drum 7 inches diameter. Find the number of square feet in this piece.

A.—$\dfrac{7 \times 3.1,416 \times 40 \times 2}{144} = 12.217$

Q.—Taking the diameter of 70s as 1/230th of an inch, what will be the count of a thread whose diameter is 1/308th of an inch. If with the 70s warp and weft a plain cloth is being woven 26×30 to the $\frac{1}{4}$ inch, what number of ends of the other thread must be used for a 2 and 2 twill to give a cloth of equal firmness?

A.—Square root of 70s = 8.36

$$\therefore \frac{8.36 \times 308}{230} = 11.2$$

With 70s warp and weft a cloth is woven, with 26 ends and 30 picks per ¼ inch, or 104 ends 120 picks per inch, if 125 counts are used, the number of ends and picks in plain cloth will equal

$$\frac{104 \times 11.2}{8.36} = 139 \text{ threads.}$$

$$\therefore \frac{120 \times 11.2}{8.36} = 1.61 \text{ picks.}$$

Plain cloth, using 125 counts, is changed to a 2 and 2 twill, the number of ends and picks per inch will eqaul :—

Ends 4 + 4 intersections = 8 in plain cloth.
Ends 4 + 2 ,, = 6 in 2 and 2 twill.

$$\therefore \frac{139 \times 8}{6} = 185 \text{ threads.}$$

$$\frac{161 \times 8}{6} = 214 \text{ picks.}$$

Economics

The science of the production and distribution of wealth as created by human industry and possessing exchangeable value.

Ecru Silk

Thrown silk from which very little (say 3 per cent., more or less) of the gum has been discharged, leaving it harsh and lusterless.

Eiderdown

Knited fabric of soft spun yarns, heavily napped on one or both sides.

Elasticity

The amount of stretch or pull, the yarn will stand before breaking: a very important factor in warp yarns. Testing machines are employed to ascertain the elasticity and breaking strain.

Elastic Fabric

Narrow fabric, part of warp consisting of rubber threads.

Elongated Twill

Twilled cloth, in which the wale extends a greater distance than usual before reaching the other side of the fabric, caused by weaving two or more picks before altering the risen ends forming the wale. These twills do not run at an angle of 45 degrees.

End

The technical name for a warp thread 60 ends per inch means 60 threads of warp yarn per inch.

Expanding Swift

A wooden winder swift (for silk winding) with a bevel gear hub, meshing in with bevel gears at the foot of each arm. According to the way the hub is turned, the arms will work out, or in, thus changing the outer circumference.

Expanding Wraith Reel or Comb

The comb at front of the machine through the teeth of which the threads are divided. Kept equidistance from one another, and contracted or expanded to any required width.

Extra Warp

The term given to warp threads which are added to a single cloth with the object of :—

(*a*) Increasing the weight of cloth.

(*b*) Figuring the cloth or,

(*c*) Both increasing the weight and figuring at one and the same time.

Q.—It is desired to make 3 lbs. of 40s cotton into a warp 56 yards long, how many ends will it contain, if the warp must occupy 30 inches in the reed ?

A.—$\dfrac{3 \times 40 \times 840}{56 \times 30}$ =60 ends per inch.

Q.—A stripe is to be formed as follows : 60 ends of blue (2 ends in a dent), 40 ends of red (4 ends in a dent), 24 ends of blue (2 ends in a dent), 20 ends of red (4 ends in a dent), and made in 80 reed or 40 dents per inch, width of piece 32 inches in the reed. How many ends of each will be required ?

Ends	Dents
60 blue	30
40 red	10
24 blue	12
20 red	5
144 total ends	57 Dents in one pattern

Thus 32 inches × 40 dents (80 reed) = 1,280 dents.

Then 1,280 divided by 57 (dents in a pattern) = 22 patterns and 23 dents.

These 23 dents must be dealt with, and it will be convenient to add them to the blue.

Therefore, 84 dents (ends of blue) × 32 (patterns) = 1,848 + 46 for the 23 dents (left over) = 1,894 (ends of blue).

There are 60 (ends of red) × 22 (patterns) = 1,320 ends of red.

Thus, giving a total of 3,214 ends (1,894 + 1,320) in a warp.

Q.—Find the number of warp ends that cloth would contain 30 inches wide, 80 reed, reeded or dented 2 ends in a dent. Allowing 20 ends for selvedges extra ?

A.—Add 2 to reed (80 + 2) = 82
82 × 30 (width of cloth) = 2,460
2,460 + 20 ends for selvedges = 2,480.

Q.—A warp 1,000 yards long, 50s counts of yarn, weighs 10 lbs How many ends does it contain ?

A.—$\dfrac{80 \times \text{counts} \times \text{weight}}{\text{Length}} = \text{ends.}$

$$\frac{840 \times 50 \times 10}{1{,}000} = 420 \text{ ends.}$$

Q.—Enumerate the factors to be considered when reckoning for warp contraction.

A.—In the case of warp contraction, the following actors enter into consideration :—

(1) The nature of yarn.
(2) The thickness or count of yarn.
(3) The tension of yarn.
(4) The intersection of the threads (class of weave).
(5) The number of picks inserted per inch of weft.

Q.—Suppose you are weaving a plain cloth with 60 ends per inch, and 60 picks per inch equal counts of warp and weft and you wish to make a 4-end twill using the same yarns. How many ends and picks per inch would you put in to make a cloth of similar firmness ?

A.—For example, the 4-end twill to be an ordinary one, 2-end up out of 4, there would be two intersections in 4 ends, that is 4 ends and 2 picks passing through equal to 6 threads.

In 4-end of plain, there are 4 intersections, 4 ends and 4 picks equals 8 threads. Then, with the same reed and pick and yarns, the twill would be looser, or to make it as firm, it must be increased at the proportion of 6 to 8 or

$$\frac{60 \times 8}{6} = 80 \text{ ends and } 80 \text{ picks per inch.}$$

Fabric (Woven)

Is the name given to any material prepared by the regular interweaving of threads or threadlike bodies by the aid of mechanical appliances or, in other words, two series of threads which cross one another at right angles and interlace with one another according to the style of structure required.

"Fabric Construction" (Woven Material)

There must be sufficient warp and weft threads. The weave must be uniform, the "surface interest" must be reasonably permanent.

"Fabric Purity"

The fabric must be free from excessive weighting and adulterants that would tend to shorten its life. Finishes must be reasonably permanent.

"Tensile Strength"

Fabric must be durable enough to withstand fair wear and tear Seaming qualities must be satisfactory.

"Washability or Dry-Cleanability"

Fabrics or garments not intended for washing are tested for dry-cleanibility. Washable tested fabrics must pass washing tests with minimum shrinkage.

"Colour Fastness"

In dry-cleaning, washing, and hot-pressing.

"Resistance to Fraying"

This must be satisfactory and there should also be all-round wearing satisfaction.

Fancies

A general term that includes all styles of fancy fabrics, as distinct from plain cloths, twills, etc.

Feel

A term used to denote the condition of the threads after passing through the sizing machine as recognised by the touch.

Feel or Handle

A term used by both buyers and sellers to denote the peculiarities of a cloth when handled, such as :—

Boardy Feel—Yarn is hard or harsh or sized too hard.

Thin Feel—Cloth is very thin in handle.

Crackly or Paperlike—The cloth has the peculiar crackle of paper.

Full and Clothy Feel—The conditions generally required.

Fell (CLOTH)

The edge of the fabric (in the loom) which has most recently woven, *i.e.*, the last pick of weft forming cloth which is beaten up by the sley.

Fents

Short damaged lengths of cloth or short length cut from piece end.

Fibre Content

Many novelty yarns are now prepared in which almost every fibre has been combined to produce unique effects. By the use of microscope and chemicals this can be found out.

Figured Cloth

Fabrics having a pattern formed upon them by the order of interweaving of the weft and warp of which they are composed.

Figured Twills

Figures running diagonally across the fabric.

Filament

Individual strand of an artificial silk thread.

Filling

Another word for weft.

Finishing Cloth

The cloth is coated with filling substances, and has a gloss imparted to it greatly improving the appearance of the fabric and gives it a certain feel.

Fixing

Tackling.

Flake Yarn

A fancy yarn, usually with a cotton foundation, showing flakes, or slugs; of untwisted fibres at intervals.

Flax

Is cylindrical and regular, which knots like bamboo at regular intervals, walls of fibres uniform in thickness and a fine internal channel, ends of fibres fine and tapered.

Floats

Where the weft and warp of which it is composed do not interweave with each other. Sometimes, patterns are formed by floats only, and sometimes, floats are formed accidentally in the process of weaving and produce imperfection—the faults is that one or more warp ends have broken, and before the weaver has detected the same, these broken ends have become entangled with adjacent ends, thus compelling them to be always either raised or lowered, and thus float on the surface or be under the cloth respectively instead of interweaving in the ordinary manner.

Floss Silk

A soft silk yarn, practically without twist, used for embroidery. Also waste silk thrown off by the worm before beginning its cocoon.

Flue

One lap of the folded cloth.

Folded Yarns

Are single yarns folded together, thus 2/60 cotton means that two threads of 60s cotton are doubled together, giving 20 hanks of the twofold yarn per lb.

Folding

The process of arranging the cloth in superimposed layers, each of the same length (generally 36 inches), so as to provide a suitable form in which the fabric may be baled.

Fork

The small pronged instrument acting as a stop motion on the loom when the weft fails.

Fringes

Threads or cords grouped or bound together and loose at one end.

Frog

A cast iron buffer for the stop rod of a shuttle protected of the fast reed type.

Fustians

A class of strong heavily wefted fabrics chiefly used for riding suits, also in lighter makes for ladies' wear. In the principal variety the weft is flushed on the surface to form "races" or rows of floats which can be cut by a finely pointed knife to form a dense pile of the several threads.

Q.—Discuss fully the location of a folding department ?

A.—The folding department should be as near weaving department as possible which saves a lot of time of the weavers. Also the arrangement of the machinery in this room should be such that it will enable the cloth to be treated with the least amount of handling and the greatest economy. The machines that are used should make an improvement in the cloth between its leaving the loom and being packed into bales with least amount of handling, and hence expenditure so that the mills will make a name and profit by it. There will always be a great demand if the cloth is well made, well finished and well baled.

Q.—Would you suggest large flanges for the weaver's beam or small flanges, and necking the yarn, and why ?

A.—I would suggest the flanges to be sufficiently deep to take up all the space allowed between the bottom binder and the back rest in the loom. By this not only the yarn is kept straight to receive the striking comb but it saves the yarn especially the sides from getting damaged.

Q.—What is the formula to find the speed of tappet ?

A.—The formula is :—

$$\text{Driving wheels} \times \text{picks to the round} = \text{driven wheels}$$

$$\text{Therefore, picks to the round} = \frac{\text{driven wheels}}{\text{driving wheels}}$$

$$\text{or, one driving wheel} = \frac{\text{driven wheel}}{\text{picks to the round} \times \text{the other driving wheel}}$$

$$\text{or, one driven wheel} = \frac{\text{driving wheels} \times \text{picks to the round}}{\text{the other driven wheels.}}$$

Q.—Give a quick and ready method to ascertain whether a fibre is animal or vegetable.

A.—Apply a light on it. If it is animal, the fibre will gradually smoulder an die out unless the light is kept constantly in contact, a peculiar smell is also given off. In the case of vegetable fibres, when a light is applied, it will rapidly burn up the fibre, and leaves a little carbon behind.

Q.—What is humidity ?

A.—The ratio of the actual amount of water vapour in a given volume of air to the amount which would be present were the air saturated, expressed as a percentage, is termed the relative humidity.

Q.—How would you ensure the smooth running of a loom ?

A.—The jobber or the loom-tackler must see that the picking bowl and the picking neb are adjusted properly. Too much lowering of the picking neb results in harsh picking. When the picking neb is worn out, it is a practice with many jobbers to chip off the entire portion of the neb to give a sharper curve which gives sufficient force to the picking stick. But this requires great skill on the part of the fitter, for if this is overdone, it reseults in the knocking off of pirns. The jobber or tackler has also to see that the picking is not unnecessarily late. For plain cloths, an early picking is desirable, but in other sorts, *e.g.*, drills or satins, dobby and jacquard cloths, late picking is often preferable, but this has to be done very carefully for a limit is soon reached which, if transgressed, leads to bad working and knocking off of pirus, which means more waste for the weaving department. Soft and badly wound weft-pirns, received from the spinning department, are the main source of knocking off of pirns. Soft bobbins are caused by slack spindle banding, too little twist and too light a traveller. Pirns which do not fit firmly on the spindles, pirns of diverse shapes and sizes all mixed together, are also a prolific cause of soft and badly wound bobbins. The speed of the ring-rail traverse is a very important factor and very often does receive all the attention that it deserves. Coarse counts require the traverse motion to be speeded up so as to secure a firm binding of the layers of yarn. This principle applies also to the universal pirn winding, where it is often advisable to increase even the length of the traverse to keep the yarn securely bound. Proper adjustment of the tension-weights is necessary, when counts are changed, to ensure a firmly built bobbin. In the ring frames, the corresponding adjustment consists in properly selecting the size of the ring-traveller which regulates the spinning tension.

Q.—What are the points to be considered for producing a perfect fabric ?

A.—The points to be considered are (1) the purpose of wear that the fabric will be subjected to (2) the nature of the raw material to be used in its construction (3) the counts of the yarns and their amount of twist (4) the texture (number of ends of warp and picks of weft per inch) to be used, (5) the weave of cloth (6) the process of finishing and the shrinkage during this operation. The more wear a fabric is subjected to, the closer in construction the same must be; also the stronger the fibres of the raw material as well as the amount of twist of the yarn.

The selection of the proper quality of the material to use in the construction of a fabric is a point which can only be mastered by practical experience. No doubt a thorough study of the nature of the raw materials, as well as the different processes they undergo before the thread as used by the weaver, (either for warp or weft) is produced, will greatly assist the novice to master this subject.

Q.—Give the process of "fabric proofing."

A.—Fabric proofing comprises three processes: "flame-proofing," "water-proofing" and "moth-proofing." To these might be added rot proofing and mildew proofing.

"Flame proofing" is a process only applied to vegetable fibres, for animal fibres are flameproof of themselves To flameproof them, fibres are generally impregnated with metallic salts. The number of substances used is very large, namely: ammonium salts, Epson salts, and water glass. Most of these substances are removed by washing, though sodium tungstate is permanent but dear. To get a flame-proof fast to washing, a double process is often given. For instance, by impregnating with borax and boric acid and then with lime water or calcium chloride. They may be applied separately or as part of the filling of the fabric. It is possible to combine flame-proofing with certain of the waterproofing processes, *e.g.*, it can be incorporated into the soap-alum waterproof. The method in which flame-proofing agents function is as follows:—

(1) The substance melts at a comparatively low temperature and so covers the fibres with a non-inflammable layer.

(2) The substance volatilises at a comparatively low temperature or gives off non-inflammable gasses such as ammonia.

(3) The heat of the flame is absorbed by physical or chemical changes it causes in the substance.

(4) The substance is a remarkably good conductor of heat and dissipates the heat of the flame by conduction, "waterproofing."

(5) Porous waterproof material, where the material has the property of not being wetted or of being very slowly wetted by water, and of not allowing water to enter and penetrate, but on the other

hand it must allow the passage of air. It is impossible to render porous waterproof material absolutely and permanently impervious to water. Methods of waterproofing coming under this heading may be applied before or after weaving.

(6) Non-porous waterproof material which is absolutely and permanently impervious to air and water. A rough test to distinguish between the two methods is to try and blow cigarette smoke through the fabric which of the two methods shall be used depends on the nature of the fabric and the use to which it is to be put. Pure wool fabrics are very rarely treated by other than proous methods, but both methods are largely used on union fabrics and cotton and cotton vegetable fibre fabrics. The waterproofing of artificial silk has assumed great importance during the last few years; acetate rayon is most generally favoured for this purpose owing to its superior strength to other artificial silks when wet.

Gabardine

A stout fabric having fine but distinct and closely placed diagonal ribs on the face.

Gait

The adjustment of a loom.

Gantrees

Beams or girders to support jacquard machines over power loom.

Gassing

Protruding fibres on cotton yarns or cloth are singed over gas flames, making a smooth surface. Only the better qualities of yarn are gassed, such as that used for voiles, poplins, etc.

Gauge

A fixed templet, employed as a quick, means of making certain articles with reference to machinery.

Gelatin Silk

One of the earliest forms of artificial silks, the filaments of which were usually treated with formaldehyde.

Gauze or Leno

A light open texture of great strength in which warp threads twist wholly or partly round each other. Especially constructed healds termed "doups" are employed in weaving to permit of "crossing" threads being raised first on one side, and then on the other of the crossed threads.

Gingham

Woven in checks, plaids, and stripes, unlimited variety of colour combinations and several grades. Lightweight fabric woven in yarn-dyed stripes, checks, or plaids in variety of weaves and finishes.

Georgette

Thin, silk fabric, dull in texture, with crepy effect due to tightly twisted yarns in both warp and weft. Right and left hand twists alternate. Weave-plain but woven in the gum, degummed before dyeing ; piece dyed or printed.

Goal

A gap caused in a piece by the cloth being drawn forward without the weft interweaving especially when used to mark the end of a piece.

Granderells

A fancy yarn produced by twisting two or more single threads of different colours or fibres together.

Grenadine

An open-mesh silk dress fabric, in which the warp ends twist round the weft picks, thus preventing slippage.

Grenadine Twist

Hard twisted organzine suitable for the warp of Grenadines, which must stand severe friction. Usual twists run between the limits of 20/18 and 60/60 turns per inch.

Grey

Yarn or cloth in an undyed or unbleached state.

Grist

Synonymous with counts.

Ground

That portion of a fabric, usually of a simple weave which serves as a base in which, to display a figure.

Gum Silk

Thrown silk from which the gum has not been boiled off.

Guz (Bombay)

1 Guz = 27 Inches.

Hammock Cloth

Strong soft cloth usually woven with bright-coloured warp, plain and fancy weaves.

Hank

A fixed length of yarn which varies for the various materials. Cotton 840 yards, worsted 560 yards, linen 300 yards, woollen 256 yards, raw silk 1,000 yards, spun silk 840 yards, etc.

Hairy Yarn

A thread that appears to be covered with hair. Canton silks are usually hairy.

Hand

1 Hand = 4 Inches.

Hard Silk

Silk from which the natural gum has not been removed.

Harness

The arrangement of leases in a Jacquard healds.

Headings or Cross Borders

Bar of coloured wefts placed at the end of each piece of cloth for distinction from other pieces. These headings are very fanciful and intricate in some instances, ranging from the simple stripe heading of 2 or 4 picks to the extensive sarie heading 15 or 20 inches in length. In the case of a certain class of goods having a range of widths, a bar of 2 or more picks of various colours or cords (colours or cords show the different widths) is inserted just close to the end of the piece.

Heald Trap

Means that the shuttle has been caught in the shed and a good number of ends broken owing to one or more healds having broken and become entangled with adjacent ends behind the reed, thus preventing these ends from being properly lifted, or lowered.

Heating

In textile factories, heating is usually obtained by the use of steam. The most efficient method of steam heating is through the use of unit heaters coupled to fans.

Hemp

Similar to flax, but the ends of the fibre are flat, large and thick.

Hollands

Plain weave and medium or lightweight; finished to imitate linen. Usually glazed or heavily sized.

Honey Comb

A weave which produces marked ridges and hollows, thereby causing the surface of the fabric to resemble that of honey comb.

Hopsack

A mat or dice weave formed by running two or more ends and picks together.

Huchaback

The short floats of warp and weft and the plain ground of these weave give a rough surface combined with a firm structure which is particularly suitable for towelling fabrics.

Humidification

Water vapour can be introduced into the atmosphere either by spraying liquid water or by introducing steam. The results are far from identical in the two methods. Humidification by the addition of water at room temperature increases the relative humidity of the atmosphere by putting the dry-bulb temperature down to wet bulb, leaving the latter unchanged. Humidification by the addition of steam increases the relative humidity of the atmosphere by raising the wet bulb temperature upto the dry bulb, the latter a'so being raised but much more slowly.

Q.—Name the principles of humidification.

A.—In general, ventilation and humidification may be carried out in three distinct ways :—

(*a*) By injection of steam into the shed or into the in-coming air.

(*b*) By passing the whole of the ventilating air over surfaces kept moist by means of cold or warm water.

(*c*) By atomising water and using this to super-saturate either the in-coming air, or by injecting the atomised water directly into the shed.

Q.—What quantity of coloured yarn would be required for the purpose of inserting a heading in a piece of cloth ?

A.—Multiply the number of picks of coloured yarn required to be inserted by the reed space and divide by 36 inches (in a yard) = yards. Then yards ÷ (840 × counts) = weight.

Imitation Leather

Various cotton fabrics treated and covered with a pyroxylin coating or other chemical compound.

Indian Linen

Fine, closely woven of combed yarns.

In the Gum

Silk in its raw or natural state, before degumming. It contains sericin or silk gum which makes it stiff and dull.

Inspecting

The examining of cloth received from the weaver, with a view to detect faults in the fabrics, taking suitable action thereon to prevent a repetition of them.

Interlace

This relates to the crossing of warp and weft; the order of the interlacing in the weave prescribing the structure of the cloth'

Intermate

The term applied to the felting or shrinking of cloths, the fibres intermating or felting together.

Intersection Theory

The theory of cloth construction determined by the number of certain intersections or interlacings between warp and weft yarns and their relative diameters.

Irvona

Staple fibre made by Artificial Filaments, Ltd.

Jack

A type of lever in dobby looms in connection with the lowering and lifting of the healds shafts.

Jaconets

Plain cloths, about 20 yards in length.

Jacquard

A pattern machine used for the production of floral and other ornamental designs in cloth weaving where the adoption of Tappet or Dobby would be useless. These machines are especially constructed for different kinds of work, the chief makes being single cylinder, two cylinder, cross border and twilling jacquard.

Jeans

Similar to drill but more closely woven and finer.

Jersey

Knited fabric.

Jute

Has stiff, cylindrical fibres. Walls irregular in thickness and a larger central channel, straight fibres like grasses, smooth and round ends.

Q.—What are the principal points to be considered when installing and arranging looms ?

A.—The operation of weaving, is such that the room in which it is carried on should be well lighted. The most suitable building is a shed with a well-lighted roof, the skylights facing in a northerly direction, as a more uniform light is then assured and the direct rays of the sun eliminated. The roof should be supported by pillars, which also serve to carry the line shafts. The size of the bays is determined by the class of the loom to be installed. The floor may be stone or concrete. The looms should be placed with their main or crank shafts at right angles to the sky-lights, as this admits of the light falling sideways on the loom, and consequently prevents any obstruction of light from the weaver or top rails of the loom when repairing broken ends, etc. As the looms are made both right and left hand they can be arranged or grouped together in various ways.

Q.—Assuming that the depth of the shed is $1\frac{1}{2}$ inches, the distance from the fell of the cloth to the heald 10 inches, and the distance from the fell of the cloth to the front side of the shuttle when the sley is on the back centre is $4\frac{1}{2}$ inches, what is the lift of the heald ?

A.—Rule :—

Multiply the distance from the fell of the cloth to the heald by the depth of the shed, and divide by the distance from the front edge of the shuttle to the fell of the cloth.

$$\frac{10 \times 1.5}{4.5} = 3.33 \text{ inches.}$$

Q.—How would you ascertain the number of jacks required for the pattern to be woven ?

A.—If a less number than the size of the Dobby, the order of jacks left idle must be noted. Supposing there are 12 jacks required and the size of Dobby is 16 shafts, the jacks not in action being the last four. Now, if the space between the sley and crank shaft was not designed for Dobby work, it would be safer to leave the first two and last two jacks idle, and so prevent the sley cap from touching the first heald when the crank is at the back centre.

Khaki

Heavy, stout, twilled cotton fabric, of various grades, dyed khaki or dust colour.

Kichoyl

Viscose silk made by Kirkless Artificial Silk Co.

Kink

A snarl or curl produced by a hard twisted thread receding upon itself.

Lace

An open perforated fabric produced by the threads of which it is composed being twisted together in such a manner as to form a pattern.

Lag (Dobby)

The small pegs fixed in the lattice for working the knives of a dobby machine are termed lags.

Lagging Back

The operation of reversing the pattern chain with the object of removing defective picks, etc.

Lanital

A protein material whose elementary chemical composition is somewhat similar to wool, except that the sulphur content is only about 0.7 per cent. instead of nearly 4 per cent. for wool. Under the microscope the fibre is fairly smooth and equivalent in diameter to the wool fibre. There is little or no crimp or scale formation.

Lappet

A frame containing eyed needles which can be moved horizontally and vertically in front of the loom reed, extra warp threads are passed through the needle eyes, and both are pushed through the warp before the passage of the weft to secure the extra thread into the ground cloth which may be either plain or gauze woven. The frame is then returned to its original position, and moved horizontally at a varying distance according to the outline of the figure required before entering the shed for the next pick.

Lathe

Synonymous with a sley, also a machine by which articles of wood, ivory, metals and other materials are turned and cut with a smooth round form.

Lawn

A very fine, plain, woven-fabric.

Lay

For sley.

Lea

The seventh part of a hank, that is, 120 yards cotton yarn.

Leaf

A heald or a plate of the shedding Tappet, *e.g.*, three-stave twill.

Lease

The division or separation of alternate threads in the warp.

Leno

(Mock) or imitation lenos are ordinarily woven cloths, that is, the warp thread do not cross each other, but the open effect is less pronounced and the fabric is not so strong.

Let-Off

A class of appliances devised to regulate the length of yarn given off by the warp beam to the need of the weave.

Lingo

The weight below the leashes in the Jacquard. A thin wire having an eye at one end; used as a weight on the end of each Jacquard harness thread.

Lining

A fabric used for dress and coat lining, finished to give a smooth lustrous surface.

Loaded Silks

Silk fabrics that have been weighted or loaded with some form of chemical substance. The loading is adulteration.

Long Cloth

A plain woven cloth used for the making of under garments. It is also sold in the bleached state.

Loom

The machine used for combining and interlacing the warp and weft threads so as to form cloth. Each loom is fitted up to suit the particular class of work required, that is, either with a Lappet, Dobby, or Jacquard shedding motion. A loom with one shuttle box at each end of the sley is called a plain loom and would only admit of one colour or counts of weft being inserted with the warp. Some looms are fitted up with more than one shuttle box at the end of the sley, and are termed multiple box or check looms. These are capable of producing various coloured patterns in the cloth known as check cloths. Power looms are required to be worked steadily whether by steam motive or by power (motors). The power loom is automatic so far as regards its essential movements which are described under various headings, such as, shedding, picking, etc., for the production of cloth.

Loom State

Cloth, when woven and removed from the loom, is known as "loom state."

Loongyees

Coloured check cloths with self-coloured crammed edges of mercerised or ordinary yarns for scarves.

L.S.

Abbreviation of long stick.

Lousy Silk

Silk which exhibits many small light-coloured specks on its surface, principally due to the splitting and curling up of fine fibres.

Luvisca

A mixture fabric containing a cotton warp and an artificial silk weft manufactured by Messrs. Courtaulds, Ltd.

Lubricating Oil

The National Physical Laboratory reports that 0.05 per cent. of water added to lubricating oil reduced seizing temperature of bearings from 200°C to 140°C and at the same time there was an increase of 40 per cent. in the friction.

Q.—How many types of power loom are there? What are the advantages of each type?

A.—There are three types of power looms, *viz.*, the Tappet loom the Dobby loom, and the Jacquard loom. The chief advantage of the Tappet loom is its quick and regular action, enabling cloth to be quickly woven, and at the same time giving the jobber complete control over the action of the warp, and consequently a better chance of making a more satisfactory cloth than in either the Dobby or Jacquard loom. Its chief disadvantage is its very limited capacity for weave effect, about eight shafts. The chief advantage for the Dobby is its greater capacity, working up to thirty-six or forty-eight shafts, and the readiness with which the pattern may be changed; wooden lags and pegs are employed.

The chief advantage of the Jacquard is its greater figuring capacity, working in its simplest form about 100 different orders of threads (heald or neck bands), and in its more complex form up to 1,800 different orders of threads. Thus if a warp contains 1,800 ends, every end may be worked, independently.

Q.—Is there any part of a loom driven by friction or contact?

A.—Yes, the cloth roller.

Q.—How would you reduce the wastage of "leather" in the weaving shed?

A.—The leather belt is formidable item in the weaving costs, but it can be reduced by attention to detail. Loom belts are ruined by only running half-way on the fast driving pulley. Worn picking sticks nip and tear the leather bands to such an extent that new bands sometimes only last a week or two. New sticks are a great saving in this instance. Leather buffers are often set too near the spindle stud, and the constant banging of the picker forcing the buffer against the stud quickly shortens the life of the leather buffer. Picking bands last longer if the hair side is put to the picking stick. Belts not running correctly on the drum, often owing to incorrect position of the drum on the shaft, cause one belt to "ride" on another. This has a premature stretching effect on the loom belt and shoftens its life. New belts are speedily ruined if put up incorrectly, *i.e.*, with the piecing running the wrong way.

Q.—In a loom with a crank shaft wheel of 20 teeth, and a tappet shaft wheel of 120 teeth, what intermediate wheels must be used to drive the tappet 7 picks to the round ?

A.—Picks to the round $\times$ drivers = driver intermediate
Driven wheel = driver intermediate.
Therefore, $7 \times 20 = 140$ driven.
$120 =$ driver.

The two wheels are, therefore, 140 and 120, or any ratio of these two numbers, say, 14 and 12, 28 and 24. 42 and 36.

Q.—How would you determine the Speed of a loom. What is the formula, what percentage would you allow for belt slippage.

A.—The speed of a loom is determined by the following formulæ :—

$$\frac{\text{Speed of line shaft} \times \text{diameter of drum}}{\text{Loom pulley}}$$

5 to 7 per cent. may be allowed for belt slippage.

Q.—Name some of the sundry defects in a loom ?

A.—(*a*) Badly fitted beam bearings ; (*b*) unequal friction applied to etch ruffle ; (*c*) faulty letting-off motion ; (*d*) badly geared wheels in the take-up motion ; (*e*) teeth worn or broken in the take-up motion ; (*f*) back rest making contact with the rim of the beam flanges ; (*g*) crank arm loose ; (*h*) non-adjustment of weights periodically ; (*i*) insecurely held reed ; (*j*) unequal lifting of the healds ; (*k*) pivots of cloth roller loose or badly worn ; (*l*) mixed cops or bobbin.

Q.—What is the aim and object of automatic weaving ?

A.—It is (1) to weave perfect cloth ; (2) to weave large quantities of the same cloth ; (3) to weave fancy cloths better ; (4) to reduce the cost of production ; (5) to improve the working conditions of the operatives.

Q.—How would you peg your lattices for left and right hand Dobbies ?

A.—If a right-hand dobby commence pegging at the top right-hand side or bottom left-hand side of the lattice. For a left-hand dobby commence pegging at the top left-hand side or bottom right-hand side of the lattice. Always arrange the plan with the working of the first heald at the left-hand side and the first pick at the bottom. Then read left to right, and after the bottom row has been pegged, place a cord or some guide over the lines pegged, in order to prevent confusion during the reading. After the lattice is pegged, be sure all the pegs are level, and also check each row off. Then turn the lattice over and shake it to see if any loose pegs drop out. If the holes are worn and gone large, a different gauge of pegs should be obtained and kept especially for the old lags.

Q.—Try to point out some improvements as to how you could make a loom run smoothly, also state how you get a loom to run perfectly and not to knock a single cop off.

A.—Pick soon, pick easy, pick light, crank arm adjusted, sley swords correct in height, loom level, reed firm, and boxes just sufficiently light to control the shuttle. If cops knock off, it is generally the loom in the picking or the boxes.

Q.—What is the lift of the jack lever when the lift of the heald is 3.33 inches, assuming a distance of 9 inches between the centre of the cross-rod and the jack-rod connection on the jack lever, and 6 inches from the centre of the cross-rod to the half-moon leather ?

A.—Multiply the lift of the heald by the distance from the centre of the cross-rod to the jack-rod connection on the jack lever, and divide by the distance from the centre of the cross-rod to the half-moon leather.

$$\frac{3.33 \times 9}{6} = 4.99 \text{ inches.}$$

Q.—A line shaft carrying a 15-inch drum making 105 revolutions per minute drives a loom pulley 10 inches in diameter. Find the production of a loom in 10 hours of a cloth which has 50 picks per inch at 66% efficiency.

A.—Speed of loom $= \dfrac{150 \times 15}{10} = 225$ speed of loom.

$$\frac{225 \times 60 \text{ (minutes in one hour)} \times 9}{50 \text{ (picks per inch)} \times 36 \text{ (inch in a yard)}} = 67\tfrac{1}{2} \text{ yards.}$$

✓ *Q.*—A loom makes 200 picks a minute and the shuttle is moved through a space of 5 feet in $\frac{3}{8}$ of a pick. Find the average speed of the shuttle in feet per second.

A.—The shuttles move 5 feet in $\frac{3}{8}$ of a pick, in one pick it will move through $5 \times 1 \div \frac{3}{8} = \dfrac{5 \times 1 \times 8}{3} = 13.33$ feet per pick.

∴ the feet per second will be equal to :

$$\frac{13.33 \times 200 \text{ picks per minute}}{60} = 44.40 \text{ feet per second.}$$

Q.—How would you make a loom stop 2 picks at the starting handle side of the loom when the weft breaks ?

A.—I would adjust the brake.

Q.—How would you determine a loom pulley ?

A.—$\dfrac{\text{Diameter of drum} \times \text{revolution of driving shaft}}{\text{Picks per minute.}} = \text{pulley.}$

Q.—What are the causes of loom not stopping when the weft is broken ?

A.—Prongs of the fork touching the sides or the bottom of the groove cut out in the sley.

Q.—Give some of the reasons of loom stopping when the weft is not broken.

A.—Prongs of the fork not projecting far enough into the grate ; shuttle touching the weft fork in passing slack trail of weft ; shuttle rebounding ; defective check strap, wrong turning and setting of weft fork motion.

Q.—Explain when a loom will not run with perfect ease.

A.—When the crank and tappet shafts are not working easily in the bearings or the wheels not geared freely or bind in each other. Swing rail bearings not dead in line or equal distance from the front of the loom. Defect in picking motion ; loom not fixed firmly to the floor ; neglect in oiling.

Q.—Assuming two looms to run at the same speed, and that the crank of one loom describe circles $5\frac{1}{2}$ inches in diameter, that those of the other describe circles 7 inches in diameter ; what relation will the beating up force of the last named bear to the first ?

A.—Let X equal the loom with $5\frac{1}{2}$ inches cranks.

Let Y equal the loom with 7 inches cranks

Then $5\frac{1}{2}^2 = X = 30.25$

Then $7^2 = Y = 49.$

The relation in the force of beat up that Y bears to X is as 49 is to 30.25, or as 1.619 is to 1.

Q.—If 160 lbs. of weft yarn was found to beafter drying of moisture 130 lbs. Find how much moisture did it contain

			lbs.	ozs.
			160	0.00
A.—Weight of yarn	lbs.	ozs.		
weight of yarn after drying moisture =	130	0.00		
+ $8\frac{1}{2}$% for moisture =	11	0.08		
lbs.	141	0.08		
			141	0.08
Less in weight due to excessive moisture =			18	15.92
				11.87%

Manufacturing

In the general acceptance of the term, manufacturing is understood to refer to the whole range of processes which convert a raw material into the finished article but whatever that word may usually signify, in the cotton trade it is technical for the department only, which comprises the conversion of cotton yarn into woven fabric.

Mash

A smash or trap which is applied to a breakage of warp threads in a loom through a faulty working, especially the shuttle being caught in the shed.

Melange Yarn

A single yarn spun from roving dyed in two or more colours.

Mercerized Cotton

Cotton yarn (or fabric) which, after being treated with cold caustic soda solution while under tension, and then washed, acquires a silky appearance in the process. It is called after Mercer, who introduced the method.

Metric Count

A No. 1 yarn weighs 1 gramme for a meter = 1 kg. for a thousand meters. No. 100 weighs 1 kg. for 100,000 meters, etc.

Merino

The merino wool is the typical wool of commerce. It is the highest type of wool and the fibres are beautiful, delicate, lustrous, and it can be spun into the finest wools. Their regularity is obvious, and in proportion to area their strength is greater than any other. Their felting proportions are also of the best.

Mexican

A plain grey cloth usually 24 to 30 inches wide and 48 yards long, about 14 × 14 reed and pick and medium sized warp.

Microscope

The microscope is an instrument for the observation of very minute objects which are not observed by the naked eye. It is a combination of lances.

Mineral Fibre

Asbestos, glass and metals.

Monofil

A single untwisted filament produced through a nozzle with one orifice, and has the appearance of horse hair. Generally used for foundation of hats.

Motes

Spots on spun yarn due to crushed seed or leaf which has not been freed from the cotton fibre during the spinning processes.

Mouline Yarn

A yarn composed of two differently coloured yarns.

Mungo Yarns

This is elall-wool yarn, and differs from shoddy in the material it is made from. Hard woollen cloths, carded and milled rags, are torn up. All the dirty old woollen rags are used for mungo, so the process of tearing must of necessity be a most thorough one. These yarns are very much inferior to shoddy yarns, and are made in various quaities. The rags are first sorted into the different grades from the new to half-rotten rags received from rag pickers and other sources. The better classes are very useful to the manufacturer, and are superior in quality to angola yarns. They are used for backing medium and low-class goods, and some fine cloths are backed with them. They make good imitation tweed yarns for backing cloths. The material may have a very fine face and yet be backed with weft of mungo. In some very low goods they are used as weft for cotton warp cloths. Both mungo and shoddy are treated in the same manner, but the yarns are entirely unlike in character.

Muslin

A light woven plain texture used for summer wear.

The name Muslin is derived from the ancient city of Mosul where it was first made.

It is a firm plain white cotton fabric, stronger and heavier than long cloth. Sized lightly except in lower or poorer qualities. Heavy and wide muslin is called sheeting. Widths 36, 42 and 45 inches.

Q.—What are the fundamental motions necessary in all looms ?

A.—The fundamental motions on all looms are (1) shedding; (2) picking ; (3) beating-up. Other motions are auxiliary.

Q.—Explain how to and fro motion may be converted into an irregular circular motion.

A.—In a power loom, the circular motion of the crank shaft gives a backward and forward motion to the sley sword, this is due to the pin in the sley sword being fixed on a higher plan ethan the centre of the crank shaft, if the order is reversed, and the sley sword becomes the moving power, and moving at a uniform rate it will communicate an irregular circular motion to the crank shaft.

Q.—Why does prevention pays better than repairing—cotton machinery ?

A.—Squeaking machinery, and burning bearings reduce the profits. Preventing needless repairs pays much better than remedying afterwards. Repairing and remedying is always very costly. This is bécause the cost is not confined to the repairing or replacement charges. It often occurs that before a machine is repaired that it has made some bad work. The machine has to be atopped to be repaired. This entails a loss to production and therefore a loss of profit.

"Measured Length" System

In this system of weaving, pirns containing a measured length of weft are used, and a special stop motion is fitted to the loom to stop the latter after a certain length of weft, corresponding to the length of weft on the pirn, has been used. An attachment can be fitted to pirn-winding machines in order to ensure a uniform length of weft on each pirn. The loom stop motion can be set to stop the loom after any length of weft has been woven, and the stoppage is effected without anypart of the motion contacting with the weft or the weft fork. It is claimed that the system does away with the need for weft feelers and, by stopping the loom just before the weft "runs out," reduces the weft waste to the minimum. Another advantage is that by stopping the loom before the weft is completely exhausted from the shuttle, pick finding is elimanated, and even the most delicate fabrics can be woven without the slightest trace of starting or joining places where multiple shuttle-box looms are installed, it is claimed that production can be increased considerably by adopting the "measured length of weft" system and allowing all the shuttles to weave out before the loom is stopped and the weft replenished. For instance, if 3,200 yards of fine weft is wound on each pirn, then in a six box loom, six pirns will weave for a period of two hours at 160 picks per minute on 36-inch wide cloth, without a stop. It is said that such a six-shuttle arrangement of weaving can compete with automatic weaving.

Nainsook

A light cotton cloth, may be plain or striped and from 30 to 31 inches.

Neck Cord

A short and strong cord, looped at the ends, connecting the hooks on a Jacquard machine with the harness threads.

Negative

A term applied to any shedding or taking-up motion requiring the assistance of springs or weights, sometimes termed non-positive.

New-Fil

An artificial linen cloth manufactured in France. Claimed to possess all the properties of the genuine flax fibre.

Neps

Damaged or broken fibres which have escaped the action of the carder and appear as specks on the doffer web.

Net

A fabric formed in manner somewhat similar to lace, but having its perforation equal.

Q.—How do you know when a picking neb is done ?
A.—When the point gets worn off, hence a weak picking.

Q.—How would you know when a picking neb wants refiling ?
A.—When it is wanting in roundness.

Oilcloth

Cotton fabric coated with a preparation of linseed oil and pigments.

Ombre

Shaded, graduated in shade, or colour.

Ombre Warp

A warp containing a series of shades of a colour or colours shaded from light to dark, or *vice versa.*

Open Band Yarn

Yarn spun weftway, that is, twisted over to the right.

Open Shed

Applied to shedding motions, *e.g.*, Tappets Dobbies, Jacquards. The system of shedding the healds or sheald shafts by which any particular group of shafts may be retained in the upper or lower position for any required number of pick. It is the opposite in principle to the closed shed.

Organdy

Thin transparent stiff, wiry muslin made of fine cotton yarns, weave plain, width 36 to 70 inches.

Organzine

Silk specially twisted for use as warp. Two (or more) raw-silk threads, which have been well twisted in the single, are doubled, and then twisted the reverse way ; 16 turns in the first time twisting and 14 turns reverse twist, is the most usual arrangement.

Overhead Run-ways

The rails, upon which the carriers travel are fixed to any convenient part of the building. They are constructed with branches to suit the different directions that the carriers are required to travel, and junctions are provided to permit of diverting the course. The carriers or trolleys are each fitted with two pairs of bowls which run on ball bearing. The lifting blocks connected with the carriers are worked by spur or warm gearing. With these run-ways very little exertion is required to move the suspended load. Its function is to save labour in conveying warper and weavers beams from one place to another in a cotton mill.

Over Pick

The picking appliance driving the shuttle, the fulcrum of which is above the level of the shuttle box.

Over-Spun

Yarn which is very uneven owing to its having been drafted to too high a count for the material of which it is composed, the result being that it is twitty, and in the thin places, there is a preponderance of twist, while in the thick places, there is an absence of twist.

Oxy-Cellulose

Oxy-cellulose formed by the action of bleaching liquors on cotton fabrics, is the most destructive damage that occurs amongst all chemical processes in the textile industry.

Q.—What are the points of overhauling ?

A.—The points for overhauling are as follows :—

(1) Fitters or men meant for overhauling must be confined to their own job and nothing else. All machinery should be properly overhauled periodically.
(2) Any machine or part of a machine that vibrates or works with excessive friction has a definite or short life.
(3) A programme of personal inspection by the head of the department is absolutely necessary.
(4) Records showing the life of machinery parts or accessories must be kept.
(5) Worn out parts should be removed and the machines cleaned periodically.

Paper Yarns

This yarn is made from paper itself or from wood pulp at a suitable stage in its conversion into paper.

P. C.

Pin cop, *i.e.*, weft size of cop.

Peg

The small wooden block inserted in holes of the Dobby lags.

Pegging Plan

A plan reduced from a large design which is required to be pegged on the lattices or lags, and which being so pegged, results in conjunction with the draft in the original design being produced.

Pick or Shoot

A throw of the shuttle carrying weft through the shed or opening between warp threads from selvedge to selvedge also a weft thread in a cloth.

Picker

A device fitted in a shuttle box for propelling the shuttle. They are of two kinds, plain picker, and drop box picker. 48 pickers should be the consumption per 100 looms per month.

Paper Yarn

Is made from paper and it is used as weft in certain fabrics such as canvas, mats, the backs of rugs and carpets, and fancy articles. Paper yarn is made by winding paper in roll form and cutting the same in narrow strips, which are then damped, the edges turned, and the strips then twisted into thread form.

Picking

The second primary movements of the loom, *viz.*, the propulsion of the shuttle across the loom sley and through the warp shed.

Picking Band

The leather band which connects the picking stick and the picker. Some mills prefer a thin band of 3½ to 4 mm. thick. Others like thick band of 5 to 5½ mm. which is better of the two. 6½ to 7 lbs. should be the consumption per month per 100 looms.

Picking Cone

The small conical roller on the picking shaft acted upon by the picking neb.

Picking Shaft

The upright shaft of the loom which is the agent of the picking motion.

Picking-Over

It is a defect caused either at or very near the selvedges. The causes are slack warp ends at the sides, picking too early, etc.

Pin Checks

Various cloths woven in very fine check.

Pile

The threads which issue from and form the surface of the fabrics, such as velvets.

Pineapple Fibre

A very fine and lustrous fibre is obtained from the pineapple in the Phillipine Islands from which fine muslins are produced of great durability and water-repelling.

Pint

Twenty fluid ozs.

Pique

A fabric having transverse ribs or welts, which are produced by stitching tightly weighted warp threads through a fine plain woven cloth, which has its warp lightly tensioned. The face cloth is thus pulled down at the stitching point and the unstitched portions assume a raised or embossed like appearance which may be emphasized by the introduction of wadding weft. By varying the lifting of the stitching end instead of lifting them in a body we get the toileting figure. Piques are used for dress fabrics, etc.

Pirn

A wooden tube on which is wound the weft yarn so as to fit the shuttle, also used for headings, etc.

Plush

A warp pile fabric in which the pile is longer than in velvet.

Plain Cloth

A fabric in which the warp and weft threads are placed at right-angles to each other, and which interweave alternately such as sheetings, longcloth, domestics, etc.

Plantain Fibre

Is a fibre from the plantain tree which is used in some parts of India in making mats and cordage.

Pongee

Similar texture as silk pongee. Irregular surface produced by a rough nubby weft of lower count than the warp. Mercerized and often dyed.

Poplin

Named from "papeline," a fifteenth century fabric woven at Avignon, France, as a compliment to the reigning pope. Originally made in silk for church vestments and hangings. Fine cotton ribbed fabric usually mercerized. White and piece-dyed. Weave-plain. 27, 32, and 36 inches.

Porocity

It is quite necessary to know the relative porocity or ability to permit the passage of water, oil and gas in fabrics used for filters, strainers or conveyors of liquid products. For this purpose porocity machines have been applied.

Printers

Plainly woven cloth used for printing made from pure yarns of good quality and well woven.

Printing

The colouring of the surfaces of the cloth according to a figure or design, and may be in several colours.

Pull-backs

Mean that the cut of cloth contains faulty places owing to the process of unweaving or pulling-back having been slovenly accomplished by the weavers.

Pyjama

Is originated from the Indian word *paejama*, meaning literally leg clothes, which is applied and used in India for the native form of trousers, wide or tight fitting at the ankles.

Pyjama Checks

Light, plain woven fabric with fine stripes or checks.

Q.—What does the value of a picker on the loom depend upon ?

A.—The value of a picker on the loom depends on (1) the quality of the hide ; (2) design and manufacture ; (3) conditions of steeping storage and maturing after manufacture.

Q.—Point out one of the defects that is apt to retard the progress of a manufacturer.

A.—One cannot disguise the fact that an industry with a modern commercial section and an out-of-date manufacturing section, is far from being sound, and immediate steps must be taken to develop this section in order to reduce the cost of production, and also improve the quality of the fabrics produced.

Q.—A loom runs 180 picks per minute, 9 hours per day and the cloth contains 60 picks per inch. The loom runs 80% of the possible time. Find the yards produced in a day.

A.—*Rule* :—

Multiply the number of picks per minute of the loom by the number of minutes in one hour and by the number of hours per day, and divide by the number of picks per inch being inserted in the cloth, and then by the number of inches in a yard. Deduct from this an allowance for stoppages.

Picks 180 × 60 (mins. in 1 hr.) = 10,800 picks per hour.
10,800 × 9 (hrs. per day) = 97,200 picks per day.
97,200 ÷ 60 (picks per inch) = 1,620 inches per day
1,620 ÷ 36 (inches in 1 yd.) = 45 yards per day.
80% of 45 = 36 yards per day at 80% efficiency.

Q.—If a loom inserts 97,200 picks per day and the price is 1.5 pies per 1,000 picks, what amount is due to the weaver for this loom ?

A.—$\frac{97{,}200 \times 1.5}{1{,}000} = 145$ pies $= 12$ annas (practically).

Q,—Find the fabric index of each fabric being manufactured in a cotton mill having 60 Ring Spinning Frames and 400 looms. The production of the Ring Frames per week of 54 hours per frame ias as follows :—

Counts of warp	Production in lbs. per frame	Counts of weft	Production per frame
15s	654	15s	655 lbs.
30s	267	30s	.327 ,,
40s	189	40s	225 ,,

Furthermore assume that shirting quality No. 201 has 30s warp and weft and is 55% warp and 45% weft. 5.5 yards per lb. The weaving production of this fabric is 187 yards or 34 lbs. per loom per week of 54 hours. Find the total yarn requirement.

A.—If the whole mill that is the whole 400 looms were to be put on shirting No. 201 the total requirements would be 13,600 lbs. or 7,480 lbs. of warp and 6,120 lbs. of weft.

7,480 lbs. of warp + 3.5% (for waste) ÷ 267 (production per frame) = 29 warp frame.

6,120 lbs. of weft + 1.43% (for waste) ÷ 327 (production per frame) = 19 weft frames.

29 + 19 = 48 total frames.

48 ÷ 60 = ·800 which is the index for quality No. 201.

In the case of a fabric or quality containing several kinds or count of yarns each count of yarn will have to be reckoned up separately as above for fabric or quality index.

To find the capacity required to supply looms working on various sorts—multiply the number of looms assigned to each quality or fabric by its index (for counts of yarn) and devide the total of the products by the total looms.

Example :—

A mill having allocated the looms for orders received as follows :—

140 looms on	32″	shirting	Q. No. 201—	.800 index
100 ,,	34″	,,	,, 101—	.860 ,,
60 ,,	36″	,,	,, 301—	1.180 ,,
100 ,,	40″	,,	,, 401—	1.250 ,,

Then again,

Looms	Index	
140	.800	= 112
100	.860	= 86
60	1.180	= 70.80
100	1.250	= 125.00
400		393.80

393.80 ÷ 400 = 98.45% of the whole of the spinning capacity is required to supply the weaving department.

Q.—Compare the production of cloth from an ordinary Lancashire loom with that from an automatic loom, each making a similar cloth with 60 picks per inch and working 9 hours per day. The Lancashire loom runs at 200 picks per minute, with 80% efficiency, and the automatic loom at 170 picks, with 93% efficiency.

A.—Lancashire loom—

$$\frac{200 \text{ (Picks per min.)} \times 60 \text{ (Mins. per hr)} \times 9 \text{ (hrs per day)} \times 80 \text{ (per cent}}{60 \text{ (picks per inch)} \times 36 \text{ (inches per yd)} \times 100} = 40 \text{ yards.}$$

Automatic loom—

$$\frac{170 \times 60 \times 9 \times 93}{60 \times 36 \times 100} = 39.52 \text{ yards.}$$

Q.—A piece must contain 176 hanks of cotton, the length of the piece to be 48 yards and width 28 inches. What number of picks must it contain ?

A.—*Rule* :—

$$\frac{\text{Hanks} \times \text{yards per hank}}{\text{Yards} \times \text{inches.}} = \text{picks per inch.}$$

Q.—Describe the merits of a plain loom and its chief function.

A.—The merits of a plain loom are that almost the whole operation of the weaving can be done by power, the chief function of a plain loom is picking, shedding and beating up.

Q.—There are six methods of increasing picks on an overpick loom. Describe them.

A.—(1) By lowering the picking band ; (2) by using a large neb ; (3) by shifting the large plate more towards the loom ; (4) by bringing the picking stick near to the loom ; (5) by tightening the picking band ; (6) by bringing the cone nearer to the neb.

Q.—What is the advantage of Under Pick over Cone Pick or over Pick.

A.—The advantages of this movement over that of the cone pick are: first, it is more direct, making it more suitable for high speed looms running a light shuttle; secondly, it is much cleaner than the over pick. The spindle on which the picker of the over pick moves requires to be frequently oiled. Sometimes too much oil is put on; it is thrown about by the action of the pickers, and would be ruinous to some kinds of cloth. This does not occur in the under pick.

Q.—(1) What is a pick and pick loom? (2) What are its advantages? (3) Would you suggest a drop box or ordinary plain loom whereby to get the fullest advantages?

A.—A pick and pick loom has movable boxes on both sides of the loom.

(2) Its advantages are that several picks of various colours and counts can be made in succession from either side of the box. One pick of a single colour can be placed at a time. In this loom, the picking, shedding and shuttle changing are all done by the same motion.

(3) I would suggest a drop box loom.

Q.—What methods would you employ to get easy and quick running on a plain loom?

A.—Very little pick, long crank arms, small sweep, all bearings bushed.

Q.—How is it that the top shaft in a plain loom moves twice as fast as bottom shaft?

A.—Because the crank shaft wheel has half the number of teeth of tappet shaft wheel.

Q.—What is the best time to commence picking?

A.—When the sley moves backwards just in front of the bottom centre, the picking band begins to get tight and commences to move the shuttle at this point; the healds are fully opened which will remain so until the crank arm passes the back centre and, as the shuttle reaches the opposite box, the shed begins to close.

Q.—Which is the best, early picking or late picking?

A.—Early picking is the best.

Q.—How do you determine the pawl to take up one tooth at a time ?

A.—The monkey tail should be $\frac{3}{4}$ of an inch up in the slot of the taking-up lever.

Q.—Suppose you had a plain loom and you wanted to make a three shaft. What wheels would you use to drive the tappet ? Also what would you do the first thing on looking at the tappets before you place them on the tappet shaft ?

A.—Wheels 20 and 60.

Rule :—

$\frac{60}{20} = 3$ picks to the round. I would see that the largest leave will work the back healds.

Q.—What are the reasons for a picking stick shaking, before it gives the blow to the shuttle ?

A.—When the picking band is too tight.

Q.—What causes stiffness in the picking shaft ? How would you overcome this difficulty ?

A.—The cause of stiffness in the picking shaft is when it is out of plum.

Q.—What is harsh picking due to ?

A.—It is due to (1) the picking nose or neb being too short, and requiring to be shaped in the form of a hook ; (2) to the picking being timed so late that it requires a very strong pick to get the shuttle through the shed before it closes ; (3) to the shuttle boxes being made so tight that an excessive amount of power is required to drive the shuttle in and out ; (4) the picking bowl stud being set too low.

Q.—The main shaft of a weaving shed runs at 100 revolutions per minute, and carries a wheel of 50 teeth, which drives another wheel of 49 teeth on line shaft ; a drum of 14 inches upon this shaft drives a loom pulley of 10 inches, how many picks per minute does the loom run ?

A.—Drivers = 100 rev. 50 wheel and 14 inches drum.

Driven = 49 wheel and 10 inches pulley.

The speed of a driven is required.

Therefore multiply all the drivers together and divide by the driven thus :—

$$\frac{100 \times 50 \times 14}{49 \times 10} = 142.85 \text{ picks.}$$

Q.—Is the wearing capacity of artificial silk more than cotton? and why?

A.—Yes. The wearing capacity of an artificial silk fabric is considerably increased by its glossy surface. Artificial silk outwears cotton. As a lining it is better than Italian lining, because it slips so easily that the wear is on the other fabric.

Quality

The number of threads per inch warp and weft way and the diameters of the threads are the chief factors in determining the strength and quality of the cloth. It will be obvious that the total number of warp threads in the fabric which varies according to the quality desired.

Quality in Textile Fabrics

Is determined by the nature and fineness of the materials. method and correctness of yarn construction, and adaptability and accuracy of manufacturing routine. It comprises softness, lustre, smoothness, fibrous density, tensile strength, and wearing property. Each of these characteristics may give the distinctive quality of the cloth.

Quilts or Quilting

The term is now applied to a variety of fabrics, chiefly of a heavy type, and used for bed quilts and table covers.

Raising

A process applied to heavy or light weight cotton goods, whereby fabrics are raised out of the body of the cloth on to the surface.

Race Board

The smooth board fixed on the loom sley over which the shuttle traverses the sweep runs at 1/32 inches to 1 foot.

Range

A series of cloths similar in style, but varying in width or other dimension.

Random Ranges

Experimental ranges or pattern trials made with a view of acquiring styles from which ranges proper may be constructed.

Raw Silk

Silk in thread form, as it has been unwound from the cocoons, the thread being composed of several cocoon filaments.

Rayon

Name given to artificial silk by America. It is similar to silk when degummed, *i.e.*, it appears smooth like a glass rod.

Rayons react to atmospheric conditions almost like silk. 62% relative humidity is considered to be the upper limit advisable for processing in the case of viscose and cuprammonium rayons. Cellulose acetate is less susceptible to changes in atmospheric conditions.

Spinning	70% R.H.
Grading	55 to 60% R.H.
Warping and Winding	55% R.H.
Winding acetate	65 to 70% R.H.
Weaving all rayon	65% R.H.
Weaving all acetate	70 to 75% R.H.
Cotton and viscose	60 to 70% R.H.
Cotton and acetate	65 to 75% R.H.

Record Books

All the pages of all record books should be numbered consequitively.

Reed

A comb like instrument with splits or dents of flattened or polished wire, three to four inches long, fixed between strips of wood by pitched band of varying gauge. It is fixed in the loom sley, and serves three useful purposes, *viz.:* (1) It maintains the warp threads in corresponding positions throughout weaving, and fixes the gauge or set of the cloth; (2) assists in the beating up the pick just into those already inserted, thus making a firm texture; (3) acts as a guide when the shuttle is crossing. Also used in the preparatory processes for regulating the width of the warp threads.

Reed Space or Sidth at Reed

The reed space of a loom is, as its name implies, a measurement of the size of cavity which receives the reed, and is generally measured from the edge of the back-board to the edge of the fork grate on the other side of the loom.

Reed Marks, Reedy

Defective streakiness warpways of the cloth, due to the threads rolling in the splits of the reed owing to local imperfections in the reed. These are generally of the kind where the opening between the two dents is greater than the average, while the two alongsides of the more opened one are closer than the average. They may also occur in the direction of the weft due to reed cutting the picks of weft. The reverse of "cover."

The temper of the steel in the dents or wires is a matter of prime importance, for, if deficient in this respect, the dents will be easily bent and injured in other ways. If not well made, also, the dents may become loosened and their position altered, or they work up and down out of place. Sometimes reeds will become very much worn out, and at times, the edges of these worn-out dents become extremely sharp. An undue amount of chafing may thus be exerted upon the warp threads, and sometimes, the weft picks will be cut by some particularly sharp dents.

Regularity

The uniformity of yarn is of great value. For this purpose "inspection boards" of black colour are generally used.

Rep

Plain woven, warp rib fabric, rib produced by heavy warp ends or by having an extra floating weft.

Ribbons

Narrow trimming fabric in great variety of weaves.

Rice Weaves

Fancy weaves formed from the simple 6 end and 8 end twills. These twills are broken at the middle and reversed, thus the 6 end rice weave is drawn in 1, 2, 3, 6, 5, 4 and the 8 end 1, 2, 3, 4, 8, 7, 6, 5.

Roughness (in Cloth)

Means that the cloth both looks and feels rough. Fault is caused by using coarse filleting on the loom emery or sand roller, insufficient weight on loom beam levers, and weights touching floor every pick or every two or three picks.

Rubberized Fabrics

Various cotton fabrics made waterproof by impregnating or coating on one side with rubber.

Run

A stripe of colour in a fabric.

Rust

Means that there are one or more streaks of rust across the cloth. The cause is that the back rest, breast beam or emery roller may have become rusty when the loom has been stopped overnight or over the week-end, and paper has not been placed under the warp and cloth at the parts of loom named.

Q.—What are the two important functions of a reed in the loom ?

A.—The functions are—one, keeping the warp threads properly spaced, and the other, the beating up of the warp threads into the cloth.

Q.—What are the German and French equivalents of reed, pick, weft and yarn ?

A.—English	*French*	*German*
Reed	Dents	Rohre
Pick	Passee	Schuss
Weft	Frame	Schusagarn
Yarn	Fill	Garn

Q.—Cloth is made with 60 reed and 25s warp. What reed should be used with 16s warp to give a similar cloth ?

A.—*Rule* :—

Multiply the square of the given reed by the counts of the new yarn, and divide by the old yarn. Take the square root and you have the desired results, or multiply the given reed by the square root or the counts of the new yarn and divide by the square root of the old yarn.

The square of $60 \times 16 \div 25 = 2{,}304$
The square root of $2{,}304 = 48$ reed
The square root or $16 \times 60 \div$ the square root of $25 = 48$ reed.

Q.—What are reed marks in a piece of cloth ?

A.—Reed marks are caused by the reed wires becoming bent or getting out of place, thereby crowding some ends together, and giving other too much space.

Q.—If a poplin fabric contained 140 ends, and 68 picks per inch, and you desired to produce stripes of the poplin alternating with some other weave, point out any limitations caused by the structure of the poplin, and suggest two types of stripe that you consider to be suitable, effective, and of sufficient contrast to the poplin weave.

A.—The limitations in the making of stripes in poplin fabrics are not easy to define, for an example a honey comb weave or a huckaback would hardly be suitable weaves. A twill or satin stripe would be effective, or a well balanced crepe, whilst a bold cord effect made on the dice principle would give satisfactory results.

A poplin is a heavy crammed warp, tightly picked with weft equal in counts or coarser than the warp, hence it would not be easy to obtain a good mock-leno effect, but occasionally weft figures are introduced with success. Again, whilst not exactly a stripe, a good effect may be obtained by weaving two picks in a shed, giving a thin cord across the cloth.

Q.—Suppose you had a 60-reed and a warp drawn through it with 10 shafts and 6 of them were operating figured stripe and plain and one inch of ground was left in between. How would you lift it ?

A.—I would lift it two and two and two stitches or repp.

Q.—What is the chief use of the lease rods ?

A.—The chief use of the rods is to keep the warp threads in a given relation to each other, so that if a thread breaks, its proper place can easily be found in the cloth, and so that it can be kept from getting crossed with the other threads at the back.

Q.—What is the reed space of warp containing 3,400 ends ? Which is drawn 2 ends in a dent in a 60-reed allowing 20 ends for selvedges extra ?

A.—3,400 ends minus 20 ends (for selvedges) = 3,380 ends.
3,380 divided by 60 (reeds) = $56\frac{1}{3}$ inches "reed space."

Q.—If 36-inch cloth cost 3 annas per yard what is the price per yard of a cloth which is 48-inches in width.

A.—36 : 48 : : annas 3 : ×

$$\times = \frac{48 \times 3}{36} = 4 \text{ annas per yard.}$$

Q.—How would you distinguish Rayon from Silk ?

A.—The coarse, stiff rayon yarns of a few years ago that were so easy to distinguish from silk are not found at all today. The microscope can no longer render an infallible decision between these two fibres. The structure of highgrade rayon yarns is so similar to that of silk that the microscope finds difficulty in revealing the identity of the specimen. The familiar burning test that is used so commonly to distinguish between silk and cotton is still useful with viscose, nitro-cellulose, and cuprammonium rayons. But acetate rayon burns much like silk and leaves a similar residue.

Sand Roller

The corrugated beam over which cloths are drawn from the loom.

Saree

A dhoty cloth with a special heading used by Hindu women.

Sase

Is the name given to a kind of spun-rayon yarn used chiefly for knitted or pile fabrics. The filaments are made in Germany by the viscose process. The fineness is due to stretch spinning. The fibres are cut and spun into a yarn which does not resemble rayon but appears more like spun silk or mercerized cotton.

Satin

A fabric with a smooth even surface of warp threads.

Sateen

Soft cotton cloths woven with weft faces for printing and lining purposes and with warp surfaces for shirtings. The finishes are various.

It has a very solid and smooth surface like satin of either warp or weft. The effect is produced by the rearrangement and regular distribution of the intersections in such a way, that they are hidden from view. A warp sateen is a cloth with a warp surface and a greater proportion of warp threads than weft; weft sateen is the reverse.

Schappe

Spun-silk yarn, more particularly, when made from stock which has been degummed by the schapping, or marceration process.

Scroop

A creaking or crunching sound which silk makes when squeezed or twisted. It can be artificially produced by special treatments in imitation of real silk.

Section Marks

Streaks in cloth which are caused by faulty spacing, or uneven tension, of the sections in warping.

Seconds

Woven pieces of cloth containing faults are termed seconds.

Selvedge

The sides of a fabric or edges woven on cloth to prevent fraying, generally of a firmer texture than the body of the cloth.

In many makes of plain cloth, warp ends similar to the body of the cloth may be used; but in some cases where those ends are made of fine twist, it is both cheaper and better to use coarser ends, and at the same time to employ a smaller number. In other makes of heavily picked cloth it is necessary to use selvedge ends of double yarn. When these threads are drawn in, one in each heald, and three or four in a dent, a very much neater selvedge is made. In some cases it is found necessary to give the weft, when leaving the shuttle, extra drag in order to prevent it from forming loops on the outside edge; but if the looms are kept in good order, this should only be required under extreme circumstances and for certain makes of cloth. As this drag is, of necessity, trying to the weft, it is obvious that it should not be used unless absolutely essential. It is, however, in cloths which have to undergo some finishing process that this question assumes its most difficult aspect, especially upon cloths which are made by treading the healds in some other way than that employed in making plain cloths.

When cloths have to be finished, it must be considered whether the selvedges will stand the different processes which have to be employed. If made too tight (and a tight selvedge for a grey piece will probably give the neatest selvedge), the cloth in some cases will be found to cockle in the centre, while in others the selvedges will curl. They have also been known to split, making a rent in the cloth. All these faults cause annoyance to the merchant, and no considerable loss to the manufacturer. It is necessary to consider each cloth upon its own merits; but with the exception of a few light fabrics which undergo a finishing process, when considerable side strain is used on the selvedges, it would seem to be quite necessary that they should be as tightly woven as the body of the piece.

Starting from this stand point, it is evident that the method employed, say, for making a selvedge of a weft sateen would not be at all suitable when used for one of a drillette. In nearly all kinds of cloth manufactured by a fancy weave it is usual to make what is called a plain selvedge, or one which has the appearance of being plain.

Semi-open Shed

A combination of the closed and open shed, in which only the crossing warp ends are transferred from the top to the bottom or the bottom to the top.

Serigraph Strength

For testing fine and slippery yarn both the single and skein method tests are nearly impractical, hence serigraph strength test is taken which consists of breaking a number of parallel stretches of the yarn, on the serigraph testing machine.

Serge

A loosely intersected twill weave or fabric having broad lines.

Sett or Set

The sett indicates the pitch or firmness or distance apart of the warp threads, as they are separated or distributed over the fabric by the reed in the process of weaving. Also signifying the amount of warp on the beams which are sized at one time.

Sewing

The stitching together of the ends of each two consecutive pieces of cloth that are intended to form a continuous length in order to facilitate the work for calendering or finishing machine.

Shaft—Heald.

Shed

The opening made in the warp for the passage of the shuttle, in order to insert the weft pick ; also a weaving mill.

Sheeting

A grey calico cloth between 36 and 108 inches in width. Weave-plain or twill. Medium-weight fabric, bleached or unbleached.

Shot—Pick.

Shrinkage

The amount of contraction which most cloths are subjected to, from the loom to the finished state. It is interesting to know that the shrinkage of cloth is dependent upon three factors, namely : structural shrinkage, shrinkage due to twist in the yarn, and shrinkage due to absolute contraction of the fibres of which the yarn is composed.

Shuttle

An oblong shaped hollow receptacle with pointed ends, used in the loom for carrying the weft backwards and forwards through the shed, so that it may be interlaced with the warp threads and form the woven cloth.

Shuttles for the same loom should be equal in size, weight and bevel. The spring peg should be held firm, if slack it will fly up and cause great damage in the warp. They should be examined each time a warp is put in the loom, and either planed level, or rubbed on sand-paper on a perfectly flat surface. Examination of the shuttles will in many cases show if there is any false alignment of reed or box back.

Shuttle (Fly)

Was invented by John Kay of Bury and patented in the year 1733.

The Care of Shuttle

The shuttle bill in many weaving sheds could be reduced 33% if more attention were given to these weaving accessories. Not only could the shuttle bill be reduced, but production would be increased and better quality cloth produced. Tight boxes, picking mechanism wrongly set, and over-facing box backs damage the shuttle. As a result of incorrect, travelling the shuttle wears bow-shaped prematurely, with plane, scraper, rasp, wood-file and emery paper the overlooker proceeds to square the two shuttles, and thus he often removes more wood than could be worn away in 12 months. The shuttles become old before their time and the shuttle-maker benefits. A pair of shuttles should last on an average from sixteen to eighteen months.

Now comes the question of ill-fitting tongues. Nothing causes the operatives more work than tongue out of position—too long, too short, too thick and badly-finished tongue cause serious loss to the manufacturers.

Quantities of good weft which ought to be woven into cloth are scrapped as waste and often taken home or dumped elsewhere by the operatives.

Some manufacturers or their managers are to blame for the purchase of tongues unsuited to the looms and weft, but the fact remains that insufficient attention is given to them by both weavers and overlookers. Evidence is not lacking that in many cases the shuttles are not examined by competent persons as often as they ought to be.

Weavers often grumble about bad weft when the trouble is directly attributable to faulty tongues or fitting. To be fit for their purpose, shuttles should be examined periodically by competent persons. Weavers should be taught to recognise shuttle faults, and jobbers ought to examine them periodically. All the average weaver can be expected to do in regard to the care of shuttles is to note judicious use of sand-paper or emery cloth which is helpful in the case of small splinters or roughness, but the man responsible for the shuttles is the jobber.

Points to be Considered when Ordering out Shuttles

(1) Iron clip; (2) length from tip to tip; (3) tip-pointed or round; (4) bottom width; (5) inside with cavity; (6) depth; (7) length of the shuttle tongue; (8) eyes single or double; (9) tongue pin should be of iron; (10) ends of the shuttles round the tip should

not be too much rounded; (11) strong spring to keep the tongue horizontal; (12) angle of the shuttle as per makers shuttle box.

Shuttle Box

An enclosure or terminus at each end of the shuttle race from the one to the other of which the shuttle is ejected, and received, and in which the picker works for propelling the shuttle a bulging steel (swell) spring fitted at the side of the box serves to neutralise the force of the shuttle when entering.

Shuttle Catching

In box looms may be due to late or weak pick, boxes moving too slow or wrong timing of boxes, boxes not steady when the pick is delivered, worn picker, faulty checkihg of shuttle, guide plate loose, or shuttle binding in the box.

Shuttle Box Dirt

Means that the shuttle has carried some of the dirt, which accumulated in one of the shuttle boxes, into cloth. This can be avoided if the shuttle boxes are thoroughly cleaned twice a week.

Shuttle Flying Out

Slack top shed, ends fast in shed, reed and box back not in line or correctly bevelled. But reed wires projecting forward, sheds too high and not on race board, picker bored wrong and pressing down on shuttle when pick is delivered. Too early or too late picking or shedding, worn shuttles, faulty setting of box rib. Spindle loose, nose-piece or cone stud loose, temples set too high, race board worn or too high in relation to box.

Shuttle Guard

A thin wrought iron rod the width of the sley top, and to which it is affixed in order to reduce the chances of a shuttle flying out of shed.

Shuttle Race

A long narrow board fixed on the upper part of the sley, and on which the warp threads of the lower part of the shed rest. The shuttle traverses on the shuttle race when passing through the shed. The shuttle race should be made of short-grained hard wood (daroo wood), well-seasoned, so that it will neither split nor warp, and it must have a smooth surface.

Sieve Tap

This is a tap fitted between the size beck and the pump. Its purpose is to prevent any substance likely to interfere with the working of the valves getting to them. The sieve should be cleaned out as often as necessary during the day in order to prevent it getting clogged up.

Silk

A fine, lustrous, thread, produced from the cocoon of a silk worm.

When examined under the microscope gives the appearance of a fine line running down the centre of the fibre. This line is the space between the two fibres ejected by the worm and joined together by gum. The quality of the silk is judged to some extent by these lines. If the fibres are not firmly united it is of inferior quality. There are spots on silk. Silk consists of a fine filament composed of a substance called "fibroin," and an outer covering of "Sericin." This sericin, or silk gum, forms about a third of the total weight of the fibre, and gives the raw silk its rough, hard character. When dyeing silk, the gelatine is partly dissolved, and thus the weight of material is reduced. This loss in some cases balanced by using loaded dyes. Silk is a most expensive material, and its lustre, strength and fineness places it easily at the head of all textile raw materials. Silk is capable of absorbing moisture readily. The recognised natural moisture is fixed at 11% regain on the absolute dry weight. It is capable of easily absorbing 30% of its weight without giving any apparent indication of dampness.

Silk Noil Yarns

Made from waste arising when making spun silk of yarns. They are pure silk when not mixed with any other fibre, but the silk is of the most inferior kind. The yarns are full of lumps and are most irregular in thickness. They are used for "silk" travelling rugs, also mixed with other yarns for a number of fabrics. They give to the fabric a rough, uneven surface, but give lustre and are inexpensive.

At high humidities, silk yarns tend to stretch and become limp. It is usually recommended that silk should not be processed at relative humidities higher than 60 to 70%.

Reeling or thraving	60 to 70% R.H.
Dressing and preparation	60 to 65% R.H.
Spinning	60 to 70% R.H.
Weaving	60 to 70% R.H.

Singeing

See Gassing.

Skein

A hank of yarn ; the circumference, for silk being usually 45 to 54 inches.

Sley

The sley is a beam of wood along which the shuttle is passed and carries a reed to beat up the weft and having a reciprocating motion to and from the fell of the cloth imparted to it by the crank on the shaft. The beam is supported on two vertical rods called sley swords attached near the bottom of the loom to a vibrating or rocking shaft or swing rail.

Slubs

It means a short thick place in the yarn, say $\frac{3}{4}$ inch, generally of a soft nature and with very little twist.

Smash

Synonymous with mash or trap.

This troublesome defect arises from a variety of causes, some of which are in the loom and others in the weft. Loom causes include picking too strong or too late, especially from the on-side of the machine, and lack of warp tension when weaving heavy sized goods results in fibrous weft being carried by the slack warp threads and formed into small loops. To remedy these faults, increase the warp tension, use a tappet, with more dwell, and set the warp shed so that as clear an opening as possible is left for the passage of the shuttle. Hard-twisted doubled weft needs controlling by elastic, fur, flannel, or any other of the methods of tensioning. Shuttle eyes that are too large contribute to this evil, and if these weft vehicles are not properly checked in the loom boxes they will encourage snarling. Where it is necessary to weave warps with little tension, earlier shedding lessens snarling.

Snarls

Snarls are caused by slack ends at the mule, the torsion of the thread taking up the loose yarn in the form of a twisted loop.

Snarls may also be caused by faulty shedding. Damping the weft before weaving will reduce snarls in the weft itself.

Snarly Weft

This may be caused during spinning or at the loom. Some of the causes of this fault are as follows : Uneven weft, weft very hardly twisted and not tensioned accordingly, picking too hard or too late, shuttle not properly checked, and weaving cloth much narrower than the capacity of the loom.

Sniafil or Artificial Wool

Was first produced in Italy but is now also being manufactured in France. The fibre resembles wool in appearance but does not have the strength or warmth of wool. It is soft and lustrous, does not cause itching, and is moth-proof. It is made of short ends of fine yarns, carded, combed, and spurn into yarns as in the case of natural wool. Artificial wool combines well with natural wool, and costs less than half as much per lb.

Snick

Snick is caused by loose ends and inferior traverses at the winding frame.

Soft Silk

Thrown silk yarn from which the gum has been discharged, undyed or dyed.

Souple Silk

Skein-dyed silk from which only about half the gum has been removed in the boiling off. It is duller looking and finer than silk completely degummed.

Spanner

A wrench for tightening or slackening hexagon or square nuts.

Spare Parts Catalogue

Always keep spare parts catalogues handy.

Spindle

(1) A common term for anything which relates for the purpose of winding thread into coils, on to bobbins or on a bare spindle; (2) an iron rod on which a tube or bobbin, holding the spun yarn, is placed.

Splintered Shuttle Trap

Means that the top of the shuttle has cracked, or the bottom of the shuttle may have cracked and caught a large number of warp ends in either the top or bottom shed and breaking them out. The causes are, and which should be avoided strong picking and very tight shuttle boxes.

Splits

Cloth woven two pieces in a width and cut apart, whilst in the loom by means of a cutter which contains a sharp blade.

The inner selvedges are imperfect and worked on the leno principle either by means of chain or a motion to prevent ravelling.

Sponge Cloth

Twill fabric of nub yarn, or honey comb effect produced by use of leno on a satin-weave base.

Spools

Warpers' bobbins.

Spun Silk Yarns

These yarns are made from the waste silk of various kinds. The fluffy fibres found outside the cocoons and called floss silk, are torn off before reeling takes place, and used for spun silk. Then the waste silk made at the end of a cocoon is used sometimes less than half the silk from a cocoon can be used for reeling. All the residue is converted into spun silk. There is also the manufacturers waste, etc. These different wastes are not all of equal value, so the spun silk will also vary. The lower grades are spun into coarser threads. Spun silk threads may be very good and very serviceable The yarns are far more regular in diameter than net silk, but they are not so brilliant, because they are built up of comparatively short fibres.

Spun Silk Count

Same as cotton yarn count, except that two (or more) ply yarns are stated differently. In spun silks, 60/1, 60/2, 60/3, 60/4, etc. Will each be a yarn counting 60 × 840 yards = 50,400 yards per lb. made up 1, 2, 3, or 4 threads, respectively. On the continent, spun silk, or schappe, is numbered by the metric system.

S. S.

Abbreviation of short stick.

Staple Fibre

Short lengths of rayon made by the same processes as other rayon yarns, except that filaments after passing through the neutralizing bath are bunched together and cut into lengths of from four to eight inches. Staple fibre is considered superior to rayon waste for spinning with other textile fibres. It also produces an excellent grade of spun rayon.

Stave

Shaft.

Stationery

Basis of Issuing—

Blotting paper	=	12 sheets per head per year.
Rubber	=	once a year.
Lead pencil	=	6 per head per year.
Inkstand	=	1 per head per year.

Holders	= 2 per head per year.
Nibs	= 24 per head per year.
Ink	= 1 bottle per year for heads of depts.
Pencil sharpener	= 1 per head per year.

Stretch

Measurement of stretch or elasticity of textile materials is of considerable importance. This should be noted on stretch measuring apparatus.

Stinging Nettle Fibre

This nettle grows profusely wild in Germany, but it is also cultivated. It was most widely used for textile purposes in the middle ages, but with the introduction of cotton from America it went out of use. During the last world war (1914-1918) it was again utilised on account of shortage of imported textile fibres.

Nettle fibres are soft, fine, strong, and characterised with a beautiful lustre. They can be bleached to a pure white colour and readily lend themselves to dyeing and even mercerising. Under the microscope each fibre appears as a straight walled cell having flat or rounded stumpy ends. The fibres are free from lignin. Fabrics made from nettle fibres have a linen-like character. Its staple length is .39 to 2.75 inches (10 to 70 mm.)

Strip

A narrow bar of heading.

Stud

A short projecting pin to carry a wheel or wheels.

Swell

A small lever of the third order placed in the shuttle box back of a loom.

Swivel Shuttle

An arrangement of small shuttles for forming figures on a fabric, somewhat after the manner of embroidery.

Q.—State how is the most perfect delivery of the shuttle is obtained ?

A.—The most perfect delivery of the shuttle is obtained when the picker glides along the spindle freely, and has a minimum amount of deviation from its true course. If the head of the picker has been subjected to excessive wear the holes are enlarged and are oval in shape instead of being round. This allows the picker to lift and draw the shuttle from its true position. This defect is quite common, and many pickers have to be replaced when the block and foot are quite good, but the head is either broken or the holes so large that the traverse of the shuttle is causing damage in the form of stitching, picking over, turning over, or flying out of the path and leaving the loom.

Q.—Give the main points about the loom stop rod ?

A.—To the uninitiated, the stop rod of a loom might appear to be a very simple piece of mechanism, but it is by no means as simple as it appears. It is very aptly named, for its function is to stop the loom when the shuttle fails to reach the opposite box. There are only three things associated with it, but all three are of special importance.

Spring on the inner side of the stop rod tongue is a hook on the rod, and this carries a closed spiral spring to draw down the tongue as soon as the shuttle leaves the box. The bottom of the spring is placed on an adjustable hook bolted to the sword front. Both ends of the spring ought to have a tab of leather, and especially the hook on the stop rod, for the leather prevents the hooks from wearing.

There is a spring for each sword, but the pull of the springs need not be excessive. If the springs draw down the tongue moderately sharp, with a reasonable margin for safety, that is all that is required. Excess pull means excess wearing of all the parts involved. Though the springs assist in breaking the shuttle after entering the box, its primary part is to pull down the tongue and keep it down until forced up by the shuttle.

When Weaving Tender Warp.—The first thing is the length of tongue. It has to protrude in front of the sword so that when the shuttle is trapped in the shed, and the going part comes forward, no ends are broken out in the warp. Usually there is a certain standard length for a particular make of loom, and this has to be maintained.

When a tender warp is being woven, recourse is made to prevent damage to the warp by moving both frogs further forward. The loose frog is placed ahead of its ordinary position by means of the brake rod, and may be moved from $\frac{3}{8}$ inch to $\frac{1}{2}$ inch. The first frog is moved about the same distance by placing a suitable piece of packing at the back of it.

Before the loom is set in motion the tongues and frogs should be tested to see that they are in the best relation to each other. When the loose frog is as far forward as it will go, then the tongue should be in contact with the frog at the opposite end of the loom. In this position, the brake should be in full contact with the brake wheel.

The next idea is that of thickness, for the tongue should be able to resist any tendency to buckle during knocking-off. Both tongues have to be made to fit the bottom of the cut on each frog, for if one be lower than the other, then the higher one is forced up by the other, and is of practically no use. This is a direct menace to the safety of the warp, and if found in time, should be remedied at once.

Preventing Accidents.—An ordinary tongue slopes downward at the end, but becomes blunter by the occasional hitting of the frog. If it becomes too blunted, it may easily ride over the frog, and especially so if the cut on the frog has also become rounded off. Both should be filed up at the earliest opportunity, for in so doing, a threatened accident to the warp is removed.

Box Swell Finger.—This finger is of malleable nature and part of the stop rod. The fore part of the finger has to be in contact with the head of the box swell when the tongue is in contact with the loose frog.

If the finger be not in contact, then so much lift is lost to the tongue when the shuttle enters the box. This is easily remedied, for a box swell bender is applied to the finger, and it is bent forward. The bender is a strong bar, with bifurcated end at right angles to the shaft. The open end passes on to the finger, and a weight placed underneath the tongue provides scope for the forward move of the finger. Careful examination has to be made to see that the bending is adequate, but not the least excessive.

Loose Box Swell Finger.—The finger is bifurcated at the bottom, and in the opening, the bolt is placed by which it is secured to the stop rod end. This finger is adjustable and removable. The same care in setting is just as essential with this as with the other. These fingers are of a more or less malleable construction, so that a certain amount of shaping may be carried out with the hammer without damage.

It will be observed that the centre of the stop rod is higher than the frog, and this is partly responsible for the elevation of the sword by the loom banging off. When this occurs, there is a menace to the warp of a shuttle trap. If it is elevated again after being reset, recourse must be made to stop this action. One of the most effective ways is to bend a flat wrought iron bar so that it conforms to the sword and swing rail to which the sword foot is bolted. It is then bored so the upper bolt in the sword foot can pass through, and another bolt passes through the bottom of a slot in the sword. The sword then becomes a fixture.

Lift of Tongue.—The two tongues on the stop rod have to clear their respective frogs every pick unless the shuttle is not "boxed" properly. The amount of lift is obtained by the setting of the box front in a plain loom or dobby loom. The shuttle should never be tight in the box, and if the lift of the tongue be $\frac{1}{4}$ inch above the frog, there will be an allowance for wearing. The amount of possible lift is dependent on the condition of the respective parts.

Knocking-off Causes.—This is chiefly due to the shuttle not getting into the box soon enough. This may be due to quite a number of causes. Castings may be loose, the shell shifted, the picking strap too slack, the warp too tight, or the shed too small. The picker may be cracked or broken, or the shuttles have become bow-shaped back and bottom so that it cannot run a true course through the shed. The reason for knocking-off is not always easy to locate. One of these is the rebounding of the tongue, and rebounding occurs most in narrow looms which run at high speed. The rebound is overcome by fixing a strap behind the box swell finger, so that while the finger can move backward by the action of the box swell, there is little excess. Well stretched and oily leather is best, for then when once fixed, it lasts for a considerable time.

Q.—How would you test a piece of cloth for shrinkage to see that it is properly shrunk?

A.—The method of testing is to take a square specimen, say, 20 cm. × 20 cm., wash this specimen in hot water and soap, then dry and allow to condition in an ordinary atmosphere, and then measure the actual shrinkage. The shrinkage could only be compared with some standard which was satisfactory.

Q.—What will be the speed of the shuttle, in feet per second, when passing across a loom having a reed space 48 inches wide, the speed of the loom being 210 picks per minute, and the allowance for passage of shuttle being 2/5th of a revolution.

A.—To find the speed of a shuttle, in feet per second, multiply the width of the reed space, in inches, by the number of picks per minute, and divide the result by 720 and by the proportion of each pick allowed for the traverse of the shuttle.

$$\frac{48 \times 210}{720 \times .4} = 35 \text{ ft. per sec.}$$

Q.—A loom giving 200 picks per minute has a shed 3 inches deep. If the speed is altered to 180 picks per minute and the depth of the shed increased to 4 inches, calculate the reltaive increase in the strain on the warp.

A.—Rule :—

Multiply the square of the required shed by the required picks, and divide the product by the square of the given shed multiplied by the given picks per minute.

$$\frac{4 \times 4 \times 180}{3 \times 3 \times 200} = 1.6.$$

Q.—What are chipped shuttles due to? What are broken healds due to? And rough reeds?

A.—Nearly always due to the reed being out of plum with box back.

Q.—If the size of the stripe be one inch, and contain 120 threads per inch the grounds to contain 60 threads per inch, the average to be 80 threads per inch. What space must there be between the stripes to produce this average?

A.—$\dfrac{(1 \times 120) - (1 \times 80)}{80 - 60} = 2$ inches.

Q.—State, why is the crank shaft driven twice the speed of the tappet shaft?

A.—The idea of driving the crank shaft at twice the speed of the tappet shaft is that it is necessary for the sley to beat up the weft at each pick of the loom, and, although one revolution of the tappet shaft causes the shed to be formed, and consequently, two picks to be placed in the cloth, yet one revolution of the crank shaft serves to move the sley forward only once, and therefore drives the weft up to the cloth only once.

Q.—A line shaft running at 90 revolutions per minute drives a loom at 176 revolutions per minute. The drum on the line shaft is 14 inches in diameter, and the pulley on the loom 7 inches, find the percentage of slippage of the belt?

A.—$\dfrac{90 \times 14}{7} = 180$ revolutions.

$$180 : 176 :: 100 = \frac{17{,}600}{180} = 97.7$$

Therefore $100 - 97.7 = 2.3\%$ slippage.

Q.—In a weaving shed the main shaft makes 120 revolutions per minute, and is connected with the line shaft by bevel wheels so that the latter rotates 140 times per minute. If the wheel on the line shaft has 30 teeth (*a*) what is the size of the other wheel ? Also if the line shaft carries a pulley 15 inches diameter, which is connected by a belt with a 10 inch pulley on the loom shaft (*b*) determine the speed of the loom.

A.—(*a*) $\frac{140 \times 30}{120} = 35$ teeth ; (*b*) $\frac{140 \times 15}{10} = 210$ revolutions.

Q.—State some of the defects that will be caused by the defective shed.

A.—When the heads are opened to their fullest extent and the yarn that forms the bottom shed should just clear the race board of the sley. If the yarn presses on the race board it will not only form nicks in the race board but will be chafed, and the consequence will inevitably be breakages of the yarn. On the other hand if the shed is too high, it is liable to give the shuttle an upward tendency as it enters the shed, which often results in the shuttle either being thrown from the loom or not passing straight from the one box to other, in fact it will result in a number of faults, which will make both bad cloth and low production. The position of the yarn, when the healds are opened, can be regulated by raising or lowering the healds by means of the cords. Other defects are a too large, or a too small, shed causing in the former case an unnecessary strain on the yarn, and in the latter case, a drag on the speed of the shuttle.

Q.—Give some of the causes of defective selvedges.

A.—(*a*) If the temple is not set perfectly straight near to the fell of the cloth.

(*b*) If the weft is catching in the box or in any way held instead of passing clear into the shed.

(*c*) If the sheds are unequal and uneven.

(*d*) If there is any ineffectiveness of check strap.

(*e*) If there is any play in the reed.

(*f*) If the warp ends are slack.

(*g*) If the flanges on weaver's beam are crooked.

(*h*) If the selvedges ends are wrongly drafted or dented,

(*i*) If the counts of yarn in the selvedges are quite out of proportion to the warp and weft in the body of the cloth.

(*l*) If there is insufficient drag on the weft.

(*k*) If the dents at the selvedges have more or less ends or less pressure or the combs being less expanded on the sizing machine.

Q.—What will be the relative strain in the shedding of two warps if one is weaving in a loom running 200 picks per minute, the shed being opened 3 inches each pick, and the other weaving in a loom running 120 picks per minute, the shed being opened 4 inches each pick, the weight of the warp being the same ?

A.—$200 \times 3\frac{2}{3} = 1{,}802$
$120 \times 4\frac{2}{3} = 1{,}920$

Suppose the strain on the warp with the three inches shed equals one, the strain on the warp in the 4 inches shed equals.

$1920 \div 1800 = 1.06$

Q.—What are the points to consider in relation to the shedding mechanism which cause strain on the yarn.

A.—The shedding mechanism is responsible for a large amount of the strain which yarn has to withstand during weaving. The points are :—

(*a*) The timing of shedding motion in relation to the movement of the crank.

(*b*) Depth of shed made.

(*c*) Position of back rest in relation to height of sley and breas beam.

Before the timing of the shedding motion can be decided some conception of what the fabric we are making is going to be and also the quality of yarns we are using are essential.

Q.—What do you understand by shedding ?

A.—The object of shedding is to make an opening for the shuttle to pass through, and to change the position of the warp thread after each pick, so that the warp and weft yarns will be interlaced together according to a definite plan or pattern.

Q.—Is the shedding in a dobby loom more perfect than a tappet loom, and if such is the case, why ? If not, why ?

A.—Yes. Because you can raise and lower the healds as you may like it.

The healds in a plain loom are timed to cross at the top centre. Healds set too early will close before the shuttle has passed through, giving stitching at the side or shuttle flying out and broken selvedges. Healds set too late will give a badly-covered cloth, and the shed will not be open sufficient to allow shuttle to enter. Healds should move evenly without any jerk and the bottom shed should just touch the race board. In plains and twills the compensating action of the top roller motion must be considered when adjusting the healds, as the pulling down of one heald will raise the one on the opposite side of the roller. The depth of the shed should suit the shuttle used and should be as small as possible consistent with a clear opening.

If the dwell of the tappet is too long the time allowed for changing is reduced, and excessive vibration is set up due to rapid movement of healds. If the dwell is too short the shuttle will not have time to pass through before the shed closes, giving weft floats and broken selvedges. A short dwell gives a bad covered cloth.

Q.—Give the reasons of badly worn shuttles ?

A.—Box plate higher than the worn race-board ; excessive picking ; reed insecurely held ; insufficient seasoned timber.

Q.—The main shaft pulley is 15-inch in diameter making 100 r.p.m. and drives a tin roller pulley of 12-inch diameter. Find out the r.p.m. of the tin roller pulley.

A.—$\frac{100 \times 15}{12} = 125.$

Q.—Explain what do you understand by "soon" and "late" shedding.

A.—If the healds are set to change before the crank shaft reaches top centre, that is known as "soon" shedding. If the healds are set to change after the crank shaft reaches the top centre that is known as "late" shedding.

Q.—Give some of the factors that affect the smooth passage of the shuttle and cause it to crash into the boxes in the opposite side, turn over, or fly out.

A.—These three tuning troubles are related but in the former the cause is least evident while in the latter it is most evident and thus more easily located and remedied.

The more frequent causes of flying shuttles are—ends forming the shed are too high instead of lightly resting on the race, reed not level ; picker badly worn or having too much play on picking spindle ; and certain or all boxes too low ; too high or lower at back than at front. Causes, more difficult to locate and remedy, are....different sizes and weights of shuttles ; incorrect shape of box swell ; picking pindle not parallel to boxes ; and faulty checking of shuttles.

Q.—What are the advantages of early and late shedding. Name some cloths that would suit some better than others ?

A.—Early shedding gives cover on plain cloths. Late shedding gives cover on 3 and 4 shafts and dobby.

By shedding soon we minimise the tendency for the last pick of weft placed in the cloth to roll back after it has been beaten up to the fell of the cloth by the reed, due to the crossing of the warp threads holding the picks of weft up to the position as left by the reed. If the picks of weft are allowed to roll back we shall give blows successively to the yarn, everytime the reed meets the fell of the cloth, which means added strain on the yarn.

Q.—What would you do to change an early shedding to late shedding and *vice versa?*

A.—Slip the tappets.

✓ *Q.*—How can you increase or decrease the size of the shed in a plain cloth ?

A.—There are various ways. But bear in mind that the yarn should get à shed the depth of the tappet. To increase shed, move hooks from tappets. To decrease, move hooks towards tappets. To increase shed, move the rollers away from the healds, and to decrease shed move rollers towards the healds.

Q.—How is a dhoty selvedge formed ?

A.—A dhoty selvedge is formed by ornamentation.

Q.—What is perfect and accurate shedding ?

A.—A perfect and accurate shedding is due to a perfect tappet with correct amount of dwell, timing it proper, and to have tappets always in connection with treadles.

Q.—Suppose you had a fine sateen which had to be perfect in cover and free from weft snarls, and also as soon as you began altering the shedding to keep weft snarls out you decrease the cover. How could you produce both ?

A.—I could produce both by picking soon and shed late.

Q.—Would you use the same size of shuttle when weaving 80s warp as when weaving 30s ? Give your reasons in full.

A.—30s warp is much stronger than 80s, so that the smaller the shuttle used for fine yarn, the better and lesser will be the strain.

Q.—How would you know the distance a certain shuttle would travel and how ?

A.—To determine the distance a certain shuttle would travel is to judge the size of the picking neb.

Q.—What difference is there between spring and top rollers ? What could you do with an increased size of treadle bowl ?

A.—Springs produce cover far better than rollers. The treadle being kept in direct contact with the tappet. If you had an increased size of treadle you would want a much larger tappet.

Q.—Give some of the irregularities in the loom that causes a bad selvedge.

A.—Wrong selvedge drafts, temples not holding cloth out to full reed width, uneven tension of weft, too much or too little, too coarse selvedge yarn, snarly weft or shuttle rebounding, bad beaming at edge of beam, bad shedding. Serrated edges due to irregular tension of weft. Too much drag on weft will cause the weft to pull at the side, break and give selvedge floats.

Q.—Give as many instances as you can that will cause the shuttle to fly out.

A.—(*a*) If the reed and the back of the shuttle box is not in a line with each other.

(*b*) When the reed is bent, *i.e.*, standing farther forward in one place than other.

(*c*) When the bottom line of warp is raised too high.

(*d*) Any downward pressure on the end of the shuttle which, is in contact with the picker just as it is leaving the box and mounting the edge of the warp into the shed is bound to cause the shuttle to fly out.

(*e*) If the shedding is not timed as to produce a clear open shed for the passage of the shuttle.

(*f*) Broken ends.

Q.—What is the size of the shed required to produce the best results ?

A.—The size of shed required to produce the best results will vary with the size of the shuttle and the quality of the warp yarns employed, but should always be as wide as the circumstances will allow.

Q.—When is it advantageous to employ a large shuttle and when a small one ?

A.—For good, strong, elastic yarns, a large shuttle may be employed but for fine, tender, or badly sized yarn, a small shuttle is the most advantageous.

Q.—Explain the effect of soft places in ring yarn and their effect on subsequent processes.

A.—Whilst quantity at the least possible cost should be the keynote of the cotton industry, it must not be forgotten that quality should be the foremost in all the essentials of production. Through the lack of attention to detail and spinning operatives ignorance of manufacturing difficulties, needless loss of production is entailed. A greater knowledge of subsequent processes imparted to operatives, both spinning and manufacturing, would result in better quality without any loss of production.

Operatives are shown that to do a certain thing is wrong, but the reason why is omitted. Manufacturers complain of faulty yarn without any accompanying explanation of the difficulties this yarn has given them. Trace one fault through all the processes of spinning, preparing and manufacturing, and view the results. When roving pegs in the ring frame become badly worn, or peg holders become out of alignment, over-running of the roving occurs and causes soft places. The over-running in this case is different and distinct from over-running caused by the roving "spewing" through. The latter is caused by the roving being drawn through the rollers without being drafted and then twisted, therefore causing hard places.

The cause and fault having been determined (*i.e.*, soft places) follow its effects in subsequent processes, assuming the yarn is intended for warps. From the ring frame the yarn is conditioned and taken to the winding frame to be wound on warper's bobbins. By means of tensioning devices and clearers an attempt is made, on this machine, to clear the yarn of faults. But if the clearing device consists of slotted steel plates, soft places of sufficient strength to withstand the tension will be allowed to pass forward. If the tension is too great the end will break. Therefore, to prevent excessive breakages the tension is invariably reduced, allowing the fault to pass forward to the next process. The end of the fault is not at this particular process, as by reducing the tension to prevent excessive breakages snarling occurs, less yarn is put on the bobbin leaving the bobbin soft. So from one small fault caused by lack of attention to detail, more faults are added and production is reduced. If the clearing device is of the comb variety soft places cause excessive breakages, lowering the operatives' wages and curtailing production. So the original fault is replaced by another —too many knots.

The full warper's bobbins are then placed in the creels of beaming frames so that the yarn may be transferred to beams. Consider the fault of soft places and its accumulations at this process. Stop motions are fitted, which, in the event of any one end breaking stop the machine, and, as the creel accommodates 540 bobbins, it will easily be seen that one soft place in any length of yarn has the power to stay the production of 540 bobbins.

In common practice it is found that most breakages occur at this machine when the bobbins are full, due to the weight to be turned round, so at this point soft places are somewhat eliminated. At three parts full less breakages occur, therefore at this point there must have been less tension, and soft places allowed to pass forward. This is explained by the fact that the weight of yarn has been considerably reduced, but the leverage from the centre of the bobbin is still sufficient to allow the bobbin to be more easily turned. As the bobbins are getting empty breakages occur due to decreasing leverage, because as the leverage to the centre of the bobbin is reduced so is the tension increased. It will be seen that at this point tension is most unreliable even when preparing good yarn, so how much more so when there are the added faults of snarls and soft bobbins? Where a snarl runs off there is no tension. A soft bobbin empties quicker than a hard one, and as the bobbins run empty there is undoubtedly a variation of tension—the beam thus being built up of tight and slack ends.

To sum up, twist will always run to the weakest place in any length of yarn, so assuming the soft place the weakest part, twist will run into it, giving it sufficient strength to be carried forward on to the beam when bobbins offer least resistence to movement, or, the soft places cause excessive breakages. When this occurs the human element tends to become indifferent and careless, and bad knots are made.

If the warp yarn is intended to be a twofold, doubled and twisted on one machine, warper's bobbins are usually put into the creel of the doubling frame. Where the tension has been reduced on the winding single and lashed yarn. Some of these faults, although the greatest care may be taken, undoubtedly pass forward to the next process where the yarn is rewound at the winding frame on warper's bobbins.

At this process, sufficient tension should be exercised to break all weak places. Unfortunately, but too true, the tension is sometimes altered by the operative working on this machine to suit her own convenience, which in this case is to prevent ends from breaking, thereby earning more wage and making the work easier. If the tension is one which can be locked when the correct tension is arrived at, so much the better, and weak and soft places can be almost eliminated.

When this excellent point has been reached there is still the possibility of bad knots, resulting from excessive breakages, and lashed yarn going forward. Where the tension has been reduced in the winding process the effected places in the yarn will now show in the beaming creel, and its effect will be the same as in beaming the single yarn.

At this point the single yarn is sized to prepare the warp for the loom. All, as regards weaving purposes, depends upon this process, because sizing is a necessary procedure to give single yarns sufficient strength to withstand the chafing and strain of weaving.

The beam is then placed in the creel of the slasher-sizing machine, to be sized, dried and re-wound on weaver's beams. The ends are now drawn off, and are under tensions due to the resistance of the beam. Whilst the ends which have been under the greater tension during preparing carry most of the strain, the slack ends under very little tension are drawn off easily, enabling some of the soft places to go forward and be given sufficient strength by the size to pass onto the weavers beam. Excessive breakages will be caused by soft places, or ends under undue tension, which causes laps to form on the back beams and rollers, necessitating stoppages of the machine.

Soft places absorb more size than the good yarn and owing to the shortage of twist, flatten out when passing through the squeezing rollers. The ends now come into contact with the drying cylinders and some of the soft places which have been flattened out adhere to the adjacent ends, thus causing breakages at the splitting rod. Stoppages of this machine make for loss of production, besides resulting in the yarn being irregularly sized and overdried.

These weaver's beams are now taken to be drawn-in, placed in the loom and gaited up. The sheet of ends is again under tensile strain due to the resistance of the beams, but owing to the ever-existent tension in the sizing process, it may be assumed that the tight ends on the original back beams have been stretched to the length of the slack ends. Good yarn has therefore lost some of its elasticity due to the bad yarn, and owing to tensional strain at this point there are breakages of stretched yarn and soft places.

Soft places which have withstood the tensile strain have still to resist the chafing of the healds and reed, such chafing, combined with the shuttle and sley-race board friction, causes breakages of soft places or sufficiently weakens them to make a fault, resulting in production being held up, reduction of operative's wages and a fault in the finished cloth. This fault, sometimes hidden by size, passes the cloth looker's examination, and the finished cloth placed on the market, the fault then remains unseen until such time as the piece of cloth is washed free from size. Then from this point fraying begins and the piece of cloth is ruined.

Q.—When should a shed be made large and when should it be made a small one?

A.—The shed formed for smooth, even yarn should be of such a size that the thread will barely clear the front of the shuttle when the sley is pushed to its backmost position. But when the yarns are rough, fibrous and difficult to separate, the shed must be made larger because the w rp yarns must be properly opened before the shuttle is inserted.

Q.—What will result if you do not make the shed larger in case of yarns being rough and fibrous?

A.—Broken thread, stitches and flying shuttles will result.

Q.—How would you detect too large a shed?

A.—If too large sheds are formed, an excessive strain will be put on the thread which will result in frequent breakages, and in bare lean looking cloths.

Q.—What will happen if the use of the check strap were to be discontinued?

A.—The shuttle without the check strap would become jammed at the end of the box, and the picking would be jerky.

When the shuttle is driven into the box at one end it should draw the picker and check strap at the other and towards the centre of the box, so that when the shuttle is driven in the opposite direction, it will be met by the picker, which will slide gradually backward under the pressure of the shuttle, against the check strap to the end of the box.

Q.—What effect the length of the check strap has on the shuttle?

A.—The length of the check strap should be carefully adjusted because when it is too short the shuttle does not get far enough back in the box, and when it is too long it is practically useless, as the shuttle will rebound. In either case the picker is unable to exert sufficient force to throw the shuttle to the opposite end of the loom. A short check strap will also cause the cops to break and weft to slip off the bobbin by stopping the shuttles too suddenly.

Q.—How would you detect too small a shed ?

A.—If too small sheds are formed, an extra power will be required to drive the shuttle through the shed and the friction of the shuttle will wear down the threads, and the weft will stitch at the edges.

Q.—When are springs chiefly used ?

A.—Springs are chiefly used in combination with dobbies, and give a steadier action at high speeds. Elastics are also employed in place of springs for one or two shafts weaving stitches and the rest plain. Springs are used for the plain shafts.

Q.—When will a small weft stitch be visible on the face of the cloth ?

A.—When a peg be broken or missing from the lags or lattice of a dobby

Q.—When should a shuttle begin to move out of the box ?

A.—When the crank is at its bottom centre, and have received its final blow by the time the crank is half-way between the bottom and back centres.

Q.—When is the sley travelling very slowly ?

A.—When it is half-way between the back and top centres.

Q.—What is gained by deepening the back part of a shuttle ?

A.—If the shuttle is made heavier at the back than at the front, in going across the sley, it would cling better to the reed. It would also assist it from turning over. If a shuttle is followed, it would be seen that when it turned over in the loom, it was caused by the front part being heavier than the back. If the shuttle is made square, a drag will be created and it will refuse to arrive home properly, as there would be a very rough edge on the shuttle.

Q.—What is the effect of the shuttle boxes on the pick ?

A.—The shape of the shuttle box, and the amount of the pressure put upon the shuttle by means of the swell, affect the amount of power required for picking in a very material manner.

The back of the box should be parallel with the reed except for the projection of the swell, and the front of the box should be set a little wider at the opening than at the end.

Q.—What effect has the tightness of the swell spring on the loom ?

A.—The effect will be, a large number of unnecessary force has to be expended in driving the shuttle both in and out of the box, and hence the loom is subjected to a large amount of wear and tear.

Q.—State the use of the check strap ?

A.—The primary purpose of the check strap is to assist in preventing the shuttle from rebounding, and at the same time, to allow it to have free play in the box.

Q.—A piece of cloth one yard square, weighing one-fifth of a lb. contains 78 threads of 40s twist and 70 threads of 50s weft per square inch what percentage of size would you put on the twist in order to obtain the above weight when woven ?

A.—Allowing 6% for contraction in width and 6% for milling up in length, the weight of warp equals:

$$\frac{78 \times 36 \times 1 + 6\%\,(\text{for length}) \times 16 \text{ ozs.}}{840 \times 40} = 1.41 \text{ ozs.}$$

$$\text{Weight of weft} = \frac{78 \times 36 \times 1 + 6\%\,(\text{for width}) \times 16 \text{ ozs.}}{840 \times 50} = 1.01\,7\text{ozs}$$

The total weight $= 1.41 + 1.017 = 2.427$ ozs.

The sample weighs 3.2 ozs.

$\therefore$ $3.2 - 2.427 = .773$ which is size.

$$\text{The percentage of size} = \frac{.773 \times 100}{1.41} = 54.8\%\ \text{size.}$$

Tabs

The bits of cloth cut from piece ends.

T. Cloths

Plain greys of low quality and heavily sized yarns always in 24-yard lengths. The name is derived from the mark of the T. of the original exporters.

Tackler

Jobber or tuner, an overlooker who keeps the looms in repairs and performs other functions necessary to keep them running.

Tachometer

An instrument indicating the number of strokes or revolutions made by a machine. A speed indicator.

Taffeta

It is derived from Persian *taftah*, to spin. It is a plain closely woven, smooth silk fabric. The warp and weft are the same or nearly the same count. May have a small figure introduced on plain background, weave-plain. Width 36 and 40 inches. Rayon taffeta may have cotton warp.

Taking-up

A motion for automatically winding the cloth as it is woven on to cloth roller.

Tapes

Borders of crammed or coarse warps.

Tappets

Tappets are names given indiscriminately to those irregular pieces of mechanism which gives a rotary motion for the purpose of producing, by sliding contact reciprocating motions in levers. Tappets are made in great variety and placed on different parts of a loom, *viz.*, under and outside the end of framing, etc., also used in the making of plain cloth, etc., and they are used for changing the position of the healds and forming the shed for the shuttle.

Tearing Resistance

It indicates a straining or rupturing action on woven fabrics. The tearing strength of fabric may be measured by the "tongue and double tear" method.

Technical

Especially appertaining to an industrial art, business or profession.

Technology

The branch of knowledge dealing with the systematic study of the industrial arts.

Temple

A cast iron in which are fitted the temple rollers that are made of round bar of iron, and in which finely pointed steel pins are driven. It is employed to contract the fabric in the direction of its weft during the operation of weaving.

Temple Marked

When there are lines of small holes at or near the selvedges caused by the temple rollers having blunt. Another cause is when the temple rollers do not rotate freely as the cloth is drawn forward but still do not bind to the extent of tearing the cloth.

Tesile Strength

Breaking strain of yarn or fabrics. Recorded on an specially made instrument. Used as selling point in comparing two or more samples.

Tentering

A finishing process. Cloth is attached by the selvedge on tenter hooks in a frame where it is stretched to the desired width, and dried.

Textile

This term refers to the process of weaving only, by convention, it has now a much wider significance, and is taken to include other branches of the manufacture of cotton, wool and silk.

Texture

The disposition of the threads in a fabric, showing the combination of warp and wefts, the closeness or openness of a fabric. The surface effect of cloth.

Thick Ends

Thick ends mean that the cuts contain one or more occasional ends which are much too thick or too coarse in counts, and show very prominently in the cloth. One cause of the fault is that of odd full bobbins, much too coarse in counts, being mixed in with other full bobbins between the winding and warping processes.

Thin Place

A thin place indicates a part of the cloth with, say 3 or more picks of the correct counts of weft not sufficiently close together as compared with the required picks per inch evenly spaced.

Thick Place

A thick place occurs when sufficient picks are also close together, thus forming distinctly thickened place across the fabric in comparison with the correctly picked part of the cloth.

"Pure-gold" Thread

"*Pure-gold*" *Thread*—is not made of pure gold but is drawn from gilded silver rod to the required fineness.

"*Pure-silver*" *Thread*—is made by forging cast silver bars into rod and then repeatedly drawing these to thread having a thickness of 0.05 mm. or about .08 inch.

"*Alloy Gold and Silver Thread*"—The alloy threads are not made by melting together the component metals by drilling a rod of the noble metal, inserting a rod of the alloy metal (copper. copper-nickel alloy, etc.), and then drawing the composite rod into thread.

"*Alloy Thread.*"—Copper rod is exposed to zinc vapour and then drawn into thread having a brass colour.

"*Lyon's (Gold or Silver Plated) Thread.*"—For this material a copper rod is gold plated and then drawn to the required fineness. The most recent practice consists of plating by an electrolytic method. Imitation or Lyon's silver thread is made by coating copper rod with silver (by treating it with silver nitrate solution or by sliding a hot silver tube over the copper rod) and then drawing.

"*Electrolytically-plated Lyon Threads.*"—They are made by electrolytically plating a metal thread with gold, silver, etc.

"*Lyon Thread.*"—Is produced by introducing fine metal threads during the spinning of ordinary yarn or by coating ordinary yarn with a metal powder by the aid of a suitable binding agent.

Throwing

The combining and twisting of raw-silk threads in various ways, thus making it practicable to dye them in the skein.

Thrum

The end of a warp where the threads are knotted together.

Ticketing

The operation of pasting to the folded piece of cloth, some printed ticket of highly coloured and strikingly designed. It may contain the name of the mill. Also another printed ticket is pasted on the piece below the coloured ticket on which is printed what all sorts of cloth can be had from the commission agent pertaining to the mill named on the ticket, also the address of the commission agent is given on the ticket. In short, this serves as an advertisement.

Ticks or Ticking

A strong heavy cloth used for bed-ticks, woven in twill herring bone, and sateen weaves. Width 32 to 60 inches. Six to nine ozs. to the yard.

Tram

Raw-silk threads doubled together and twisted, usually about two to five turns per inch, used for weft.

Trap

Synonymous with mash.

Treadle

The lever by which heald shafts are actuated on the looms.

Trevette

A knife used in cutting the pile wires out of the cloths.

Turkish Towelling

A loop pile fabric used for both towels and sheets. Two warps are employed in weaving. The ground warp being tightly ewighted, and the pile warp very lightly tensioned. For two picks the reed gives way slightly as it approaches the cloth, but on the third pick it is held firmly and gives a full stroke, thereby sliding the three picks along the tight ground warp, and flushing the pile warp which has been intersected by the weft in the form of loops on one or both surfaces of the cloth.

Turns (per Inch)

The extent of torsion in yarn.

T. W.

Twist-way yarn or thread, which, in being spun, has been twisted over the left distinct from weft-way.

Twells,

Twill.

Twill Weave

This is the simplest variation from the plain weave and consists of each thread passing over one end under two for, say, the first pick of weft, and the next one starts on the next adjacent thread, and so on, forming a line diagonally from selvedge to selvedge.

Twill Classification

Twills are generally classified under the following general heads :—

Continuous or Regular.—A regular diagonal line is produced, and the lift is regular all across.

Zig-zag.—The diagonal line is reversed at fixed intervals, producing a series of waves.

Rearranged.—A regular twill is taken as a basis, and the lifting is rearranged to a definite plan.

Satin Twills.—Gives a very smooth face both warp and weft, and are produced by rearranging a regular twill.

Corkscrews.—Are also rearranged twills, but step two or more instead of one.

Broken.—A regular twill is broken in its direction at any desired interval.

Figured.—Simple spots or figures are combined with some simple twill.

Combined.—Formed by taking two regular twills and arranging them as one by taking the threads alternately either end and end or pick and pick.

Twist

Warp yarn. The amount of twist or number of turns per inch.

Twist-way Weft

Yarn that has been spun to the right is known as "twist-way" spun.

Q.—How would you test artificial silk chemically ?

A.—When small samples of artificial silk are treated with equal parts of concentrated sulphuric acid and iodine, the following reactions take place.

(1) Viscose turns blue.
(2) Acetate turns yellow.
(3) Nitro-cellulose turns violet.
(4) Cuprammonium turns light blue.
(5) Gelatine turns yellowish-brown.

Q.—How would you distinguish cellulose—acetate from all other artificial silks.

A.—(1) Twist fibres into a tight wad and then cautiously approach to a match flame, without being brought into contact with the flame.

Cellulose-acetate artificial silks melt or fuse, forming a black knob, or globule on the end, which precedes the small spluttering, relatively slow burning flame down the thread. If the flame be extinguished and the knob cooled, this will be found to be somewhat hard and resistant to crushing.

Nitro-cellulose, cuprammonium and viscose do not melt back, but burn quietly and readily like bleached cotton fibres and the colour from the fumes is the same as that coming from burned cotton.

(2) Treat the sample with pure acetone.

Cellulose-acetate is soluble upto 1%, while nitro-cellulose, cuprammonium, and viscose are insoluble.

(3) Treat the sample with glacial acetic acid (water white) cellulose-acetate dissolves, and on adding water precipitates as a milky unstable emulsion or translucent gelatinous material.

Nitro-cellulose, cuprammonium, and vicose are all insoluble.

Q.—Discuss the value and importance of technical training pertaining to textiles.

A.—In textiles, this is an absolute necessity, and higher the standard of training, the better it is for the trade. The day is not far distant when all important posts in the industry will be filled by trained men who will be prepared to work on scientific lines, and substitute "brains for brawn." New conditions demand new treatment, and it is becoming more and more recognised that the technical requirements of the cotton industry, in all its varied branches, will have to be appreciated, and mutually considered by all sections of employers and employed.

Q.—State the importance of taking-up and letting-off motions?

A.—These are important motions, as not only do they regulate the thickness of the cloth by controlling the picks per inch, but upon their regular action the regularity of cloth depends. As a rule, these two motions are worked together, the taking-up effecting the letting-off. There are also positive and non-positive (or negative) systems of both taking-up and letting-off.

Q.—A cloth is made 40 inches wide, 40 yards long, 10s warp, 20s weft, the threads and picks per inch are equal, the total weight of the piece is 15 lbs. Find the threads and picks per inch. Allow 5% for length and 5% for width. The weights of warp and weft will be in inverse proportion to the counts of yarn, that is, as two to one.

A.—$15 \div 3 = 5$

Therefore warp = 10 and weft = 5

$$\frac{840 \times \text{counts of warp} \times \text{weight of warp}}{\text{Length} \times \text{width}} = \text{threads per inch.}$$

$$\frac{840 \times 10 \times 10}{42 \times 10} = 50 \text{ threads per inch.}$$

$$\frac{840 \times \text{counts of weft} \times \text{weight of weft}}{\text{Length} \times \text{width}} = \text{picks per inch.}$$

$$\frac{840 \times 20 \times 5}{40 \times 42} = 50 \text{ picks per inch.}$$

Q.—What is tuning of a loom?

A.—*Tackling*—getting all movements to work accurately at their proper time in conjunction with each other.

Q.—What is dwell of a tappet?

A.—By dwell is meant the length of time the healds are kept stationary, in order to allow the shuttle to pass from one side of the loom to the other.

Q.—What is the action of the tappet in a plain loom ?

A.—The action of the tappets is, when one or the other of the tappets depresses its treadle, the heald to which it is connected is depressed. The upper portion of the healds are attached to roller straps, and as one is depressed it lifts up the other by winding on the strap.

Q.—Why is it convenient to change from tappets to a pegged lattice ?

A.—It is more convenient to change from tappets to a pegged lattice when a pattern is beyond the range of a tappet either in the number of shafts to be manipulated or in the picks to a repeat of the pattern, and is, at the same time, too small to be economically produced by Jacquard.

Q.—How are 3 shafts, 4 shafts, 5 shafts worked with tappets ?

A.—Top rollers, when one heald is pulled down, lifts the other up.

Q.—The length of the treadle is 30 inches, distance from the stud to contact 18 inches, and the shed required is 3 inches. Find the lift of the tappet ?

A.—To find out the lift of the tappet, multiply the size of the shed required by the length of the treadle from the stud or fulcrum to point of contact, and divide this result by the whole length of the treadle, thus :—

$18 \times 3 = 54$

$54 \div 30 = 1.8$ inches, the lift of the tappet.

Q.—What is take-up motion ?

A.—A take-up motion regulates picks per inch.

Q.—How is a take-up motion set ?

A.—When the crank arm is at its back centre, the taking up lever catch should be midway between one tooth of the rack wheel and the letting-back catch should be holding back a tooth, when the crank arm is brought to its front centre. The taking-up lever catch should push forward a tooth and lettong-back catch should be in the midst of two teeth.

Q.—How is the timing of the sheds and size of the shed determined in a dobby ?

A.—They are determined by the position of the crank in relation to the sweep, the throw of the connecting rod, the movement of the knives, the amount of clearance given to the hooks, and the point of connection with heald cord on the jack lever. The shed can be graduated by increased and decreased leverage of the jack lever and an inclined knife which gives the maximum amount of movement to the back heald and minimum amount of movement to the front heald.

Q.—Does more twist in weft increase the contraction in width of plain cloth ?

A.—The theory that inserting more twist in weft materially increases the contraction in width of plain cloth is refutable.

Umbrella Fabrics

Made of all silk or all rayon or in combination with cotton for covering umbrellas, shower-proofed. Usually 36 to 44 inches wide, 75 to 90 yards long, fine reed and pick (96 to 110 threads or picks per inch), and fine yarns 30s to 60s warp and weft), always plain weave. The cloth is also used for dress purposes. Many makes have a coloured cotton or worsted selvedge.

Under Pick

A picking motion, the picking arm or stick is under the shuttle box.

Up-Taking

The take-up motion.

Uneven Weft

It is a fault denoting very irregular thickness of weft.

Q.—What are uneven places in a piece of cloth due to ? And how can they be overcome ?

A.—Uneven places in a piece of cloth are due to cover and take-up motion.

Variation in Width (of Cloth)

Means that the cut varies excessively in width.

It may be caused by a variable amount of tension on the warp and trouble with the selvedge ends breaking out, owing to it being soft or cut.

Vegetable Fibre

Flax, cotton, yarn, hemp and jute.

Ventilation

Two distinct methods of ventilation are possible. Fresh air can either be forced into the room or the air can be exhausted and fresh air to find its way inside through accidental or specially constructed inlets.

Vistra

A staple fibre, the production of Vistra Gesselschaft, Berlin.

Warp or Twist Yarn

The yarn arranged lengthways of the cloth. Usually stronger and harder twisted than weft yarn. The twist in warp extends spirally from left to right in an upward direction. Also a number of ends of yarn of equal length, parallel to one another that go to form the lengthwise series of threads in cloth which may be defined as a warp.

Water T.

Throstel twist.

Waterproofing

Process of rendering fabrics waterproof or moisture repellent, the latter describes most so-called waterproof fabrics. Produced by treatment with aluminium salts. Actual waterproofing is done by impregnating fabric with (*a*) solution of crude rubber (vulcanized to fabric); (*b*) preparation of oils or paraffin; (*c*) application of paint or varnish. Water repellent is a term used for garments so treated.

Waves

Ziz-zag twill pattern.

Wear

This can be mechanically measured and rated by artificially wearing the surface upon an "abrasion machine." It is highly desirable that all fabrics should have a good degree of resistance to wear.

Weaving

The interlacing of threads (warp and weft), forms a fabric (a firm wearable texture) by alternate crossing of weft upon warp, usually at right-angles to one another. The succession and number of intersections being determined by the character and pattern of the cloth.

Weaver's Beam

Will hold on an average 1,088 yards, barrel of the beam = 4½ inches, flange = 17 inches.

Weft

The yarn arranged across the cloth. Usually spun softer than warp yarn. The twist ends the opposite direction to that of the warp yarn, it is from right to left in an upward direction. The weft can be either in cops or bobbins.

Weft Feelers

Weft feeler motions are a useful aid to weaving. Their function being to supplement the weft stop motion (which stops the loom only when the weft breaks or "runs out") by automatically stopping the loom just before the weft is completely unwound from the pirn or bobbin. Their degree of usefulness depends, of course, on the type and quality of the cloth woven, whether "pick finding" is necessary, etc., when the cloth woven is of costly nature and must be produced free from what in cheaper fabrics might be regarded as very minor faults, then weft feelers are particularly useful. For instance, when the weft in completely unwound from the shuttle before the loom is stopped, joining places in the form of cracks, or thick and thin places in the cloth are very liable to occur where the fresh pirn commences. Even when the weaver takes the trouble to take out or match the broken pick and adjust the cloth take-up motion, a joining mark may appear. Thus, the use of a weft feeler motion by stopping the loom before weft exhaustion will prevent or reduce starting or joining places.

Weft-way Spun

Yarn that has been spun to the left is known as "weft way" spun.

Weft Fork

A simple and ingenious contrivance for stopping a loom automatically, should the weft in shuttle break or become exhausted.

Wiry Weft

Weft that is about double the proper thickness and twisted about 50% too much. A common cause of the defect is that two ends of roving instead of one in case of spinning from single roving or three ends in place of two, when spinning, from double roving, are passing through one guide eye at the ring spinning frame.

Whip Thread

The crossing thread in gauze.

Whip Roll

Back rest.

Wood Pulp

Raw material for the viscose process. Delivered to the factory in sheets.

Woof

The weft.

Woollen Cloths

Rough-faced fabrics made from yarns produced by carding, afterwards being shrunk to such an extent that the weave is, hardly seen, such as tweeds, etc.

Worsted Cloths

These are fabrics made from combed wools. Most worsted are smooth faced, such as serge suitings and dress cloths.

Wrong Cops or Bobbins

Odd bobbins or cops of weft of the wrong counts are sometimes mixed in, because of odd bobbins dropping on the floor of the ring spinning, department, weft-store room, weaving shed, and finding their way into cloth requiring weft of very different counts.

Wrong Change Wheels

When a warp is started up with an incorrect number of teeth in the take-up motion change wheel, there may be a whole cut, or even more woven before it is discovered.

Wrong Lifts

It means, that the healds, in dobby loom cloth, are not being lifted in the correct sequence to produce the desired pattern or design. The lattice may not be correctly pegged, or a peg may have dropped out or be too short or bent.

Wrong Drafts

It means, that one or generally more of the warp ends have been drawn through the wrong healds, and hence, lift incorrectly.

Yarns

Are spun for commercial purposes as high as 400s, but counts above 200s are used only in the finest kind of lace specialities.

Zathate

The alkali cellulose after being treated with carbon bisulphide.

Q.—Give the causes of defective operation of the side weft fork motion.

A.—The causes of defective operation of the side weft fork motion can be grouped under two headings, *viz.*, those which result in the stoppage of the loom when the weft has not broken or become exhausted, and those which occasion the continuance of the loom's operation after weft breakage.

Probably the most frequent causes of the weft fork motion unnecessarily stopping the loom is the weft fork prongs coming in contact with the grid. This may be due to the rong setting of the fork or grid or bent fork prongs. The fork and grid should be set so that the lower portions of the prongs project from an eighth to three-sixteenths of an inch through the spaces in the grid when the sley is in its mot forward position, and when the weft is absent. The prongs should not touch the bars of the grid, and the height of the fork should be such that the prongs do not touch the bottom of the grid or the sley when the hooked end of the fork is raised to its highest point. The fork must, however, be low enough for the weft to give the necessary action to the prongs. The points of the prongs should be a little below the level of the race board. It is important to see that the prongs of the fork and the bars of the grid are parallel to each other throughout the complete action of the fork for much unnecessary stopping of the loom is caused by an inaccurate action of the fork. When fixing a new fork it is advisable to make sure that the screw hole in the fork is perfectly straight and in correct alignment with the corresponding holes in the weft fork holder. The hooked end of the fork should not be too heavy or the fork itself too light for the kind of weft used. Weavers should take care that they do not bend the fork prongs when they are changing shuttles and sweeping the loom, for the prongs are easily deflected so that they contact with the grid and cause unnecessary stoppages.

Other causes of the weft fork motion unnecessarily stopping the loom are wrong setting of the weft fork hammer, and wrong timing and setting of the tappet which operates the hammer. The purpose of the tappet is to move the hammer just at the time when the hooked end of the fork is raised by the action of the weft against the fork prongs.

If there is insufficient tension on the weft, the latter will fail to exert the necessary pressure on the fork prongs to raise the hooked end of the fork, and this is bound to result in unnecessary stoppage of the loom. If the weft comes from the cop, bobbin, or tube too freely, it must be tensioned at the shuttle. The method of tensioning will, of course, vary according to the type of weft; for ordinary cotton mule cops a small piece of flannel attached to the shuttle near the entrance to the shuttle eye, would be sufficient in the great majority of cases, while for rayon it would probably be necessary to glue rabbit fur along the inner sides of the shuttle and insert a tuft of soft worsted yarn in the shuttle eye.

Another cause of insufficiently tensioned weft is the rebounding or bad checking of the shuttle, especially at the setting-on side of the loom. The rebounding of the shuttle will cause the weft to become slack, and when the sley moves forward, its action on the weft fork will be inadequate, and thus the loom will be unnecessarily stopped by the weft fork motion. The shuttle will rebound if the check strap is not working properly, if the picking action is too strong, if the shuttle box is not correctly adjusted to the width of the shuttle, and if the shuttle box "swell" exerts insufficient pressure on the shuttle.

Bad timing or weak action of the picking motion is sometimes responsible for the unnecessary stopping of the loom. In loose reed looms, the picking action from the "off" side box occassionally gets so weak that the shuttle strikes the weft fork and causes the loom to stop. A similar effect is occasioned in both fast and loose reed looms when the picking motion is timed very late from the "off" side box. Very early picking from the starting side of the loom will also cause the stoppage of the loom, as in this case the shuttle commences to move and thus releases the tension on the weft, before the stop or catch of the hammer has passed the hooked end of the fork.

Failing to Stop when necessary.—Some of the faults which cause the loom to stop unnecessarily also result in the weft fork failing to stop the loom when the weft is broken or becomes exhausted from the shuttle. Any obstruction to the free action of the weft fork, such as the fork catching the grid, the sley, the check strap, etc., may cause the lifting of the fork when the weft is absent, and thus the loom will continue to run until stopped by the weaver. If the fork is set too high or goes too far through the grid, the weft will be liable to catch on the ends of the prongs and thus keep the fork in a raised position so that it cannot stop the loom when the weft breaks. In course of time, the step or catch on the hammer head becomes sufficiently worn for the hook of the fork to slide over it and thus cause the loom to continue running when the weft is absent. A similar effect obtains when the hooked end of the fork is bent or unduly worn. Care should also be taken that the lift of the tappet is sufficient to draw the weft fork lever far enough to push the starting handle off its catch. If the movement is not great enough, the lift of the tappet or the leverage of the weft fork lever should be increased. Another method is to file off the corner of the starting handle catch until the movement of the weft lever will push the handle off the catch. Care should, however, be taken to see that the lift of the tappet is not too great, otherwise the hammer will be moved so far that the weft fork will drop off the hammer altogether, and put the motion out of operation.

Q.—Describe a warp line.

A.—The normal warp line is a straight line from front rest to back rest, and passing through the centre of the shed when fully open. It may be horizontal or inclined, the main thing being that the threads forming the bottom shed shall lie as flat as possible on the sley, while the shuttle passes through the shed. With such a warp line, the threads forming the top and bottom shed would be of the same tension and it will be found that the warp threads enter into the cloth in the same order as passed through the dents of the reed, making what is known as reedy cloth. To overcome this defect, taking a plain cloth, as an example, the practice is to raise the back rest of the loom, thus slackening the top shed, and as weaving proceeds, alternate threads are made tight and slack, thus on the first pick, odd numbered threads will be tight and the even ones slack. On the second pick, these conditions will be reversed. From this it will be plain to see that the shed must be fairly well open at the beat-up to get the full advantage of this variation in tension for with a closed shed at beat-up, the tension would be the same on all the threads, even with the back rest raised. The reason is now clear for shedding tappets being constructed with considerably more dwells than that necessary for the passage of the shuttle.

Q.—Give some of the reasons of excessive waste in the loom shed.

A.—Badly-made cops. Excessive picking. Imperfect action o check strap. Carelessness in shuttling cops. There is more wastage from through tube than short-tubes in the case of mule cops. Soft pirns (that is, the yarn on the pirn being so softly wound that it can be pulled out from it.) Weak shuttle tongue springs. The practice of using the knife to the pirns, and thus forming nicks in the pirns, should never be allowed.

Q.—Give the causes of warp breakages.

A.—Bad shuttle. Rough shuttle sides. Excessive bottoming or overshedding. Healds having lateral movement. Non-adjustment of lease rods or back rest. Defective sizing. Want of humidity in the shed. Rusty reed or sharp reed wires.

Q.—If the price paid for weaving a piece of cloth 75 yards is rupees 2 and annas 8, what price must be paid if the length is increased to 135 yards, all other particulars to remain the same ?

A.—75 : 135 : : 40 annas.

$$\frac{135 \times 40}{75} = 72 \text{ annas or Rs. } 4/8/\text{-}.$$

Q.—What are the causes that form kinky weft in the cloth ?

A.—Kinks in the weft are usually the result of too much twist, when such is the case, the weft should be thoroughly damped either by being steamed or having water sprinkled on it. Another point to be noted is the friction on the weft. If the weft is allowed to run out of the shuttle too freely, more than the required length for one pick is very liable to be given off, and when beaten up by the reed it will be sure to rise in ridges. A piece of flannel in the nose of the shuttle will remedy the defect.

Q.—What are the four factors connected with the weaving process.

A.—The four factors are (*a*) materials (*b*) operatives (*c*) machines (*d*) organisation.

Q.—What would you do to prevent warp snarling and weft snarling in fine goods ?

A.—Warp snarls can be prevented by adjusting the shedding motion and keeping the warp tightly set up.

Q.—Mention wheels you would put on the crank top shaft to drive a 120 teethed tappet wheel, 2, 3, 4, 5, 6 and 8 picks to the round ?

A.—60 T = 2 picks, 40 T = 3 picks, 30 T = 4 picks, 24 T = 5 picks, 20 T = 6 picks, 15 T = 8 picks.

Q.—Suppose a warp in the weaving shed was soft and downy, how would you overcome such a difficulty ?

A.—Shed less, bottom less, put lease rods back, also examine the temple rollers whether they are placed right, and see if the reed is rusty, see also to warp line and put little weight on.

Q.—Given a warp of 900 yards of 32s twist 2,400 ends, to be drawn into a 70 reed (stockport counts), and woven into a plain cloth with 21 picks of 36s weft per quarter inch, how many yards of cloth should this make, and of what width ? If the weave were changed to a two and one twill, what difference (if any) would there be in the width and length of the cloth ? Particulars of plain cloth are as follows :—

A.—Reed	70	32s warp	2,400 ends.
Picks	84	36s weft	900 yards.

Allow 6% in length for milling up and 60% in width for contraction.

∴ 2,400 ÷ 70 = 34.28 inches. Reed space less 6% (2 inches) = 32.28 inches width of cloth.

900 yards length of warp, less 6% (51 yards) = 849 yards length of cloth.

Particulars of Twill Cloth

Reed	70	32s warp	2,400 ends
Picks	84	36s weft	900 yards.

Allow 4% in length for milling up; and 4% in width for contraction.

∴ 2,400 ÷ 70 = 34.28 inches. Reed space, less 4% (1.31) = 32.97 inches, width of cloth.

900 yards length of warp, less 4% (34.6) = 865.4 yards length of cloth.

Q.—Describe the action of the weft fork motion ?

A.—One of the most useful adjuncts to the power loom is the motion for stopping the loom when the weft breaks or runs out. The grid is placed at the side of the reed and the shuttle box. When the grid moves forward the prongs of the fork pass through the grid. When the weft comes between the fork and the grid, it raises the hook end of the fork out of the way of the hammer, which is moved forward every two picks by a tumbler boss on the bottom shaft of the loom. If the weft that breaks or runs out, the fork will, of course, pass through the grid, and it is so balanced that the hook will be caught by the hammer and the loom handle knocked off.

Q.—What is the cause of brittleness in the yarn ?

A.—All yarns must have a little amount of natural moisture in them. In order to allow the moisture in the yarn to remain the same without increasing or decreasing the shed should be at the normal temperature, but if the temperature has exceeded that of the normal, then, the yarns get dried, that is, it loses all its natural moisture and strength in it and, this is how it becomes brittle.

Q.—Presuming that the relative diameters of cotton yarns are inversely as the square root of their respective counts. What counts of yarn will give the same firmness in a 2 and 2-twill that 20s would give in a plain cloth, the threads being equal in number both ways ?

A.—Assuming that the opening between the warp threads, where the weft passes through in interlacing, is about equal to the diameter of the weft, and consequetnly of the warp, where the same counts are used for warp and weft, then in plain cloth, where the weft interweaves with every end, there will be 4 spaces or intersections for 4 ends of warp, that is, 4 ends occupy a space equal to the diameter of 8 ends. If the weave is changed to a 2 and 2-twill, then for each 4 ends, the weft passes once under, and once over, or occupies two spaces, making the 4 ends of warp to occupy the diameter of 6 threads. If the counts remained the same, the cloth would consequently be more loosely built. To remedy this, the yarn must be made coarser, and the diameter of the new yarn must be to the diameter of the old yarn as 8 is to 6. these being the relative spaces occupied.

The square root of 20s is 4.47

$(4.47 \times 6) \div 8 = 3.3{,}525 =$ the square root of $11\frac{1}{4}$s yarn.

Q.—A sample 3 inches × 3 inches weighing 25 grains has been submitted, for the purpose of manufacturing a cloth 54 inches wide. What is the weight per yard ?

A.—$3'' \times 3'' = 9$ square inches. The width of the cloth is 54″.

Therefore, $54'' \times 36'' = 1{,}944$ square inches.

$1944 \div 9 = 216 \times 25 = 5400$

$5{,}400 \div 437.5 = 12.34$ ozs. = the weight of the cloth of one yard of 54 inches.

Q.—State the causes of weft cutting.

A.—Prongs projecting too far through the grid. Prongs touching the sides of the grate bars. Irregular tensioning of weft. Shuttle tongue not held firm. Front part of the shuttle badly worn or having rough surface.

Q.—What are the qualities of wool ?

A.—The quality of a wool depends chiefly on the average diameter of the wool fibres, this constituting a standard of the degree of fineness. The finer and thinner the single wool fibres, the more valuable the wool.

Q.—How would you determine the effect of the working conditions on the efficiency of the textile processes ?

A.—The effect of working conditions on the efficiency of textile processes must take account of the fact that the ultimate efficiency of any industrial process depends on the properties of the materials used, the efficiency of the machines and the personal efficiency of the workers.

Q.—Can you gait a weaver's beam without making waste ?

A.—At the loom, it is almost impossible to "gait" a new warp without some waste of both warp and weft, and at the finish of the weaver's beam there will also be a small length of unavoidable waste. But quite often during the normal working day at any weaving mill, a large amount of waste is made that could with care be avoided.

Q.—State what amount of waste would you consider reasonable?

A.—One often hears discussions as to the amount of waste that can be considered reasonable, but in the writer's opinion there can be no hard and fast rule on this point, as it depends very considerably on the condition, the type, and the quality of the yarn used. For instance, waste will, generally speaking, be greater when using mule yarns as against ring yarns, and greater in single yarns than in doubled yarns, in coarse than in the finer counts, in small cops as against large cops, and in cops with paste bottoms when compared with cops spun on tubes. The weight of the tubes must be considered, as the manufacturer generally pays for tubes as yarn, and most important of all, perhaps, more waste must be expected from poor quality as compared with good quality yarns.

Q.—What quantity of weft waste would you consider satisfactory ?

A.—A question very often discussed amongst weaving masters is the quantity of weft waste which may be considered satisfactory when some manufacturers state that they cannot get below 3 to 4% of the weight of weft used others say quite confidently that they can get away with 1 to 1½% when the weft waste is very low, it is well worth while seeing what means are used to encourage the weavers to keep waste down. If the methods are unsuitable it may mean that the weft waste appears low, but that weavers are taking some waste away from the shed surreptitiously rather than risk being censored for making excessive waste. Then this means double loss. It is always worth while for a manufacturer or a manager to consider ways and means of reducing or, if possible, eliminating waste in processing of his yarns, and the first method of approach should be a careful analysis of the character of waste made and its source, followed by an equally careful examination of its course.

Q.—Give the different methods adopted for removing excess of moisture from cloth.

A.—(1) Water mangle is used to remove excess moisture and it is designed to leave 85% moisture in the fabric, and it is well suited to thick cloth and to situations where frequent cleaning of rolls is not required.

(2) The basket centrifugal extractor is used for cloth in the rope form.

(3) The vacuum extractor removes the excess liquid from a single layer at a time.

Q.—What are the fundamental factors controlling the structure and appearance of woven textures.

A.—These are (1) the yarn unit; (2) the relative setting of ends and picks; (3) the weave or order of thread interlacing; (4) the nature of the finishing process applied after weaving.

Each factor embodies in itself a wide range of variation, and the possible combinations of types and qualities of textures arising from the four groups are without limit.

Yarn quality and appearance are in the first place determined by the nature of the raw material used, such as cotton, wool, and silk; each imparts its own peculiar characteristics to the yarn and through the yarn to the finished cloth.

The twist factor is of great importance in the structure and appearance of the fabric. Twist largely determined the lustre and covering powers of the yarn, and clearness of weave details in the fabric, while excess of twist lends to harshness of feel and shrinkage or crimping of the cloth. The degree of twist is of great importance, because many effects are dependent upon the contrast between yarns spun with different twist constants and directions.

All kinds of woven textiles are classified under eight main heads, according to the manner in which they are woven namely: plain weaves, twill weaves, satin weaves, figured or Jacquard weaves, pile weaves, gauze or Leno weaves, lappet weaves and double-cloth weaves.

Q.—Find counts for weft yarn required for following cloth. 80 picks per inch 30 inches reed space, 70 yards length of cloth 10 lbs. of weft to be used.

A.—$\dfrac{80 \times 30 \times 70}{840 \times 10}$ = 20s counts of weft.

Q.—Suppose 26,880 yards of yarn weigh 3 lbs., what is the count of yarn (1) worsted (2) cotton (3) linen (4) yorks skein, and (5) gala woollens.

A.—Rule :—

$$\frac{\text{Total length in yards}}{\text{Weight in lbs.} \times \text{yards per hank}} = \text{hanks per lb} = \text{counts.}$$

(1) Worsted $= \dfrac{26{,}880}{3 \times 560} = 16$ hanks per lb. or 16s counts.

(2) Cotton $= \dfrac{26{,}880}{3} \times \dfrac{1}{840} = 10\frac{2}{3}$ counts.

(3) Linen $= \dfrac{26{,}880}{3 \times 300} = 29\dfrac{13}{15}$ Lea.

(4) Y. S. Woollen $= \dfrac{26{,}880}{3 \times 256} = 35$ Y.S.

(5) Gala woollen $= \dfrac{26{,}880}{3 \times 200} = 44.8$ Gala.

DYEING AND BLEACHING

Cashmere

Cashmere is the name given in India to a mixture of two or more dyed cottons spun into yarn, black and grey, in varying proportion, being most used, one of which is known in Lancashire as *mock grandrelle* or *imitation grandrelle* is made by mixing up two or more colours of dyed cotton at one or other of the various stages available in the process of spinning. Yarn may be produced by doubling three laps of black cotton and one of grey cotton in the blowing room, others made by mixing at the drawing frames in varying proportions. Others are mixed at the roving frame or in the spinning creel where double roving is used, and, at the latter, retains a twisted formation ; it has an appearance somewhat similar to grandrelle yarn. Their use is practically confined to a light suitings in imitation of woollen and worsted goods.

Colours

Colours consist essentially of two classes, the dull and the bright. The dull colours are the greys, white (which is the lightest grey), and black (which is the darkest grey) ; the bright colours include yellow, red, blue, green and all intermediate colours.

Q.—How would you ascertain the moisture contained in cloth ?

A.—Cut a sample from a piece and dry it at 100°C., weight it, say, every half an hour until no loss is recorded. The difference betweeen the dry weight and the original weight gives the amount of moisture. About 8 % is usually considered correct.

Q.—How would you find the mineral substances contained in a piece of cloth ?

A.—Place a weighed sample in a porcelain basin resting on a wire gauge placed on a tripod, with a Bunsen burner underneath. It should burn down to a small quantity of white ash. Add a drop or two of strong nitric acid to assist complete combustion. There should not be more than 1 % of ash left if the cloth is pure.

Q.—What are the discolouration due to in bleached cloths ?

A.—Discoloured, shady, or dark coloured bleached cloth occurs at times, and the fault is very difficult to trace. Some of the causes are : water, chemicals, mildew, size used on yarn, and others.

Q.—Why does sunshine make some colours fade ?

A.—Sun-light is made of a bank of colours which we can see, ranging from red to violet, and of certain other rays which are invisible to our eyes. Some of these rays, known as 'Actinic' rays, are those which so often destroy colours. The chemical pigments in dye-stuffs are, of course, liable to chemical action, and this action is exercised by the actinic rays, in the same way as they have a chemical action upon the film of a photographic plate. No dye-stuff will withstand all chemical actions and if stuff is bought containing pigments chemically subject to the actinic rays, then that pigment will be oxidized, or literally burned up by the light.

Q.—Give the primary, secondary and tertiary colours.

A.—Primaries—Red, yellow and blue.

Secondaries—Orange, green and purple.

Tertiary—Russet, citrine or citron and olive.

Orange is obtained by mixing red and yellow. Green is obtained by mixing yellow and blue. Leaf-green is obtained by mixing sea-green and yellow. Purple is obtained by mixing blue and red. Russet is obtained by mixing orange and purple. Citron is obtained by mixing orange and green. Olive is obtained by mixing green and purple. Neutral grey is obtained by mixing yellow and ultra-marine blue. So will orange and ice-blue, red and sea-green, violet and leaf-green.

Q.—What is tone, harmony, hue, shade, full and dark in colours ?

A.—Tone is the general effect of colour.

Harmony.—Two colours may be said to harmonize when they reduce a pleasing effect in jaxtaposition, or are used together in suitable proportions in a design. Colours that do not harmonize when associated together produce effects that are displeasing to the eye.

Hue.—One colour overshading another.

Shade.—A variation in colours as darker or lighter.

Full.—Means complete or not wanting in essential qualities.

Dark.—Means less clear.

Q.—Explain the use of Emulsion for brightening and softening of dyed yarns and also state how would you give a good handle to the yarn ?

A.—Brightening is chiefly concerned with silk and artificial silk and practically only for certain black dyes in cotton. The material suffers to a greater or less degree through the processes of boiling, bleaching, or dyeing, the lustre being diminished and the thread becoming brittle. The best treatment to remedy this is found to be by means of an oil emulsion, the most suitable oil being olive oil, but others, such as groundnut oil, cotton seed oil, etc., are also used. The main point is that the oil should be applied to the fibre as finely distributed as possible, which is best attained by emulsification by means of boiling the oil, with the addition of soda by direct steam. This produces an even milky liquid which remains stable even when diluted. The amount of oil and preparation of the emulsion must, of course, be carried out with care and within certain restricting limits. The foregoing treatment refers only to silk and artificial silk and an acid is added for silk. Acids can be added to artificial silk also, in order to give the goods more handle, in which case a certain amount of starch is alsousually added.

Q.—What are water soluble oils ?

A.—These preparations are mostly similar to or contain the turkey red oils. A complete substitution of the emulsions by such oils is out of the question, the brightening effect being produced by the fine distribution of the oil over the fibre. Turkey red oils do not contain free oil in the above sense, as they are soluble in water and have the approximate effect of soap. In consequence of these characteristics they give the goods a very soft handle, which may often not be desired, but where it is, the employment of water soluble oils is, of course, correct.

Q.—State what would you do in case of old stocks of grey cloth which has for various reasons become unsaleable ?

A.—I would either bleach them or dye them.

Also goods that have developed mildew can, if caught in the earlier stages, be rendered saleable by bleaching.

Q.—Explain briefly the process of mercerizing and state how it has come to exist and why it is one of the most important of all finishing processes.

A.—Mercerising has come to be one of the most important of all finishing processes. It takes its name from John Mercer, an English calico printer who patented the process in 1850. Mercer's process was made simply to give strength to cotton fabrics. In 1890, however, some German textile makers tried stretching the cloth in order to overcome the shrinkage caused by the mercerizing process and discovered accidentally that stretching gave the cloth a beautiful lustrous finish. Since then the use of mercerization has grown rapidly, and several improvements have been made in the process. Today the finest mercerized cottons can be distinguished from silk only by the eye of an expert.

Mercerization is done by soaking the yarns or cloth in a caustic alkali solution ; usually caustic soda and sometimes caustic potash or sodium peroxide. The action of the alkali on the cotton fibre is three-fold. (*a*) It causes the fibre to shrink in length ; (*b*) it causes the fibre to swell up, thereby making the fibre round instead of flat ; (*c*) it brings about a chemical change in the cellulose which gives the fibre a greater affinity for dye-stuffs. As a result of these effects mercerized cotton is stronger and more easily dyed than unmercerized cotton. The lustrous finish is obtained by stretching. The greater the stretch the greater the lustre. But as stretching beyond a certain point weakens the fibre, the finest mercerized yarns are made from Sea Island and long-staple Egyptian cottons, which have a high natural lustre and can be subjected to a good deal of stretching without being weakened.

Q.—What is the main object to overcome in the dyeing of blacks on cotton hanks ?

A.—In the dyeing of blacks on cotton hanks the main object is to overcome the tendency to bronze, and t ogive a fuller and more bloomy tone. This after-treatment is of special importance with sulphur black. If a soft handle is desired, as in artificial silk, an oil emulsion is used, but soap is often added at the same time. For a harder handle grease, wax, or paraffin may be used with the addition of size or starch. The treatment is carried out as hot as the colour will stand. For sulphur black brightening is usually done at about 60°C.

"*To Give Handle*."—The production of a crackling and silky feel may be described as a by-process of brightening. Even with silk the natural handle is supplemented by adding acid to the brightening bath and the same effect is desired for the inferior fibres, such as artificial silk and mercerized cotton, which resemble silk in appearance, especially with regard to the lustre. The crackling effect is produced through the disintergration of the soap on to the fibre by means of acid. The soap being a combination of fatty acid and alkali is broken up by the acid, free fatty acids are liberated and the alkali salt of the acid produced, which results in the desired effect. Consequently, to obtain this silky handle the goods are treated by immersing in consecutive soap and acid baths.

The amount of soap used is usually about ½% of the bath. Marseilles or any other good Kernel soap is most suitable. After immersion and subsequent draining, the goods are immersed in 1/5 to ½% cold acid bath, turned a few times, centrifuged and dried as hot as possible.

Only organic acids can, of course, be used for cotton and artificial silk, as mineral acids or sulphuric or hydrochloric acid would cause tendering when dry. The chief acids used are formic and acetic acids, but these two acids have the disadvantage of being volatile, so that the goods lose their crackling effect after a time. To maintain this handle lactic and tartaric acids are used, the former being the cheaper. It has also been found that it is easier to give handle to bleached goods and goods treated with tanin.

Q.—What is the action of water on cotton ?

A.—Under ordinary conditions water has no action on the cotton fibre, but, when heated under pressure to 150° with water, the fibre is sensibly attacked. Raw cotton subjected to this treatment for eight hours had decreased in strength about 6%, bleached cotton about 35% when heated with water to 200° cotton turns brown, and is decomposed with the formation of carbonic acid, formic acid, catechin, glucose, etc. Prolonged steaming at 99° to 100°C. Also has a tendering effect, which after 420 hours, amounts to about 75%.

Q.—State why is it preferable to dye in yarn than in piece.

A.—One important reason for dyeing fabrics in the yarn rather than in the piece is that dyed yarn permits the weaving of coloured patterns such as checks, stripes, etc. Another reason is that the cotton fibre has little affinity for dye stuffs, and it is impregnated more readily in the yarn than in the piece, and hence yarn dyeing is preferable for fabrics which are subjected to much sunlight or washing.

Q.—How would you test khaki dyed cloth (*a*) for fast to washing (*b*) fastness to light.

A.—(*a*) Boil in a weak solution of carbonate of soda for about 30 minutes, and, if colour good, it will stand washing.

(*b*) Soak for 30 minutes in a cold solution of peroxide of hydrogen, and, if colour good, it is fast to light and air.

Q.—What are the causes of uneven dyeing ?

A.—The causes of uneven dyeing may be :—

(*a*) Textile materials themselves and faults in them. Such as the use of cotton of different grades, presence of dead cotton, presence of homicellulose in the pulp used for making viscose, rayons of different manufacturers, rayons of different age even though of the same manufacturer, are some of the well-known causes of uneven dyeing.

(*b*) Lack of selection of dyes, chemicals and water. The hair or filament denier controls the depth of shade. The amount of dye required to give any shade is greater on a fine denier material than on a coarse denier material.

For dyeing a fibre, a dye must be taken up by the fibre ; but it does not follow that the process is at an end when this stage has been reached. Before a material can be said to be dyed, it is necessary that the dye should be in such a condition that it cannot be readily removed by washing. The two stages may be described as absorption and fixation, which may or may not be simultaneous. For obtaining even dyeing the first requisite is, that the dye is soluble in water or rather that it forms such a state of dispersion as to penetrate the fibres. All fibres have a structure of their own. The dye molecules are often aggregated into groups of varying size and shape. Unless they are made sufficiently fine to enter into the fibre, the dyeing will not take place. Temperature affects the dispersion of the dye. That is one reason why hot dye baths are used. Temperature also affects the interstices of the fibres and also increases the kinetic activity of the dye-particles, and hence helps dyeing.

The use of protective colloids in a dye bath prevents dye particles from aggregating. This will at once explain why gum or glue is often added to the dyebath in the case of vat dyes.

In dyeing, the use of wetting agents is advantageous : (1) they give a high adhesion of the liquid to the solid; (2) they diminish both the surface tension of the liquid to the air and the interfacial tension and thus ensure spreading. Water has got a lot to do with the results obtained in dyeing. In many cases soft water is needed.

(*c*) Use of improper machinery, faulty processing and manipulation. It is necessary that thorough cleaning of material, specially the removal of all size, and natural impurities, is done for obtaining level dyeings.

The provision of well-designed and well maintained equipment in a sufficient variety of types is requisite for satisfactory results. For a full range of dyeing of fabrics jigs, padding machines, continuous machines, dye winches or reel machines are necessary, because each can perform a specific function better than other substitutes.

(*d*) Personal and faculties. In a progressive industry, the advantages of scientific control cannot be over-estimated.

Q.—How would you distinguish whether a piece of cloth has been piece dyed or yarn dyed ?

A.—Remove some warp and some weft threads, and if there is a difference in shade, the cloth is made from yarn dyed material. Piece dyed goods are, of course, same shade for warp and weft.

Q.—Explain briefly how is scrooping of yarn is carried out.

A.—In order to impart a scroop-like handle to them, the dyed, rinsed and hydroextracted yarns are treated with 0 cold to lukewarm soap solution containing 5 grammes Marseilles soap per litre. It is then hydroextracted or wound off and treated in a second lukewarm bath containing 1.5 to 3 grammes formic acid or 2.5 to 5 grammes acetic acid per litre. 2 to 3 grammes tartaric acid or 3 to 5 grammes lactic acid per litre may be used instead of the formic or acetic acid.

Q.—What will be the approximate consumption of water for dyeing for 1 lb. of yarn and 1 lb. of cloth ?

A.—For dyeing 1 lb. of yarn 20 lbs. or 2 gallons of water will be required.

For dyeing 1 lb. of cloth 30 to 40 lbs. or three to four gallons of water will be required.

Q.—How much water would you require to bleach 1 lb. of yarn and 1 lb. of cloth ?

A.—For bleaching 1 lb. of yarn, 15 lbs. or 1½ gallons of water will be required.

For bleaching 1 lb. of cloth, 10 to 15 lbs. or 1 to 1½ gallons of water will be required.

Q.—How is the bleaching of the many varieties of cotton effected.

A.—The bleaching of the many varieties of cotton goods is effected at all places by the same system, comprising working.

Q.—How would you test a tendered cloth after bleaching ?

A.—Place one or two drops of a very dilute solution of methy orange on the suspected portion of the cloth (in grey state). If acid of a dangerous character be present the dye will be coloured pink.

To determine whether oxalic acid be present the portion of cloth showing the presence of acid should be soaked in distilled water for a few hours, filtered off and the clear solution tested as follows.

A solution of ammonia chloride of ammonium and afterwards a solution of chloride of calcium should be added. If a precipitate be formed oxalic acid is probably present. To confirm filter off, dry, and heat to dull redness.

Oxalate of calcium is converted into carbonate of calcium when heated to dull redness. Test for carbonate by the addition of hydrochloric acid, which will cause effervesence when acid is added.

Q.—Explain hardness of water.

A.—In a general way all water is impure. The first source of all natural water is the sea, by the evaporation of which the air becomes more or less humid, and in time this moisture is condensed and falls back on the earth in the form of rain to undergo anew the process of evaporation. Rain water is the present form of water met with in nature, but rain water is never pure, for in its passage through the atmosphere it dissolves gases of atmospheric origin, the amount of these gases in solution depending on the composition of the air through which the rain falls. Charged with gases, the water falls on the rocks of the earth's crest and a chemical action takes place, the water exercising its power of destruction and decomposition or even the hardest rocks and by this means hardening salts, are taken into the water. In addition the action of the rain as it falls on the earth's surface is to loosen the surface soil and carry it into the streams, rivers and tanks. A considerable proportion of coarse sediment therefore also polutes the water though matters in suspension are not to be confused with hardening salts.

The substances most commonly found in natural waters are :—

Carbonate of lime.
Carbonate of magnesia.
Sulphate of lime.
Silica.

Chlorides of calcium, sodium, potassium, and magnesium. Sulphates of sodium, potassium and magnesium. Nitrates of calcium, sodium and magnesium. It is the calcium and magnesium soluble salts which are the hardening salts of water, and which are so destructive of economical production and satisfactory finish of the fabric in its various stages of process. The hardening salts are usually expressed in parts per hundred thousand.

Q.—Give a process for dyeing 100 lbs. of cloth chrome khaki colour.

A.—(1) Boil the cloth in 2% soda ash. Boil for one hou backward and forward on the Jigger. (2) Wash in cold water (3) Squeeze the water out. (4) Make a solution of chrome alum.

200 lbs. chrome alum
20 buckets water
200 lbs. Ferro sulphade coporas in
15 buckets of water
25 lbs. of soda in 5 gallons of water.

Mix soda and chrome alum together. Stir well while adding it. Twaddle 26B. Copper solution twaddle 30B. add 2½ buckets or 5 gallons of coporas to the chrome alum bath and that should stand at 26B. Both is now ready for use. Add to the padding machine (3 bowls). Take 12 gallons of chrome alum liquor. Let down by water to 26°B. For every gallon of chrome alum add 9 ozs. of copras. Stir well and run the cloth through four times. The cloth before being put through chrome alum must have been worked through maryboloms for half an hour at 10% solution. After running the cloth through chrome alum four times dry it through hot air drying machine, when dried pass it through a jigger. Give it 4 times on the jigger wash well and dry it on the cylinder drying machine. The liquor left after running cloth through four times will stand at 16°B . This must be kept and for lots that follow take 3 buckets of this liquor and strengthen with strong bath to 20°B using 9 ozs. copras for each gallon of strong bath. The old liquor when quantity accumulate boil down to 26°B. and treat as a fresh strong bath.

Q.—How would you test cloth for fastness to washing.

A.—Take a small sample, and, along with a white cutting of cloth, soak and press eight or ten times in a solution of soap and water (Marseilles soap) at a temperature of 50°C. leave about 20 minutes in the solution, wash, leave another 25 minutes in the washing water, squeeze, and dry. The colour should remain unaltered the white material show no colour at all if fast to washing. Many colours do not bleed during the soap washing, but when left in a cold water bath after washing in soap solution.

Q.—How would you test khaki dyed cloth for fastness ?

A.—(1) Boil for 10 minutes in a solution of soap. Laundry soap 80. grm. to 1 pint of water.

(2) Boil for 10 minutes in a solution of soda, 20 grm. of carbonated soda, pure, dried, to 1 pint of water.

(3). Steeping 24 hours in a solution of citric acid, 3 dr. acid to 2 fluid ozs. cold water.

A colour that can stand the above tests can be considered good enough for any practical uses.

Q.—How would you test for mercerized colour ?

A.—The sample for test must not have any foreign or sizing matter on it at all.

Prepare a solution of 20 grm. of iodine 100 c.c. of a saturated solution of potassium iodide in water. Place the sample in a small basin containing enough of the solution to cover it. Allow to soak for a few minutes, then rinse well in water. The cotton will remain white if not mercerized, if mercerized, the sample will be of bluish colour.

Q.—Explain the action of oxycellulose on cloth.

A.—Several chemicals used in bleaching have the property of combining in air with cotton, and converting it into oxycellulose, rendering the cloth tender. If the air is not excluded from the kier, this compound will form on the cloth that is exposed to the air. It can also be formed during the process of chemicing if the bleaching powder used is too strong, in which case all the cloth is tendered. Improperly dissolved bleaching powder would cause damage and perhaps burn a hole. These oxycellulose places will not absorb the colour in dyeing, but show lighter tones than the bulk of the cloth.

Q.—How would you test cloth for fastness to perspiration ?

A.—Nearly all colours are affected by human perspiration and the best test is, actual wearing.

For a quick test place a dyed sample braided with equal quantity of white cloth in a bath of 5 c.c. of acetate of ammonia per litre of distilled water at 80°C., for 10 minutes and afterwards take it out and dry it in the air without rinsing.

(*a*) If colour fades and stains the white cloth it is poor.
(*b*) If colour does not fade but stains the white cloth it is fair.
(*c*) If colour and cloth remain unaffected it is good.

Some perspirations are acid and others alkaline, so both tests should be made.

Q.—How is the blueing of bleached yarn done ?

A.—It is mostly done during the last rinsing or in the soap bath, using either basic dyestuffs, such as :—

Methylene Blue BB
Methyl Violet
Water Blue B Crystals
Bronze Blue for Laundry Blue,

or preferably fast-to-light acid dyestuffs, as :—

Anthralan Violet 3B, 6B, 4BF,
Anthralan Blue R,
Alizarine Sky Blue B,
Alizarine Sapphirol B.

If special demands upon fastness to light are made, the Indanthren dyestuffs should be used. Particularly suitable for the purpose are :—

Indanthren Blue GGSZ paste, RZ paste,
Eglantine BBP

either alone or mixed. An addition of 0.5 to 1 gramme Igepon T per litre blueing bath shows an especially favourable influence, as it effects a very level distribution of the blueing dyestuff.

COLOUR DYEING CHART	
Original shade	*Shades it will dye*
Blue	Navy, dark green, nigger brown, black.
Green	Navy, dark green, nigger brown, black.
Fawn	Navy, dark green, terra cotta, nigger brown, black.
Yellow... ..	Dark green, terra cotta, nigger brown, black.
Orange... ..	Dark green, terra cotta, nigger brown, black.
Red	Wine, terra cotta, black.
Purple... ..	Navy, nigger brown, black.
Brown.. ..	Nigger brown, terra cotta, black.
Grey	Navy, nigger brown, dark green, wine, black.

CALENDERING AND FINISHING

Q.—How are cloths for calendering or even in case of uncalendered goods treated for the removal of loose threads, loose fibres, dust, etc. ?

A.—The cloths are treated by the revolving brushes (bristles) on one or both sides, for the purpose of removing loose threads, fibres, dust, etc.

Q.—State the reason of attaching a number of pieces of cloth together before passing them through calendering, etc., machine.

A.—It is desirable for economy and convenience sake that the cloth should always be in one continuous long sheet which also saves a good deal of time in their passage through calendering, etc., machine by being one continuous sheet.

Q.—When pieces of cloth have come up light in weight from the loom, and a definite weight is required what would you do to obtain it.

A.—The pieces can be passed through an Epsom Salts mixing of such a strength as to give the desired weight. If the goods are subsequently to be calendered, and Epsom Salts are not suitable, white Dextrine can be used at from 1 to 4 lbs. per gallon. No filled goods should be weighed in a warm condlion, as the pieces leaving the drying cylinders lose a greater portion of their natural moisture, and this is slowly reabsorbed as the goods cool down.

Fabrics can quite easily be made to weigh heavier than they should by storing in damp places for some time. But bear in mind that this added moisture is a very good way to increase the liability of the cloth to become mildewed.

Q.—How would you improve grey cloth in whiteness ?

A.—The grey cloth can be improved in whiteness by passing them through a mangle containing a little starch and china clay adding just sufficient clay to increase the whiteness without dusting.

Q.—Find how many yards of cloth would a roller 14 inches in diameter deliver if it is going at 40 revolutions per minute ?

A.—$14 \times 40 = 560$.

$560 \times 3.1{,}416 = 1{,}759.2{,}960$ inches.

$1{,}759.2{,}960 \div 36$ (inches to the yard) $= 49.86$ yards.

Q.—If the top roller in a friction "filling mangle" is making 10 revolutions, find the revolutions of the bottom roller. The driving wheels are 30, 22, and 26. The driven wheels are 46, 60, and 34.

A.—$\dfrac{10 \times 30 \times 22 \times 26}{46 \times 60 \times 34} = 1{\cdot}83$ revs.

Q.—What is the ratio of friction if a 14-inch roller revolves at the rate of 10 revolutions per minute and the other roller which is 22-inch in diameter revolves 1.83 revolutions per minute.

A.—$10 \times 43.98 = 439.80$ inches.

$1.83 \times 69.12 = 126.49$ inches.

$\dfrac{439.80}{126.49} = 3.48$ or 3.48 to 1.

Q.—What are the objects of finishing a cloth ?

A.—As a general rule the finer the cloths the less the china clay and minerals are used and the mixing paste is made thinner by adding water. Clay is used when bright finishes are wanted and mineral for dull finishes. The best way to produce a particular kind of finish is to run a piece or two through and to regulate the weights on the mangles by the result obtained with these pieces. As regards stiffening the following points may be mentioned, the greater the pressure there is on the mangle the less stiffening is put into a cloth, but on the other hand it helps the stiffening to penetrate into the cloth and not leaves it on the surface to dust off when dried up.

Q.—Explain the change that takes place when water evaporates from cloth.

A.—When water is evaporated from cloth in a drying range or machine, it passes from a liquid to a gaseous state, as steam or water-vapour, into the atmosphere, against the atmospheric pressure. The total atmospheric pressure is the sum of the partial pressure of the air, and the water-vapour in it. The total pressure of the atmosphere is 14.7 lbs. per square inch. If the vapour pressure of air at 70°Fah., is .3,626 lbs. per square inch, that is, the weight of the water in the air, the partial pressure of the air is the total pressure 14.7 — .3,626 = 14.337 lbs. per square inch. As the evaporation increases, the atmosphere surrounding the drying element becomes filled with water-vapour. This increases the vapour pressure of the atmosphere and retards the evaporation.

Q.—What does a good finish of any class of goods depend on ?

A.—A good finish of any class of goods depends on three essential conditions, namely, good judgement, good materials, and good machinery.

Q.—What would you attribute defective work to.

A.—(1) The human element (2) Faulty machinery or tools.

Q.—Give some of the damages that occur in the finishing department.

A.—(1) Bad sewing of ends ; (2) presence of various forms of foreign matter ; (3) damage caused by external factors such as nails and wood ; (4) stains from cylinders due to improper washing and cleaning or not washed or cleaned often enough.

Q.—What are the various processes for finishing textile goods ?

A.—The processes are bleaching, dyeing, starching, mercerizing, drying, printing and finishing.

Q.—What effect has water on cotton ?

A.—Water under ordinary conditions has no action on cotton. If cotton is boiled under pressure at a temperature of 140°C., it becomes tender, and the loss in strength will continue as the time and temperature of the boiling increase, until the fabric may be entirely destroyed.

Q.—What action has mineral acids on cotton ?

A.—Dilute mineral acids have little action on cotton when cold. Treatment in sulphuric acid does not injure the fabric until the acid becomes sufficiently concentrated to generate heat, with the absorption of water from the bath or from the cotton. As the strength of the acid increases from dilute to concentration with an increase in the time of exposure, the reaction on the cotton becomes quite noticeable, and a tendering sets in, leading to complete destruction. Cotton treated for a few minutes with strong sulphuric acid and washed free from the acid at the end of the exposure, acquires an increased affinity for dye stuffs.

Q.—What is the effect of sulphuric acid on cotton ?

A.—One of the chief sources of trouble in the bleaching of cotton fabrics lies in the drying of sulphuric acid in the fibre. This very often happens when soured goods are allowed to dry in storage bins. As the water evaporates the acid becomes more and more concentrated, until destruction of the fibre occurs. Bleached cotton goods improperly washed from this acid will become tender and the sections laden with the acid after drying will dye deeper shades than the sections that have been thoroughly washed.

Q.—What will be the pressure on the rams of a schreiner calenders if the pressure on the gauge is 1.5 tons and the radius of the ram is 3 inches.

A.—The total pressure on the two rams will be as follows :—

$2 \times$ pressure $\times$ radius square $\times$ 3.1,416

$2 \times 1.5 \times 3 \times 3 \times 3.1{,}416 = 84.82$ tons.

The pressure of about 85 tons will be transmitted to the full width of nip or nips.

The pressure per inch in width on the face of the calender may be found by dividing the total pressure by the width of the bowl in inches.

Q.—Find the total pressure put on goods that are being pressed on an hydraulic press the ram of which is 6 inches and is connected to a hydraulic pump worked by power and the gauge of which shows a pressure of one ton per square inch.

A.—The total pressure on the goods is obtained by multiplying the pressure per square inch, indicated by the gauge, by the sectional area in square inches of the ram.

$3 \times 3 \times 3.1{,}416 = 28.27$ tons is the total pressure.

Q.—How would you find the percentage of filling contained in a piece of cloth.'

A.—I would take (1) a square of piece of cloth say 10 grammes in weight from the sample, loose ends should not be lost sight of, they can be tied to the sample itself; (2) the piece should be weighed and the weight carefully noted; (3) the cut piece should be thoroughly washed in a stream of running water; (4) place the piece in an enamelled pan containing water in which has been dissolved caustic soda in the proportion of 1 part weight of soda to every 100 parts of water and boiled for an hour; (5) take the cloth out and wash it thoroughly in clean running water; (6) after this boil in a solution containing 1 part of hydrochloric acid to every 100 parts of water, taking care not to allow the acid liquor becoming thus concentrated; (7) after removal from the acid bath wash the cloth again in running water and finally boiled for an hour in clean water; (8) wash again wring out as dry as possible and then dry; (9) weigh carefully and then loss in weight thus found will represent the total size. To the bone dry weight add 8 % of moisture thus :—

$$\frac{\text{Weight of dry fibre} \times 8}{92} = \text{amount of moisture to be added to dry fibre.}$$

Q.—Name some of the substances that are used for "waterprofing" fabrics.

A.—The substances are: salts of Alumina wit acetate of lead, paraffin wax, resin, greasy matters, tannic acid and carbonate of magnesia.

Q.—Name some of the substances that are used to render fabrics "fireproof."

A.—The substances are: alum with acetate of lead, borax, phosphate of ammonia, boraci acid, tungstate of soda, salts of titanium and silicates.

Q.—Give a recipe for weighting cotton yarn about 30 %.

A.—Cotton yarn is weighted in finishing by fixing considerable quantities of grape sugar, glycerine, magnesium sulphate, dextrin, on the fibre.

Recipe No. I—

For 1 gallon weighing liquor.
1½ lbs. Dextrin
1 lb. Epsom salt.
¾ oz. Monopol soap.

Recipe No. II—

10 ozs. potato flour.
2½ ozs. Amylose D.
1½ lbs. Epsom salt.
1½ to 3 ozs. Prestabit oil G.

For Blacks the weighting is best done twice with Sumac extract and acetate of iron. Weightings up to 10% be obtained with Ramasit I alone.

Q.—Explain what are the faults in finished goods due to and how are they affected during the process of dyeing and bleaching.

A.—Faults in finished goods are due to the pressure of oils, fats, and waxes, and they fall into two classes, those in which the defect is purely local and those in which there is a general excess or deficiency of fat and wax.

The first class are for the most part due primarily to oils used in lubrication, additional sources being the use of grease to soften a rough warp, the presence of an abnormal amount of fat in a cloth for bleaching, due to heavier sizing than is necessary for weaving only, and the use of paraffin wax or other unsuitable ingredients in sizing goods for bleaching. Further the majority of the stains arising from lubricating oil containing metallic, graphite, or other impurities.

The elimination of this material during the scour is materially affected by changes caused by the action of air, light, and moisture, the oils tending to become darker in colour and increasingly viscous. In the case of saponifiable oils the discoloration varies with the liability of the oil to attack in this manner, rape oil for example, changing much more markedly then castor oil, while oils of the type of olive, neatsfoot, and sperm fall intermediately between the two. Such changes, however, have relatively little effect on the subsequent removal of the oils during bleaching. With mineral oils, however, the dark brown products of oxidation become increasingly difficult to remove, and remain even when the unaffected oil has been eliminated. In the case of compounded oils the tendency to permanent staining of this nature is directly proportioned to the percentage of the mineral component, the presence of the usual small proportion of saponifiable oil being insufficient to prevent permanent staining or to ensure the complete removal of the oil.

It is often assumed that the stains which remain after scouring must have been caused initially either by mineral oils or paraffin wax, but this is by no means always the case. When a light scour is employed, as is essential for many modern finishes, the removal of fat and wax is generally considerably less thorough than when the treatment is more severe, and a similar effect is found with local excesses of oils and fats, whether saponifiable or otherwise.

Common sources of faults in finished goods are therefore (1) the dark brown products formed by the ageing of a mineral oil on the cloth ; (2) metallic or other impurities in lubricating oil stains which may remain even when the oil itself has been eliminated ; (3) residual oil, fat, or wax ; (4) distortion of the surface of the cloth during the removal of stains from the grey material, and (5) the indiscriminate use of soap and other substances in padding stains in the grey cloth to facilitate their removal during bleaching.

Q.—Discuss fully the location of a Folding Department ?

A.—The folding department should be as near weaving department as possible which saves a lot of time of the weavers. Also the arrangement of the machinery in this room should be such that it will enable the cloth to be treated with the least amount of handling and the greatest economy. The machines that are used should make an improvement in the cloth between its leaving the loom and being packed into bales with least amount of handling, and hence expenditure, so that the mills will make a name and profit by it. There will always be a great demand if the cloth is well made, well finished and well baled.

Q.—If a folder operates at the rate of 80 yards per minute, how many hours will be required to fold 12,000 yards of cloth, allowing 50% for stoppages, etc.

A.—80 yards in $\frac{1}{60}$ hours.

1 yard in $\frac{1}{60} \times \frac{1}{80}$ hours.

$\therefore$ 12,000 yards in $\frac{12{,}000 \times 1 \times 1}{60 \times 80} = 5/2$ or $2\frac{1}{2}$ hours.

In 60 minutes or 1 hour is allowed $\frac{50}{60}$ hours.

$\therefore$ In 5/2 minutes or 1 hour is allowed $\frac{5}{2} \times \frac{50}{60} = \frac{25}{12}$ hours

$= 2.08$ hours.

$2\frac{1}{2}$ hours $= 2.5 + 2.08 = 4.58$ hours will be required to fold 12,000 yards.

Q.—Discuss briefly the process of Bundling the cloth.

A.—There are two kinds of bundling press namely geared press and hydraulic press. Both types are made in various sizes, representative geared presses having tables 50 or 60 inches long and 20 inches wide, with an opening of 24 or 30 inches in height. In most of the geared presses the bottom table rises about 9 inches and is lifted by means of a cam motion worked by very powerful gearing. The machines are also provided with a stop motion to stop the machines at any required point, so as to ensure as far as possible all bundles being the same size.

The main features of the hydraulic press for cloth, are similar to those of the geared press, the only difference being in the method of raising the table to compress the cloth. On the shaft on which the belt pulleys are mounted are keyed two eccentric sheaves that drive the connecting-rods. The lower ends of these rods are connected to the rods of two small force pumps working in a tank. A small delivery pipe from these pumps leads to the cylinder in which works a ram that is attached to the table. The tank is filled with oil, and when this is forced by the pumps into the cylinder it causes the ram to rise, carrying with it the table and compressing the bundles of cloth. The belt fork is attached to a rod that terminates in a handle on the other side of the press, and a spiral spring attached to the rod tends to pull the driving belt on to the loose pulley. In starting the press the starting handle is pulled over, against the pull of the spring, until the belt is on the fast pulley, and at this point a latch drops into a slot in the fork rod and holds it. The pressure applied by the pumps is maintained, even after the pumps are stopped, until released by opening the tap which allows the oil to flow back again into the tank the weight of the table and the bundle forcing the ram back into the cylinder until the press becomes stationary with the table at the lowest point, ready for the next bundles. A lever safety valve fitted with a weight is provided for relieving the pressure if from any cause the machine does not stop in time to prevent damage to pipes, tank, or cylinder. In some hydraulic presses there is no knocking-off motion to stop the press when the table reaches a certain height; instead, the presser moves the belt on to the loose pulley when he considers that the bundles are pressed sufficiently. If the belt is not moved soon enough, or if the safety valve is too heavily loaded, then either some part of the press will be broken or the belt will slip off the pulley. In starting up the press after the bundles to be pressed have been put on the table, the tap must be closed to enable the pumps to force oil into the cylinder again; the tap must then be left closed until it has to be opened to reverse the press. Although oil is preferable, water is generally used in India in the cylinders of hydraulic presses. With this there is always the risk of corrosion, and the ram should therefore be well rubbed with tallow, at intervals, when it is at the top of its stroke.

COSTING

Q.—Define Capital.

A.—Capital is surplus money secured by saving or borrowing or the sale of an interest in the business. Capital is the greatest and cheapest productive force in the world. Money is not money until it moves. Put the annas together and they make rupees. Put rupees together and they make capital for large or small enterprises. The value of capital depends upon the use that is made of it. Usually, it depends most of all upon quick, profitable selling.

Capital assists production by bringing within the reach of labour, food, clothing, housing accommodation, education, etc.

Q.—What would an increase in Capital lead to?

A.—An increase in capital may lead to:—

(*a*) An increase in productive activity,

(*b*) An increase in the demand for labour;

(*c*) A rise in wages.

Q.—What would shortage or scarcity of capital lead to ?

A.—(*a*) Low production ;
(*b*) Increase in unemployment ;
(*c*) Low wages ;
(*d*) Low prices ;
(*e*) Low profits, etc.

Q.—Define Costing.

A.—Costing is the proper allocation of expenditure, and involves the collection of costs for every order, job, process, service or unit, in order that suitably arranged data may be presented to a producer or manufacturer as a guide in the control of his business.

The costing scheme should not only find what various operations or products have cost, but also what they should cost ; it should indicate where losses and waste are occuring before the work is finished, in order that action may be taken to avoid loss and waste there and then.

Q.—Define Money.

A.—Money is our birthright. We must struggle for existence. We must fight to make our living which should be made honestly and faithfully.

Money is any commodity to which the functions of a medium of exchange, a store of value, and a standard of comparison of future values are attached by human convention such as the gold dollar.

Q.—What is an Income ?

A.—Income is the surplus of wealth produced from the bringing together of the three factors of production (namely Land, Labour and Capital) that is, the addition to the store of wealth after a year or other period of trading, production, etc.

Q.—Describe the term value.

A.—Value and usefulness are necessary attributes of wealth. The goods must possess the quality of exchangeability (value) and also be capable of satisfying a desire (usefulness). Value is not necessarily the true commercial value—the value based on cost of production. But bear in mind that demand increases as price falls, and decreases as price rises. Also remember that if the price obtainable is less than supply-price, or cost of production, then the supply will fall off, but where extra profit is made through a rise in price above supply-price then the supply will increase.

Q.—What are the elements of prime importance. Give your reasons.

A.—(*a*) Time.

(*b*) Material.

To increase the "rate of production," is to decrease the "unit cost of production." In other words, any increase in production-cost means so much profit gained.

Idle machines and waste of material are the greatest enemies of efficient production.

Q.—Give some important factors which need close watching.

A.—(*a*) Requisitioning of material.

(*b*) Placing the purchase order.

(*c*) Receipt of material into stock.

(*d*) Issue of material to the various departments.

(*e*) Getting the finished yarn or cloth or article ready within the stipulated time.

(*f*) Prompt delivery or execution of orders of finished articles.

Q.—What are the causes of productiveness differing from one country to another (*a*) in price (*b*) in quality, etc.?

A.—(1) Because there is a difference in the geographical positions, leading to a difference in the quantities of rain, heat, frost, etc., received by the countries, leading ultimately to the difference in productiveness.

(2) Because there is a difference in the nature of different soils leading to the difference in fertility.

(3) Because nature has provided different countries with different facilities of obtaining the raw materials such as coal, water-power, etc., and hence one country has more advantage of cheapness than others.

(4) Labour power may be cheaper, hard working more efficient in one country than others.

(5). .Facility of transport.

Q.—What is the difference between "full time running" and "running full capacity." Discuss fully.

A.—Although a great deal of attention is given to "full time running" very little seems to be given to "running full capacity."

That the two expression are not synonymous is quite easily understood when we remember that several frames or machines may be running at much less than the standard speed, yet they would have to be reckoned as running full time, which may be quite true, but they can hardly be said to be running at "full capacity." Reductions from the standard speed, however, are not by any means the only cause of the diversity of the two expressions, for anything that causes the machines to be stopped must necessarily have an effect upon the productive efficiency of the mill. A mill running 100% full capacity has all its machines or frames or spindles running at the standard speed usually run at that mill for the whole of the possible time. All changes, either due to quality, or counts or breakages must receive very careful attention.

Q.—Define Service.

A.—Service embraces not only durability of the article, but its various and specific uses to the purchaser. This would take into account its adaptability for a particular country in any part of the world, having regard especially to climate and general physical conditions. Service and marketing are inseparable. To market successfully, service must be offered, and any particular service depends solely upon the requirements of the markets, a knowledge of which will be gained through exhaustive research and extensive travel. The creation and retention of markets depend upon the quality of marketing.

(*a*) What are the disadvantages of production on a small scale ?

A.—The cost of production will be higher due to want of perfect organisation, internal and external economies, efficient labour and up-to-date machinery.

Q.—Discuss Responsibility with reference to Management.

A.—Responsibility begets enthusiasm and enthusiasm is the soul of progress. Enthusiasm is essential to the well-being and success of administration. For the present time it is necessary to improve and reorganize an industry on scientific lines by the elimination of 5 Ms. of Waste: (1) Material; (2) Machinery; (8) Men; (4) Minute and (5) Money.

Q.—What does a successful organization implies ?

A.—Successful organization implies a capable organizer, and it may be well at the outset to consider the qualifications necessary for the manager of any large undertaking.

Q.—Explain fully what do you understand by organizing ability ? and is it possible to acquire it ?.

A.—It is true that many men have that gift intuition which enables their minds to grasp almost with lightning rapidity the bearings of a case, that logical faculty which marshals up without difficulty the pros and cons of a knotty point which must be settled, that ability of foretelling results or events which is almost uncanny in its farsightedness, that grasp method and of detail which makes their brain like an orderly cabinet from which may be obtained at a second's notice whatever information may be required, and that capacity for rapid and accurate decision which almost amounts to genius. But, on the other hand, much of each of these qualities may be attained by that infinite "capacity for taking pains," which, we are told, is akin to genius, and is asserted by some to begenius itself. The cultivation of a habit of business accuracy. the thoughtful study of varying indiosyncrasies and types of character, the careful tracing of cause and effect, research into sources of textile and commercial information, the compilation of useful notes, a tactfully exercised curiosity acted upon by a soupcon of that "gospel of discontent" which is so powerful an incentive to those who desire to mount life's ladder, will go far to foster powers of organization, and there are many ways in private and social life in which useful experience may be obtained.

Q.—Explain what do you understand by simplification ?

A.—The function of simplification is to determine which sizes, items, or varieties of a product are most important, and to concentrate production so far as possible upon them. It may be applied to articles already standardized as to design or dimensions, or may be adopted as a step preliminary to standardization. In the latter situation it clears the way and reduces the number of "items to be later standardized. It finds its widest and most beneficial application in the manufacture of everyday commodities produced in large quantities.

Q.—Explain what do you understand by the term "standardization"?

A.—It seeks to determine and establish, in use and practice, best design, size, quality , method, or process for performing a desired function. As a process it is primarily an engineering activity. A standard the result of either process, is not unalterable and ultimate as is often thought, but on the contrary is subject to change and is progressive. It crystallizes the best thought and practice at the time it is established.

Q.—How would you save and reduce cost ?

A.—(1) By lowering manufacturing costs due to increased quantities, permitting adoption of mass production methods.

(2) By lowering selling prices due to lower manufacturing costs.

(3) By improving product designs and manufacturing plans because supervision is concentrated on essentials.

(4) By improving quality of product due to better concentration.

(5) By reducing inefficiency and waste.

(6) By more punctual deliveries.

(7) By reducing stores inventory.

(8) By increased turnover of capital.

(9) By eliminating all unnecessary types, sizes, grades, and qualities, selection being based on relative commercial demand.

Q.—Give the chief elements in the case of re-organization of a mill.

A.—These can be classified as follows :—

(*a*) Standardization of materials and methods.

(*b*) Specialization (if necessary consult an expert).

(*c*) Cutting-out of wasteful methods.

Q.—Define Matter.

A.—Matter does not vary in quantity, but is constant. All that man does is to change it into want-filling form that is from one shape to another. For an example timber from forest does not supply a want, but a chair can be prepared from it and in wide form it satisfies a want and becomes a economic good. This change takes place through the medium of three agents, namely, 'land,' 'labour' and 'capital.'

Q.—Define Economic Goods.

A.—Economic goods may be defined as those things produced by man from the free gifts of nature which go to satisfy a want.

Q.—Define Mass Production.

A.—By mass production is meant the production of articles in bulk to standard specifications, as opposed to production to order or as required.

Q.—Define Utility.

A.—Utility may be defined as the power of a commodity to yield satisfaction.

Q.—What does the efficiency of labour depend on ?

A.—It depends on : physical and intellectual qualities, due to the influence of climate, food, technical education and family comforts.

Q.—Define Time Study.

A.—Motion study is an element of scientific management in its aim of simplification. The necessary movements for a given operation are scientifically studied, and the worker is instructed so that he makes those movements only. The assumption, that in process of time the worker himself will find out the "one best way" to perform the operation, is not accepted.

Time studies are undertaken for two purposes : (*a*) to find out what improvements can be made in the general conditions of labour and also equipment, affecting the performance of the tasks set ; (*b*) to study the actual performance of the work by the operator, to determine what improvements can be made.

Before studying the carrying out of an operation it should be proved that :—

(1) It is wholly or partly indispensable from the aspect of the quality and design of the product.

(2) It should be proved that the operation cannot be eliminated, reduced, or simplified by changes in preceding or succeeding processes.

(3) Study of the operation should begin by analysing the technical methods (machines, position of worker, schedule of operations, etc.), and their possible improvement and a suitable wage rate fixed.

(4) In brief the time study is nothing more or less than to ask one's self why a thing is being done how it is being done and what should be done to improve the products (both in quality and quantity) so that the manufacturer can compete in price in accordance to demand,

(5) Time spent is effectively necessary for a certain piece of work. Apart perhaps from unimportant differences in the use of driving power suitably allowed for, every man and every machine require the same overhead expenses for the time unit, whether they work slowly or quickly. Hours of standstill, or stopped times, are in any case booked under expenses.

In a mill where carefully carried out time studies give out reliable data, rates set will of course be the starting point for the determination of index figures. Where they are not already available, time studies should be made. Modern well conducted works of any kind cannot possibly manage without them.

Q.—What are the fundamental principles of organisation and administration ?

A.—The fundamental principles of organisation and administration are common to the whole industry the methods of application vary in accordance with the peculiarities of the specific lines of manufacture. A certain method which proves successful in one factory will not attain the same measure of success in its application in another factory, manufacturing the same product. It depends upon (1) location of factory ; (2) building, equipment, whether constructed with reference to heat, light, humidity and air circulation ; (3) lay-out of manufacturing plant ; (4) planning and progress, research and investigation ; (5) organisation (*a*) line, (*b*) functional, (*c*) staff and line ; (6) labour conditions ; (7) (*a*) vocational selection on psychological tests, (*b*) vocational training, (*c*) time study, motion study, fatigue study and job analysis ; (8) measurement of wage factors (*a*) old wage system (*b*) new wage system ; (9) welfare and other activities ; (10) office, purchase, selling, and stores organisations.

Q.—What is a scientific management ?

A.—It is the common sense and economical application of all available knowledge and skill to every part of operation, however great or however minute. In other words, it means managing a business according to facts rather than opinions or heresay.

Besides the administration must possess genius and ideas, and the organization have the capacity to carry into effect the ideas when formulated.

Q.—Name three principles developed from the scientific study of the problems of management.

A.—The three principles are as follows :—

(*a*) Research, investigation, and experiment as the basis for determining policy and procedure.

(*b*) Establishment of standards in respect of policy and procedure, and continuing these until improvement is made possible.

(*c*) Controlling operations and all interrelated efforts by means of a predetermined programme of procedure.

Q.—What does the initial cost depend upon ?

A.—The initial cost depends upon (1) cost and particularly the position of land ; (2) cost and type of building ; (3) cost of machinery.

Each of these three items requires careful consideration as the earnings are calculated at so much per cent. on the capital involved.

Q.—What are the principles of cost calculation ?

A.—(1) To arrive at a basis for fixing the selling price.

(2) To arrive at such constructional designs or methods as will lead to lowest costs of manufacture.

(3) To achieve a scheme of manufacture on the cheapest possible lines.

Q.—Define Organization ?

A.—It is difficult to give a start clear defination. Shortly the word means to form several parts into an organized whole—to arrange. The parts to be considered are as follows :—

(*a*) Materials and their transportation.
(*b*) Machinery.
(*c*) Labour for handling the materials and the machinery.
(*d*) Provision of suitable buildings for the housing of the three first mentioned.

Q.—How would you survey the work and the labour conditions ?

A.—In the preliminary survey of the particular operator as a whole the observer must note the following :—

(*a*) The raw material at the start.
(*b*) The same material in the finished state.
(*c*) The various changes from one state to another.
(*d*) The equipment and power available.
(*e*) The operator himself, as regards :
  (1) His physical condition.
  (2) His mental condition.
  (3) His skill.
  (4) His previous experience.

Q.—What are the principal or essential details in connection with textile plant that needs very careful supervision.

A.—(*a*) Market demand.

(*b*) Buying of raw material.

(*c*) Designing.

(*d*) Dyeing and bleaching.

(*e*) Manufacturing.

(*f*) Finishing.

(*g*) Organization.

(*h*) Care and control of labour.

(*i*) Wastes.

(*j*) Finance.

(*k*) Selling of product.

(*l*) Delivery of product.

Q.—What does the manufacturing cost depend upon ?

A.—Economy in purchases of :—

1. (*a*) Cotton.

(*b*) Coal.

(*c*) Stores.

(*d*) Economy in fuel consumption.

(*e*) Economy in repairs and renewals.

(*f*) Economy in labour.

2. Conditions of machinery.

3. Maximum production and minimum waste which certainly depends on sound cotton mixing to a great extent.

4. Taxes and interest.

Q.—What are the factors the spinner has to bear in mind when he is buying cotton ?

A.—In buying cotton the spinner must bear in mind (1) the amount of cotton he is likely to need for a definite period ahead ; (2) the possible fluctuations in the price of cotton during the period for which he must cover his needs ; (3) the varieties of yarn which he intends to spin.

Q.—How would you find the weight in ounces per running yard ?

A.—$\dfrac{\text{Weight of cloth in ounces}}{\text{Length in yards.}}$ = weight in ounces per running yard.

Example :—

If the weight of a piece of cloth is 20 lbs. and the length is 40 yards. Find the weight in ounces per running yard.

20 lbs. = 320 ozs.

$$\frac{320}{40} = 5 \text{ ozs. weight per running yard.}$$

Q.—How would you find weight in ounces per square yard ?

A. $\dfrac{\text{Weight in ounces per running yard} \times 36}{\text{width in inches}}$ = weight in ounces per square yard.

Example :—

Find the weight in ounces per square yard of a cloth weighing 10 ozs. per running yard, and the width of cloth is 30 inches.

$$\frac{10 \times 36}{30} = 12 \text{ ozs. per square yard.}$$

Q.—How would you find the weight in grammes per running metre ?

A.—Ounces per running yard $\times$ 31 = weight in grammes per running metre.

Q.—How would you find the weight in grammes per square metre ?

A.—Weight in ounces per square yard $\times$ 33.91 = weight in grammes.

Q.—How would you find the number of threads in 5 mm. square.

A.—Add picks per inch and ends per inch together and multiply the result by .2 and the answer will be number of threads in 5 mm. square.

Q.—Is an oral or verbal contract valid or legal ?

A.—A verbal contract is no use. Any private or supplementary contract is not valid unless in writing, and any variation in contract should be in writing. Verbal orders should always be followed by written orders and copies of letters must be recorded.

Q.—Can a manufacturer or seller refuge to complete an order if the buyer is in arrears with his payment ?

A.—If the buyer is in arrears with payment the seller or manufacturer may refuse to proceed with it.

Q.—Does an acceptance and payment close a contract ?

A.—No. Acceptance and payment do not close a contract as there may be a liability some time after due to damage.

Q.—Define a promissary note.

A.—An unconditional promise in writing made by one person to another signed by the maker, engaging to pay on demand, or at a fixed or determinable future time, a sum certain in money, to, or to the order of, a specific person or to bearer.

Q.—How many kinds of assets are there in a company ?

A.—A company's assets are of two kinds : (1) floating or circulating assets ; (2) fixed assets.

Q.—If you were entrusted with selecting a site for a weaving mill what are the points that you would consider before doing so ?

A.—(1) The district.

(2) Class of goods intended to be manufactured.

(3) Class of work people in the place or round about the place.

(4) There should be no liquor shop in close proximity.

Q.—What are the problems involved in the manufacture of woven fabrics ?

A.—The problems involved from a manufacturing point of view are (*a*) selection of correct type of yarn ; (*b*) the most efficient means of yarn preparation for the loom ; (*c*) weaving.

Q.—What are the factors to be considered while ascertaining the quantity of cotton required to produce one lb. weight of yarn of a particular count and quality under consideration ?

A.—The factors for consideration are (*a*) the amount of waste taken out of the cotton during working, and (*b*) the amount of regain after spinning.

Q.—Suppose, that a yarn is being made from a cotton at 12 annas per lb., which, during its passage through the mills is losing 15% in waste, visible and invisible. There is, however, another lot of cotton ½ of an anna cheaper per lb., which is quite equal in staple, strength and other features, and will make quite as satisfactory a yarn, but which contains a greater amount of dirt or of short fibres, and consequently makes a greater amount of waste—say, 18%. For this waste there is an average price of 3 annas per lb. which cotton is cheaper, and by how much ?

A.—The common basis for comparison will be the cost in cotton of yarn produced less the amount received for waste.

No. 1 *Cotton at* 12 *annas per lb.*	Annas
If the cost is 12 annas per lb. and loses 15 %, then 100 lbs. of cotton will produce 85 lbs. of yarn and will cost ..	1,200
There will be received for 12 lbs. (visible waste) at 3 annas per lb.	36
(allow 3 % for invisible waste)	
Nett cost	1,164

or per lb. of yarn $= \frac{1,164}{85} = 13.7$ annas.

No. 2 *Cotton at* $11\frac{3}{4}$ *Annas per lb.*	
If the cost is $11\frac{3}{4}$ annas per lb. and loses 18 % then 100 lbs. will produce 82 lbs. of yarn and will cost	1,175
There will be received 15 lbs. (visible waste) at 3 annas. .	45
(allow 3 % for invisible waste).	
Nett cost	1,130

or the lb. of yarn $\frac{1,130}{82} = 13.8$ annas.

Q.—State how does excessive waste in the process of weaving can effect the profit and loss account ?

A.—Waste made in the process of changing yarn into woven fabric is a serious question, for it can quite easily influence the profit and loss account far more than is desirable. It is agreed that some waste is unavoidable, and in the costing out of a fabric a certain percentage is usually calculated for, but care must be taken that in actual processing this percentage is not exceeded. If possible, it should be reduced, thereby lowering the real costs of production.

Waste naturally varies in both quantity and character, according to the nature and quality of the yarns, the condition in which these yarns are received by the manufacturer, and to a great extent according to the processes through which the yarns must be passed in preparation for weaving and the type of cloth being produced. Owing to the nature of the various operations through which the yarns have to pass and to the types of packages used for making the yarns into a workable form, some waste is unavoidable, just as it is in the making of garments of all types from woven cloth. Much waste, however, could be avoided in a weaving mill if all concerned in the various processes would exercise as much care as possible, and give full attention to the operations of the various machines. It is certain that much waste could be avoided if proper care was exercised in examining the warp and weft yarns before allowing them to go into process.

Q.—What are the principal elements for accounting transactions in a scientific manner ?

A.—(*a*) For showing the manufacturing and expense accounts for the year in 13 equal periods of 4 weeks, each with a statement of profit and loss instead of 12 unequal periods.

(*b*) For showing the costs and output of each department by unit costs.

(*c*) For making the ledger-account control all issues or consumption of raw-materials, etc.

(*d*) For facilitating the work of the cost system, and accounting generally, so that no delay is caused by stock-taking.

Q.—Give a reasonable labour and overhead charges for dyeing yarn or cloth.

A.—As a rule in India 2 pies for labour cost and 2 pies for overhead charges are taken for dyeing department.

Q.—Discuss whether or not efficiency depends on energy alone.

A.—Efficiency is the cry the world over. Energy alone cannot bring success. Clear thinking and correct presentation of one's thought is the basis of efficiency.

Q.—Define efficiency.

A.—Efficiency means securing a higher percentage of result by applying the scientific method to any business matter. Efficiency is not will-power nor energy, nor system, nor slave-driving, nor courage, nor speed, nor cleverness. Above all else, it means finding out the facts and learning. The one best way to do a job. Find out exactly what is being done. Then, bit by bit, cut out the waste —the waste time and money and machine—power and materials. Create a new routine, based on exact knowledge. Get rid of the guess work and obsolete work—habits. Increase the percentage of result.

Q.—Define fatigue and give examples that creates a feeling of fatigue.

A.—Fatigue is the sum of results of activity, which show themselves in a diminished capacity for doing work.

Thus, noise, worry, flickering lights, or light reflected from bright parts of machinery striking the eyes—in fact anything that disturbs the comfort or arrests the attention of the worker creates a feeling of fatigue, and this feeling varies in degree according to the condition of his health. Also for instance a machine may be too high, or too low, for the individual worker, and a slight adjustment may make all the difference to his or her output.

Q.—Do you think that the cost of the warehouse should be based for each particular style or sort separately or individually or one average labour cost for all sorts or style would do give your reasons ?

A.—The cloth room or warehouse presents a problem by itself, which may be simple or complex, depending upon the character of the mills product. It may be so simple as to require only one average labour cost for all styles, or it may be necessary to time-study numerous special operations carried on in this room and then the cost or charges fixed for each individual sort or style.

Q.—Do you agree if a mill agent is offered a large quantity say 3 to 4 years consumption or requirements of strappings at a lower rate than the market ruling price, should he commit himself to such a purchase ? Give your reasons.

A.—No. Because nobody can forsee the possibility of fluctuations in prices of course either way is possible. But one of the biggest risk would be the chances of the goods perishing, or get stolen, or used up too quickly then he stands to lose more than the difference he had benefitted by way of a lower price.

Q.—How can the highest quality be produced at the least cost ?

A.—It can be produced by (1) the most careful supervision should be exercised ; (2) the machinery should be put into the best condition its state will allow, in order that the least possible waste may be made and the best work brought out.

Q.—What is the most important factor that a manufacturer must look to, and why ? Discuss fully.

A.—The most important factor that a manufacturer should look to is that he gets the best possible profit on his sales. In quoting the price for a certain article it is necessary to know the cost of producing that article.

Competitive prices do not form an accurate guide in fixing the selling prices because the conditions in different establishments and different districts vary so greatly. Two factories selling the same goods at the same price, there may be profit for the one and loss for the other, but by means of an cacurate system of costing, the manufacturer is enabled to know not only the result of the competition which exists, but also the profits of prosperous times and the losses of disastrous ones. It further enables him to see the weak spots in this organisation and to know when economic method and machinery can be utilised.

There should also be a chart kept showing the weaving production turned out each day, thereby the manufacturer becomes at once informed of any variation in the output and can set to work to determine the cause.

It will be understood, however, the output in the production will vary according to the number of picks per inch and counts of weft that are put into the cloth. Therefore, it is necessary to mark on the chart alongside the production, the average pick per inch and the average counts of weft.

Q.—How would you control the purchases of raw material in bulk before hand for manufacturing purposes.

A.—The difficulty of buying before hand is mainly due to want of knowledge or capacity or experience to forecast the possible future prices.

It is always best to cover the forward sales immediately after it has been affected.

It is very unwise to overbuy the raw material unless one is sure to visualise the future and then to decide whether to buy or not to buy.

Q.—Explain what do you mean by productive and unproductive labour.

A.—Productive labour means that labour applied directly to the productive processes of the plant while the unproductive labour is not expended directly in the manufacture although necessary to every operation.

Q.—How would you realize higher efficiency and closer organization in various branches of Textile Industry.

A.—Higher efficiency and closer organization can only be realized through a general understanding of the principles of the industry. To be successful, the manufacturer must keep a wide outlook, must keenly observe the sources of raw materials and the markets for his finished products, and organize his operations on the most economical lines.

In the textile industry, labour, to be efficient, must be intelligently self-directed. Knowledge of the material he manipulates, and the uses of his own product, adds incalculably to the interest and ability of the worker. It is not possible for operatives to acquire such knowledge in the factory, as they are too fully occupied with the practical duties of their own departments. Therefore they should be given such opportunities whereby they can advance their knowledge with a view not only to better themselves but to improve their work efficiently.

Q.—Give an instance which retards the output of the weaving shed and how would you prevent it.

A.—By keeping a loom waiting either for fresh warp or repairs and thus the production is greatly affected. I would prevent it by strict supervision.

Q.—How can the overhead expenses be predetermined or controlled.

A.—It can be controlled (1) by the study of machine or plant capacity, which focuses attention on the necessity for additional or improved plant before the production demand arises or arrives. (2) The calling of attention to possible idle capacity to invoke further sales or the introduction of new lines.

Q.—What are the factors to be borne in mind while costing a piece of cloth ?

A.—(*a*) (1) Supervision ; (2) insurance ; (3) land rent ; (4) taxes ; (5) office charges ; (6) interest ; (7) coal ; (8) stores ; (9) sundries and commission ; (10) repairs and renewals ; (11) travelling Expenses ; (12) postage ; (13) law charges; (14) stationery ; (15) railway freight ; (16) income tax ; (17) agents commission ; (18) directors fees.

(*b*) Cost of size mixing 5 % is to be allowed for droppages.

(*c*) Fixed wages in winding, warping and sizing.

(*d*) Rates (*piece work*)—winding, warping, sizing, drawing and weaving.

(*e*) Dyeing and bleaching charges.

(*f*) Finishing, calendering, folding and baling.

Q.—Discuss fully normal production.

A.—When a mill comes to decide upon a proper figure for normal production, it has to face the tendency of over-estimating the production which, if followed, will result in an underestimate of costs.

If the experience of a mill indicates that its actual production is and will be at the rate of 75% of its total maximum theoretical production, it is this 75% which should determine the figure to be employed as its normal production in reckoning its pre-determined costs.

If, instead of this, the mill employs 100% of its total maximum theoretical production as the figure to be used, the result will be that the mill's cost per yard or per lb., or per piece will be understated as to many important items by 25% and the mill will be deceiving itself accordingly in relying upon its predetermined costs. If, as it is more likely, the mill assumes as its normal production a figure less than its maximum theoretical production but nevertheless substantially in excess of its actual production, past and prospective, it will commit the same error but in a less degree. For example, if a mill assumes that its production is 90% of its theoretical maximum capacity but in fact its production is only 75%, the result is that it underestimates its cots to the extent of 16/23%. Experience must convince the mill that it does not, in fact, produce for the full 52 weeks in the year and 100% of its theoretical maximum capacity for every one of those weeks. Many causes contribute to actual production being considerably less. Among these causes are the inevitable stoppages of spindles and looms, and other stoppages due to mechanical conditions or labour interruptions, all of which, though only partial and temporary, operate to cut down the actual production per year. Therefore without ascertaining the actual production, the cost per lb., per yard or per piece will be inaccurate and misleading.

Q.—Discuss fully normal value.

A.—Normal value is the relation of a thing to others, decided by their respective costs of production. Things are at their normal value when they exchange in accordance with the outlay required to bring them into existence.

Q.—How would you avoid the accumulation of stocks.

A.—It is always best before manufacturing a particular sort to study in minute details the possible absorption of that sort in the market or by the consumers and then decide whether to manufacture or not to manufacture and how much or for how long to manufacture thus and thus only excessive stock can be avoided.

Q.—How would you meet the modern demand for a reasonably good article at a low price ?

A.—The demand can only be met by manufacturers who are producing with the maximum efficiency possible. That many producers are not working at 100% efficiency is painfully obvious, and the reason is usually not far to seek. They are using old and in many cases obsolete plant. The manufacturer, who wants to raise his productive efficiency percentage, must install the very latest machinery which gives the utmost output at the lowest cost.

Q.—State briefly what is meant by a costing valuation of a factory or mill ?

A.—A costing valuation is a valuation of the land and buildings, plant and machinery, analysed according to processes, so that trade expenses, such as labour, power, and standing charges can be correctly allocated to the respective processes.

Q.—Explain briefly what is meant by "a fire insurance policy."

A.—A fire insurance policy is a contract of indemnity against loss by fire (and incidentally by lightning) up to the amount insured, but subject to the conditions, warranties, specifictions, and terms, therein contained. Providing the wording of the policy is in order and the amounts insured are sufficient, the policy holder may recover the value of the property destroyed. This brings us down to hard facts, for the policy is a contract and as such must be interpreted word for word and amount by amount ; consequently it is essential to see that the amounts of the policy are sufficient, and correctly apportioned over the various items. One of the most important conditions of the policy (usually found on the back) is to the effect that on the occasion of a fire the claim must be made "having regard to the value at the time of the fire." It does not matter what was the original cost, whether more or less, but what does matter is the present basis. More often than not, the figures in the account books of a mill are seldom any guide as to the insurance value. The question of condition and maintenance is a frequent bone of contention, but is generally admitted by the insurance company's assessors where the insured are able to prove such. It is only right and just that those who have expended moneys in keeping the machinery, etc., in an efficient state, should have the benefit of such, and should not be led away into agreeing to a fixed percentage allowance for depreciation. Another condition of a fire policy is that the responsibility of proof of loss rests on the insured party, hence an up-to-date inventory should be considered a essential feature in every factory.

***Q.*—What is finance ?**

***A.*—Finance is the supply of the necessary capital to facilitate the carrying out of the operations for which the business was formed.**

***Q.*—Define production.**

***A.*—Production is the term applied collectively to all those activities inside a factory which transforms the raw material into the finished manufactured article.**

In other words the transformation of matter from one state into another takes place through the medium of three agents, namely, land, labour, and capital.

***Q.*—What steps should be taken by a manufacturer if sales fall off ?**

***A.*—If there is a weak spot in a firm, it must be strengthened. If there is an unprofitable department, it must be reorganised or given up.**

A manufacturer can study his products, and cut out those on which he is losing money, He can concentrate on his best profit-makers and stimulate his salesman.

By making fewer products, he can greatly reduce his manufacturing costs too. And he can introduce an "anti-waste campaign" in his factory.

He may find, very likely, that he is making no net profit at all upon twenty of his products, and during a recession in business he can't afford to carry dead qualities or sorts. When business conditions become unusual, the manufacturer must do unusual things. The most vital point to consider is that if a firm sits still when the time has come for a special effort, its sales may continue to fall, and it may have a bad Balance Sheet at the end of the year.

***Q.*—What are the four most essential factors in business.**

***A.*—They are : knowledge, decision, judgement, and strength.**

***Q.*—What are the essential factors that go to help in consumption of cloth production ?**

***A.*—(*a*) Opening of new markets ; (*b*) increase in population ; (*c*) increase in the purchasing power of the consumers ; (*d*) creation of demands by introducing new designs, new styles and new finish ; (*e*) competitive price.**

***Q*—What are the principal elements which require analysis for the cost—accounting of a commodity.**

A.—(*a*) The cost of raw material; (*b*) the cost of labour; (*c*) cost of running the machines, based upon their price, and also interest, rent, power, light, etc.; (*d*) the cost of selling and distributing.

Q.—Differentiate between stores and stock.

A.—The term stores is applied to the raw or partly-manufactured material which the manufacturer uses to work up into a more complex, or a finer product.

Stock on the other hand, is the finished product, set aside awaiting sale.

Q.—State why constant or continuous overtime is objectionable?

A.—Because overtime is liable to impose too severe a strain on the operatives or workers. While a spell of overtime is effective in an emergency, yet, after a time the rate of production tends to decrease, and the increase of hours to produce little or no increase of output. Moreover, the quality of the output may be adversely affected during the whole period of work and not merely during the period of the overtime. This may be attributed, in part, to the workers becoming tired and taking a rest; and, in part, to sickness. It imposes a serious strain on the management. It is very true maxim that the longer the hours, "the greater the amount of broken time."

Q.—What do 9 firms out of 10 need the most?

A.—Better and efficient salesman. Skill is required in manufacturing, but much more skill is required in selling.

Q.—Give the advantages and disadvantages of night work or double shift.

A.—From a sound business standpoint, it is advisable to work the machinery which a mill has as many hours as business will permit, rather than buy more machinery and invest money in a dead-stock (because, that is what the machinery amounts to, when idle) of course, when business is slow there can be no question of working nights, but when a mill has plenty of orders there is nothing like night work to reduce overhead and the general cost of production.

But night work is not profitable when all of its many evils are taken into consideration, such as illumination, second (damaged pieces) health, and the annoyance that is created between the day and night shifts by deliberte negligence of work, etc., also from want of efficient labour, It is a question that how long should the workers remain on the night shift at any one time? A week is the most common period, and a fortnight is much adopted, and in some cases there is no alteration at all. Those in favour of the weekly change argue that the strain of the night-work and the difficulty of obtaining adequate sleep are such that it is undesirable for workers to remain on night-work for a longer period than this. On the other hand, it is argued that repcted changed make it more difficult to settle down to either system and that the night-work after the first week becomes less trying, while ability to sleep by day increases. In any case adequate rest-periods must be arranged. It is essential that the workers should be allowed "to have a say in the matter."

Q.—Distinguish between 'nominal' and 'real wages.'

A.—Nominal wages are the actual amount in money paid for services.

Real wages are the amounts of wealth or goods and services for which that money can be exchanged; so that if prices are high the amount of wealth obtainable for the money wage may not be sufficient to maintain the desired standard of life. Consequently discontent is found although the nominal wage is high. It can be seen from this that the level of nominal wages can vary greatly, even though real wages remain steady.

Q.—What ought the labourer to receive as wages?

A.—Wages should be paid to the labourers out of the products and it should vary with the amount of product.

Q.—What is meant by valuation of a factory or mill?

A.—A valuation is an estimate in monetary terms of the worth of an article or property according to the purposes required.

Q.—Do you consider goodwill (if any) while valuing a factory or mill?

A.—Valuations for company formation exclude the goodwill but for partnership purposes the valuer has to consider the goodwill for in the majority of cases the remaining partner enjoys the benefit of it by way of getting either cash or shares and at the same time the benefit of business connection.

Q.—Is it more dangerous for the spinner to be under-covered in a rising market than to be over-covered in a falling market? Discuss fully.

A.—It is wrong for the spinner to be on a 'short' position, than on a 'long' position, since in the 'long' position he can always spread his dear cotton over a period, and average by purchases in the falling market, whilst in the 'short' position, he is forced into the market and must use his dear cotton at once in order to keep his mill working.

Q.—Explain what do you understand by the term standard of comfort ?

A.—An indefinite term implying such an income as will support a family in health and decency.

Q.—Explain what do you understand by the term statistics.

A.—Statistics are a method of study by utilizing numbers. It is concerned with the study of masses of things, dealing not with individuals but with large numebrs. The type is everything, the individual nothing. By comparison of the results of enumerations it seeks to derive true and useful information. The subject of averages forms a great branch of statistics.

Q.—What are the expenses incurred by a mill owner or mill agent whether he keeps his mill working or not ?

A.—In all mills a large amount of 'general' or 'standing' expenses is incurred whether the mills is working or not. Such charges are interest rents taxes, rates, insurance, salaries and wages of officials.

Q.—When is it advisable for a mill owner or mill agent to stop a mill taking in view the standing expenses that will have to be incurred by him ?

A.—It is very wise for the mill owner or agent to ascertain before shutting down, the point, at which the loss incurred by spinning or weaving, exceeds the amount of standing expenses which would be incurred by stopping. He should investigate by means of costing which count of yarn or kind of cloth is more profitable to spin or weave in order to improve the position.

Q.—What do you understand by "value of statistics."

A.—The problem of the future cannot be solved by satistics alone, but in the decisions affecting them can be greatly helped by having correct information and satistics on which to base policy. This study of markets and future possibilities before manufacture is proceded with, has been termed "market research" and market research and "budgets" have been found to go hand in hand.

Now slowly we are awakening to the appreciation of the fact that many outside statistics indicate factors which affect our businesses, and the great growth and use of statistical information issued by government departments and in economic papers and reviews are tendering towards the increased use of information by managements. It is obviously not feasible for statistical departments to be set up in each business, and there is a growing tendency for industries or districts to have centralized bureau.

Q.—Give your reasons why every business person who has both the means and time to travel should do so.

A.—Because you and I occupy only an infinitesimal part of the earth's surface, even if we own acres of estate. Moreover, though our friends number hundreds, we have but met the tiniest proportion of the peoples who inhabit the globe. Therefore it is necessary for the sake of gaining wide and varied experience that every business man should travel for the following reasons.

(1) In another country, your perceptions are quickened by the very strangeness of it all; hence you are more impressionable than in your own little sphere, and ideas readily occur to you for betterment of your own business from what you see of the methods of other folk.

(2) Different countries are at different stages of progress in business; hence, in the cities of the continent or England are often to be found window displays, methods of service and selling, etc., far in advance of our own. On the other hand, in countries not so advanced we may see some of our own weaknesses accentuated and learn the cures.

(3) "Away from the maddening scene" of our own problems, it is surprising how insignificant those problems become; we realise, in our fresh interests, how relatively unimportant our own little worries are, and grow in stature thereby.

(4) To meet other humans, whatever their language or colour, is always a great experience. We can learn more about the brotherhood of man, his strengths and weaknesses, by studying him in his own home, than in any other way. If your business brings you into contact with people of other countries, then study the lands of those peoples and try to understand their thoughts.

(5) You live only once, and we have such a great storehouse of wonders to see that it is truly an impertinence to be forever smugly satisfied with the little corner of the globe you know.

Q.—Which would you prefer a constructive criticism or a destructive criticism ?

A.—Of course the former which should always be welcome by any sane business man though at times it may be flavoured with indignation.

Q.—Can the causes of success and failure be taught ?

A.—Yes, there is no higher mission than to teach men, the practical lesson that if they want anything in this world they must learn to earn it. To acquire excellence in anything, you must work—work persistently and unceasingly.

Every man, each in his place, must put his hand to the work as if he was working for his very life, and from a sense of honour, built upon self-reliance and self-help. A real man will toil amid obstacles, struggle against impediments, allow neither wrath nor despair to slacken his energy—determined to succeed.

Q.—Describe the nature of discipline.

A.—(*a*) There is the discipline of life itself, arising from daily contact with the existing order of things, and impelling us to obey the common rules of human existence.

(*b*) In a narrower sense, we speak of the self-discipline of successful men, the outcome of a definite regulated life, following set observances.

(*c*) In the narrowest sense of all we use the word to denote the act of punishment inflicted with the object of encouraging observance of prescribed conduct or rules.

If the "atmosphere" of the place is correct, the operatives usually put forth their best energies. But the chief responsibility in this connection rests with the management. Unless the management transmits their ideals and purposes to the employees, the spirit of discipline will not rise to the level that it is aimed at.

Q.—What is a cheque ?

A.—The smaller or left-hand part of a cheque when in the cheque book is termed the "counter-foil," the part torn off being the "cheque" proper.

Q.—What is a bearer cheque ?

A. When a cheque is made payable to "bearer" it is payable to anyone who present same—subject sometimes to identification. If a cheque is made payable to "order" which is the more usual method, it must be endorsed on the back by the payee before cashing.

Endorsing means writing the name at the back of the cheque, preferably at the perforated end.

A cheque becomes "dishonoured" if the bank refuses payment because the "drawing" person or firm has not sufficient money in the bank. In such cases the bank may write R/D—refer to drawer.

A crossed cheque has two parallel straight lines drawn across it more especially with the expression & Co., put between the lines.

A crossed cheque has its chief merit in not being exchangeable for cash at the bank upon which it is drawn. It must be paid into the bank, and they will collect the amount from the banker specified and place the amount to the credit of the person or firm paying in.

Q.—Give few of the general terms in connection with cloth contract.

A.—(1) A verbal contract is no use, all contracts must be put down in "black and white" even it may be of a private nature. Also bear in mind it is absolutely necessary that any variation in contract should be in writing.

(2) If the seller is in arrears with delivery the buyer may cancel.

(3) If the buyer is in arrears with payment the seller may refuse to proceed with it.

(4) Acceptance and payment do not close a contract as there may be a liability some time after due to damage.

(5) In cloth contracts definite particulars should be given. and if the particulars are quoted actual, then those particulars must be actually put in the cloth.

(6) If quoted nominal a variation up or down may occur, usually a limit of two counts in yarns used, and half an inch below width.

Q.—Does a high rate of wages mean high labour cost ?

A.—No, if accompanied by increased efficiency, the high wages may mean a lower labour cost. But there is a limit even to this, for efficiency does not always improve in proportion to the increase in wages. If no increase takes place in efficiency, then an increase in labour cost must follow.

Q.—Define 'profit.'

A.—Profit is the difference between the cost of materials together with all costs of production and distribution, and what the article realizes in the bazar or market.

The profit and loss account of any industrial enterprise is the only true index of the general efficiency with which the business is conducted. Efficiency, not only in respect of the adminisrtation and general management, but also in the equipment of the works with the most efficient plant of machinery for the particular class of goods to be manufactured, and one that will also yield the maximum production of the best quality, with the least capital expenditure and the minimum production cost.

Q.—How would you eliminate waste ?

A.—The eliminating of waste must be carried out in every department of organisation and administration, such as waste of floor space, the waste of machine time and the waste of power, of labour and of supplies. Every thing that enters into the operation of a plant is an element in the cost of production, and any kind of waste is a drain upon the profits of the firm.

Q.—Discuss the chief ways in which the Banks assist the Cotton Industry.

A.—The banks assist the cotton industry in the following ways.

(1) Lends money against stock to help the spinners and manufacturers to buy raw materials and to run their mills.

(2) Advance money against importation of cotton.

(3) Advance money against exportation of yarn and cloth.

In these days of distrubed exchanges difficult world trading, the banker's knowledge, administrative machinery is invaluable. They undertake acceptances, discount bills, arrange their collection and payment in the later stages, and thus clearly relieves the exporter and importer.

Q.—Explain what do you understand by real cost ?

A.—The actual sacrifices (of material wealth or human effort) to which the money cost of production corresponds. The money costs must be incurred in order to divert the various requisites of production into the particular channel. The real cost of a thing, therefore, is the fact that there is a less production of other things that might have been produced by the same productive resources.

Q.—What do you understand by the term assets.

A.—Assets is a term meaning the total funds, goods, and property of every kind belonging to an individual or a company, and which may be liable for the payment of debts. It includes debts owing by others to the firm or person. More technically, assets may be defined as the debit balances of the ledger accounts.

Q.—Discuss Textile Business prospects.

A.—Cotton is the world's most discussed commodity with ample of business potentiality. Cotton is still a world power. There are millions without a shirt, while warehouses and godowns are choked with bales of cotton. What is then the remedy? The remedy lies in all owing sound business sense to prevail and however the business battle may be raging between the various fibres, that the wise textile manufacturer, whether spinner, weaver, knitter, or finisher, finds his greatest scope, on the same lines as merchanting business has developed through the ages. Some one fibre is always relatively reasonable in price. That fibre is the one which finds the most favour, if carefully handled.

Q.—What are the two best qualities that will enable any man of ordinary abilities to make a success.

A.—The two qualities are teachibility and common sense.

Q.—What are the terms and conditions which usually govern the selection and purchase of "Spot" cotton in Liverpool or Manchester? What is the difference between purchasing cotton on "Spot" and on C.I.F. terms? What is meant by "On call"? Why do some spinners deal in cotton "Futures," as a safeguard against speculation? Is this method effective in all cases?

A.—The term "Spot" cotton, used in connexion with the purchase either at Liverpool or Manchester, refers to cotton actually in the warehouse at either of these ports, and which may be sold either for immediate delivery or at a specified date.

It is the usual custom for the spinning concern to obtain its requirements through a buying broker, who is generally fully conversant with actual requirements as to grade, staple, etc. This buying broker either purchases the cotton himself on behalf of the spinner, or assists him in its sleection, by obtaining suitable samples of the required type from a selling broker who has the cotton for disposal. These samples of different cotton, but of all the type and grade required, will be tested at the office of the buying broker and after a selection has been made, a offer as to price will be made to the seller for his acceptance, and if the sale is agreed to a duly signed contract is forwarded to the spinner later in the day by the seller. This contract note contains such particulars as, number of bales purchased, the mark of the bales, the price per lb., the terms of purchase, the date on which delivery is to be made, and date of invoice.

It is understood that either all or the bulk of the cotton is ready for immediate delivery, and that should the seller fail to deliver any portion by the specified date, the buyer is at liberty to cancel that portion of the contract, or to claim that the average date on which the cotton is ready for delivery shall be the date of the invoice.

The cotton must be taken by the buyer within ten days of invoice and payment for same must be made within ten days of invoice date unless special arrangements have been made. Interest at the rate of 5% is allowed on any money paid before the date due, and is also charged at this rate on any outstanding account, together with warehouse and insurance charges.

On receipt of the cotton at the mill, should any bales prove faulty, *i.e.*, not be up to standard, show excessive tare, be of wrong weight, be damp, or be falsely packed, then the spinner is entitled to make claim to the seller for a refund and the seller either accepts the responsibility or the matter is subject to arbitration.

The selling broker charges ½%, commission on the gross value of the cotton to the selling merchant. The buying broker also charges ½%, commission to the spinner and sees to the forwarding of the cotton from the warehouse to its destination. The warehousing, insurance, and forwarding costs must also be paid by the spinner through his broker. The allowance for tare is 4% for canvas plus the actual weight of the bands.

C. I. F. Terms.—These letters, C.I.F., refer to cotton which is bought before arrival; the cotton may be already at sea or to be shipped at an early date.

Under the contract the shipper guarantees the cotton to be equal to type samples or to samples actually drawn from the bales which have been forwarded either to Liverpool or Manchester.

The contract may be for any amount and the price to be paid includes the actual cost of the cotton at the port of shipment, the insurance charges, and the frightage charges from port to port.

The terms of the contract state that the cotton is invoiced at the actual gross weight less an allowance of 6%, or the net weight, *i.e.*, the actual weight of the bales less bands, and 8-9/16% allowance for canvas, after deducting the bands. It also states the quantity of bales to be delivered and also the dates between which shipments must be made.

The invoice, with full particulars, is to be furnished to the buyer within four weeks of the date of the bill of lading. The date of invoice shall be the seventy-fifth day after date of bill of lading, payable at Liverpool or Manchester.

Payment shall be made in exchange for shipping notes on or before arrival of the vessel or failing previous arrival, not later than the date due, less the customary rebate for any prepayment, or, payment be made in exchange for the delivery of the cotton as it arrives, less the rebate for payment made before it is due or plus interest at 5%, for any overdue charges. Delivery to be taken at the quayside and the buyer pays the necessary transit fees to the mill and also any other expenses such as dockdues, portering, and weighing charges.

On Call.—Here the cotton is selected on an agreed basis, the final price depending upon the time the spinner calls or fixes his cotton or the expiration of the call period. This system which is of a non-speculative nature, enables a spinner to operate without actual futures contracts and serves the purpose of a spot purchase and a future cover where spinners need to ensure continuity of quality, this system helps greatly as the correct grade is thus secured.

Q.—Describe current assets.

A.—In the majority of balance-sheets the chief of them are "stock in trade," "sundry debtors," "investments" other than trade investments or investments in subsidary companies which are of a permanent or semi-permanent nature), and "cash."

Q.—What do you understand by the term an assignment ?

A.—An assignment means a legal transfer of property, goods, interest or right, from one firm or person to another who is termed the "assignee." An agent owing money for yarn or cloth could become an "assignor" by executing a deed for the benefit of a firm to enable them to realise his estate, or there might be a duly stamped and registered "deed of arrangement" between a debtor and his creditors in order for them to get the most they could, without the debtor being forced in bankruptcy.

Q.—What do you understand by the term Dr. and Cr. ?

A.—The credit side of an account is the right-hand side, and to credit a person or firm with goods or money it is entered on that side.

To debit is to charge against and must be entered on the left-hand side.

A creditor is a person who has money or goods owing to him, while a debtor is a person who owes something.

Q.—Give the practical points which the ordinary investor should always bear in mind.

A.—The first is that "current" assets other than cash and gilt-edged investments always tend to be less liquid than the "creditors" item on the other side.

The second is that most businesses have assets which can be pledged to raise money when necessary; if there is no indication of an undue use of the directors' borrowing powers in that direction it is fairly safe to assume that working capital is adequate and liquidity never a serious problem.

Q.—Explain what do you understand by "fixed" assets.

A.—Fixed assets are the permanent equipment of the business and will include such things as "freehold and leasehold land and buildings" (where there are the property of the company), "plant and machinery" (in the case of a manufacturing business), "fixtures and fittings," and a number of other items of a similar kind. Then there may be motor-cars, lorries, railway waggons, and other transport equipment owned by the business, furniture, tools, and a dozen other items of a similar nature. Now "fixed" obviously does not mean that such assets cannot be disposed of. In a business which grows and changes, and is bound from its very nature to go on doing so, the so-called "fixed" assets will change a good deal from time to time. A new manufacturing plant may be built and the old one sold. "Plant and machinery" may be in a constant state of flux.

In most cases the figures (of fixed assets) in a balance sheet represent the original cost of the assets less any depreciation or obsolescence which has been charged against profits in previous years. The "cost" figure may, of course, be the result of a professional valuation of the assets of a business taken over and incorporated in the company, in which case the "cost" figure is simply the proportion of the purchase price which was assigned to the fixed assets acquired.

Q.—Can you consider the value given for "fixed" assets in a balance sheet as the current market value.

A.—No. Satisfactory as such figures or values may be from the book-keeping angle, they really tell us very little of the current market value of the assets.

The land and buildings may have increased very considerably in value since they were acquired. The market value of the machinery, on the other hand, may be absolutely nil. If it has been specially designed for the needs of the particular business concerned and is of no possible use to anyone else, its value as scrap metal may not even pay the cost of breaking it up.

On the other hand, it would be absurd to suggest that the fixed assets should be revealed at a "break-up" figure each year, and profits and reserves credited or charged according to whether the value had gone up or down since the date of the last balance-sheet. In the first place, break-up value could not be assured until a buyer had come forward and agreed a price. Secondly, the process would be very expensive. Thirdly, it might involve writing the assets down to nothing at frequent intervals because of trade recessions making the business temporarily unprofitable.

Q.—Explain what do you understand by the term economic ideal ?

A.—Economic ideal is the aim of those who seek to promote "economic progress." It includes the maximum production of goods with the least amount of human sacrifice and the distribution of these goods in such a manner that the different factors will maintain a maximum flow of services to the general good.

Q.—Should a shareholder be satisfied with the assurance of an auditor with regard to the value of fixed assets being "true and correct view of the state of the company's affairs" ?

A.—A shareholder should be satisfied so far that the balance sheet statement of assets—and that not only of fixed assets—represents a reasonable average. Valuation of the bsuiness as a "going concern" over a period of years, both good and bad. Or, at any rate, he wants to know that the balance-sheet figures are not unreasonably in excess of such a valuation.

Now taking the profits factor into consideration, and where the fixed assets are concerned the balance sheet figures arise from book-keeping entries based primarily on original cost, whereas a "going concern" valuation implies that the fixed asset values are somewhere in the neighbourhood of current replacement cost. On the other hand, the prime factor in determining "going concern" value is the record of profits over a period of several years, the size of the business, its stability and prospects of permanent life being among the circumstances to be taken into account.

Now the use of the "going concern" value is that it establishes at once what may be taken as the absolute upper limit of a reasonable total of all assets. If the "fixed" assets alone exceed that limit, without the inclusion of the other asset items, then clearly the balance-sheet figures are unreasonably high and will probably have to be deflated at some future date.

A "going concern" valuation is, of course, not always a satisfactory criterion. A business may be going so steeply downhill that its value as a "going concern" is very little, whereas its assets in the form of land and buildings may command a very substantial price if offered for sale.

Q.—Give a short discription on speculation and the Liverpool Cotton Market.

A.—Speculation enters into the marketing of all commodities, and like most human institutions, is neither wholly good nor wholly evil. The speculator has been blamed and denounced for ages as responsible for small supplies and high prices and *vice versa.* He is, however, no more responsible for these conditions than for any astronomical occurence which may favourably or otherwise affect the growth of the crop. It is well to remember that the law of supply and demand is still supreme and in the long run controls the price of all commodities. In spite of denunciation, and much attempted legislation, speculation still persists and does useful service in the distribution of commodities.

There are two classes of speculators :

(1) *Intelligent*—a combination of hazard with calculation,

(2) *Gambling*—which is hazard without calculation,

It is the latter which merits severe condemnation. It is generally admitted that somebody must speculate if wants are to be anticipated, and the more speculation is concentrated and specialized the healthier and smoother will be the course of prices.

It is now the universal custom of merchants, shippers, and spinners to use the futures market as a "hedge" against violent price movements and so protect their interests by the form of trade insurance. It is imperative in such a system to have a free trading market in futures ; and it is in this connection that justification for much criticism seems to arise. It is necessary to have professional jobbers willing to make a price at any moment, to have dealers and operators who are willing to absorb contracts or sell "short" when they consider the markets are temporarily too depressed, or too high; to have speculators who will carry heavy stocks when they are weighing down prices and who will sell contracts ahead when they believe prices are too high; to "straddle" in order to keep American and Liverpool markets in time relation to each other.

Statements that speculation constitutes the greater part of the Liverpool cotton market are erroneous, and if the market were closed we should only encourage speculation and prevent the legitimate use of "hedging" operations and so encourage illicit trading. Whilst it is contended that if operations were confined to those with legitimate trade interests that smoother and less violent prices would be sustained, the argument is advanced that if the public were excluded the effect would be to limit strictly the activities and scope of the market and consequently there would be no selling and buying at a very fine point.

The Liverpool cotton market undoubtedly serves the interests of the trade by giving price protection without which business could not be carried out either with security or confidence.

Q.—Describe a straddle ?

A.—"Straddle" is a term given to a form of dealing which covers operations on the differences between the prices of different qualities of cotton or between the prices of futures with different periods to run, or between two markets such as New York or Liverpool. This type of speculation is obviously only a field for skilful and experienced dealers, and its purpose is to stabilize the course of prices and keep them in healthy relation to each other. There are of course many reasons which induce straddle operations. It may be a view on the probable movement of the dollar rate of exchange, or the bulk of cotton on the way either to New York or Liverpool, but the objective in effect is to forecast circumstances which correctly anticipated will bring profit to the operator. For example, if Liverpool were temporarily a dearer market than New York futures might be sold in the former and bought in the latter. When the forces of supply and demand had corrected the variation in price parity the operation could be reversed. Similarly, straddles may be effected between different months in the same market, when one market is considerably relatively dearer than another Advantage of the time factor is imperative in successful "straddling."

Q.—State what do you understand by the Manchester Chamber of Commerce Arbitration Clause ?

A.—It is quite a common thing for a clause to appear on a yarn contract saying that all dispute arising thereunder shall be referred to arbitration, and the one most frequently met with is the triburnal of Arbitration of the Manchester Chamber of Commerce. It is considered that the Arbitration Clause should only apply to disputes as to length, quality, and similar practical matters as these are best dealt with by practical men, but in legal matters which arise, the parties to have the right to go to law. It is quite a common experience for H. M. Judges to bring pressure to refer such questions to arbitration.The process is more expeditious, less costly and worrying. The arbitration panel consists of men accustomed to practical and technical problems. and the aim and object is to give fair and just decisions and uphold the reputation of the Chamber.

Q.—What do you understand by the term Bills of Exchange ?

A.—Bills of Exchange or "drafts" may take the place of payments in notes, cheques, or coins.

Bills of Exchange are stamped and certified promises to pay a stipulated sum of money at a certain future date. It is possible that a Bill of Exchange may enable a creditor who has funds in the hands of another person, to transfer those funds or part of them, either to a third party or to himself. These documents may be employed in order to suit the custom of the trade concerned, or when it is inconvenient to make the payment at once in cash.

A trustworthy firm wishing to purchase certain goods but not having ready money, may have the goods invoiced to them, and the selling firm may draw for the buyer's acceptance.

A three month's bill which must be signed and accepted, thus making the buying firm legally responsible for paying the money at the time stated. Discounts in such cases are not allowed.

A Bill of Exchange is a negotiable instrument and may be exchanged for cash. One firm may owe another large sums and not be able to pay cash down, although the cash is badly needed by the seller. The buying firm having good assets and a good name may accept a Bill of Exchange drawn up by the seller, who can then convert into cash, since a Bill of Exchange is a negotiable instrument. A Bill of Exchange could be changed for cash by a discounting broker, who will not pay quite the full amount to the seller.

Q.—Use the Lancashire cotton industry to illustrate the economic effects which result from a highly specialized and localized industrial organization.

A.—Two of the outstanding characteristics of the Lancashire cotton industry are its high degree of specialization and localization. The primary advantages sought being efficiency and economy in production and distribution, in consequence of being able to function as a trade rather than as a single works. The world wide outlet and complexity of its constitution no doubt account for these characteristics. Renowned natural and regional advantages ultimately enlarged into acquired and attracted other ancillary industries such as :—

(1) Artificial silk.

(2) The growth of textile machinists who have helped to keep the trade abreast of the times mechanically.

These anicilliary activities have encouraged the growth of the population and encouraged labour to remain immobile. Certain localities produce different classes of goods and have acquired regional customs and reputations. Commercial efficiency has been assisted by the establishment of well organized markets at Liverpool and Manchester. These economic factors help to keep the old and attract new industries.

This intense geographical specialization, however, has its marked disadvantages in times of prolonged and persistent depression, throwing a heavier strain on local administration, adversely affecting the level of costings, and thus yielding economic consequences which press severely upon the welfare of the people concerned.

Q.—What do you understand by the term "Freight"?

A.—Freight is the term applied to charges for taking goods across the water.

Q.—What do you understand by the term "forwarding"?

A.—Forwarding means transferring of goods from warehouses or godowns to a railway station for inland transit, but does not include railway charges.

Q.—Give a brief description of the internal distributive trade in cotton yarn or finished piecegoods, confining yourself to the English trade.

A.—The production and distribution of finished piecegoods in England is a highly specialized undertaking.

Cotton spinning is responsible for the production of cotton yarns, and their conversion into grey cloth is the task of cotton weaving. Thence the grey cloth passes to the merchant or wholesale houses if for the home market, or to the shipper for export. The grey cloth often passes through ancillary processes of bleaching, printing, or dyeing and then packed in innumerable different ways to suit the idiosyncracies of the varies markets.

Respecting the home market the wholesale house purchases goods in the finished state from the manufacturer or cloth merchant and sells to the retailer or alternatively purchases same in the grey state and subjects it to the processes of bleaching, dyeing, and printing according to needs. The wholesale house deals with the retailer through the machinery of travellers. For the small man who has to do everything, who is his own financier, has to buy and sell, and cover a great many functions which in a large establishment are divided, there is no doubt that the very big wholesale house is very useful. It is very difficult for a manufacturer who has only his own mill to provide for the variety and range of goods possible to the wholesale house.

The last decade has witnessed a remarkable change in the variety of cotton fabrics and the presence of cloth agents and merchants functioning between the manufacturer and the shipper or wholesale houses has become indispensable to its efficiency. The times point to a greater advance in our home trade in the near future, through a widening circle of prosperity and a greater variety of artistic designs and to this end retailers can fully rely upon the continued efficiency of our internal distributive machinery.

Q.—Give a standard form of a Balance Sheet

A.—Unfortunately there is no standard form of balance sheet laid down by law or even universally prescribed by accountants. In some countries it is usual to place assets on the left side and liabilities on the right side, thus reproducing the balances on the sides in which they appear in the actual books of account. While in other countries it is customary to reverse the balances and show liabilities (credit balances on the left side, and assets (debit balances) on the right side.

....Co., Ltd.

Imaginary Balance Sheet—For information only.

Balance Sheet as of December 31, 1940

LIABILITIES

		Rs.	Rs.
Share Capital:			
Authorised—			
750,000 Cumulative Preference Shares of Re. 1 each ...		7,50,000	
750,000 Ordinary Shares of Rs. 1 each		7,50,000	15,00,000
Issued:			
500,000 Cumulative Preference Shares of Re. 1 each ...		5,00,000	
600,000 Ordinary Shares of Re. 1 each		6,00,000	11,00,000
General Reserve			1,00,000
4½% First Mortgage Debenture Stock:			
Authorised and Issued ...		3,00,000	
Less—Amount Redeemed to Date		25,853	2,74,147
Profit and Loss Account— Balance per Balance Sheet Dec. 31, 1939		1,94,762	
Less—Final Dividend on Preference Shares for year to Dec. 31, 1939	Rs. 15,000		
Final Dividend on Ordinary for year to Dec. 31, 1939	90,000		
Transferred to General Reserve	50,000	1,55,000	
		39,762	
Balance from Profit and Loss Account		1,96,530	2,86,292
Sundry Creditors			3,47,581
		Rs. ...	20,58,020

ASSETS

	Rs.	Rs.
Freehold Land and Buildings ...	1,83,422	
Plant and Machinery	7,45,548	
	9,28,970	
Less—Reserve for Depreciation	61,437	8,67,533
Shares in and Advances to Subsidiary Company		2,53,694
Goodwill	2,70,000	
Discount and Expenses on Issue of Debenture Stock	26,530	2,96,530
Sundry Debtors	3,17,826	
Stocks on Hand as valued by Managing Director	2,89,456	
British Government Securities (at cost: Market value, Dec. 31, 1940, Rs. 29,517)	28,624	
Cash in Hand and at Bank ...	4,357	6,40,26
	Rs. ...	20,58,0

For and on behalf of the Board.

B. S. BENN }
B. A. BENN } *Directors.*

AUDITORS' REPORT

We have examined the above balance-sheet together with the books and accounts of the compa for the year ended December 31st 1940. We are unable to form an opinion as to the adequate of t amount allowed for depreciation of plant and machinery. Subject to this provision we are of the opini that such balance-sheet is properly drawn up so as to exhibit a true and correct state of the compan affairs as at December 31st, 1940.

FIGURE, PERFECT & CO., *Auditors.*

29th March, 1941

The order in which the balances appear and the way in which they are grouped are again purely matters of choice, but a good practice which is being adopted by an increasing number of companies is to divide liabilities into three main heads—capital items, profit and loss balances and current liabilities and assets also into three main groups—fixed assets, "intangible" assets and current assets. "Current" liabilities are the liabilities which the company expects to be obliged to meet in cash at a near date, while "current" assets consist of cash, bank deposits, marketable securities, stock-in-trade, and in general, anything the company could quickly and easily turn into cash to meet maturing liabilities. It is usual, when the balance-sheet is grouped in this way, to place current assets and current liabilities opposite one another so as to show the company's "liquid position" at a glance.

Q.—What is a balance-sheet ?

A.—(1) A balance-sheet is a statement of what a company owes and what it owns.

(2) It is a sheet setting out the balances of the various accounts which is necessary for the sake of the efficient conduct of its business that a company should keep.

(3) A balance-sheet gives the position of a company only at a single date. It does not give a cinema picture of the company's operations during the year. It is merely a "still." Of course you can, to some extent, judge the progress during the year by comparing the balance-sheet issued at the end of it with the one issued the previous year. But don't think that you will necessarily get a true idea of what has happened in between, any more than you can gather the plot of a film merely from the observation of two stills from it.

Q.—Distinguish between horizontal and vertical combines and explain the advantages and disadvantages which are usually claimed for both types of organization. Illustrate your answer by reference to the Lancashire cotton industry.

A.—A "vertical combine" unites various industries not in competition but working in close connexion with each other. The purpose of such unity is to obtain a degree of self sufficiency and to avoid being dependent on the vicissitudes of the market as regards raw materials or semi-finished goods, or at the mercy of a horizontal combination affecting some stage or process of manufacture. It is the declared purpose of the Lancashire Cotton Corporation Ltd., to eventually reach this ideal of self sufficiency by undertaking the purchase of raw material, manufacture of yarn and cloth, and the sale of the completed article.

A "horizontal combine" unites previously competing firms in the same line of business in order to achieve the economies of rationalization, *viz.*, the elimination of waste and the increase of economical power by such methods of systematic works specialization, the elimination of inefficient and surplus plant, and in general the realization of the advantages of concentrated management, large scale production, distribution and research. The combine is an organization of a non-terminable character with distribution of profits on a common basis, which seeks independence of the market and in time destroys the individuality of the units. The combined Egyptian Mills. Ltd., Fine Spinners and Doublers Association, Calico Printers Association, are examples of horizontal combines.

It is contended that the problem of carrying out an agreed policy for the benefit of the whole trade would be greatly facilitated if the cotton trade were amalgamated into more horizontal units, and particularly if such horizontal units were co-ordinated vertically.

Q.—What are the essential factors for business success ?

A.—(*a*) Skill and energy ; (*b*) the necessary capital ; (*c*) the means of speedily acquiring connection or reputation ; (*d*) tact ; (*e*) push and principle ; (*f*) sound common sense.

Q.—Give the most important points that a partnership agreement should provide ?

A.—(*a*) The term and duration of partnership ; (*b*) the actual amount of capital each partner undertakes to bring in ; (*c*) the total amount that each is to be allowed to draw out for personal use, monthly or quarterly ; (*d*) the percentage of interest, if any, that has to be allowed on each partner's capital and charged to each partner against his withdrawals from the firm, before profits are ascertained ; (*e*) the actual apportionment of work, for which each partner makes himself responsible to his co-partners ; (*f*) the proportion in which the profits and losses are to be divided among partners at agreed intervals ; (*g*) the steps to be taken on dissolution, by death, retirement or otherwise as to the calculation of "goodwill" and the method by which such a share has to be paid out ; (*h*) the arbitration clause providing for certain disputes and differences between partners to be settled by a reference to arbitration ; (*i*) the right of a partner to get books of accounts independently examined by an expert of his own choice.

Q.—Explain why the control of joint stock companies largely depend on the constitution of its board of directors.

A.—The successful organization and the control of joint stock companies largely depend on the constitution of its board of directors and more care and judgement is required here than is frequently displayed. The temptation to include gentlemen of title with very little business experience or training, seems to have proved all powerful in the past, with results disastrous from the point of view both of the shareholders as well as the directors.

Q.—Why is the purchasing department of vital importance ?

A.—The organization of this department is of vital importance as to the degree of success with which the business can be managed, whether wholesale or retail. The head of this department should keep himself in close touch with the dealers and manufacturers from whom he purchases.

Q.—Explain briefly why the sales department is of great importance ?

A.—In the case of the sales department, care has to be taken to see that the department is left in charge of those who are experts in the line, and know how and where the goods dealt with by their firm can be sold to the best advantage. A number of salesman are employed even in the case of wholesale business to go round and secure orders. The men should be imbued with enthusiasm in their work, and should know the articles they are attempting to push forward in all their details, including both their strong and weak points, in comparison to those of competing business houses.

Q.—Describe "double entry."

A.—A double entry means that every business transaction carried out by the company is considered in two aspects, and entries in the account books made from both those aspects. If, for example Hudson and Company, a firm of traders, sell Rs. 200—worth of goods to Robinson, a customer, the transaction will figure (apart from subsidary entries) twice in the ledgers of Hudson and Company, namely, once in its personal aspect, as business with Robinson, and secondly, in its impersonal aspect, as a transaction in such-and-such goods. There will be an account in the ledgers headed "Robinson" and an entry on the left-hand side of this account (the "debtor" side of the account) will be made, showing the amount that Robinson owes for the goods. It will read, "To goods bought Rs. 200."

Simultaneously another entry will be made on the right-hand side (the "creditor" side) of an account, called "Good Account." It will read, By goods sold to Robinson Rs. 200.

This procedure serves two essential purposes. It enables the managers of Hudson & Co., by turning up the goods account to see actually what goods they have bought and sold, irrespective of whom they have sold them to, and by turning up the account of the individual customer to see how much he owes to, or is owed by them. And, secondly, it provides a method of checking the accuracy of the accounts as a whole. Unless the same mistake has been made in entering the transaction both in the Goods Account and in Robinson's account, any accounting mistake which has been made will be bound to reveal itself when the balances of all the separate accounts are extracted and the sum of all those which have credit balances is compared with the sum of those which have debit balances. The sums should agree, and if they don't there is a mistake somewhere which must be looked for and found.

Q.—What do profits and reserves indicate in a balance-sheet of a limited company ?

A.—In most businesses profits are largely a matter of opinion and not a matter of fact. Because there is not a business whose assets had been written down virtually to nothing, and which received all its income in cash and paid all its expenses in cash could, of course, say exactly what its profits had been in any particular period right down to the last penny.

Gross Profits.—A manufacturing concern, for example, draws up its trading and profit-and-loss account at the end of the year. To the debit side of the account are transferred the stock valuation at the commencement of the year and the net balance of the "purchases account" (representing goods and materials bought during the year, less any returns). To the credit side are transferred the net balance of the "sales account" and the stock valuation at the end of the year. The difference between the two sides represents the gross profit or loss on trading.

Here the attention of the reader may be drawn that the stock valuations are generally made by the officials of the company. Therefore they are estimates. The auditors are not in a position to say for certain that the estimates are made honestly, much less whether they are liberal or conservative. The auditors can only advise the directors and shareholders whether or not, in their opinion, the methods employed in taking stock are sound.

"*Net Profits.*"—Assuming the result is a profit, the estimated gross profit is transferred to the credit of profit and loss account, and against it are set off all the "overhead" expenses—office salaries, wages, rent, rates, transport costs, and a hundred and one other items. Then there are allowances to be made for rent, insurance, and other items which have been paid in advance but part of which is properly chargeable against the next year's profits. There then arises the question of bad debts, and whether or not it is desirable, in view of trade conditions, to make some special allowance for depreciation of stock values. A dozen other things may call for some allowance to be made from profits before the net figure is arrived at.

Again, the allocation of items as between trading account and profit and loss account is a matter of choice in which practice varies very widely. So the reader can see that the net profit figure itself is the product of a set of figures which in the majority of cases are matters of opinion. In considering how the net profit is to be dealt with, many more things which are matters of opinion remain to be considered by the management.

The management will usually have some development schemes up its sleeve to be carried out when funds and trade conditions permit, or when the competition of other businesses makes such a course necessary. Again, the management will be thinking not merely of business conditions at the moment, but also of what business conditions are likely to be in the course of the next two or three years. And here it is worth remembering that, when the year's profit is arrived at, the financial period under consideration is already a thing of the past by perhaps several months, and the balance—sheet represents a state of affairs which has already undergone material changes.

This time factor is important. Equally so, and often connected with it, is the matter of cash position when considering dividend policy. The net profit figure is only a paper entry. Like everything else on the liabilities side (with the sole exception of "creditors") it is simply the book-keeping "opposite number" of the concerte and tangible assets owned by the business. There may not be one farthing in cash in the cash box. When dividend time comes round, the profits of the previous year may be represented by new machinery, new premises and fittings, stocks of raw materials and goods not yet sold, and a great many other things—anything except cash, in fact; and it is only out of cash that a cash dividend can be paid.

In such a case the directors might be perfectly justified in borrowing from the bank to pay the dividend, and in practice that is often done. They would not do so, however, if the use of borrowing facilities in that way were likely to handicap them in the normal conduct of the business.

There are other factors to be considered—whether there is a reasonable chance of maintaining the rate of dividend decided on, whether new development schemes call for the conservation of liquid resources for the time being, whether the dividend will annoy customers by suggesting profiteering or attract competition by indicating big profits to be made.

Altogether it is very easy to appreciate that in perhaps the majority of cases when a dividend is paid it leaves a paper balance on profit-and-loss account to be disposed of. If it is a small balance it will probably be left to swell the profit balance carried forward to the next year's accounts. If it is a large one, the obvious place for some of it at least is "reserves."

Some businesses make a practice of creating, out of trading profits, special reserves for contingencies which are likely to arise from the circumstances of their particular line of business. Thus one finds "dividend equalisation reserve," "machinery obsolescence reserve," "foreign exchange reserve," and many others. Some firms again, merely lump all together in "general reserve" or, maintain a general reserve with the addition of a contingencies reserve which is intended to be of a less permanent nature than the general reserve.

The idea of a reserve being "something on which a business can fall back in time of need" is true only in certain limited and purely technical senses. A reserve is really nothing more than a figure on paper which constitutes a sort of "pool" to be drawn on to adjust other balance sheet items without cutting into "share capital."

Q.—Explain why a company's capital is considered to be its liabilities?

A.—A business' assets are certainly its capital in the generally accepted sense of the word, but we have to remember that the item "capital" which appears in the balance-sheet is, by reason of the double-entry system, a counterpart of the assets which appear on the other side of the balance-sheet. The entry "capital" does, in fact, represent simply the amount of nominal capital with which shareholders are credited as having given to the company. It is true that all the shareholdings are lumped together in one entry under "capital account" in the company's books, but it is a credit entry nevertheless and hence appears in the balance-sheet under "liabilities."

Q.—Explain what you understand by debentures issued at times by various companies.

A.—Debentures, of course, are not, strictly speaking, a part of the capital of a company, but they are often loosely referred to as "loan capital," and inasmuch as they are usually issued with the express purpose either of providing a company, with working capital or of financing the acquisition of "fixed" assets, they are in practice regarded as part of the capital structure.

As regards their legal status, on the other hand, debentures must be clearly distinguished from proprietors' (or share) capital. They are simply a loan of money and are commonly secured by the pledge of all or part of the assets of the company. Moreover, in most cases the terms of the debenture provide for the repayment of the loan at some fixed or determinable future date, in preference to the claims of any other creditors.

Q.—Critically examine debentures and preference shares as methods of raising new capital for a joint stock company from the point of view of (*a*) the board of directors; and (*b*) the investor.

A.—A limited company for trade purposes has usually an expressed power conferred by the articles of association, to borrow, and give as security debentures or bonds under the company's seal charged on the assets of the company. They may be of two kinds :—

(1) A mere promise to pay called a simple mortgage.

(2) Those which acknowledge the debt, and convey security by way of a mortgage covering the fixed and moveable property.

The directors secure additional and stable loans either for a fixed or indefinite period at a rate of interest relative to the value of the security offered. The freedom of the directors is limited if the latter be of doubtful value.

Debentures properly secured by fixed charges on the property of old established companies with many years of successful trading and conservative finance behind them may be regarded as a safe investment. They are often difficult to secure, and the yield is proportionately moderate.

The investor secures good security, a specific charge on the fixed, and a floating charge on the moveable property, together usually with an undertaking that the stock will be allowed to fall below a certain specified figure. This position, if it is a first mortgage, is a privileged one, ranking for payment after the crown debts.

Preference shares are those which carry preferential rights either to : (*i*) a fixed rate of dividend ; (*ii*) a return of capital. They, however, carry no priority in the event of liquidation, except when provided in the articles of association.

The investor secures, therefore, no protection if the company be unsuccessful and yet is limited to a moderate dividend in the event of success. The directors secure stable capital which under ordinary reasonable capitalized circumstances places no considerable burden on the earning capacity of the company.

Q.—Explain when does an increase in debentures in a company become dangerous and why ?

A.—An increase in debenture and loan capital over a period, without increase in profits corresponding to the increase in total resources, is an obvious danger signal. It implies that the company is mortgaging its assets to provide itself with money to keep going, or, alternatively, is raising money for new ventures which are either not producing any profit or are merely making good a falling off in profit elsewhere. In any case, there is a *prima facie* incentive for inquiry on the part of the shareholder. A private individual does not, as a rule, borrow money and pledge his property without a confident expectation that he will profit by doing so. A public company certainly should be at least as cautious.

Q.—Explain what do you understand by the term "credit" ?

A.—Belief in one another. It usually implies permission to make use of the capital of another. In one very important sense the progress of society has consisted in the increase of the reliability of its members. That is, a community is civilised in proportion as its members are able to rely one on another. To a savage it would appear incredible, even if he could apprehend the idea, that a man could incur obligations for the future and not seek to evade them ; yet, if we could not trust one another, a modern civilised society could not hold together a single week. Trust, the confidence that promises will be performed, that engagements will be kept, that contracts will be fulfilled, is the essence of our modern industrial society.

Describe the word intangible as connected with a balance-sheet.

A.—The word "intangible" has been borrowed, and given a useful special meaning, to indicate items on the assets side of the balance sheet which are simply book-keeping entries and have no physical counterpart.

Q.—Name the principal ones amongst the intangibles and describe them.

A.—The chief ones are "payments in advance," "goodwill" and "loss carried forward" (if any).

"Payments in advance" indicates amounts which have been paid out during the year under review, but which should properly be borne by the following financial year. Adjustments for rent and insurance under this head are very common, and they are dealt with by re-crediting the profit and loss account with the sum due to be charged in the following year, and debiting it to a "payments in advance" suspense account, the final balance of which appears in the balance sheet.

"Goodwill" is a sum representing the difference between the value of the concrete assets of a business and the value of the business as a going concern.

"Loss carried forward" explains itself, since profit carried forward appears on the liabilities side, it follows that a loss carried forward must appear on the assets side, however curious it may seem that a loss should be an asset.

Q.—Explain what do you understand by the term credit instruments ?

A.—Credit instruments are means of payment other than coined money or commodities. They include Bills of Exchange, Bank Notes, Cheques, and also papers which represent and transfer possession of goods for instance, warehouse bonds, bills of lading, share certificates and the like. Credit has now become so admirably organized that the mere transmission of paper—with indorsement, or simply by transfer from hand to hand—enables property of the greatest value to change owners. The Factors' Act, too, tends to make credit instruments like negotiable instruments : the present holder, provided he has obtained the instrument without force or fraud, has absolute right to the property represented by the paper.

Q.—Fear, doubt, and apathy are the three evil spirits in business what would you do to overcome them ?

A.—I would overcome them by courage, self-confidence and ambition.

Q.—Explain the three most necessary things for every business man to possess.

A.—(1) *Brain*—to know and think.
(2) *Heart*—to feel and help.
(3) *Pocket*—to earn and spend.
In other words knowledge, kindness and wealth.

Q.—Give the three steps that are very essential in the business process.

A.—(1) Thinking and Designing.
(2) Manufacturing.
(3) Selling.

Q.—Are ideas alone enough for successful manufacturing purposes.

A.—No. Though they are the most important things in the business world, there must be up-to-date "efficient power machinery," "efficient manager and officers," and "efficient operatives."

Q.—Name the most necessary things for making goods efficiently and at a low price.

A.—To make goods efficiently and at a low price, there must be efficient—machinery, organisation and management.

Q.—How can the efforts of the thinkers and designers and manufacturers be nullified.

A.—All the hard work of the thinkers and manufacturers goes for nothing unless the goods are sold at a fair price. Of course with a profit to the manufacturers. To think is not business and to manufacture is not business. The completion of the business process depends upon selling goods at a profit.

Q.—What does "consumer analysis" refer to ?

A.—Consumer analysis refers to the study of the consumer's wants.

Q.—What does "product analysis" refer to ?

A.—Product analysis refers to the analysis of the product in order that it may be modified to fit the consumer's wishes.

Q.—What does "sales analysis" refer to ?

A.—Sales analysis refers to a study of past sales as a basis for a picture of the present status of the business and as a guide for further distribution efforts.

Q.—What does "market analysis" refer to ?

A.—Market analysis refers to the study of past sales, the product, and consumer in relation to each other, in order that all factors may be effectively co-ordinated in future activities. A comprehensive market analysis offers the management a scientific measuring rod of the past efforts of the business, and the potentialities and channels for future business. Regardless of past successes of the business, the future must be forecast by frequent studies of the consumer and the distribution channels.

Q.—Explain the term costs (real).

A.—The real costs of a product—the costs that are measured by the money costs—are the actual human effort and sacrifice entailed in the process of production. We may regard this actual cost from another aspect by considering that productive resources, being engaged in one direction, are no longer available in another direction : real costs are thus the curtailment of possible satisfactions in that other direction.

Q.—Describe "monopoly."

A.—A monopoly, strictly speaking, is an absolute and exclusive right to trade, and is one of two groups, namely, natural and artificial.

Q.—How can an executive build "initiative."

A.—Be a good listener.

Q.—How should mistakes be pointed out to executives and to those under them ?

A.—Never point out a mistake in an offensive way ; but never fail to point it out in a polite way.

Q.. .—What is the best way to train men for larger responsibilities.

A.—Responsibility quietly delegated is a business-developer.

Q.—Does persistency play a part in success ?

A.—Persistency plus consistency is success.

Q.—Why is it important to make friends of subordinates ?

A.—You are a half-way success until you can call your associates by their first-names.

Q.—What is the worth of a man with a capacity for much and varied work ?

A.—The man with a capacity for much and varied work is an inspiration.

Q.—How do you make your personality felt in the organisation ?

A.—By a modest blank.

Q.—Define creative thinking.

A.—Creative thinking may be defined as being mental activity which solves a new problem, or presents a new method or idea, or throw new light upon any old problem or idea.

Q.—Is "imagination' valuable in business life ?

A.—Yes. But it is dangerous when it is not balanced by a knowledge of the facts. It must be backed up both by knowledge and skill.

Q.—What is good judgement ?

A.—Good judgement is largely skilled forethought that is a man must study his mistakes and not commit the same mistakes twice. In order to have good judgement and to achieve results it is necessary that a man must be able to work smoothly with other people—to see other points of view than his own. It must be remembered that good judgement depends on "knowledge," "decision," and "strength."

Q.—Differentiate between judgement and commonsense.

A.—Judgement is not the same as we call "commonsense." It implies knowledge of a subject, while commonsense does not.

Commonsense may prevent a man from acting foolishly, but it may not help him to act wisely. Usually, when a man says that he has used commonsense, it means that he has not taken the trouble to study his problem and find out the facts. A man who has commonsense plus knowledge of the facts, is likely to have a good judgement.

Q.—What does progress depend upon ?

A.—Progress depends upon changes that prove to be improvement. It does not depend upon time.

Q.—Why is it necessary that every keen business man should know what his competitors are doing ?

A.—Because competition can never be ignored, not even by the largest firm. It is opposition. The general of an army wants to know most of all what the enemy is doing. When you look at your business, you should think of the future as well as the past. You should not regard it as a finished product.

Q.—Explain what do you understand by measuring one's judgement in business.

A.—Wise judgement means selecting a course of action that will bring the best results. It is an act of reasoning—a decision based on a comparison of objects, people, methods and ideas. It is always a process of comparison.

Q.—What is interest ?

A.—The payment to be made for the use of the capital is known as interest.

Q.—Differentiate between interest and profit.

A.—Interest is the reward paid for the use of capital; while profit is the reward paid to the enterpriser for the risks he runs in organizing and managing the business.

Q.—What is an equitable rate of interest ?

A.—An equitable rate of interest is decided by competition, that is, by supply and demand. If there is an ample supply of capital on the market, the rate of interest will fall; but should the supply be scarce and the demand large, the rate will be high. If the risk is nil, or practically so, the rate of interest will be low, whereas if the risk is great the rate is correspondingly higher.

Q.—What do you understand by the term "discount" ?

A.—Discount is an allowance made upon the payment of a sum of money such as the more usual 2½% payments in 14 days or as may be stipulated.

Prompt cash discount is an allowance made on the immediate payment of a debt, terms for this being 3% or as the case may be.

There is also a trade discount made by wholesale dealers to retailers, irrespedtive of time.

Q.—Distinguish between salary and wages ?

A.—Salary is the share given to the organizer and is similar to that made to the labourer under the term wages.

Q.—What are the different rates of payment ?

A.—Fixed rate or time rate and piece rate.

Q.—What is the object of piece rate ?

A.—The object of piece rate is to pay by results.

Q.—What are the great law of business ?

A.—Finance, improvement, production and sales.

Q.—Can a company be run (*a*) by one man's will (*b*) by one man's knowledge ?

A.—(*a*) A company can be run by one man's will (*b*) but not by one man's knowledge.

Q.—Is knowledge power ?

A.—Yes. When it is put to work. The successful man is the one who gets an idea and uses it.

Q.—Explain caution.

A.—Caution has its value, but it is much overpraised virtue. A man needs a certain amount of it, but too much of it at times will do more harm than good. To play safe means to stay with the crowd. To take a risk means either to lose or to win the prize. In business life the wise policy is to minimize the risk as far as possible and then to take action. A competent business man is both cautious and daring. He considers the risk and details of success.

Q.—What are the principal elements of success that creates business ?

A.—Knowledge, decision, judgement and strength.

Q.—Explain what are especially necessary to do when a firm is in financial difficulties ?

A.—The following things are necessary to be done and they must be carried out with speed and quick decision.

(1) Lighten itself by liquidating.

(2) It must have more money at once.

(3) It must sell its stock on hand and whatever is possible by way of land, building or machinery even at a loss.

(4) It must collect its debts.

(5) If it has a overdraft, it must by hook or crook reduce it.

(6) It must retain the goodwill and confidence of its banker and creditors.

(7) It must be quick and use all its energy.

(8) Consult experts.

Q.—How long can hardship (economically) be endured before it forces a change ?

A.—History teaches us that hardships will be endured over a prolonged period before the weight of sheer necessity forces a change. Hence the reader must bear in mind that in the case of one county selling against another at a sacrifice will achieve its purpose if effective counter measures are not adopted against it.

Q.—Discuss briefly what do you understand by the term fixed assets.

A.—By the term "fixed assets," is meant assets that are of an established or permanent nature, and that are used to carry on and earn income for the business. They consist of such items as land, Buildings and Plant (engines, boilers, machinery such as carding, spinning, manufacturing, finishing, etc.) These assets should appear on the balance-sheet at cost less any depreciation that has been written off. The market value of these items may vary greatly at different balance-sheet dates, but as such fluctuations do not effect the value of the assets to the business as a going concern, they are ignored. It does not necessarily follow that the book figure is higher than the market value, often the market value is higher than the book figure. Cost price less depreciation represents the value of the assets as a going concern.

Q.—Explain the importance of the Memorandum of Association and the Articles of Association of a public company.

A.—The Memorandum of Association may be defined as the charter of the company, outlining its objects and intentions, and in the case of a company limited by shares must contain the following :—

(1) The name of the company.

(2) The situation of the registered office.

(3) The objects of the company.

(4) A statement that the liability of the members is limited.

(5) The division of the share capital and the division therofs into shares of fixed amounts, *e.g.*, the capital of the company is Rs. 5,00,000 divided into 1,000 shares of Rs. 500 each.

It is the custom to specify the objects of the company in extenso to avoid further recourse to law if their scope is desired to be subseqauently widened. The Memorandum is fundamental to the nature, i8nd needs of the company, and vital to its legal interests.

The Articles of Association are the rules and bye-laws for the government of the company's internal affairs. They are numbered in paragraphs, and *inter alia*, deal with such matter, connected with the holding of directors' meetings, shareholders' special and ordinary meetings, conduct, powers, qualificatirons, calls, forefeiture, transfer of shares, issue of debentures, and all relevant matters necessary to the conduct of its official administration, *Q.*—What are the functions of the following in the affairs of a public company: (*a*) shareholders; (*b*) the board of directors; (*c*) managing director or general manager.

A.—The directional control and authority is vested in the hands of a board of directors appointed by the shareholders. They decide the company's general and special policies, and to assist them in their execution usually appoint one of their colleagues to act as managing director. Again, the managing director is linked with the departmental heads whose object is the maintenance of maximum production coupled with efficiency.

Q.—Explain fully what you understand by board meetings.

A.—The company's business is, generally speaking, transacted by the directors at these meetings and, unless expressly authorised by the articles, the directors cannot act without meeting as a board. But, more generally, questions of policy are decided at board meetings, and the managing director or other officials are 'directed' to give effect to the directors' decisions.

Q.—What do you understand by shareholders' meetings.

A.—At these meetings, the directors' report of the company's progress is submitted for approval, and various other matters, which are reserved by statute or the company's articles for decision by the shareholders, are put forward for consideration.

Q.—Explain fully chief features which distinguish private from public limited liability companies and show how such differences affect the distribution of both types of business units.

A.—Whereas the private limited liability company is usually built up of only a relatively small number of individuals, and amount of capital, the position of the public limited company is usually in the opposite direction, appealing to the confidence of the general public through the issue of shares, and thus being built up of a relatively large number of members and capital. It is obvious, therefore, that in the former, personal relationship between employer and employee is more pronounced than in the latter, where delegation of control by appointed directors function on behalf of the large body of shareholders. This lack of personal touch has contributed to make the art of management a task onerous and exacting. It therefore follows that as a rule the private company will function most effectively where the management has to make responsible dicisions quickly, and where the time—factor is all important. The closer the individual trade activities lie to the ultimate consumer, the more will it have to adapt itself to the peculiar, and passing phases of public tastes.

Q.—Write a short account of the financing of raw cotton from the selling merchant in America or Egypt, until it arrives at an English spinning mill.

A.—The financing of the American crop may be said to begin when the farmers receive advances from the local banks to raise their crops.

The sale of cotton to the Liverpool importing merchant is made in sterling. To reimburse himself the American shipper draws a bill on the importer's bank at sixty or ninety days for the value of the shipment, and furnishes with the bill the necessary documents (*i.e.*, bill of lading, invoice, and insurance certificate), to enable the importer to obtain delivery. In addition to the sterling bill, the shipper draws a bill in dollars for the amount of the sterling bill at the agreed rate and attaches it to the other documents on receipt of these, the buying bank remits the dollar amount to the shipper through his bank, and retains the sterling bill and documents. The bill buyer then forwards the sterling draft and shipping document to his agent in Liverpool or London, who presents the draft for payment or acceptance if it is for sixty or ninety days sight.

The documents are not handed to the importer but are retained by the banker until the arrival of the cotton. Many of the importing firms have ample capital resources or are in a good financial state and thus can borrow freely, especially as cotton, if hedged on "futures" is very good security. When the cotton arrives the banker hands over the necessary documents to enable the importer to make his agreed deliveries.

The responsibility for the provision of finance to cover the importation of cotton, therefore, falls on the banks, acting on the importers behalf, with the knowledge that any price fluctuations are carried by a "hedge" in futures.

Loans against the purchase of cotton, and acceptances, are also effected by the spinner. Payment by the spinner is usually on a ten days credit basis.

Q.—Explain fully the methods, other than by the use of "futures" a spinner might adopt for buying raw cotton to meet his requirements. Give the advantages and disadvantages of each method you describe.

A.—Cotton covers an infinite variety of growths and grades, differing from each other by variations almost imperceptible to the untrained observer, each having its own specific uses in the manufacture of various classes of goods. Consequently the buying and selling of cotton is a complicated and technical business requiring marketing, financial machinery of a complex nature, and technique and experience of a very high order.

Cotton is usually bought in the following manner: "on spot," "on call," and c.i.f. and 6% terms.

"Spot" cotton under the Liverpool terms contract is in the warehouse ready for inspection and delivery. The samples or "redraws" from the actual bales are available and the price is fixed at the time of purchase. In this system risk is reduced to a minimum as the buyer is assured of his correct quality. This system is recognised as a safe, although often a more expensive procedure.

"*On Call*"—Here the cotton is selected on an agreed "basis," the final price, *i.e.*, price of futures plus basis, depending upon the time the spinner calls or fixes his cotton or the expiration of the call period. It enables a spinner to operate without actual futures contracts, and serves the purpose of a spot purchase and a futures cover. Where spinners need to ensure continuity of quality this system greatly helps as the correct grade of the cotton is thus secured. Here dealing with reputable firms is advisable, as large differences may recur in prices before the time of delivery.

"The c.i.f. and 6%" contract differ from the Liverpool terms contract in that the cotton becomes the property of the buyer as soon as it is shipped, and the price covers the cost, insurance, and freightage, and 6% is allowed to cover tares. Any bales not equal to the "type" sample are not exchanged, but must be accepted at an allowance to be decided by arbitration unless otherwise agreed. It is essential that cotton on this system be bought through a reliable merchant, who will guarantee the quality up to the sample. The price usually works out cheaper than "spot" cotton as the seller has no warehouse facilities to provide. Ofcourse a buyer will always be prepared to pay a little higher price for cotton of a guaranteed quality. The possibility of the cotton on arrival not reaching the standard required may often prove extremely troublesome and expensive.

Each system, therefore, finds favour according to the conditions and tendencies, which preva il in such variable commodities, from time to time.

Q.—What do you understand by the term "bank charges" ?

A.—Bank charges comprise interest on overdrafts, commission on drafts and cheques, postages, charges for collecting debts from abroad if any, etc.

Q.—What do you understand by the term demurrage ?

A.—Demurrage means a storage charge of so much per day made by holders of goods on behalf of persons or firms who have failed to remove same at the proper time.

Q.—What do you understand by the term "firm offer" ?

A.—A term sometimes used by business men, and may mean on the part of a spinning and manufacturing concern a binding that is, they have made definite or "firm" offer at a certain price, within a specified time of certain yarns or cloths or articles. Being a "firm" offer they will not offer or sell the same goods to anyone else until the time limit expires or the goods are definitely refused.

Q.—State what is the income-tax liability in the case of those businesses carried on by persons in partnership.

A.—Under the Partnership Act of 1890 a partnership is defined as being the relation which subsists between person carrying on business in common with a view of profits. It is well to remember that determinations on questions of fact are left to the commissioners, and the officials have no power to refuse to regard a business as being owned by a partnership. It has to be proved by banking account and the registration under the Business Names Act and the recognition of suppliers and customers that the business is owned by a partnership is evidence that should be brought forward.

Q.—A good many investors seem to regard "allowance for depreciation" as a device employed by niggardly directors to rob them of their well-earned dividends. Discuss fully your views on this point.

A.—There is sometimes the germ truth in that idea, but there is no gainsaying the fact that physical equipment does depreciate. Machines wear out, if not in one year, then perhaps in three, or five or ten.

If the whole of the profit they earned during their life time were paid out in dividends and no allowance made for the fact that they would one day wear out, then at the end of the five or ten years or whatever the period might be the business would have no money with which to replace them—unless, of course, it made a regular practice of charging replacements against current profits.

In fact, many businesses do treat a large proportion of their replacement costs in this way. Where the depreciating items are small and numerous and their replacement averages out fairly evenly over an extended period the cost of renewing them is quite adequately and fairly handled by simply charging them as "repairs and renewals" in the profit and loss account. Certain items, on the other hand, obviously cannot be dealt with by this method. Leaseholds, for example, must be written off in such a way as to have become extinguished by the time the lease expires. Again, buildings do not last for ever, no matter how carefully they are reconditioned. Then there is the problem of OBSOLESCENCE to be considered. In this age of rapid progress equipment has an unfortunate habit of becoming out of date before it is worn out. Sometimes the invention of a superior machine will do it. Sometimes, too, a mere change of style or fashion will put a complete field of industry almost out of business.

Allowances for obsolescence can never be anything more than intelligent guesswork, of course, but few businessnes are justified in dispensing with them altogether. Some businesses may be sufficiently large, and have their interests sufficiently well spread, to be able to charge obsolescence, like depreciation, to current renewals.

The apparent niggardliness of managements in increasing depreciation allowances at the expense of dividends is usually accounted for in a very simple way. Most live industrial businesses keep growing, and hence are constantly increasing their fixed assets. In the majority of cases some portion if not all of the growth is financed out of profits and not by the continual raising of new capital

The new assets bought out of profits fall due for replacement in time, just as do the original assets purchased out of capital. It follows therefore, that as the business grows so must the depreciation allowances grow. It is a matter of necessity, not of niggardliness.

Q.—Explain what will be the result of adopting the policy of those directors that lighten the load of depreciation charges by increasing it in good years.

A.—If this policy is pursued steadily over a considerable period the result may be that the assets become written down to figures below even their "break-up" value, such a reserve is obviously a very real one, although it cannot be detected by an examination of the balance-sheet.

Hiden reserves in the form of low values for stock-in-trade, on the other hand, are always available for swelling profits. The thing is done simply by entering the "stock carried forward" in the trading account at a fair value. If the figure for "stock brought in" at the beginning of the year is artificially low, the balance of the account, representing profit, is automatically increased to the extent of the under valuation.

Q.—Define an error of principle.

A.—The term error of principle applies where revenue and capital items have not been dealt with correctly. Such errors often have far-reaching effects in the accounts.

Q.—Define a compensating error.

A.—The term compensating error is applied to cases where one error is offset or counterbalanced by another error—or by more than one.

Q.—Define a clerical error.

A.—This term is applied to errors that are the result of mere negligence or oversight in making up the books, and are not intentional.

Q.—What should be the depreciation of an engineering department.

A.—

Lathes and machine tools, first class	5 %
Engines, shafting and gearing	7½ %
Lathes and machine tools, second class	10 %
Machinery in general	10 %
Boilers	12½ %
Leather belting	40 %
Mill or factory Building—	
Stone or brick built	2 %
With machinery (ordinary)	3 %
With machinery subjected to unusual amount of vibration	5 %

Q.—What do you understand by the term "depreciation."

A.—Depreciation is a periodical deduction on account of diminished value of buildings, machinery, or other property, on account of age or wear and tear.

It is desirable that depreciation allowances of whatever form adopted, shall treat the normal capital so that it shall as nearly as practical represent at any time the "real" value. It is a convenient methods to fix average rates which can readily be written off yearly.

Q.—What do you understand by the term audit ?

A.—An audit means a thorough examination of the books of a spinning or manufacturing or any business firm periodically say every six months.

It involves the accounts, securities, vouchers, stocks and other matters, with a view to detecting any possible fraud or error in the mill accounts and statistics. An audit should be conducted by an accountant, who, being skilled in keeping and balancing books, and a member of a responsible independent firm, may be relied upon to enlighten the shareholders upon the exact standing of a firm.

Q.—Define an error of omission.

A.—Errors of this nature may occur in a number of ways.

Q.—What do you understand by the term sinking funds ?

A.—If a business has to meet a certain liability some years hence, it invests (if possible) an annual sum at compound interest so that these annual investments with the interest they accumulate will total to the amount of the liability when it becomes due, when a business adopts this procedure, it is said to establish a sinking fund.

Q.—Is it wise on the part of a manufacturer or producer to dictate to the consumers ? Give your reasons.

A.—Whilst the dictator of markets has always been, is, and will be the consumer, people submit the markets artificially to the dictatorship of the producer, prescribing to the customer what he ought to buy, how much, and at what price, and wonder why the system does not work. Generally speaking, the modern economists, forgetting that they are dealing with human beings, are furious that, whilst physiology, chemistry, and technology have been able to subdue the forces of nature, the economy of the world refuses to be ruled by the modern economists.

Q.—Define Purchases Book.

A.—This book is for the entering in of invoices of purchases. these invoices should be first checked and verified as to quantities, prices, and extensions, then arranged alphabetically, numbered at the right-hand corner to correspond with the running number in the book, and entered. All invoices from one firm should be kept as much as possible together, the amounts being entered in "invoice amounts" column and the total in the adjacent column, the purpose being to abbreviate the postings to the ledger, in the case of single invoices the amount can be carried direct to the total column. After this is done each amount should be carried across to its particular analysis column.

The amounts in the "total" column will be posted to the credit of the individual personal accounts in the Purchases Ledger, and the amounts in the "returns" column to the debit of the particular personal account, filling in reference folios for each. The totals of the Purchases Book should be carried through to the end of the financial period or year, the aggregate of the totals of the analysis, columns agreeing at any time with the amount of total column excluding, of course, "Returns and Allowances" column, which should likewise be carried through and at the end of the period analysed and deducted off the particular analysis column in the Purchases Book to which they relate.

Q.—Describe Sales Day Book.

A.—All goods sold are invoiced, and a copy of the invoice is entered in the Sales Day Book. The amounts in the "total" column are debited against the customers accounts in the sales ledger, and analysed to their respective impersonal accounts in the analysis columns of the Day Book. The totals must be carried through to stock-taking, those of the analysis columns agreeing in total with that of the total sales. Thus we should get against the customers accounts the debit, and to complete the double-entry we should post the totals of the analysed columns to the credit of Trading Account. Another plan is to make monthly totals and post to the credit of Sales Account, transferring ultimately to credit of Trading Account.

Q.—What is the Cash Book ?

A.—The cash book is such as to show cashier's balance and bank balance at any time.

Q.—What is a "Petty Cash Book" ?

A.—All petty payments are entered in the "Petty Cash Book" which is totalled daily and monthly and the totals of the analysis columns brought into the cash book on the credit side and from there debited to the different accounts or to Sundry Expenses Account in the Private Ledger. The difference between "amount received" and "total paid" will of course represent balance in hand.

The following Chart * which is somewhat amusing, will show the various agencies through which the trade is carried on.

60s Warp | 40s Weft
Cotton grown in Egypt | Cotton grown in U.S.A.
Egyptian Cotton Broker and Shipper | New Orleans Shipper

Liverpool Cotton Broker

Lancashire Cotton Spinner

Manchester Yarn Merchant

Madras Importing House

Contractors

Mofusal Middleman

WEAVER

Contractors

Madras Exporting House

Manchester Cloth Merchant

African Importing House

African Consumer

* From Department of Industries Bulletin No, 22 of 1926.

Appendix A

"STAINS" AND OTHER INFORMATIONS

Acid Stains.—Remove with warm water and white soap, to each quart of which a teaspoonful of aqua ammonia has been added. Nitric acid stains cannot be removed successfully.

Alkali Stains.—Remove with cold water, to which add one teaspoonful of acetic acid to each one-eighth pint of water used.

Ammonia Stains.—Ammonia is an alkali stain, and should be removed in same manner as alkali stains.

Ammonia diluted with a little water, is the best reviver for blue Serge suits. Apply with a sponge and press the suit well after laying a cloth between the iron and the serge.

Ammonia sometimes changes the colour of fabrics on which it has been used for cleaning purposes. The original colour may often be restored by applying either vinegar and water or a weak solution of acetic acid—but the latter must be used with the utmost caution.

Asphalt Stains.—Scrape off crust, and apply wood alcohol or turpentine. No water is required to neutralise the action of these solvents.

Blood Stains.—Remove by soaking the spot repeatedly with chloroform or peroxide of hydrogen, working in the open air. For thick goods use a paste of raw starch and tepid water. Spread freely on the goods, removing when perfectly dry. On silk use strong Borax water.

Books.—If dusted over periodically with a little white pepper and powdered alum become immune to insects.

Brass Cleaning.—Methylated spirit removes the most obstinate marks even from silver without injury. Apply a little on a clean cloth, or if embossed use a small nail or tooth brush. Another method is to wash the brass in warm soap and water to which ammonia is added.

Coal Stains.—Colour stains (coal tar) are removed in the same manner as colour stains (aniline).

Colour Stains (Aniline).—Apply hot wood alcohol, heating same by placing in small can and immersing in bucket of boiling water. No water is required to neutralise the action of this solvent. If stains do not yield apply permanganate of potash solution from bottle; then immediately apply a mixture of one part peroxide of hydrogen, one part acetic acid, and two parts water. Keep saturating with latter mixture until permanganate of potash and stain disappear.

Coffee Stains.—Apply cold distilled water, then apply permanganate of potash solution from bottle; then immediately apply a mixture of one part of peroxide of hydrogen, one part acetic acid and two parts water. Keep saturating with the latter mixture until permanganate of potash and stain disappear.

Dampness.—Dampness in a room can be remedied by placing a block of camphor in each corner. This absorbs the moisture.

Deal Table.—To keep deal table tops clean and white, mix six table spoonfuls of chloride of Lime with ½ lb. of soft soap and ½ lb. silver sand, apply with a scrubbing brush and rinse with fresh water to remove all traces of the scouring mixture.

Dry Cleaning.—Soak garment in petrol overnight and in the morning hang up to dry and then iron if so required to be done.

Dye Stains.—Removed in the same manner as colour stains (aniline).

Euclyptus Oil.—Euclyptus oil applied with a clean piece of white flannel will remove practically any stains from light fabrics without leaving a mark.

Fruit Stains.—Fruit stains can be removed from material by rubbing with salt as soon as they are made wash in the usual way or, apply cold distilled water, then apply permanganate of potash solution from bottle; then immediately apply a mixture of one part peroxide of hydrogen, one part acetic acid, and two parts water. Keep saturating with the latter mixture until permanganate of potash and stain disappear.

Glycerine—will often remove an obstinate stain.

Gelatine Stains.—Removed in the same manner as fruit stains.

Glue Stains.—Apply wood alcohol. No water is required to neutralise the action of this solvent. If this solvent produces no effect, apply a mixture of luke-warm water and white soap, to which has been added a teaspoonful of aqua ammonia to each quart of water used.

Grass Stains.—Apply hot wood alcohol, heating same by placing in small can and immersing in a bucket of boiling water, or hot glycerine (heated in same manner) however, in this latter use, the glycerine must then be removed with wood alcohol.

Grease Stains.—(1) Grease can be effaced from books by sponging the mark with benzine. Place the page between two sheets of blotting paper and press with a hot iron.

(2) Apply petrol or choloroform; allow same to soak in well; then place piece of blotting paper over stain, and pass slightly heated iron several times over.

Grease Stains (Axle).—Remove in same manner as grease stains; however, should after this operation a yellowish stain remain, apply bioxolate of potash (two table spoonfuls to one-half pint of water, dissolved by boiling, and allowed to cool), or apply a mixture of one part hydrochloric acid and ten parts cold water.

Ink Stains (Writing).—(1) Apply a solution of bioxolate of potash (two table spoonfuls to a half pint of water, dissolved by boiling, and allowed to cool). Then apply water, to neutralise acid. If stain does not yield, apply permanganate of potash solution from bottle; then immediately apply a mixture of one part peroxide of hydrogen, one part acetic acid, and two parts water, keep saturating with the mixture until permanganate of potash and stain disappear. If stain still remains, apply a few drops of carbolic acid and then wood alcohol.

(2) Milk will be found an excellent remover of fresh ink stains. Sponge with cold milk and rinse in warm water. An alternative treatment is ordinary table salt spread on, rubbed with lemon, rinsed in cold water, and placed in the sun .

(3) (*Red*)—Apply white and yolk of egg, which should be mixed thoroughly, and to which add two drops of sulphuric acid. Apply to stains several times, and then rinse with clear water.

(4) (*Printer's*)—Apply turpentine; allow to stand for five minutes; then apply petrol.

Indelible Pencil Marks.—Indelible pencil marks on paint and wood work can be removed by applying lemon and dry salt.

Iodine Stains.—Iodine stains may be easily removed with bicarbonate of soda. First damp the affected part and then rub in the bicarbonate of soda. Repeat the process several times, applying the powder liberally. Finally wash the articles in the usual manner, and it will be found that no trace of an iodine stain remains.

(2) Dip in ammonia water and rinse as soon as stain disappears.

Iron Stains.—Iron rust may be removed from muslins and linens by covering the spots with a paste of salt and lemon juice. Leave on for half an hour, rinse and hang out in the sun to bleach.

(2) May be removed by treating with dilute Hydrochloric acid. If the stain be very persistent and resists this treatment, strong hydrochloric acid should be used and the part affected rubbed with a crystal of sulphate of copper and then the cloth should be well washed.

Lampblack Stains—Wash with kerosene and wipe with dry cloth. Then use soap and water to remove the kerosene.

Leather Stains.—(1) Leather stains can be removed effectively by being rubbed with a cloth dipped in spirits of wine.

(2) Boil half a pint of linseed oil, and when it is almost cold add half a pint of vinegar. Mix thoroughly and bottle after applying the oil polish off with a soft cloth.

Linen Articles.—Linen articles can be whitened and stains removed if one or two slices of lemon are put into the boiler with them.

Medicine Stains.—To remove medicine stains on silver spoons, rub with a rag soaked in methylated spirit. Then wash the spoons in hot soapy suds and polish in usual manner.

(2) Dissolve with alcohol.

Mildew Stains.—(1) Use Javelle water, wetting repeatedly and exposing to the sun.

(2) Mildew stains can be removed from cloth by sprinkling them with salt and rubbing them with the juice of a lemon.

Motor Oil.—Motor oil and tar stains on clothing will disappear if the part affected is placed in olive oil and allowed to soak overnight. Wash next day in the usual way.

Oil Stains.—Mineral oil stains should be removed as soon as possible by treating them with Benzine.

Oil Stains (Black).—Should be treated with :—

(1) Benzine.

(2) Carboneum.

(3) Medicinal Tetrachlorethylene.

Paint Stains.—Use a mixture of turpentine and ammonia for linen, cotton and wool. For silk, use benzine or ether, later wash in soap and warm water.

Chloroform removes paint marks from delicate materials.

Perspiration Stains.—(1) Use one part Javelle water to four parts of hot water. Rinse well. For wool or silk, use warm water and ammonia. Press well before dry.

(2) Perspiration stains on coloured fabrics may be removed by sponging with a solution of vinegar or Caustic Soda. White garment should be washed with borax in cold water.

Rust and Ink Stains.—Immerse portion of fabric with rust or ink spot alternately in A and B solutions as follows :—

SOLUTION A	Ammonium sulphate	=	5 parts by weight
	Distilled water	=	95 ,, ,,

Mix both together.

SOLUTION B—	Oxalic acid	=	5 parts by weight
	Distilled water	=	95 ,, ,,

Mix both together.

Rinse with water after each immersion.

Scorch Stains—Dampen and expose to the sun.

Soot Stains.—Saturate with ether and cover with a cup to prevent evaporation until the stains disappears.

Stained Clothes.—To remove any very bad stain from clothes, soak the article in a solution of "hypo" such as that used for photography. Then wash the article with ordinary soap and water.

Stains on Leather.—Boil half a pint of Linseed oil and when it is almost cold add half a pint of vinegar. Mix thoroughly and bottle. After applying the oil polish off with a soft cloth.

Tar Stains.—Except on wash goods, use turpentine and rub with benzine. On wash goods, use lard and after several hours wash with soap and water.

Tea Stains.—(1) Glycerine will remove tea stains from delicate fabrics if it is allowed to soak into the affected parts a little while before they are washed with soap and water.

(2) Potato water can be used for removing tea or coffee stains. The article should be soaked in the potato water before it is washed.

APPENDIX B

FIRST AID TO THE INJURED ETC

Air.—About 25-30 cubic inches of air is inhaled and exhaled at each breadth in ordinary respiration. A man breathes 18 times a minute. He inhales about 15-20 cubic feet of air every hour.

The air is a mixture of gasses. Its average composition by volume is as follows :—

Nitrogen	=	78.49
Oxygen	=	20.63
Water vapour	=	0.84
Carbonic acid	=	0.04
		100.00

The carbonic acid gas is breathed out by human beings and animals, but the quantity in the air does not vary for plants and trees decompose it, assimilate the carbon and restore the oxygen to the air, thus purifying it. The oxgyen is continuously consumed in the processes of respiration and combustion.

Ankle.—The proper treatment for a sprained ankle is the application of a stimulating yet soothing liniment. Bandage with flannel to restrain movement and give support to the part.

Antiseptics (Emergency).—A dessert spoonful of salt dissolved in a cup of warm water or, methylated spirits with an equal bulk of water, or Whisky similarly tampered with vinegar.

Apoplexy.—Raise the head and body, bare the head and neck, and promote circulation of fresh air.

Artificial Respiration.—Lay patient down full length on stomach, head on side. Loosen neck and waist, remove dentures, open mouth, with palms press forcibly on lower ribs for four seconds, release rapidly. Repeat fifteen times per minutes until breathing restored.

Bites and Stings—Poisonous—Dog Bites.—It is some satisfaction to know that all "mad" dogs are not hydrophobically so, and that distemper madness makes dogs more frantic than does rabies pure and simple. If you have reason to believe that the dog that has bitten is suffering from rabies, tightly bandage or ligature above and below the bite; the wounded part should then be entirely excised, taking care to cut out every part that has come in contact with the animal's teeth, expose the wound to a stream of cold water, and thoroughly canterise the edge with lunar caustic.

For a Bee Sting.—An alkali such as soda is the antidote or acid such as onions for that of a wasp.

For a bee sting dab on weak ammonia. For a wasp or hornet sting apply vinegar.

When stung you must apply as soon as possible the appropriate remedy.

Failing the correct antidote, do not postpone the application of tinture of iodine.

Bleeding.—Blood coming in jerks shows that an artery is severed, tightly bandage between the wound and the heart, apply cold —amongst styptics are lunar caustic, tannin, alum and all astringents. Nose bleeding may be stopped by putting ice up the nostrils or injecting a strong solution of alum, or applying cold to the spine.

Blowing the Nose.—The most effectual way for a person to clear the nasal passages is to use a long strong blow and not a sharp short one.

Bread.—Makes an excellent poultice for gathered fingers.

Blood.—All the blood in the body passes through the heart once every minute. The full capacity of the lungs is about 230 cubic inches.

Borax.—Cleanses and heals ulcers, festering wounds, sore throats, etc., and is beneficial for teeth and gums when used as a tooth powder.

Broken Arm.—Pull the arm to the same length as the sound one. Apply a wood splint to each side of the arm, and bind them firmly above and below the fracture, with bandage and pocket handkerchief.

Broken Collar Bone.—Bend the arm over the front of the chest, place it in a sling, and bind it in that position by a scarf, going round the chest, outside the sling.

Broken Jaw.—Bind a handkerchief under the chin and over the top of the head, and bind another across the chin and round the nape of the neck.

Broken Leg.—Pull the leg to the same length as the sound one, roll up a sack or rug into the form of a cushion, and place the leg carefully upon it, and with handkerchiefs or scarves bind the two together. Do not move the sufferer until the stretcher arrives, and use care in lifting to prevent the broken bone coming through the skin.

Broken Ribs.—Cause great pain when breathing, bind a long broad bandage firmly round the chest.

Broken Thigh.—Pull the leg to the same length as the sound one, the knees must next be tied together, and afterwards tie the ankles together; then lay both limbs over a sack of straw or folded rug, so as to bend the knees. The sufferer not to be moved until the stretcher arrives.

Bruises.—To render less painful apply diluted Arnica or bathe with spirits and water. Aconite belladona and opium usually afford relief, but must not be used when the skin has been broken. Injuries such as severe blows or bruises should be bathed, in water as hot as can be borne immediately they occur.

Burns.—Keep air from wound, do not disturb the burnt skin. Dust with flour, chalk or carbonate of lead.

Burns and Scalds.—Remove the clothes with utmost care from the burnt part cutting them away where necessary, so that no blisters be burst. If the clothes adhere, gently remove after first soaking in olive oil; if this is insufficient, immerse the part in warm water. Apply lint soaked in carron oil (equal parts of linseed oil and lime water) or one part carbolic acid in 40 parts of water, or a saturated solution of washing soda. If burn is excessive, dress only a portion of the body at one time, keeping the rest covered up. A saturated solution of picric acid in water. or 4 grains per ounce, has been much recommended as superior to oil. A dressing of this need not be removed for 48 hours. It is valuable and safe, for superficial burns, but scarcely so far extensive ones. It is dangerous in the powder form, being much too strong.

Note.—Picric acid stains the hands and clothing.

Burns from Acids.—Drench with clean water, apply pad soaked in vegetable oil or solution of bicarbonate of soda, magnesia, or whiting, finally treat as an ordinary Burn.

Burns from Alkalies.—Flush or drench with clean water gently remove any solids then wash with vinegar and water or lemon juice and water finally treat for an ordinary burn.

Burns from Concentrated Carbolic Acid.—Use no water, but immediately remove, as far as possible with a dry cloth or cloth moistened with alcohol. Next apply oil, alcohol or glycerine to dissolve the remainder. Then rub off with a cloth.

Camphor Ice.—Is a beneficial liniment for a "cold on the chest."

Carbuncle or Boil.—Apply a compress of hypericum three drops to 1 oz. of water. Cover with oil—silk and wool. Bandage lightly.

Care of the Feet.—Foot health and comfort lies in bathing the feet regularly, changing the socks frequently avoiding footwear made with leather substitutes.

Chill.—Mustard bath is a stimulant for anyone suffering from a chill or nervous debility. Add two table spoonful of mustard mixed with a cup of cold water, to a gallon of hot water. Make sure the water is not too hot or fatigue will be the result.

Chilblains—are due to imperfect protection of the feet, also not infrequently they are due to too tight boots. Defective circulation and anæmia are often present.

Avoid sudden and extreme heating or cooling of the feet and hands. Always keep them at as uniform a temperature as possible.

Choking—go down on hands and knees and cough.

Cholera.—The symptoms are: very profuse watery motion which occur in rapid succession, vomiting, severe cramps in the muscles especially of the thighs and calves, inability to pass urine and extreme weakness. In the case of an attack send for a doctor at once.

Concussion.—Caused by a violent shock. The immediate consequences are collapse, vomitting and loss of muscular power of control. Cold applications to the head should be made, Ammonia held to the nostrils and stimultants given. Warmth should be applied to the extremities, and mustard and hot water over the stomach.

Cotton Wool.—Cotton wool should always be handy and should be kept in an airtight and dust proof container when not required. A glass or plain earthenware jar with a screw top is most satisfactory.

Cracked Lip.—Is easily cured by first drying the crack, and then painting it with a little "blue stone," or lunar caustic. This is to be repeated in a few days, taking care to apply a little cold cream or vaseline once or twice a day in the interval which will cure the condition in a week or ten days.

Cramp.—Warmth with a little gentle rubbing.

Cuts.—Cuts of a small and not very serious kinds are conveniently protected against germs and dirt being painted with artificial "Skin" instead of bandaging. There is a great danger in leaving even a minute cut exposed.

Remove dirt from and close the wound. If bleeding will not stop, bandage tightly between the cut and the heart. Perchloride of iron quickly arrests bleeding in cuts and slight wounds. A better antiseptic, however, and one that is painless is Acriflavine jelly (Flavogel). Cover the cut with bandage or strapping until healing has well begun.

Death Tests.—Hold mirror to mouth. If living moisture will gather. Push pin into flesh. If dead the hole will remain, if alive will close up. Place fingers in front of a strong light. If alive, they will appear red ; if dead, black or dark.

Dislocation.—Wrist elbow, ankle, thigh and knee dislocations are reduced usually by drawing the limb forward in its long axis, and when fully extended, exerting side pressure to force the displaced bone into the socket. The tissues which have undergone great strain should be given rest to receive natural consolidation. Prompt action saves much pain and trouble—the longer the dislocation is left the harder it is to set right.

Drowning.—(1) Loosen clothing, if any (2) Empty lungs of water by laying body on its stomach and lifting it by the middle so that the head hangs down. Jerk the body a few times (3) Pull tongue forward, using handkerchief or pin with string, if necessary (4) Imitate motion of respiration by alternately compressing and expanding the lower ribs, about twenty times a minute. Alternately raising and lowering the arms from the sides up above the head will stimulate the action of the lungs. Let it be done gently but persistently (5) Apply warmth and friction to extremities (6) By holding tongue forward closing the nostrils and pressing the "Adam's apple" back (so as to close entrance to stomach) direct inflation may be tried. Take a deep breadth and breathe it forcibly into the mouth of patient, compress the chest to expel the air, and repeat the operation (7) Don't give up! People have been saved after hours of patient vigorous effort (8) When breathing begins get patient into a warm bed, give warm drinks, or spirits in teaspoonfuls, fresh air and quiet.

Dysentery.—There are two types of this disease—amæbic dysentry and bacillary dysentery—due to two different micro-organisms. In both cases there is severe inflammation of the bowels which shows itself by abdominal pain and the passing of copious liquid motions containing blood and slime. In the case of an attack send for a doctor at once.

Ear.—To remove insects, pour in oil or warm water. To remove foreign substances, syringe gently with warm water.

Enteric Fever.—Is a disease characterised by an acute inflammation and ulceration of the inner wall of the small intestine. At first the patient complains of rather vague and indefinite symptoms—headache, pains in the back, abdominal discomfort and tenderness, and a slight rise of temperature. He feels "seedy" but is not acutely ill. The temperature rises gradually, that is, it rises, then falls slightly, rises again, then falls a little, and so on. In spite of the falls between each rise, each succeeding rise is higher. In 7 days the fever reaches its maximum. Rash shows itself on the chest and abdomen in 7 days. Diarrhœa starts, the motions resembling pea-soup. After a week the disease may take a favourable course. Recovery takes a long time and relapses are very common. Flies are apt to carry the disease.

Epilepsy.—Lay patient on floor, plenty of air, raise head, warm clothes, put something between teeth to prevent biting tongue: if face blue, cold water to hand, give snuff to induce sneezing.

Eye.—Bruised or black, bind on a linen pad soaked in brandy.

Eyes—Foreign Bodies in—Get the patient's head bent well backwards drop a drop or two of olive oil between the upper eyelid and the eye, then seize the upper eyelashes, and pull the upper eyelid well forward and in front of the lower one, press it against the latter as it retruns to its lower one, press it against the latter as it returns to its original position.

If possible remove foreign bodies with corner of clean handkerchief, but use great care. If not, wash out with boracic lotion. A little castor oil or liquid paraffin can be dropped in.

Apply pad and bandage to prevent movement. For acids wash out with vegetable oil, clean water or very weak solution of soda bicarbonate.

For caustics do the same as under acids or wash with very weak solution of vinegar.

Fainting.—A Fit of—Patient is pale and unconscious, skin clammy, pupils dilated, limbs loose and he looks deadly. Lay him down dash cold water on his face, loosen his neck; open window and door and place in a draught, and use a strong smelling salt bottle. Place head lower than the rest of the body.

Fire—Clothes on—Don't run, roll in blanket or rug.

House on Fire.—Cover head with wet towel, etc.,crawl along floor, so as to get best air.

Petrol, Oil, etc., on Fire.—Use sand, earth or flour to extinguish; on no account use water, which only spreads the flame.

Fish Bone in Throat.—Will dissolve if ordinary vinegar be swallowed.

Fracture.—The break of the bone may be simple, as when the bone is cleanly snapped—there being no splinters; or compound when the bone is smashed or splintered. A doctor should be summoned: Meanwhile the broken limb should be supported on a wide board or shutter and great care should be taken when moving the patient or a simple fracture may become a compound fracture.

Fits—Keep the head raised. If snoring and face flushed, bare the neck and dash cold water on the top of the head, and apply hot water bottles to the feet. If foaming at the mouth and convulsed, bare the neck and apply smelling salts, and prevent the sufferer from hurting himself or herself until again conscious.

Flesh Wounds.—Wash with clean water, apply lint soaked in water, and bind round with a handkerchief.

Fresh Air.—Costs nothing but is priceless all the same, see that you get your full measure of it day and night.

Frost Bites.—Rub with snow, or pour iced water, on to the part, until the colour changes and a stinging pain comes. If the frozen part turns black next day, a poultice should be applied.

Gassing.—Take the patient out into the fresh air. Apply artificial respiration and stimulants or the antidote for that particular poison.

Headaches.—Can be cured by applying a towel wrung out in boiling water to the back of the neck. Bathing the feet in hot water to draw the blood from the head is another preventive, and a cup of strong tea flavoured with lemon juice will work wonders.

Hay Fever Cures.—A simple remedy for hay fever is two teaspoons of lime water taken three times a day in a small glass of milk. Hay fever can be prevented by frequently sniffing a few grains of boracic powder up the nostrils.

Hicoughs.—Can be cured by sucking a lump of sugar saturated with vinegar.

Hot Water.—Is a stimulant in case of vomiting. Hot water fomentations relieve pain. Cold water dressings relieve strains and sprains.

Human Body.—There are 500 muscles in the human body, and an equal number of nerves and blood vessels.

The normal temperature of the human body is 98.6°Fah. The human skeleton contains 200 bones; including the small bones in the ear there are about 206 altogether. The body throws off daily from the skin about 20 ozs. of water, from the lungs about 10 ozs. and from the kidneys about 50 ozs. Equal altogether to about 4 pints. In addition the body loses daily about ½ oz. of nitrogen, 1 oz. of mineral salts and 8 ozs. of carbon.

Hysteria.—Be firm and do not sympathise with patient, throw cold water on face, apply ammonia to the nose.

Ice.—Is not always obtainable. Cloths soaked in equal parts of milk and methylated spirit will keep vessels cool in the hottest of weather.

Infantile Diarrhœa.—In cases of infants suffering from diarrhœa. before receiving medical advice, give rice water prepared as follows :—

1 Tablespoonful of rice for ½ a litre (about 15 ozs.) of water. Boil the same for 25 minutes. This quantity is enough for the whole day. If, after 12 hours for very small babies and 24 hours for those over 8 months, there is no amelioration with this treatment, seek medical advice at once or the condition may become dangerous. In case of constipation give barley water in the same manner as above. Orange juice in the morning is also for constipation in infants.

Infectious Diseases.—Incubation and Infectivity period.

Diseases	Incubation	Infectivity
Cholera	1 to 6 days	7 to 14 days.
Small Pox	12 to 14 days	Till all the scales disappear.
Chicken Pox	12 to 14 days	Till all the scales disappear.
Plague	2 to 8 days	As revealed by Bactro findings.
Typhoid	5 to 21 days	As revealed by Bactro findings.
Diphtheria	2 to 10 days	As revealed by Bactro findings.
Erysipelas	3 to 10 days	7 to 10 days.
Measles	7 to 18 days	7 to 10 days.

Important to Bathers.—Do not bathe within two hours after a meal or when exhausted by fatigue, etc., or when the body is cooling after perspiration. Leave the water immediately there is the slightest feeling of chillness.

Insect Bites.—These should be treated by the application of dilute Ammonia failing this a strong solution of washing soda or the Blue Bag should be used or a teaspoonful of Epsom salts dissolved in 1 oz. of water. Do not rub the spot where stung.

Insect in the Ear.—A drop or two of olive oil or sweet oil in the ear will at once cause the insect to come out.

Insensibility from Wounds or Blows on the Head.—Send the sufferer to the hospital, keeping him on his back, with his head raised and his neck bared.

Insensibility from Breathing Foul Gas or from being Buried in Falls of Earth.—Proceed as in case of drowning.

Iodine.—After washing wound in cold boiled water, apply to all cuts and scratches, and cover with perfectly clean rag.

Lightning—Struck By—Dash cold water over a person struck.

Man.—The average height of a man is 5 feet 8 inches. The average weight is 140 lbs.

The average man takes about 5½ lbs. of food and drink each day. This amounts to nearly one ton of solid and liquid refreshment a year.

The heart varies in weight from 8-12 ozs. It beats about 70 times a minute in men and more often in women and children. The average weight of a man's brain is 8 lbs. 8 ozs.

Mad Dog Bite.—Tie cord tight above wound, suck wound, canterize with caustic or white-hot iron.

Malaria.—Is extremely prevalent all over the East. It is caused by a parasite carried by a certain species of mosquito. The attack begins by the patient shivering. Soon this is succeeded by fever. The fever reaching 105°Fah. or even higher. There are several types of malaria fever.

Milk.—Remains fresh longer if it is kept in dark green glass or by stirring in a pinch of bicarbonate of soda.

Nose Bleeding.—A cold, wet cloth at the back of the neck will often stop it. If persistent, insert cotton wool in the nostrils. To remove foreign bodies from nose blow the nose forcibly or gently syringe with warm water.

Nutmeg Tea.—Made by pouring boiling water on from ten to fifteen grains of nutmeg (according to age) helps to induce sleep.

Oil of Cloves.—Is excellent for external use over the seat of muscular and other kinds of pain. Taken internally according to directions given by a doctor or qualified chemist, it will aid digestion and improve a poor appetite.

Oil of Olive.—Good for scalds and burns, or eye wash if lime has got in the eye. A few drops will often remove an insect that has got in the ear. Do not cover a burn with a dry cloth. Do not break blisters. Keep out the air. Soak cloth thickly with oil. If olive oil is not available castor oil can safely be used intead of it.

Pain.—Or discomfort of a recurring nature should always be "taken" for expert medical advice ; it is a warning that something is not functioning properly and therefore needs attention.

Pepper.—A sniff will cause a child to sneeze to get rid of a foreign body in the nose.

Peppermint.—Taken internally is apt to set up digestive disturbance in some people, also in certain cases it causes vomiting. This should be borne in mind by those who resort to this "granny's remedy" with any frequency.

Plague.—This is a most serious disease with an extremely high death-rate. Very few persons indeed survive an attack. It is spread by the bites of fleas which have received the germs during their coming in contact upon the bodies of rats suffering from the disease. In the case of an attack send for a doctor at once.

Quinine.—Is more palatable if taken with the juice of an orange.

Scalds.—Proceed as in the case of burns.

Scratch or Slight Wound.—Do not wash a scratch or slight wound with soap and water, but apply iodine at once all over the wound and allow it to dry. Iodine sterilizes the wound and makes dirt harmless. Do not use iodine that is stale.

Shin Wound.—Apply a linen pad soaked in cold water, and bind round with linen.

Small Pox.—This is a disease which is very prevalent in the East. It is highly contagious, and when it attacks unprotected persons, it has a very high death-rate.

Smelling Salts.—Are helpful to ward off faintness, but as they contain Ammonia, which irritates the air passages, they must not be applied to the nose for long.

Snake Bite.—Tie cord above wound. Suck wound, cauterise with caustic or white-hot iron. Wherever a bite occurs, instant treatment is vital. It may be found necessary to excise the part injured, so deadily and swift is the action of the poison. Permanganate of potash crystals previously moistened may be rubbed into the bite, which should be enlarged with a knife, this is a safe mode of treatmet.

Sprain.—To a sprain, apply a lotion of the tincture of calendula, in the proportion of one part of the tincture to four parts of water.

Sty on Eye.—Can be removed very easily if it is bathed with confrey leaves from a fresh plant after scalding.

Suffocation from Gas.—Get into fresh air, lie down and keep warm. Take 2 to 4 drops of Nux Vomica every hour for about six hours.

Sun—The sun is Public Enemy No. 1. Fortunately a very great deal can be done to limit its power to cause you harm, Indeed, provided you pay great care and carry out certain precautions, it will not cause you much harm—only some discomfort. Never forget, however that it is always lying in wait for you to make one false move. Apart from the actual "heat" produced by the sun—temperatures of 128° to 130° Fah., or more in the shade—the light rays can exercise a most rapid, severe and disabling effect upon the human body. This they do by their action upon the skin.

Sun Stroke.—Sun stroke may occur in daytime or at night. The affected person becomes feeble, giddy, staggers, sways about and falls to the ground. He complains of great thirst. His skin is pale, cold and clammy. His pulse is rapid and very weak. His temperature soon rises to a great height, 106° or even 110°Fah.,—the normal is 98.4°. The patient is flushed and becomes sick and vomits. He develops delirium and convulsions. Death may occur very rapidly. The chief causes may be alcoholism and fatigue. The Indian farmers as a protection against sun stroke carry onions under their turbans or caps.

(2) Bathe the head with brandy and a little water, and give a teaspoonful internally at intervals until the prominent symptoms have abated. Then give 2 drops of Camphor every half hour, followed after 4 or 5 doses, by belladona, 2 drops at some intervals. Or in the case of one struck due to alcoholic effects.

The patient must be taken into the shade, if possible into some place where there is a current of air circulating. Strip patient to the waist, and if he is conscious place him in the sitting position on the ground. Cold water in the form of a spray is showered over his head and down his back, and this procedure is continued till his temperature falls. If ice is available and he is conscious, he is given small pieces to suck. Failing ice, small sips of cold water are given. When the temperature falls he is wrapped in a dry blanket and is made to lie down in a cool place. An attendant must remain with him fanning his head. On no account must any alcoholic stimulant be given.

Tooth.—Relief given to a tooth that requires filling if a piece of cotton-wool be dipped into oil of cloves and laid in the cavity.

Vinegar.—Equal parts of vinegar and water form a good mouth wash, if mouth has been burnt with an alkali, as lime, or strong soda.

Vomiting.—Can be relieved by sipping hot water.

Woman.—The average height of a woman is 5 ft. 3 inches. The average weight is 120 lbs. The average weight of a woman's brain is 2 lbs. 11 ozs.

Wounds.—(*a*) If only slight, apply small piece of boric lint and then rubber adhesive plaster to hold lint in position (*b*) If more severe, clean well with warm water using an antiseptic in the water, fix the parts as near as possible in normal position, apply a pad of boric lint and then bandage (*c*) For arterial bleeding get medical aid as soon as possible, in the meantime try and stop flow of blood by applying pressure on the heart side of the wound.

Weights—

1,000 Milligrammes	= 1 Gramme.
1,000 Grammes	= 1 Kilogramme

APPROXIMATELY

1 Gramme	= 15½ Grains
1 Killogramme	= 2 lb. 3 ozs.
1 Grain	= 65 Milligrammes
1 Oz.	= 28⅓ Grammes

FLUID MEASURE

1,000 Cubic Centimetres (C.C.)	= 1 Litre.

APPROXIMATELY

1 C.C.	= 17 Minims
1 Litre	= 1¾ Pints
1 Fluid Ounce	= 28⅓ C.CS.
1 Gallon	= 4½ Litres
3½ Fluid Ounces	=100 C.CS.

MEASURE OF LENGTH

1,000 Millimetres	= 1 Metre (100 Centimetres)
1,000 Metres	= 1 Kilometre.

APPROXIMATELY

1 Metre	= 39½ Inches.
1 Kilometre	= 5 Furlongs
1 Inch	= 25 Millimetres
1 Mile	= 1⅝ Kilometres.

RESPIRATION AT DIFFERENT AGES

In infancy	35 per minute
In childhood	25 per minute
In adult age	16 to 18 per minute

RELATIONS OF PULSE AND TEMPERATURE

60	usually	corresponds	with	98°Fah.
80	,,	,,	,,	100°Fah.
90	,,	,,	,,	101°Fah.
100	,,	,,	,,	102°Fah.
110	,,	,,	,,	103°Fah.
120	,,	,,	,,	104°Fah.
130	,,	,,	,,	105°Fah.
140	,,	,,	,,	106°Fah.

APPENDIX C

ANTIDOTES FOR POISONS

Acids.—Mineral (sulphuric, Murriatic, Nitric, etc.)—Chalk or Magnesia stirred up in water, oil and afterwards milk.

Ammonia.—Is a handy antidote to insect bites and stings.

Strong Acids.—Mouth or lips may be stained. Do not make sick. Wash mouth out with weak solution of chalk, whiting or magnesia and water, allow sips.

Alkalis.—Same, but use weak solution of vinegar, orange or lemon juice.

N.B.—Any vegetable oil can be given in either case.

Carbolic.—Give milk or weak tea or Epsom salts and water. Any vegetable oil except castor.

Phosphorous.—Give weak Condy's fluid or Epsom salts. No oil.

Gas and Fumes.—Get patient into fresh air. If unconscious apply artificial respiration. If conscious take to first aid station.

N.B.—In all serious cases burns, scalds and poisoning, send at once for doctor. Keep patient warm.

Aconite.—Emetics of warm water, strong black coffee or tea; brandy, artificial respiration.

Ammonia.—Fumes from—inhale the fumes of boiling vinegar or acetic or hydrochloric acid.

Antimony.—Abundance of warm water; strong infusions of tea or coffee; decoction of oak bark.

Arsenic.—Induce vomiting, and give an emetic of sulphate of zinc.

Belladonna.—Give stimulants such as brandy and opium, which antagonise the action of this drug.

Blue Vitrol and other Compounds of Copper.—Sugar and water, white of egg.

Cantharides.—Emetics; white of egg (not the yolk) mucilaginous drinks.

Chloral Hydrate.—(See Opium).

Chloride of Zinc.—White of egg; milk; Carbonate of soda.

Carbonioc Acid Gas.—Artificial respiration and bleeding.

Charcoal.—Artificial respiration and bleeding.

Cockroaches.—Get some Borax and grind it in a mortar into powder and mix it with molasses to form a paste. Smear the paste on pieces of papers, which should be placed here and there at night with 3 days they will all disappear.

Colchicum.—Stimulants, warmth, emetics and external friction.

Conium (*Hemlock*).—Emetics, see "Opium"

Corrosive Sublimate.—Albumen (*e.g.*, white of egg) gluten of wheat milk. Use the stomach pump. Some give lime water in large doses.

Digitalis (*Fox Glove*).—Emetics, stimulants, external heat and artificial respiration.

Emetic to a Child.—Two teaspoonful of ordinary sa't in a tumbler of lukewarm water should be given as an emetic to a child who has eaten poisonous berries.

A teaspoonful of mustard in a tumbler of likewarm water is a good emetic for a child. A tablespoonful for an adult.

Flies.—To kill flies which is a distinct danger to health, being a carrier of disease such as dysentry, typhoid, cholera, etc., they should be attacked in their breeding places, and their eggs and larve destroyed. These are to be found in most decaying and fermenting matter of various kinds such as, ash pits and house refuse, in fresh stable manure etc. It should be stated that for the prevention of house-fly breeding the use of chloride of lime is of no value whatever. In stable or farm yard manure the egg-masses may be removed and burnt or the manure may be treated with powdered borax dissolved in water (half a lb. to three gallons) or with a solution of powdered hellebore (half a lb. to ten gallons of water), apply the solution with a watering can or sprayer. To prevent breeding in household refuse the receptacles should be absolutely fly-proof. If accumulations of refuse cannot be avoided, they should be treated with borax as above described. Measures against adult flies may be taken by means of traps, tanglefoot, poisons, spraying fluids, flame, petrol fumes, and fly killers.

Hydrocyanic (*for Prussic*) *Acid.*—Cold affusion, artificial respiration, chlorine, ammonia, and strong galvanism.

Iodine.—Emetics.

Lead.—Sulphuric acid dilute with aerated water iodide of potassium.

Monkshood (*or Aconite*).—Emetics, demulcents and animal charcoal.

Nitrate of Silver.—Lunar caustic, copious draughts of salt water.

Opium.—Stomach pump, sulphate of zinc emetic or mustard, tannin, animal charcoal, cold to the head, artificial respiration; keep patient awake by slapping, pricking, or pinching and galvanise.

Oxalic Acid (*or Salt of Lemons*).—Give chalk, whiting, induce vomiting, use stomach pump, and give emetics.

Phosphorus.—Emetics and magnesia.

Poisoning.—A tablespoonful of mustard in a tumbler of lukewarm water should be given at once in case of poisoning. Children half the quantity of mustard.

Potash.—Vinegar, lemon juice, oils, demulcent drinks, emetics.

Prussic Acid.—Alternates douches of hot and cold water; friction of the limbs, artificial respiration.

Rat Poison.—Usually made of arsenic; sometimes, but rarely, strychnia is used.

Strychnia.—Emetics, stomach pump, and charcoal administered thereby; chloroform during the spasms.

APPENDIX D

GLOSSARY OF STOCK AND SHARE MARKET TERMS

Above Par.—Stocks and shares are said to be above par or at a premium when their prices get higher than that originally paid for them.

Account Days.—Two days in a month (one about the middle and other towards the end of it) on which the members of the Stock Exchange have to settle bargains entered into by them. Also called "settlement days."

Allotment.—Distribution of shares after applications have been made for them.

Amortization.—The process whereby bonds and shares are redeemed by means of annual drawings from a sinking fund, or the complete extinguishment of a loan by means of a single payment out of a fund specially created for the purpose.

Arbitrage.—The term implies buying securities in one market and selling them in another.

Articles of Association.—An important document giving the terms of agreement upon which the concern has been transferred, and specifying the rules and conditions upon which the company's business is to be managed and carried on.

Backwardation (*Back*).—Backwardation is said to be in evidence when securities can be bought cheaper "for the account" than "for money." The term also denotes the rates of interest, charged or allowed for carrying forward a "bear" transaction to the next settlement.

Bear.—A "bear" is one who sells for a fall, that is, sells when the price is high, in order to buy back when it is low.

Below Par.—When the price for stocks, shares or other securities is lower than that originally paid for then, they are said to be below par or at a discount.

Broker.—A broker does not deal on his own account. He is an agent acting for his principal the client, his remuneration taking the form of a commission that he charges to the client.

Bucket Shop.—This term is given to the outside brokers who carry on a purely gambling business.

Bull.—A bull is one who buys for a rise, that is, he buys expecting the price to rise above the figure he pays and intends to sell again when it does.

Bying in.—If the seller fails to deliver securities to the buyer on the due date, the latter can enforce delivery by buying in against the seller, and in that case the seller would be responsible for all charges and expenses the buyer might incur in getting delivery of his purchase.

Call.—A demand for payment due on a stock or share which is not fully paid.

Carrying Over.—Postponing the settlement of an account from one settling day to another, 'contango' or 'backwardation' being charged or allowed for the accommodation. The first is 'contango' or 'continuation' day.

Continuation Rates.—The rates (contango and backwardation) charged or allowed for carrying over bargains to the next account.

Contango.—Commission charged for carrying over transactions to the next settling day.

Cum-Div.—Buyer entitled to next dividend.

Cum-Rights.—The term means that the purchaser also acquires any right attaching to the shares to take up further issues, etc.

Cumulative Preference Shares.—See Preference Shares.

Debenture or Debenture Bond.—This is a written transferable instrument given by a company under its seal in acknowledgement of a loan to the company. The instrument contains an undertaking to pay periodically interest on the loan at a specified rate; and unless it be an irredeemable debenture, to repay the loan itself, either at a stated time or at such time as the company may determine.

Deferred Shares.—These are such as have their claim to dividend put back until a certain rate has been paid on the ordinary shares. Sometimes they are called "founders" shares and sometimes "management shares" because they are taken by person intimately connected with the floating or the working of the company.

Differences.—A term referring to those bargains in which the operator does not intend taking up or delivering the stock in question, but is speculating for the differences in price which there may be at the settling day.

Dividend.—The name is commonly reserved for a distribution on shares or stock, when the distribution depends on profits, so that it cannot be made if sufficient profit for the purpose has not yet been earned.

Dividend Warrant.—A document issued to the shareholders by a company after a dividend has been declared, entitling them to the amount of the dividend.

A Lame Duck.—A man who cannot pay his debts on the Stock Exchange.

Ex-All.—"Ex-Dividend" and "Ex-New" combined.

Ex-Dividend.—Without the dividend due or accruing. Abbreviated to Ex-Div. or to X.D.

Ex-New.—Without the right to claim any new stocks or shares about to be issued.

Ex-Rights.—The term means that the price does not include rights to new stocks or shares.

Ex-Rights.—The term means that the price does not include rights to new stocks or shares.

Face Value.—The nominal value of a security printed on a certificate or bond, as opposed to the market value.

Fided Charges.—Standing charges such as debenture interest, payments to leased undertakings or loans, which a company has to meet regularly before it can distribute profits.

Floaters.—These are bearer securities accepted as security for loans.

Floating Capital.—The available sum actually at command for carrying on any concern. This includes money which is not permanently invested, but only temporary employed for profit in marketable securities.

Founder's Shares.—See Shares.

Gilt-Edged Securities.—Government stocks and other investments of first-class quality as regards safety of both capital and interest.

Giver and Taker-in.—A giver is a bull who causes stocks bought by him to be delivered to the 'taker-in' who is carrying it over for him.

Guarantee Stocks.—Stocks upon which the interest, or principal and interest, are guaranteed.

Interest.—When the distribution must be made, whether profit sufficient to provide the amount has been earned or not, 'interest' is the term that is used.

Interim Dividend.—A dividend paid at a moderate rate when the first-half of the year has passed.

Jobber.—The jobber is a merchant dealing on his own account in certain classes of stocks. A dealer or jobber will make a price for a broker who approaches him, and without knowing whether the broker will require him to buy or to sell.

Joint-Stock Companies.—These are public companies whose capital is formed of shares and in which every shareholder is usually liable only for the amount unpaid on his shares. The shares or joint-stock companies are transferable and they may be sold at any time.

Letters of Allotment.—These are sent to all persons whose applications for shares have been accepted informing them that so much stock or so many shares have been allotted to them.

Limited Liability Companies.—Public companies with a capital formed of shares, which are transferable, but the liability of each of the shareholders is limited to the uncalled amount of the shares they have subscribed for.

Memorandum of Association.—A stamped document containing the objects for which a company is formed, the name of the concern, the amount of capital to be subscribed, the number and name of the shares to be issued, etc.

Name Day.—See Ticket Day.

Option.—An option is a right over certain shares. This is a right which may be exercised or not, at the pleasure of the person who has paid a fee to acquire it. The option may be to buy so much of a certain stock at an agreed price not later than a specified date. In that case, it is termed a "call." Or it may be to sell on similar conditions, and then it is termed a "put." When the right is either to buy or to sell, it is said to be a double option, or a "put and call" option.

Ordinary Shares.—These rank for dividend after the preference shares, if any of the latter exist in the company in question.

Paid-up Capital.—The total amount of capital paid on shares which are not fully paid up, though fully subscribed for.

Paid-up Shares.—Shares upon which the whole amount to be paid has been paid up.

Partly-Paid Shares.—Sometimes a company does not call up all the amount payable on its shares, with the result that a purchase of its shares carries with it liability to an additional payment.

Pay-Day.—The third day of the settlement is "pay-day" or account day.

Preference Shares.—These entitled the holders to a fixed rate of dividend each year, out of the profits of that year, before the ordinary shares of the company have any dividend declared upon them, when they are cumulative preference shares, deficiencies of dividend accumulate from year to year as arrears to be paid off before ordinary shareholders have any claim on profits.

Private Companies.—Associations of two or more persons by private arrangement among themselves for the purpose of carrying on any business or trade, each of them sharing the profits and losses as may be agreed upon, according to the amount of capital or personal ability which they individually put into the business.

Public Companies.—Joint-stock companies, or limited liability companies, which are formed of large bodies of shareholders whose individual shares are publicly at any time without the consent of the other shareholders.

Put and Call Option.—This gives the purchaser the right to call for delivery of stock at a date and price arranged when the bargain was entered into.

Put of More.—The right to sell a certain amount of stock with the option to double the quantity, at a price agreed upon.

Rentes.—The French term for loans raised by the French government.

Rig, Rig the Market.—Artificially to inflate prices much above intrinsic merits.

Sag.—The term is used when prices of securities drop slowly owing to an absence of business.

Scrip.—Correctly the provisional certificates of title given in respect of a new issue of shares or stock, 'scrip' a contracted form of the word "subscription." More generally any kind of bearer certificate.

Settlements.—Take place about the middle and the end of every month. Each settlement extends over three days.

Shake Out.—The activities of "bull" speculators send prices up, but as weak "bulls" drop out there is a temporary reaction in the rising market. The term "shake out" is used to denote the dropping out of the "bulls" who discontinue their operations.

Shares.—There are the fixed, equal and indivisible parts into which, by the terms of its Memorandum of Association, the capital of a company is divided.

Slump.—Sudden and violent fall, opposite to "boom."

Stag.—The name is given to a person who has subscribed for a quantity of a new issue of shares, not intending to keep them, but hoping that the price will rise and enable him to dispose of the shares at a profit.

Stock.—This is a form of capital which has no division into shares, and no distinctive numbers. The capital of railways and other statutory companies is usually created and issued as stock, and not as shares. Many of these railways again, have divided their ordinary stock into Preferred ordinary and Deferred ordinary. The Preferred policy-holders is entitled to a certain rate of dividend each year, if it is earned, and the Deferred policy-holder to whatever rate any surplus of revenue will allow to be paid.

Subscribed Capital.—The amount of capital subscribed or guaranteed by shareholders to a public company. As a rule, the subscribed capital is not all paid at once, but only a certain portion of it is paid on allotment, and the balance by "calls" either at stated intervals, or as may be required.

Ticket Day.—The second day of the settlement is "ticket" or "name" day, when the clerks of members hand over tickets with the names of the buyers of the stocks.

Trustee Stocks.—Securities in which trustees are permitted by law to invest trust funds.

Uncalled Capital.—That portion of the subscribed capital of a company which has not been called for by the directors.

Underwriting.—The term means that in return for a commission, a certain number of individuals pledge themselves to take a fixed proportion of any shares or stock that the public may not have applied for; it is, in fact, a sort of insurance by the promoters of the issue or company against failure in the event of the public not subscribing readily.

Vendor.—A person on whose behalf a sale is made, or the person is himself a seller.

Vendor's Share—Shares taken, instead of cash, by parties who convert their business into a public company.

Watered Stock.—Stock representing a company's capital that has been increased without any corresponding addition having been made to the company's assets.

Appendix E

GLOSSARY OF SHIPPING TERMS

Act of God.—A clause used in the Bill of Lading to indicate such perils or dangers of the sea as are beyond human power to control or oppose. This includes any violent or sudden accident due to natural forces, as distinct from the action of man, and such that the carrier could not be expected to foresee the event and provide against it. Examples would be damage by lightning or by impetuous flood, or due to sudden illness of the person in charge of the goods. Also known as "Vis Major."

Average Bond.—Where a ship has suffered an intentional loss of cargo in order to save the ship and the rest of the cargo, the master of the ship obtains from the consignees of the goods, before delivery is made, a bond, under which they agree to pay their proportion of the general average as soon as the amount is ascertained.

Backward Ship.—To load some time ahead.

Ballast.—Water in tanks (water ballast), sand, stones, etc., carried when a vessel has no cargo on board, to make her draw sufficient water.

Bill of Health.—A certificate issued by the customs authorities stating if any infectious disease was prevalent at the port from which the vessel sailed at the time of its departure. The bills may be "Clean," "Suspected" or "Foul."

Bill of Lading.—The receipt for the goods shipped on board a ship stating the terms as to their delivery, freight, etc. It is also a document of title which gives the holder or endorsee the right to claim the goods at their destination. Each bill of lading consists of a set of three copies, all of which are exactly alike.

Bill of Sight.—A temporary form of entry at the Custom House, permitting goods to be landed so that they may be examined in the presence of one of the officials, and a perfect entry made of them, in cases where the consignee from insufficient advice, is not certain what goods are consigned to him, or the bill of lading leaves him ignorant of the exact description, value, or quantity of goods he is importing.

Bill of Sufference.—The term means a Customs permit allowing persons engaged in the coastal trade to carry duitable goods from one port to another and land these on "Sufferance Wharves."

Bond Note.—A Customs House document certifying that bond has been given for the dutiable goods leaving the bonded warehouse for export.

Bonded Warehouse.—A licensed warehouse where dutiable goods may be kept until they are removed after payment of the dues.

Bottomry Bond.—Under exceptional circumstances when the voyage cannot otherwise be completed the master may borrow on the security of the ship by bottomry bond, engaging on behalf of the owners for the repayment of principal and interest if the ship shall arrive at the port of the detsination.

Broken Stowage.—Articles used to fill up the spaces between goods.

Captain's Entry.—A provisional entry passed by the captain of the ship, when it is desirable to discharge the whole of the cargo at some particular place, or in cases where the merchant has omitted to pass the prime entry within the prescribed time.

Captain's Protest.—A declaration made by the captain of a ship, giving details of damage or accident to his ship or cargo.

Certificate of Registry.—A document granted at her port of Registry by the Registrar containing the name and description of the vessel, her tonnage, the name of the master and her owners.

Charter Party.—A written contract act where by the owner agrees to place his ship, or a part of it, at the disposal of a charterer or hirer of the ship, either for a stipulated time or for a specified voyage the charterer agreeing to pay a certain freight on the cargo to be carried.

Clearance Untowards.—All vessels leaving port with cargo for abroad must, before sailing obtain a clearance outwards.

Contraband.—Prohibited or dutiable goods smuggled in to the country.

Cranage.—A charge made at some seaports for the hire of a crane, when used for loading or unloading such goods as are too heavy for the ordinary tackle on board. Also a charge made by dock companies for using their cranes for any purpose whatever.

Customs Bill of Entry.—Daily lists issued by the customs authorities (to merchants and others subscribing), containing a summary of shipping, useful for general information.

Customs Entry.—A list given to the customs authorities by the importer or shipper showing the weight, value, and description of goods to be landed or shipped. (See Entry).

Customs House.—This is a government office which is situated at all ports, where all ships report on arrival, and are cleared inwards and outwards, and where all entries have to be lodged. Moneys are also received here in payment of duty, light dues, etc. The captains of all ships (except those engaged in the coasting trade) have to go to the customs House and hand in the ships report within twenty-four hours of the vessel's arrival.

Dead Freight.—This is the compensation payable to the shipowner when the charterer has failed to ship a full cargo. The amount is, generally, assessed by ascertaining the loss actually sustained by the shipowner, after taking into account the further expenses he would have been put to if the whole cargo had been shipped.

Dead Reckoning.—The calculation made of a ships whereabouts by means of the compass and log-line, the former serving to point the course she sails on, and the latter the distance run, From these two things a skilful mariner, by making proper allowances for the variation of the compass, currents, etc., is enabled, without any observations of the sun or stars, to ascertain the ships place fairly well, in any part of the world.

Dead Weight.—That portion of a ship's cargo, paying freight according to its weight; such as coals, iron, coke, flints, and similar heavy goods, either in bulk, or packed in casks or cases.

Delivery Order.—A document issued by the steamship office when the bill of lading is surrendered. It instructs the dock authority to realse the goods named in the order, and enables the consignee or his agent to collect goods from the docks.

Demurrage.—This signifies the charge to be made for exceeding the number of lay-days allowed.

Derelict.—Boats and ships foreshaken or found at sea and having no persons in charge of them, goods cast upon the shores by the waves, abandoned, or wilfully cast away by the owner. Salvage is payable to persons bringing derelicts into safety, whether their owners appear to claim them or not.

Despatch.—As an implied warranty, this term requires that the voyage shall be begun and completed without unreasonable delay.

Dock Warrant.—This is a document issued to the owners of the goods by the Dock Company when they have removed the goods to the warehouse.

Draw Back.—When goods are re-exported on which customs or excise duty has been paid, the exporter may claim the duty back. The form on which he makes his claim is termed a debenture; and the return of the money, a draw back.

Dunnage.—Any article used in stowing a ship's cargo to protect it from damage during the voyage.

Embargo.—An authoritative order restraining lading or unloading certain goods on ships preventing their arrival or departure.

Enterpot.—An intermediate sea port or warehouse temporarily receiving goods which are meant for reshipment.

Entry.—To pass "customs" entry is to give the authorities an exact description of goods to be shipped or landed, and pay the duty (if any) upon them. Goods arriving are "Entered Inwards" and those shipped, "Entered Outwards."

Entry for Baggage and Private Effects.—This entry, which is called a "Baggage Sufferance" is required for goods of a personal character, household goods used and private effects not being imported by way of merchandise.

Entry for Warehousing.—A Custom House document issued when dutiable goods are imported, but are to be stored in a government or Bonded Warehouse until required for use.

Force Majeure.—Circumstances or events which no human precaution could have averted, and which no fraudulent intention could have produced; those dangers and accidents which are beyond human power to control or oppose.

Free Entry.—If the goods are not liable to duty, a "Free Entry" is passed.

Freight.—Forms a perfectly valid insurable interest and may be roughly divided into two kinds: (*a*) Money payable for the carriage of goods (*b*) Money payable for the hire of a ship. The agreement under which the goods are carried is termed a contract of affreightment.

Futures.—Goods for shipment at some future time. The term usually refers to foreign produce to be shipped. Importers, merchants and the like speculate in "Futures" of produce, cotton, jute, etc., in the same way that speculators on the stock exchange operate for the "account."

General Average (*G.A.*)—A proportionate contribution levied on the owners of a ship and the owners of her cargo, according to value, to indemnify the party who has been incurred a loss, when part of the cargo or vessel, has been voluntarily sacrificed, or any loss or expense incurred, for the preservation of the rest. This is the risk covered by all ordinary insurance policies.

Jettison.—The name given to the throwing over-board of cargo or tackle in order to lighten the ship in an emergency.

King's Enemies.—The term refers to the actions of a foreign foe, and does not include depredations of rebels and pirates.

Landing Accounts.—When goods have not been removed within a certain time having been landed, they are weighed, tared, etc., and entered on a form called the Landing Account. This contains all the particulars of the goods, marks, numbers, etc., also the weights, the name of the firm who entered them, with steamers name from which the goods were discharged, where the steamer was from, and also from what date rent is incurred.

Landing Order.—A Custom House document addressed to the chief officer of a ship (after the importer has passed his entry, and paid duty, if any, upon goods he is importing), authorising him to deliver the goods overside so as to permit of their being landed.

Lay Days.—A name given in a charter party to the time allowed for loading or unloading. The days commence as soon as the ship has been given permission to load or discharge.

Liner.—One of a line of steamers running regularly to and from fixed point in distant lands.

Lloyd's Registry.—An establishment for the purpose of surveying and classing ships so as to afford to underwriters and others interested an independent guarantee of the quality and condition of ships offered for insurance or employment.

Loading in Turn.—A charter party term used in the coal and other trades, meaning that when a number of boats are waiting at a loading berth to be loaded, the loading of each shall commence according to and in the order of their arrival at the berth.

Manifest.—A detailed account of a ships cargo, sent by her owners or brokers at the port of shipment to their agents abroad.

Mate's Receipt.—A receipt given the mate of a ship for goods received on board. This is handed over to the ship-broker who exchanges it for the bills of lading.

Measurement Goods.—Goods on which freight charges are made, not on the basis of weight but on the basis of 40 cubic feet.

Non-Deviation.—The term implies that the ship has not to be navigated out of the usual course, and thereby exposed to extra risks, unless deviation from the usual course is justified by necessity.

Over-Entry Certificate.—When an importer over-enters the quantity of dutiable goods, and pays duty on more than is landed Over-Entry certificate is issued by Customs' authorities for the difference between the quantity entered and that landed.

Owners Risk.—Many goods are carried under such specially signed contracts at owner's instead of company's risk, and at much less than the ordinary rates in force.

Particular Average (*P.A V.*). This is any loss arising the partial damage of a ship or cargo from the common perils of the sea and navigation incident to a voyage, and not involving their general safety. Such a loss rests where it falls and is borne by the owner or insurer.

Post Entry.—When the quantity of dutiable goods landed is in excess of that entered by the importer, the latter will have to pass Post Entry.

Primage and Average Accustomed.—In this phrase, which is usually inserted in a bill of lading, the word "Average" means a *pro-rata* charge levied by the ship on the owners of its cargo, to cover the expense of lights, pilotage wharfage, etc. It is now generally included in the charge for primage.

Prime Entry.—When dutiable goods are intended for immediate home consumption, a "Prime" entry or "entry for home use" is required.

Prohibited Goods.—Such goods as are not allowed to be imported into this country at all, or under certain restrictions.

Prompt Ship.—A vessel shortly ready to load.

Quarantine.—A regulation in force at most sea ports cutting off and forbidding, for different periods, all communication between ships and the shore on their arrival from places commonly affected with contagious diseases.

Request Note.—A special permit from the Customs to land perishable or other goods before the ship has reported and cleared at the Custom House.

Re-Shipment.—Goods which, having been imported, are re-shipped or exported.

Respondentia.—A loan under exceptional conditions raised upon the cargo of ship on the personal responsibility of the master at a foreign port in order to effect repairs which are absolutely necessary and is to be repayable only if the ship arrives in safety at its destination.

Rummaging.—Official searching of a vessel to ascertain if any dutiable or prohibited goods are concealed on board.

Running Days.—A chartering term for consecutive days including Sundays, as opposed to working days.

Ship on the Berth.—Ready to load and booking cargo.

Ships Clearance.—Upon the arrival of a vessel in port, the captain before the hatches are opened, or the bulk broken, makes known his arrival by lodging at the Custom House a report of his ship, her cargo and crew, upon the prescribed form, when on payment of the tonnage dues, etc., permission is given him to unload. This is called her "clearance." An outward steamer also having loaded her cargo, must obtain permission from the customs before she may sail, the form of clearance being much the same as for boats just arrived.

Ship's Husband.—An agent appointed to manage a ship on behalf of the owner.

Ship's Log.—This is a book which particulars of the daily runs of the vessel, the weather and winds encountered the places passed, and the time of passing are recorded.

Ship's Protest.—The Master's declaration upon oath regarding the circumstances which led to any injury to the ship or damage to her cargo.

Ship's Report.—The master of every ship, whether laden or in ballast, must within 24 hours, after arrival from parts beyond the seas at any port report his ship and answer all questions relating to the ship, cargo, or crew, on the prescribed form.

Short Shipment.—Goods are said to be a short shipment, or short shipped, when they are shut out of a ship, either accidentally or for want of room.

Slinging.—A charge for hoisting the goods on board from the craft alongside the ship.

Specific Duties.—The duties which are charged at so much per maund, cwt., ton or gallon, as the case may be.

Sufferance Wharf.—A wharf licensed by the Customs (and at which a Custom House officer attends) where certain goods may be landed and cleared.

Survivorship Policy.—Is one under which the sum assured is payable if one person dies before another and in that event only.

Sweating.—This is caused by cargo, such as grain, being shipped in an immature state, thus causing heating during the voyage, The air in the hold becomes warm and moist, and condenses on the hold beams in the form of sweat, which then falls back on the cargo below, causing deterioration.

Tare and Draft.—Tare is the weight of the wrapper and hoops, of the box or case, or of the cart or wagon, in which goods are packed or loaded at the time of their weights being taken. Gross weight is the weight of the goods and package together; net weight that of the goods alone. Freight is charged on the gross weight, but customs duty is payable on the net weight. It is made by the seller to the buyer of goods to cover possible shrinkage in weight after unloading from the ship and before delivery from the warehouse.

Through Bills of Lading.—Bills of lading which cover both the journey by rail to port of shipment and the sea passage.

Tonnage, or Tons Burden.—A ship's carrying capacity—the number of tons she will carry. A ship's registered tonnage and her actual carrying capacity differ, at times, very considerably, owing to the peculiar build of some vessels.

Tramps.—These are steamships and sailing vessels moving about from port to port under telegraphic instructions, in search of cargo. These are usually chartered full loads.

Transhipment Bond Note.—This forms an entry for the goods when dutiable goods are transhipped, and states that the party named has given security for the due transhipment and exportation of the goods named therein.

Transhipment Entry.—When goods are imported with the intention of being re-shipped to another country, transhipment entry will have to be lodged.

Vatting.—A Custom House term for the mixing together of the same sorts, brands, colour or rate of duty of wines (or spirits) for the purpose of fortifying, colouring or strengthening the whole or obtaining uniformity of character.

Warehousing Entry.—When dutiable goods are imported, which are not required for immediate use, they are stored in warehouses approved by the Customs authorities.

Appendix F

GLOSSARY OF INSURANCE TERMS

Adjustment.—A term much used in marine insurance for settling loss incurred by the insured.

All Other Perils.—This includes only perils similar in kind to the perils specially mentioned in the policy.

Assurance.—Same as Insurance.

Average.—In marine insurance the word is used in two senses; when employed to denote partial loss it is called "particular average"; and when to denote contribution, it is termed "general average."

Average Clause.—A clause in a marine insurance policy, which provides that some articles shall be free from average, unless general, and that others shall be free from average, if under a certain percentage named.

Bonus System.—According to this, the balance, or profit, after all liabilities have been assessed and provided for, and suitable reserves set aside, is distributed amongst such of the policy-holders as are entitled to participate.

Contract.—In fire insurance when a contract is made, the insurers undertake to pay or make good to the insured any actual loss or damage by fire which may happen during a particular period to specified property, not exceeding the sum named as the limit of insurance, or of each item thereof, in consideration of an immediate fixed payment.

Covering Note.—Is a form used by Insurance Companies undertaking to indemnify the insured, should any damage happen between the time the insurance is arranged and the issue of the policy.

Deferred Assurance.—The payment of a very small annual premium being made, if death occurs before that age.

Deviation.—In marine insurance, any divergence from the terms and conditions specified in the policy of insurance which thereby discharges the undewriters' risk.

Endowment Assurance.—A form of life assurance according to which the sum insured is payable after the expiration of a certain term of years if the policy-holder is alive, or at his death if he dies previously. Such a policy combines the essential features of life assurance with the advantages of a saving bank.

Express Warranty.—This is a stipulation inserted in writing on the face of the marine policy, upon the literal truth or fulfilment of which the validity of the entire contract is dependent.

Fidelity Guarantee.—Bonds issued by Insurance and Guarantee Companies, whereby in consideration of the premium, they guarantee the fidelity of persons holding positions of trust, and undertake to make good any loss occassioned by defalcations.

Fire Policy.—This covers loss arising from fire due to explosion or lightning, but unless specially provided, the cover does not extend to consequential loss, *i.e.*, rent loss of profits, interest on debentures, etc.

Floating Policy.—A policy of this nature usually describes the insurance in general terms, leaving the voyage and steamer's name to be defined by subsequent declaration.

Flotsam.—In marine insurance, flotsam is where a ship is sunk or cast away, and any goods forming part of her cargo are found floating on the surface of the waves.

Free of all Average.—Means that claims for general and particular average cannot be recovered under an insurance policy containing this clause. Such a policy insures against total loss only.

General Average.—Represents a voluntary sacrifice when in danger for the general benefit of ship, cargo, and freight.

Implied Warranties.—In a marine policy these are three in number: (*a*) that the vessel in which the venture is made is seaworthy; (*b*) that the venture be completed without deviation; (*c*) that the venture is legal.

Insurable Interest.—The merchant or shipowner who effects an insurance or who gives instructions to an insurance broker to effect an insurance on his behalf must have what is termed an "Insurable Interest."

Insurance or Assurance.—Is a contract between two parties, in which one of them, the insurer, undertakes in consideration of a certain periodical or fixed sum, called the premium, to indemnify, or assure, the other against a certain amount of loss from the occurence of a specified contingency, as the burning of certain premises, the loss of a certain ship, or the death of a certain person.

Insurance Premium.—The consideration paid by the insured to the insurer to cover the risks specified in the policy of insurance.

Joint-Life Policies.—Are issued under which the sum assured is payable at the death of the first of two lives.

Life Assurance.—Provides for the payment of fixed capital sum at death.

Ligan.—A marine insurance, ligan is where heavy goods (which would sink to the bottom and be lost) are cast into the sea by jettison, having attached to them a cork or buoy so that they may be found again.

Lloyds.—The famous association of underwriters whose name is synonymous with maritime transactions throughout the world.

Marine Insurance.—Is a contract of indemnity in which the insurer, commonly called the underwriter, undertakes to indemnify the assured in consideration of the payment of a certain sum of money, called premium, for all losses arising from the perils of the seas, that may happen to the subject insured.

Mixed Policy.—Sometimes a ship is insured from a certain place to some other place, say for a year, in which case it is both a voyage and a time policy ; hence the name.

Mutual Life Assurance Office.—An office which works for the benefit of its members only.

Named Policy.—A marine insurance policy in which the name of the vessel carrying the goods insured is inserted.

Non-Profit Policy-holder.—Is entitled to the privilege of assurance only, and to the extent of his sum insured and no more.

Open or Unvalued Policy.—In such a policy the value of the ship or goods insured is not stated, but left to be ascertained.

Particular Average.—A term used in marine insurance representing damage or loss which is purely accidental in its nature and due to a peril insured against to ship, cargo or freight.

Perils of the Sea.—A marine insurance clause referring to those dangers and accidents which a vessel may meet with on a voyage, the risk of which being excepted in a bill of lading, is undertaken by insurer.

Policy.—Is a document containing a contract of insurance.

Policy Value.—This is the amount of money which the assurance fund should have in hand at any given time, and its amount is the present value of all future liabilities.

Pro Rata Average.—Provides for a sharing of the loss between the insured and insurers, in proportion to the risk that each is carrying.

Profit-sharing Policy-holder.—A term used in life assurance and refers to a holder who is entitled to the full privileges of his policy together with a share in such profit as the office may make, and pays on an average 10% more than the non-profit rate of premium.

Proprietary Company.—Is one which possesses a body of shareholders who have subscribed the original capital, and to whom some shares in the profits must be allocated.

Re-Insurance.—This term denotes a form of sub-insurance to minimise the risks undertaken by the underwriters and others.

Return of Premium.—The return of the excess of premium in case of goods insured for a larger amount than their real value.

Running-Down Clause.—A clause in the marine insurance in pursuance to which the underwriters concur to pay certain damages if the ship comes in collision with another vessel.

Salvage Loss.—A marine insurance term for a loss settled by underwriters after a certain sum representing the value of goods saved has been deducted from the amount the goods were insured for.

Short Interest.—In marine insurance the excess of the amount for which goods are insured over the value of the goods shipped, is called "Short Interest," and the assured may claim this amount from the underwriters.

Slip Risk.—When a broker has instructions to effect insurance on, say, a certain steamer, he proceeds at first to make out what is known as a "Slip" which is a short memorandum of the proposed "risk" or property to be insured.

Stranding.—In marine insurance the term is used when the vessel takes the ground by reason of some accidental occurrence and remains fast for an appreciable time.

Subrogation.—The acquirement by underwriter's on settling a loss, of the rights and remedies of the insured in the thing insured.

Surrender Value.—Is simply what the life assurance office will pay for the policy, and its amount is guided by the policy value of the particular policy at the date of surrender.

Term Assurance.—Is the simplest form of assurance contract and provides for payment only in the event of the life dying before a certain date or age.

Terminable Annuities.—Are annuities granted by Government, and by most insurance offices, for a period of years, or for the life of a person, in return for a present payment of money.

Time Policy.—An insurance for any stated period of time but not exceeding 12 calender months.

Voyage Policy.—This refers to a marine insurance effected from one port to another, and in case of a voyage insurance on the hull of a ship or steamer, the insurance usually extends for thirty days after she has arrived in safety or until she sails on another voyage, whichever may first occur.

Wager Policy.—An insurance when the assured has no actual insurable interest, or else that the underwriter is willing to dispense with any proof of interest. The common name for a wager policy is a "P. P. I. Policy" meaning "Police proof of interest" or "without further proof of interest than the policy itself," and all such insurances are void by law.

Warranty.—See Implied Warranty and Express Warranty.

Water-Logged.—A marine term applied to ships which, owing to leakage or collision, have so much water in their holds as to become quite unmanageable.

Whole Life Insurance.—This form of policy undertakes the payment of the sum insured at death only, whenever it may occur, and from whatever cause. Such a policy can be obtained for a single payment or by annual payments spread over a fixed number of years or by annual payment until death.

APPENDIX G

GLOSSARY OF COMMERCIAL PHRASES, ETC

A,—First Class.

@.—At.

A Fortiori.—With stronger reason.

Ab Initio.—From the beginning.

A/c.—Account.

Accepting Houses.—Firm, that through accepting bills on behalf of their customers, guarantee payment of the bills at due date and thereby reduce the risks of those who give credit against the security of bills of exchange.

Accommodation Bill.—Bill drawn for one person and accepted by another, promising to meet the bill when due.

Act in Pais.—An act done without formating or legal proceedings.

Actus Dei Nemini Facit Injuriam / *Actus Dei Nemini Nocet*.—The action of God injured no one.

Ad Idem.—Tallying in essential point.

Ad Infinitum.—Without end.

Ad interim.—Meanwhile.

Ad libitum.—At pleasure.

Ad Nauseam.—Until disgusted.

Ad ref.—Matter subject to reference before being final.

Ad valorem.—According to value, or A/V.

Ad valorem duty.—A percentage of the market value of goods purchased and delivered to the importer at the port of importation, the value to include freight, insurance, commission and all other charges incidental to the purchase and delivery at that port (except any duties of customs.)

Advowson.—The patronage of a benefice.

Affidavit.—A written declaration on oath.

Agio.—An Italian term to denote a premium. It is usually employed to indicate the difference in value between a gold currency and a depreciated silver or paper currency.

Agenda.—A list of items of business to be considered at a meeting.

Agistment.—The taking in by a person of other men's cattle to graze on his ground for a payment.

A la carte.—According to the bill of fare.

Aleatory Contract.—One which depends on an uncertain event.

Al fresco.—In the open air.

Alias.—Otherwise.

Alibi.—Elsewhere.

Aliem juris.—Of another's right—the phrase is applied to those who have not full legal capacity: *e.g.*, infants and married women, as contrasted with those who have full legal capacity, *sui juris*.

Aliter.—Otherwise.

Aliunde.—From another source.

Allegaus contraria non est audiendus.—He is not to be heard who alleges things contradictory to each other.

A.M.—Before Midday.

Amende honorable.—Satisfactory apology.

Amicus curiæ.—A friend of the court.

Amour propre.—Self respect.

Amt.—Amount.

Animus revocandi.—The intention of revoking.

Ante.—Before.

Ante nuptial.—Before marriage.

Appriase.—To value goods or property.

A priori.—From the cause to the effect.

A.R.A.—Asso. Royal Academy.

Arbitration.—The submitting of matter of controversy to the judgement.

Arrha.—Earnest—of a bargain.

A/S.—Account Sales.

A.S.A.A.—Associate of Society of Incorporated Accountants and Auditors.

Bls.—Bales.

Bona fide.—In good faith.

Bon mot.—A witty remark.

Bottomry.—Borrowing money on security of a ship.

B.P.—Bills payable.

B.P.B.—Bank post bill.

B.R.—Bills receivable.

Breveté—Patented.

B.t.—Berth terms.

Bucket Shop.—A place where small brokers speculate in differences on margins.

Bullion.—Gold or silver in bars or in the mass as distinct from coined metal.

Business Forecasting.—The making of business decisions as a result of scientific study of statistical data. It is an attempt to base the decisions upon reasons supported by accurate information, rather than upon impulse.

By-Product.—A commodity obtained during the process of production of another that is the main object of the process. Thus, if gas is the main purpose in a gas-works, the coke is a by-product.

C.A.—Chartered accountant.

C.A.V.—(*cur. ad. vult.*) *Curia adversari vult.*—The court wishes to deliberate before pronouncing judgement.

C.F.—Cost and freight.

C.I.F.—Cost, Insurance, Freight. Shippers pay freight and insurance, but the goods travel at the risk of the consignee.

Carte blanche.—Full discretion.

Casus belli.—That which causes or justifies war.

Cash-Nexus.—The term embodying the idea that the relations between employer and employed can be summed up by the payment and receipt of money; that, when a worker has sold his services and the employer has paid for them, nothing remains outstanding.

Catching bargain.—A bargain made with an expectant heir on the strength of his expectations.

Caveat.—Let him take heed.

Cavet emptor.—Let the buyer beware.

C/o.—Care of

C.O.D.—Cash on delivery.

Central Bank.—The institution entrusted with the special duty of maintaining the conditions upon which the smooth working of the monetary machinery depends. These conditions are: (*a*) maintenance of such a stock of gold as assures parity between gold and the paper tokens of gold; (*b*) the minimising of gold movements by so managing the currency that a parity in gold purchasing power is established among the nations associated by trade. The central bank, in its function of surveying the whole field of finance, is an application of rationalization to money makers.

Cestui qui trust.—The person for whose benefit a trust is created.

Ceteris paribus.—Other things being equal.

Chancery Division.—That division of the High Court which deals with matters pertaining to trusts, mortgages, partnerships and specific performance of contracts relating to reality.

Chattels.—Moveable possessions.

Cheap Money.—Loanable money which is offered at a low rate of interest. Money is cheap, in the money market sense, when the floating supply is plentiful; and the bank rate of interest is low.

Cheque (*Chq.*)—Is a written order on a banker for the payment of money on demand. It may be made payable to a certain person or bearer, and it then requires no endorsement. When it is made payable to a certain person or order, the payee before presenting it for payment, must endorse it by writing his name on the back of the document. Cheques are sometimes crossed, *i.e.*, two transverse lines are drawn across the face of the cheque with or without the words & Co., written between them. Payment of a crossed cheque can only be produced by passing it through a bank.

Cherchez la femme.—Look for the woman in the case, that is get to the bottom of the scandal.

Circular Note.—A written request by a bank to one of it's correspondents abroad to pay a specified sum to a specified person.

Clearing.—The term refers to a special plan adopted by banks to avoid bills and cheques being taken individually to the banks upon which they are drawn.

Collateral Security.—Any secondary or indirect security which may be available in the event of default in the repayment of a loan, or the failure of some personal or other obligation.

Com.—Commission.

Comm. or Coml.—Commercial (quality).

Common Law.—That law which is embodied in judicial decisions as contrasted with statute law or Acts of Parliament.

Compos mentis.—In a state of same mind.

Commerce.—The exchange of commodities by means of money. The term is usually restricted to the trade that takes place between men living in different countries.

Commercial Crises or Panics.—Periods when credit is lessened so greatly that business men have difficulty in meeting their engagements. If so, as is often the case at the commencement of a period of industrial activity, loanable money is plentiful, no great difficulty is experienced in borrowing money, and a manufacturer will borrow at 4 to 6 per cent. hoping to earn 12 to 15 per cent. When this happens on all sides production overtakes demand; manufacturers find themselves compelled to reduce prices in order to secure orders; as new undertakings, brought into existence by prospective profits based on high prices, come into operation, prices fall; loans are called in by bankers, and the position of many who hve ventured beyond their capital resources becomes critical. A general state of of depression follows the over-speculation and many in extreme cases become a panic.

Consideration.—That evidence required by law in simple contracts to show the intention of the parties to enter a legal agreement (see Form).

Consignee.—The party to whom goods are consigned.

Consignment.—The goods consigned, merchandise in a state of transport.

Consignor.—The party who consigns, or sends goods to another party.

Consols.—Consolidated funds.

Consul.—The commercial representative of one country residing officially in another, whose duties are to facilitate business, and represent the merchants of his nation.

Contra.—Against.

Council Bills / *Council Drafts*—Drafts issued by British Government upon the Indian Government and payable at the Reserve Bank of India, to raise funds in England without the transmission of bullion.

Cul-de-Sac.—A blind alley ; a street with only one opening.

Cum grano salis.—With a grain of salt, with some allowance for exaggeration.

C/p.—Custom of port.

Cr.—Credit.

D/s.—Days of sight.

Dft.—Draft.

D/A.—Document for acceptance.

d/d.—days after date, or delivered.

D/D.—Demand Draft.

D/y.—Delivery

Days of Grace.—As applied to the Bills of Exchange the days of grace allowed are three in number. In the case of hundis, no days of grace are allowed on hundis of less than 11 days' usance, in case of hundies of 11 to 20 days' maturity the days of grace reckoned are 3, and for those of longer usance they are 5.

Debenture.—Acknowledgement of a debt. An instrument of the nature of a bill or bond, by which a debt claimable. May bear interest or confer some peculiar advantage.

decre nisi.—Order for divorce unless cause to the contrary is shown with a period, at least six months.

Dei gratia.—By the grace of God.

de jure.—By right.

Delegatus non potest delegare.—An agent may not delegate his authority.

de minimis non curat lex.—the law takes no notice of matters which are trifling importance.

De trop.—In the way ; out of place.

Dekhandar Hundi.—Payable to the presenter or bearer.

Demand Draft (*D/D*)—A bill of exchange payable on demand, *i.e.*, it is payable as soon as presented. Unlike the usance bills, these do not require accepting.

de novo.—Anew, afresh.

Deo volento.—God willing.

Dhanijog Hundi.—The term applies to a Darshani or Muddati hundi payable to a dhani or person. The drawee has no liabilities whether the person presenting the bill is the proper person or not.

Discount.—An allowance made for money paid before it is due.

Discount a Bill.—To discount a bill is to buy from the holder the right to receive the money upon it when due, proper allowance being made for the interest for the remaining term of the bill.

Document Bills.—A term used to indicate a set of bills of exchange having the bill of lading, invoice, and policy of insurance attached to them, these latter documents being available in the event of the bills of exchange not being duly honoured at maturity.

Document Credit.—This is a Letter of Credit, issued on condition that certain named securities shall be deposited as a collateral security for the money advanced.

dolo malo pactum se non servaturum.—An agreement obtained by fraud cannot be upheld.

D.R.G.M.—Deutsche-Reichs-Germain-Muterschutz; German protection of patents.

Duress.—Forcible restraint, compulsion.

Drawee.—The debtor on whom a Bill of Exchange is drawn.

Drawer.—The creditor who writes out the bill of draft.

Dumping.—A slang mercantile term. The selling of goods abroad at a price lower than the home or original price.

Duties.—Taxes levied by the custom-house upon goods exported or imported.

D.V. (*Deo Volente*).—God willing.

E.E.—Errors excepted.

E.g.—*exempli gratia.*—For example.

E. and O. E.—Errors and omissions excepted.

Encl.—Enclosure.

Endorsement.—This means writing one's name upon the back of cheques, bills of exchange, etc., so that they may be paid away to or collected by other parties.

entre nous.—Between ourselves.

Equitas sequitur legen.—Equity follows the law.

Escrow.—A sealed writing delivered conditionally and which operates as a deed as soon as the condition is performed.

Esprit de corps.—The animating spirit of a collective body, as a regiment, one of the learned professions, or the like.

Est.—Estimated.

Estoppel.—A rule of evidence. If a man causes another to believe in the existence of a certain state of things, and that other acts on that belief, and so changes his previous position, then that man is precluded from averring that a different state of things existed.

etc., &c., et ceteri or cetera.—and others, and so forth.

ex.—From or out of.

ex contractu.—A term used to describe actions arising out of breach of contract as contrasted with those actions ex delicto which arise out of torts.

ex debito justitiæ.—As a matter of right not of favour.

executed consideration.—Present consideration.

executory consideration.—Future consideration.

ex equo et bono.—According to equity and good conscience.

ex gratia.—As a matter of favour.

ex nudo pacto non oritur actio.—No action arises out of a bare promise.

ex-officio.—By virtue of office.

ex parte.—On the one side, where only one side is heard.

ex post facto.—After the event.

express contract.—A contract expressed in words or writing in contradistinction to implied contract where the contract is inferred from conduct.

ex turpi causa non oritur actio.—No action arises out of a base cause, *e.g.*, an immoral consideration.

Ex-mill.—Sellers deliver out of or from mill.

F.a.q.—Fair average quality.

f.a.s.—Free alongside ship.

Facsimile.—An exact copy.

faux pas.—A blunder.

Fcp.—Foolscap.

Felo-de-se.—Suicide.

Feme covert.—A married woman.

feme sole.—A spinster or widow or a woman divorced or judicially separated from her husband.

Filling Marks.—*F.W.* = File wanted; *I.R.* = Investigate and report; ***J.R.*** = Means that the matter is to be investigated and report made to the executive; ***B.F.*** = Bring forward; ***B.F.*** **14** *days* = means that the letter is to be filed and the whole file is to be brought to the same person 14 days later, for further attention; ***P.A.*** = Means put away showing that the letter needs no later attention.

Firmanjog Hundi.—A hundi payable to order.

First-class Paper.—A phrase given to bills, drafts, promissory notes and similar documents which bear the names of well-known houses or financiers as acceptors or endorsers.

flagrante delicto.—In the very act of committing the crime.

fo., fol.—folio.

F.O.B.—Free on board.

F.O.C.—Free of charge.

F.O.R.—Free on rail.

Force majeure.—Circumstances beyond one's control.

Form.—That evidence required by law (and explained by formality and solemnity) in contracts under seal to show the intention of the parties to enter a legal agreement (see Consideration).

Franchise.—The right to vote at public elections, especially for Members of Parliament.

F.P.A.—Free of particular average.

G.A.—General average.

Garnishee.—A person who is warned by the court to pay his debt to one who has obtained a final judgement against his creditor.

Guarantor.—One who makes a guaranty.

Guaranty.—A warrant or surety, a contract to see performed what another has undertaken.

hiatus.—Gap, opening, cleft.

hors de combat.—Out of condition to fight.

H.M.C.—His Majesty's Custom.

Hundi.—A written order, usually unconditional, made by one person to another for payment, on demand or after a specified time, of a certain sum of money to a person named therein. Hundies are of two kinds Darsani (sight or demand bills) and Muddati, sometimes called Maidi (deferred or usance bills), *i.e.*, bills payable after a stipulated period of time mentioned in the Hundi and reckoned from the date of drawing.

Hypothecate.—Is to place or assign property as security under an agreement ; to pledge or mortgage.

ibid (ibidem).—In the same place.

idem.—The same.

id est.—That is.

ignorantia legis nemin excusat.—Ignorance of the law excuses no one.

in camera.—In secret.

inchoate.—incomplete

in curia.—In open court.

Indemnity.—Security from damages, compensation for loss or injury.

Indent.—Indenture.

Index Numbers.—Numbers whereby the rise or the fall of general prices with reference to those of a selected year is indicated. The value of money is measured by the quantity of commodities for which a unit of money will exchange : the less this quantity, the less is the Value of Money—or in other words, the higher are market prices. To form an index number, to give definiteness to this idea "value of money," a large number of articles of common consumption is taken. The recorded prices of these are taken for the selected year and the sum is reduced to 100 : the prices for the year that is to be compared with this year are taken, and the sum of these prices, given as a percentage of that of the selected year, is an Index Number.

in extenso.—In full length.

infra dig., infra dignitatum.—Beneath one's dignity.

in forma pauperis.—As a poor person.

Injunction.—A legal prohibition or restraint, as upon the infringement of a patent right.

in pari delicto potior est conditio defendentis.—Of two wrong-doers it is better to be the defendant.

in pari delicto potior est conditio possidentis.—Where two parties are in equal fault the condition of the possessor is the stronger.

in re.—In the matter (as regards the person).

in rem.—In the matter of (as regards property).

in statu quo.—In the state in which it was.

Ins.—Insurance.

inst., Instant.—Present month.

inter alia.—Among other matters.

inter nos.—Between ourselves.

inter se.—Between themselves.

in toto.—Entirely.

intra vires.—Within their powers.

Int.—Interest.

I.R.O.—Inland Revenue Office.

In trans.—In transport or on the way.

Inventory.—A list or schedule of articles comprised in an estate, describing each article separately and precisely so as to show of what the estate consists.

Invoice.—A letter of advice of the despatch of goods, with particulars of their price and quantity.

I.O.U.—A memorandum of debt given by a borrow to a lender, requiring no stamp, but to be wholly written by the borrower, dated, and addressed to some person.

ipso facto.—On the fact itself.

jus accrescendi inter mercatores locum non habet.—The right of survivorship among merchants has no place.

Jokhami Hundi.—Hundies drawn against goods despatched under the condition that if the goods are lost or destroyed on transit the drawer or the holder of the hundi has to suffer the loss.

Laus Deo.—Praise be to God.

laisser-faire.—Non-interference, non-intervention. Let people do as they think best.

Lessee.—Holder of, tenant (of house, etc.) under lease.

Lessor.—Person who lets lease.

Letter of Credit (*L/c*).—A letter empowering the bearer to obtain money from the party addressed.

lex fori.—The law of the place where the case is heard.

lex loci.—The law of the place where the bargain is made.

Lieu.—A right to retain property until a debt due in respect of it to the person detaining it is satisfied.

Licence.—A government permit.

locum tenens.—A temporary substitute or a deputy.

£.s.d. (*libræ, solidi, denarii*).—Pounds, shillings, pence.

locus in quo.—The place in which.

Long-Dated Bill.—A long-dated bill has a long term to run, such as a bill drawn at six or nine months after date or after sight.

L.S. (*locus sigilli*).—The place of the seal. These letters are placed on the copy of a document to indicate the position of the seal on the original.

Malfeasance.—Official misconduct.

m., mille.—A thousand.

Mandamus.—A writ from a higher to a lower court.

max., Maximum.—The greatest possible.

Metre (*m.*)—1.0936125 yds., 3.28043 ft., 39.370113 inches.

Mile.—Statute 5,280 ft., nautical 6,080 ft., geographical 6,087.2 ft.

Mm.—Millimetre, 0.0394 inches.

Mo., Mos.—Month, Months.

M/d.—Month after date.

M/s.—Month after sight; Messrs.

Memo.—Memorandum.

Moratorium.—A legal authorization to a debtor to postpone payment for a certain time.

modo et forma.—In the manner and form.

modus operandi.—Plan of working.

Moiety.—The half of anything.

Mortgage.—A conditional conveyance of property as security for money lent, or other valuable consideration, becoming void on the performance of the condition.

Mortgagor.—The person who receives the money lent on mortgage.

MS. MSS.—Manuscript, manuscripts.

Multum in parvo.—Much in little.

Nee.—Born so-and-so, refers to maiden name of a newly-married woman.

Negotiable Documents.—These when transferred from one person to another entitle the possessor to the property or goods named therein.

Nemo dat quod non habet.—No one can give what he has not got.

Net.—Without any further reduction.

Next friend.—The person in whose name those *alieni juris* conduct actions, except a married woman who may sue in her own name

Nil desperandum.—Never despair.

nisi.—Unless.

Nominee.—One who is nominated by another.

non obstante—notwithstanding.

non sequitur.—It does not follow.

nota bene (*N.B.*)—Note well. Take notice.

Note of Hand or promissory Note.—A document promising payment of a sum of money named at a specified rate of interest on a particular date. Promissory notes have to be stamped with British revenue stamps of one, two or four annas according as the loan is Rs. 20 or under Rs. 250, between Rs. 250 to Rs. 1,000 or above Rs. 1,000 respectively.

N.T.—New terms.

nudum pactum.—A bare promise.

obiter dicta.—Something said by the way; a cursory remark.

Octovo (*8vo.*)—Sheet divided into 8 leaves.

On Demand.—Applied to bills of exchange when they are payable on presentation.

Onus.—The burden of proof.

Open Credit.—Is the name given to a letter of credit, an unconditional request to advance money to another.

Opn.—Optional.

Ord.—Ordinary.

O.S.—On sample.

O.T.—Old terms.

Overt.—Open.

par.—Equality of nominal and market value.

pari passu.—Proportionately, on an equal footing.

parol agreement.—An agreement by word of mouth, but used also of agreements in writing.

particeps criminis.—A partner in crime or fraud.

Passport.—An official licence or permission to enter or leave a country.

Pd.—Paid.

Payt.—Payment.

Per.—Through, by means of; according to.

Per Ann.—By the year.

per procurationem (*p.p. or per pro.*)—Signed by an authorised person on behalf of his principal.

per cent., %., *per centum.*—By the hundred.

per capita.—By the number of individuals.

per stripes.—By the number of families.

per se.—By itself.

per eundem.—From the same judge.

petitio principii.—Begging the question.

pkgs.—packages.

P.L.A.—Port of London Authority.

Plebiscite.—A vote of the people.

Policy.—A document containing the contract of assurance or insurance.

p.m., post meridiem.—Afternoon.

Post date.—To date a document in advance of the real date.

Poste restante.—Post office department where letters remain until called for.

Power of Attorney,—P.A.—A document which empowers one person to act for another.

Ppt.—Prompt.

Pp.—Pages.

Preamble.—Preface introduction.

Premium.—Payment made for insurance, Bonus.

Pref.—Preference.

Pfd.—Preferred.

P/av.—Particular average.

prima facie.—At the first glance.

Pro.—For.

Pro hac vice.—For this occasion.

Pro bono publico.—For the public good.

Pro forma.—For form's sake.

Proletariat.—The people, the labouring class.

Promissory Note.—A note by one person promising to pay a sum of money to another, or to bearer, at a certain date, or at sight, or on demand.

Prompt.—A term to signify the period of time within which a payment of money is to be made. If goods are sold to be paid for in, say, a month, the agreement is called a one month prompt.

Pro-rata.—Proportionately.

Pro tem.—For the time being.

P.S.—Postscript, written afterwards.

P.T.O.—Please turn over.

Prox., *Proximo.*—Next month.

Proxy.—A deputy; a stamped power of attorney, or authority to vote or act for another.

Purchasing Power Parity.—Equality in command over the market.

q.e. (*quod est.*)—Which is.

q.e.d. (*quod erat demonstrandum*).—Which was to be demonstrated or proved.

qua.—On the character of.

Qualified Acceptance.—On a bill of exchange is either (1) Conditional, making payment depend upon the fulfilment of a condition therein stated; (2) Partial, for only a portion of the amount named on the bill; (3) Local, making the bill payable at a particular place, and there only.

quantum meruit.—As much as he has deserved.

qui tam.—Who as well, an action on a penal statute.

quid pro quo.—A mutual consideration, one thing for another.

qui facit per alium facit per se.—He who does a thing through another does it himself.

Quire of paper.—24 Sheets.

quod vide.—Which see.

quod hoc.—As to this.

quorum.—Of whom. The number of members whose presence is necessary to render valid the acts of the corporation

Qn.—Quotation.

quarto (4*to*)—Sheet divided into 4 leaves.

q.v., quod vide.—Refer to.

q.s., quantum sufficit.—To a sufficient quantity.

Qr.—Quarter.

raison d'Etat.—A reason of state.

raison d'etre.—Reason for existence.

ratio decidendi.—The reason for the decision.

Rate of Exchange.—The amount in the currency of one country offered for a fixed sum in the currency of another country on a given date.

Reference.—A person or firm who will agree to answer questions as to the financial status, etc., of the party giving his or its name.

Rebate.—An allowance made as discount.

recd.—Received.

retd.—Returned.

res inter alios acta alteri nocere non debet.—A matter litigated between two parties ought not to prejudice a third party.

Ream of paper.—480 Sheets.

Respondeat superior.—Let the principal be held responsible.

Ring.—A combination of operators, etc., to control the output of a commodity.

Rd.—Registered.

Rly.—Railway.

R.I.P.—Rest in peace.

R.S.V.P.—Please reply.

Sans recours.—A term used in the endorsement of bills and notes by an endorser desiring to free himself from responsibility, the expression literally meaning without recourse to the drawer.

Scire facias.—That you cause to know. The name of a writ to revoke letters patent.

Second and Third Class Paper.—Indicates the commercial reputation or standing of acceptors and endorsers of bills, etc.

Sequestrate.—To take possession for creditors.

Shajog Hundi.—This signifies a Darsani or Muddati hundi or bills having less than ten days to run.

Shipt.—Shipment.

Short Bills.—Bills having less than ten days to run.

Short Loans.—Are advances made for short periods at a fixed rate of interest.

Sic.—Thus, so given.

Sine die.—Indefinitely.

Sign Manual.—The King's signature.

Si quis.—If any one.

Sine qua non.—An indispensable condition.

Specie.—Coin as distinguished from paper money.

Specific gravity.—The weight of bodies compared with similar bulks of water.

Square of timber.—One hundred superficial (surface) square feet irrespective of thickness.

SS.—Steamship.

S.W.—Shippers' weight.

Status quo.—Existing state of affairs.

Stg.—Sterling.

Stale Cheque.—A cheque remaining unpaid for some considerable time, either through delay in its presentation or from any other cause.

Subpœna.—A writ commanding the attendance of a person in court under a penalty.

Sub rosa.—Secretly or privately.

Sue.—To take proceedings in a civil action.

Sui generis.—Of its own kind, peculiar.

Syndicate.—An association of capitalis to carry out some undertaking.

Telegraphic Transfers or (T.T.)—Rate of exchange for transferring money by cable from one country to another.

Term of a Bill.—The time for which a Bill is drawn, also currency of a Bill.

Thesaurus inventus.—Treasure trove.

Ton.—Long 2,240 lbs. ; metric 2,205 lbs. ; short 2,000 lbs.

Tout ensemble.—The broad or general effect.

tr.—Transfer.

Treasury Bill.—Short term Government loans.

ult. ultimo.—Last month.

ubi jus ibi remedium.—Where there is a right there is a remedy.

ubi supra.—Where above mentioned.

ultra vires.—Beyond their powers.

Usance Bill.—Is the time allowed by usage for the currency of bills of exchange between any two countries. The Muddati hundis are drawn from 11, 21, 41, 51, 61, or even more or less days upto 361. They are sometimes classified according to their term stipulated such as iksathdini (of 61 days) eksovisdini (120 days) baramasi (of one year).

Vade mecum.—Go with me : a constant companion.

Verbatim.—Word for word.

Verb. sap. or *verb sat* (*verbum satis sapienti.*)—A word to the wise is sufficient.

v., versus.—Against.

V.G. (*verbi gratia.*)—For example.

Vice versa.—The order being changed.

Videlicet (*viz.*)—namely.

Vide.—Refer to or see.

Viva voce.—By word of mouth.

Vis a vis.—Opposite, face to face.

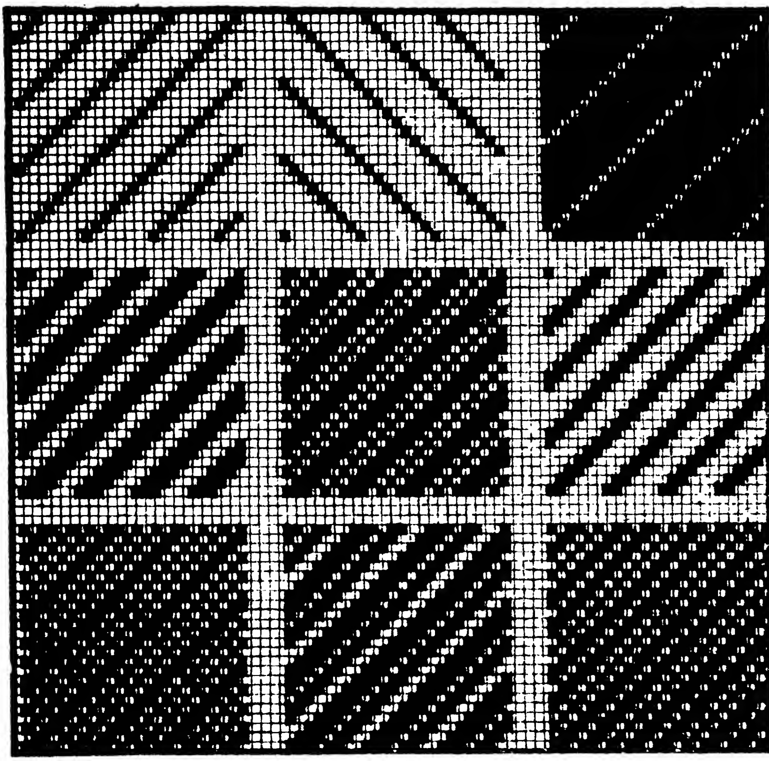
Vise or visa.—An endorsement on a passport denoting that it has been officially examined, and that permission has been given to the bearer to proceed on his journey.

Wt.—Weight.

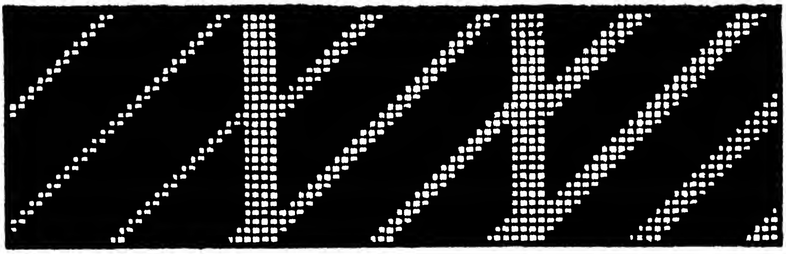
w.g.—Weight guaranteed.

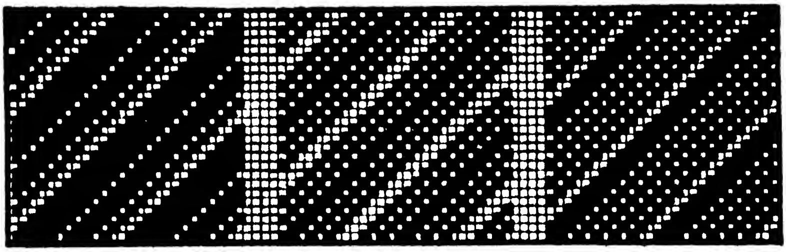
Without prejudice.—Leaving the question open.

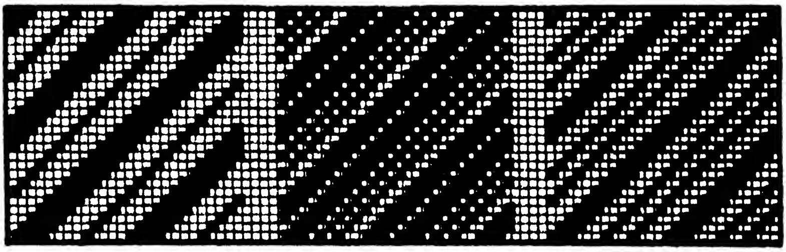
TWILLS

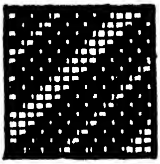


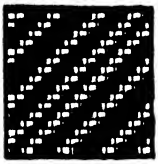
FANCY TWILLS

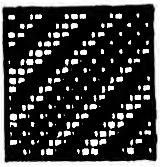


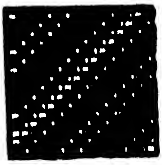












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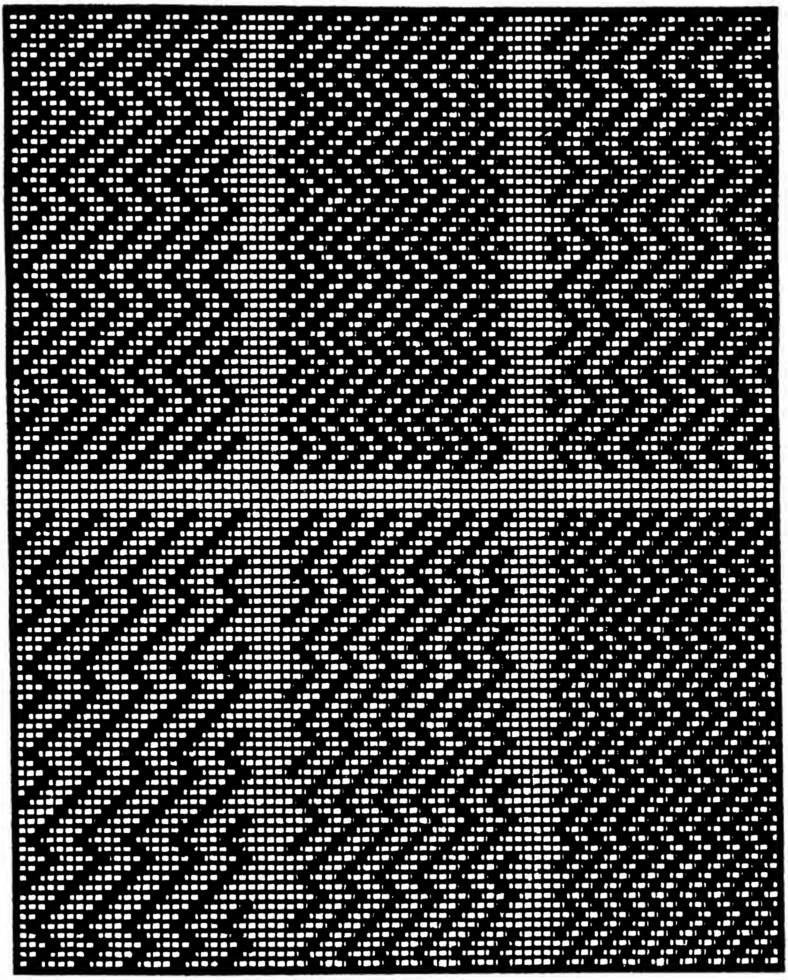

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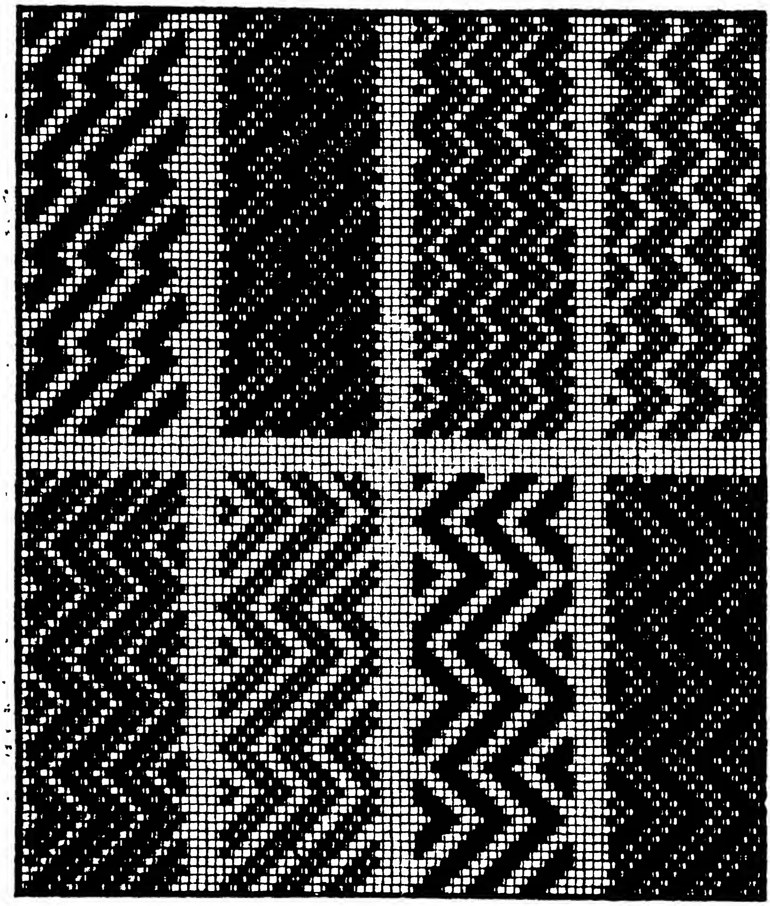

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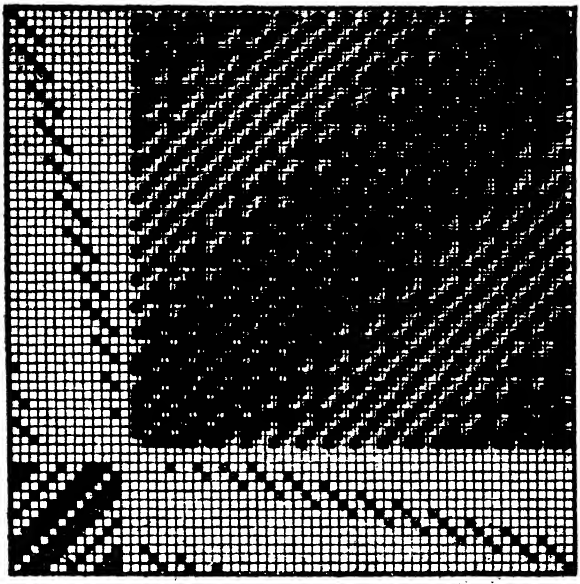

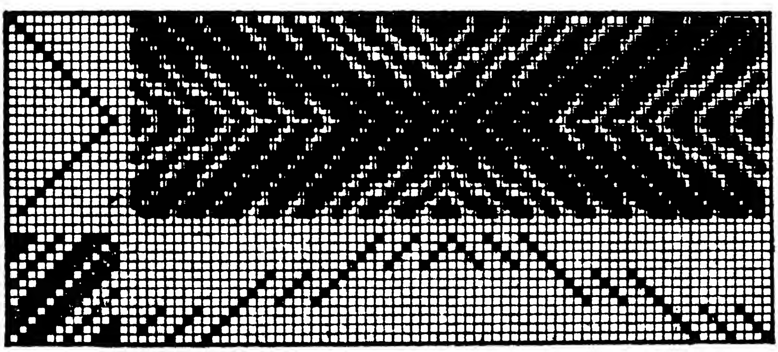

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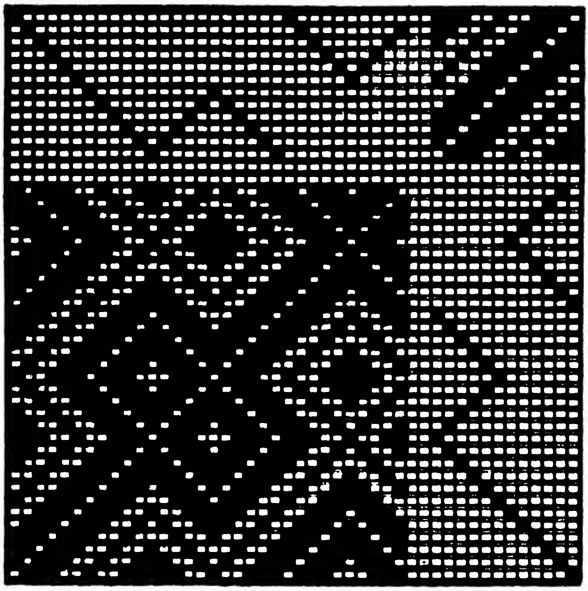

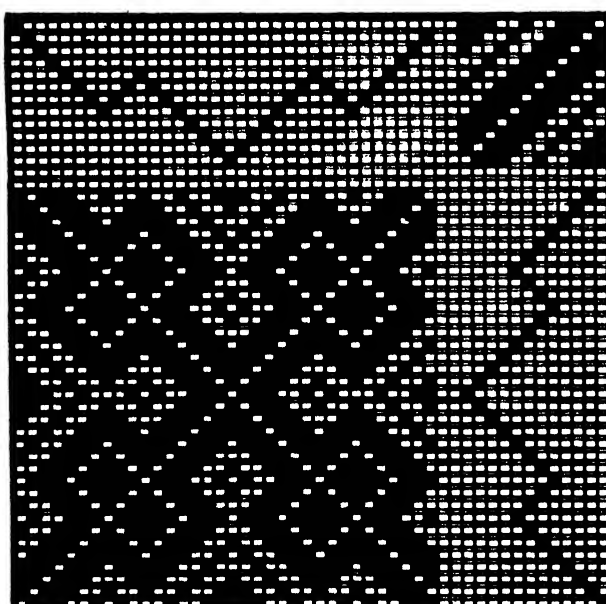

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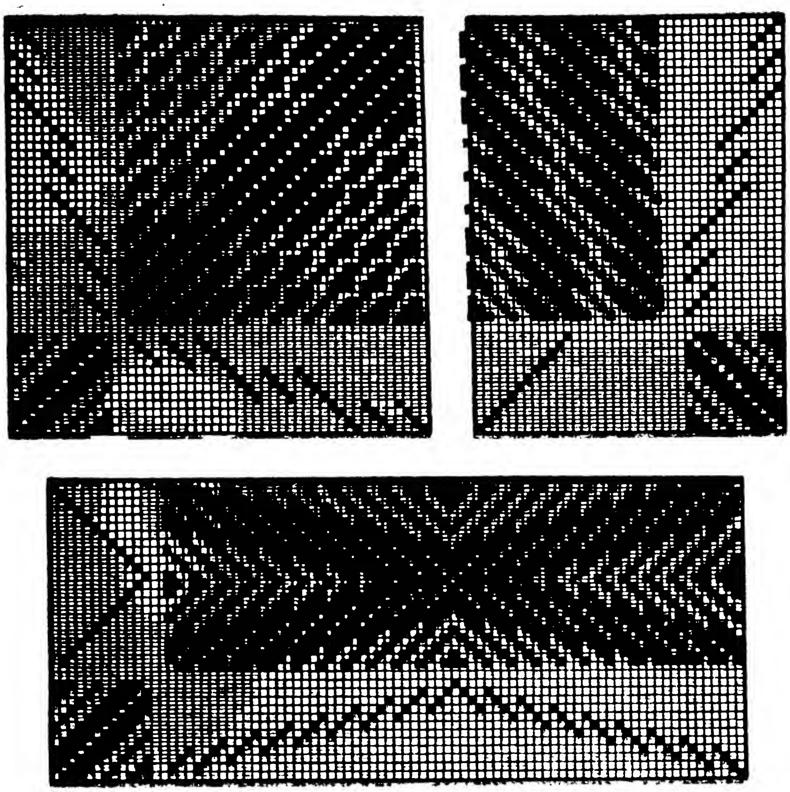

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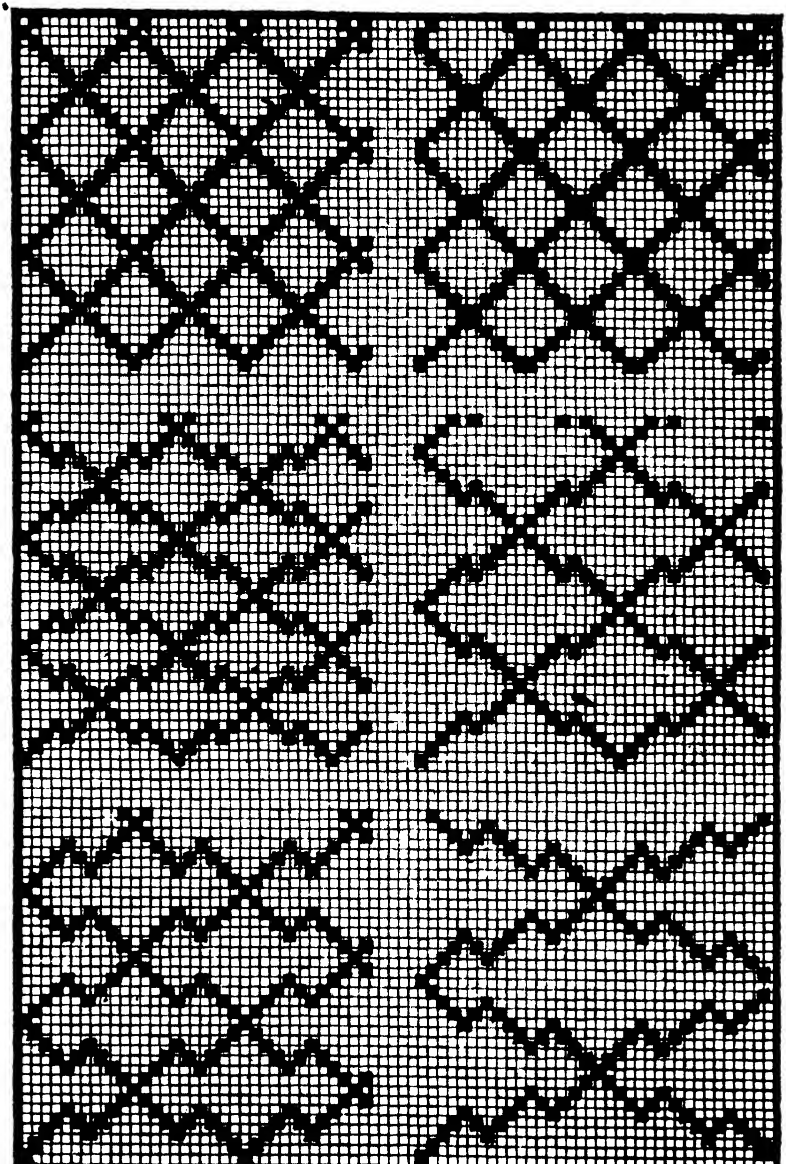

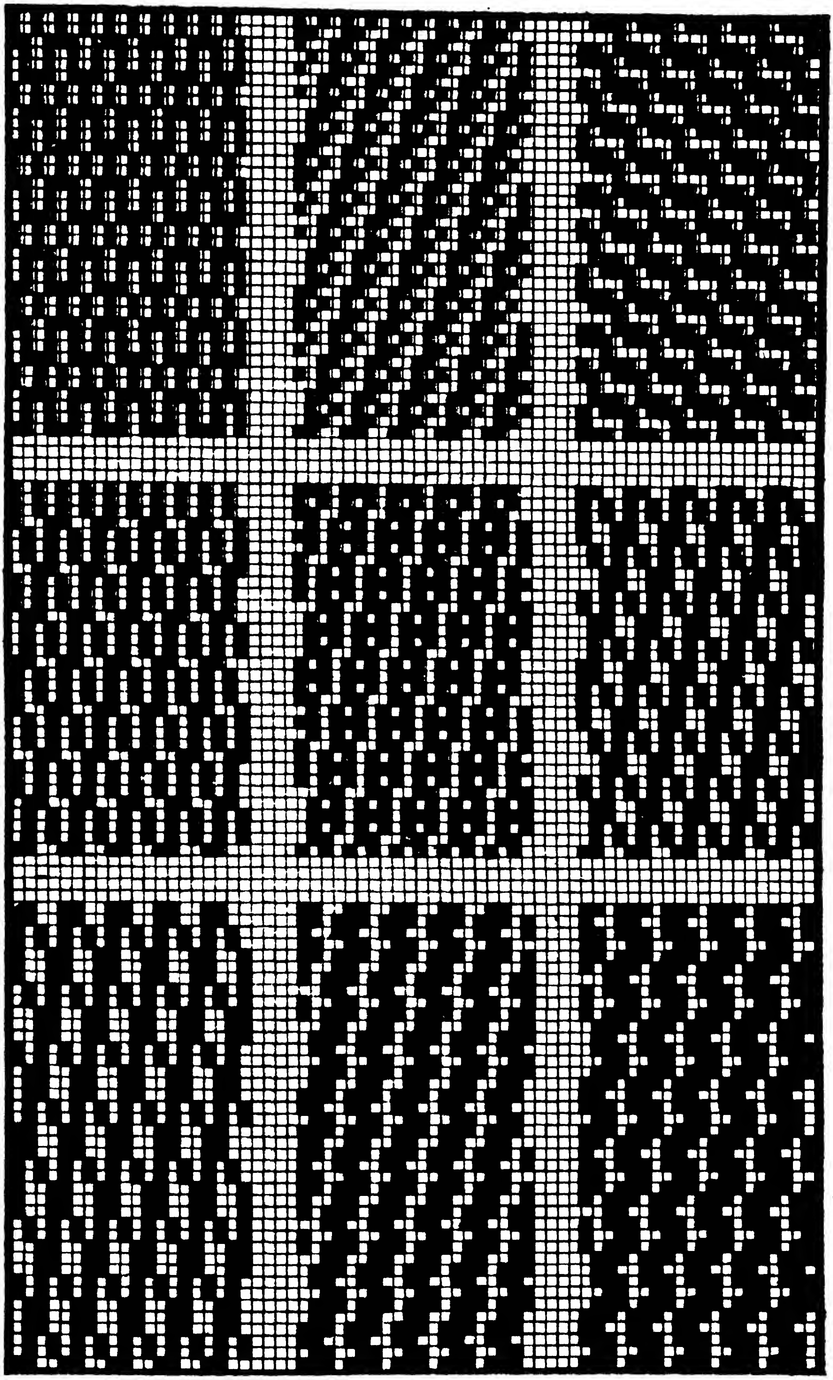

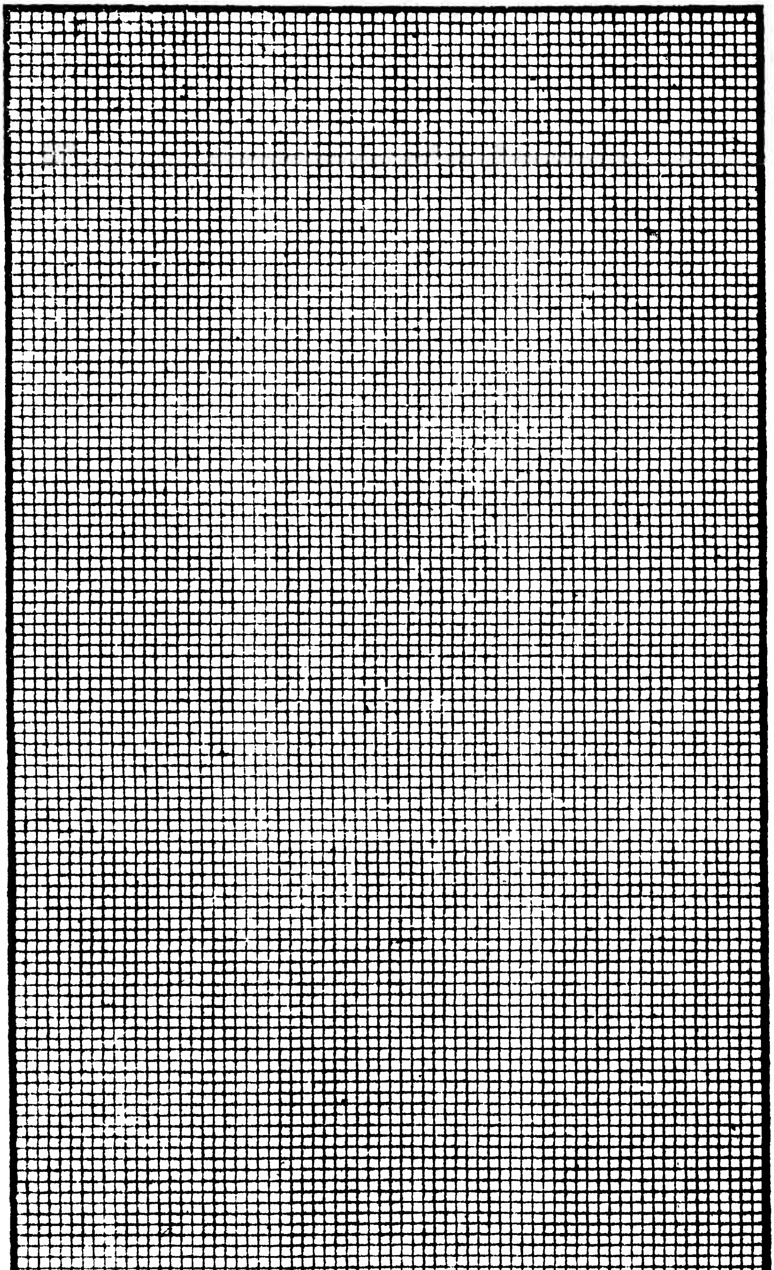

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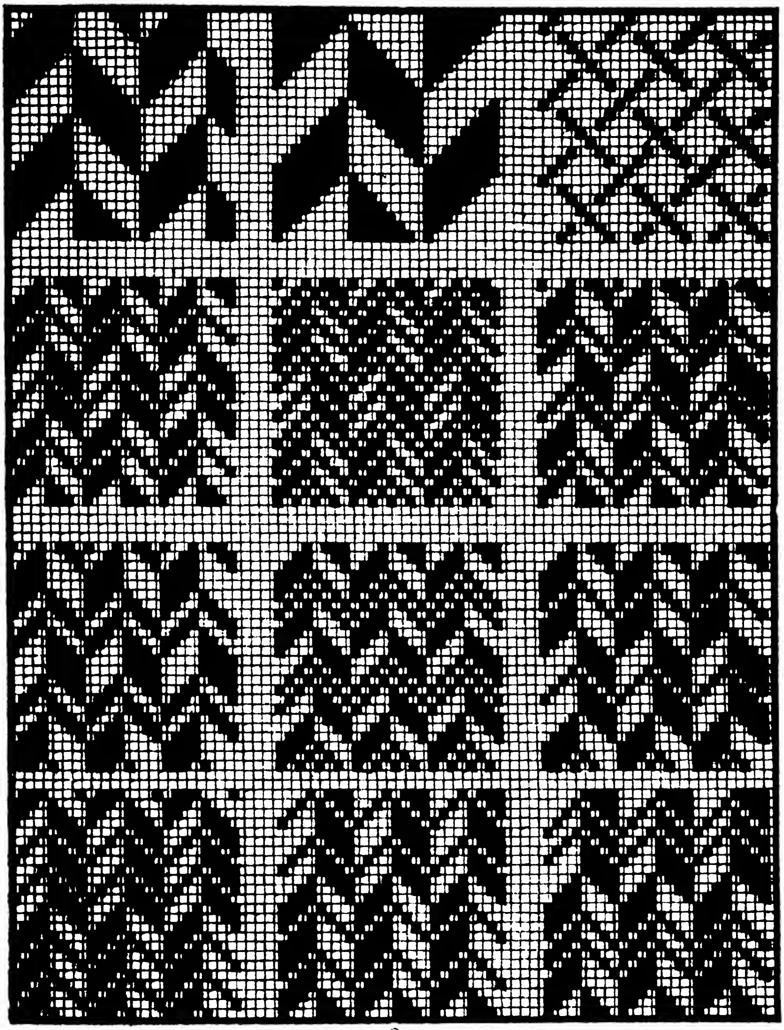

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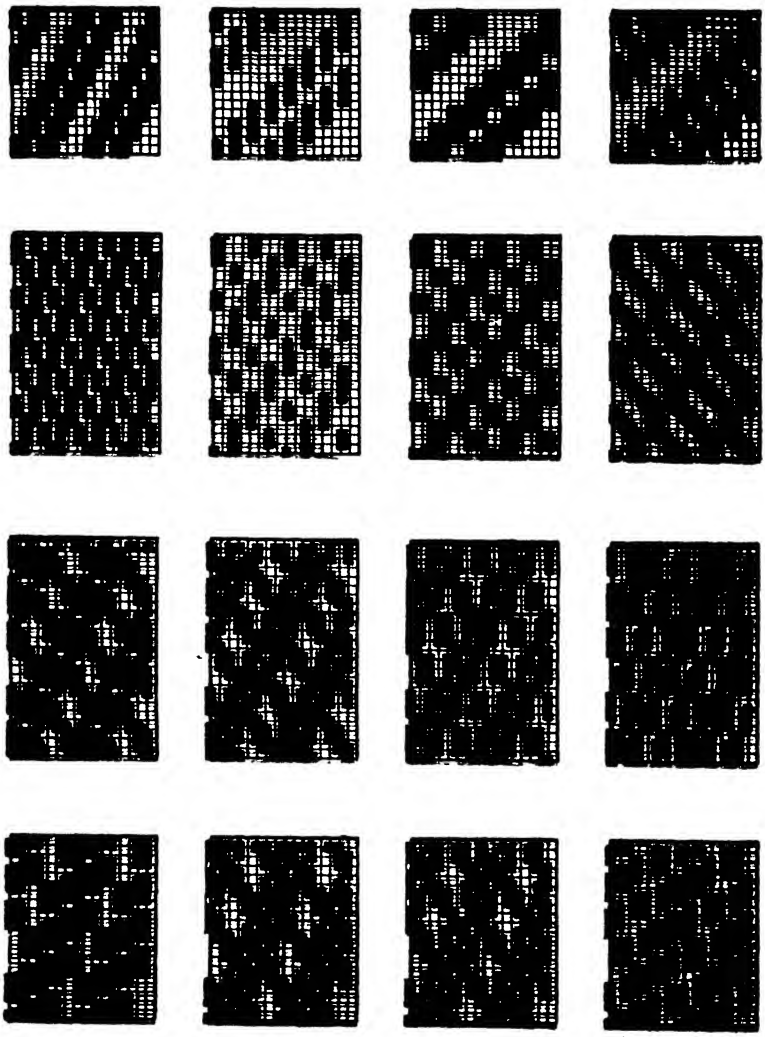

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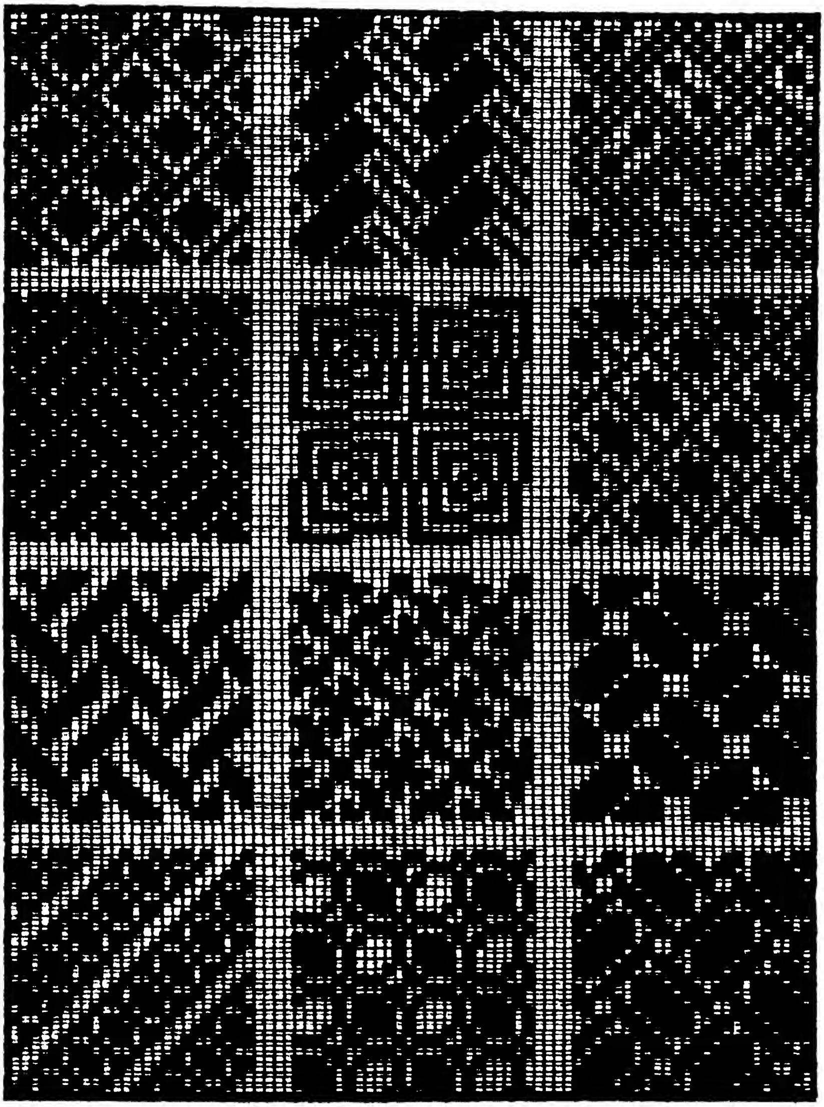

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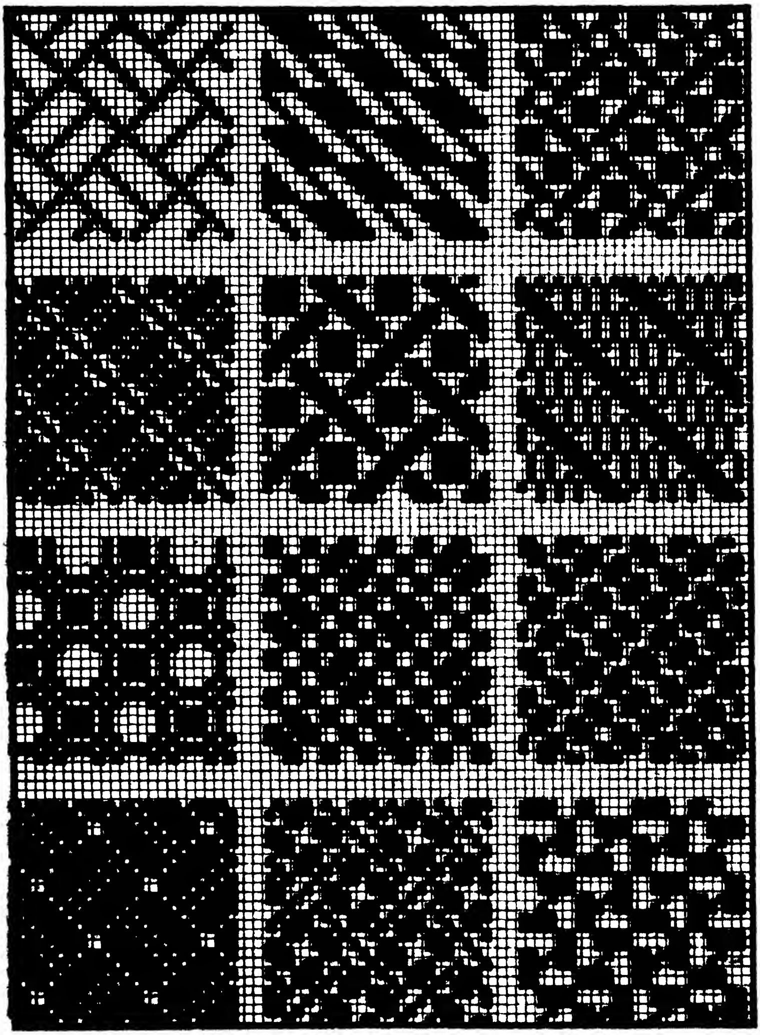

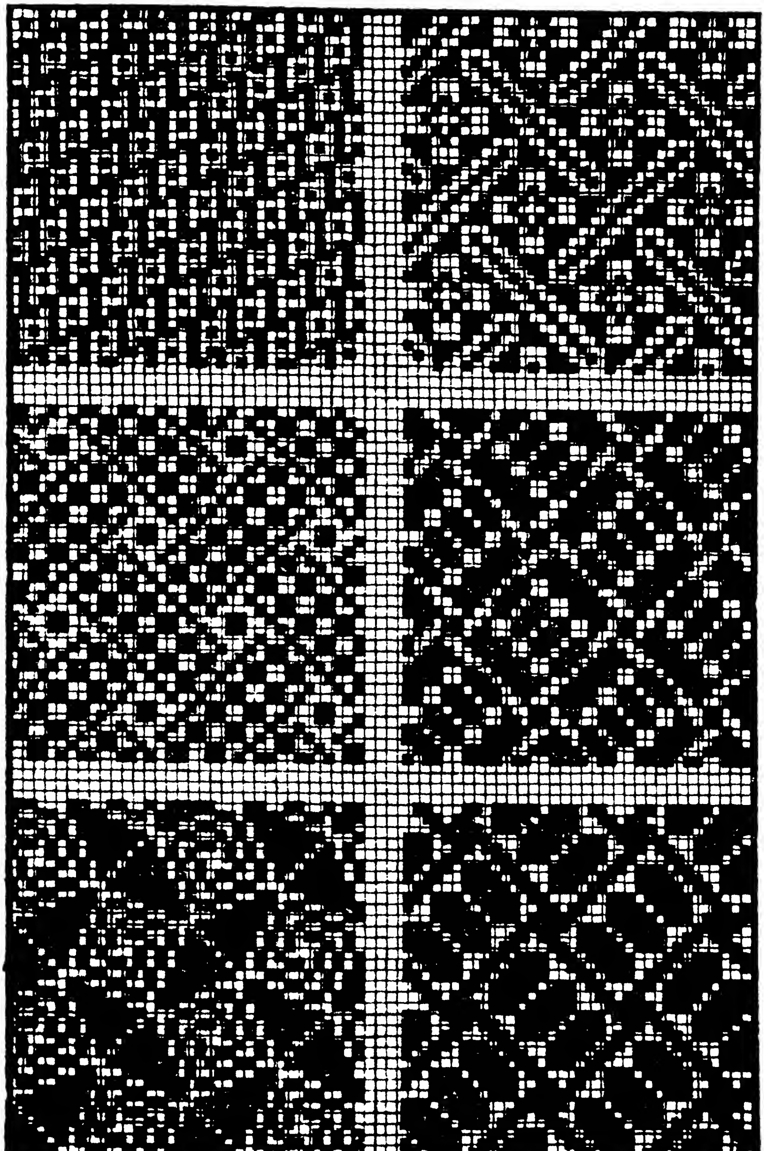

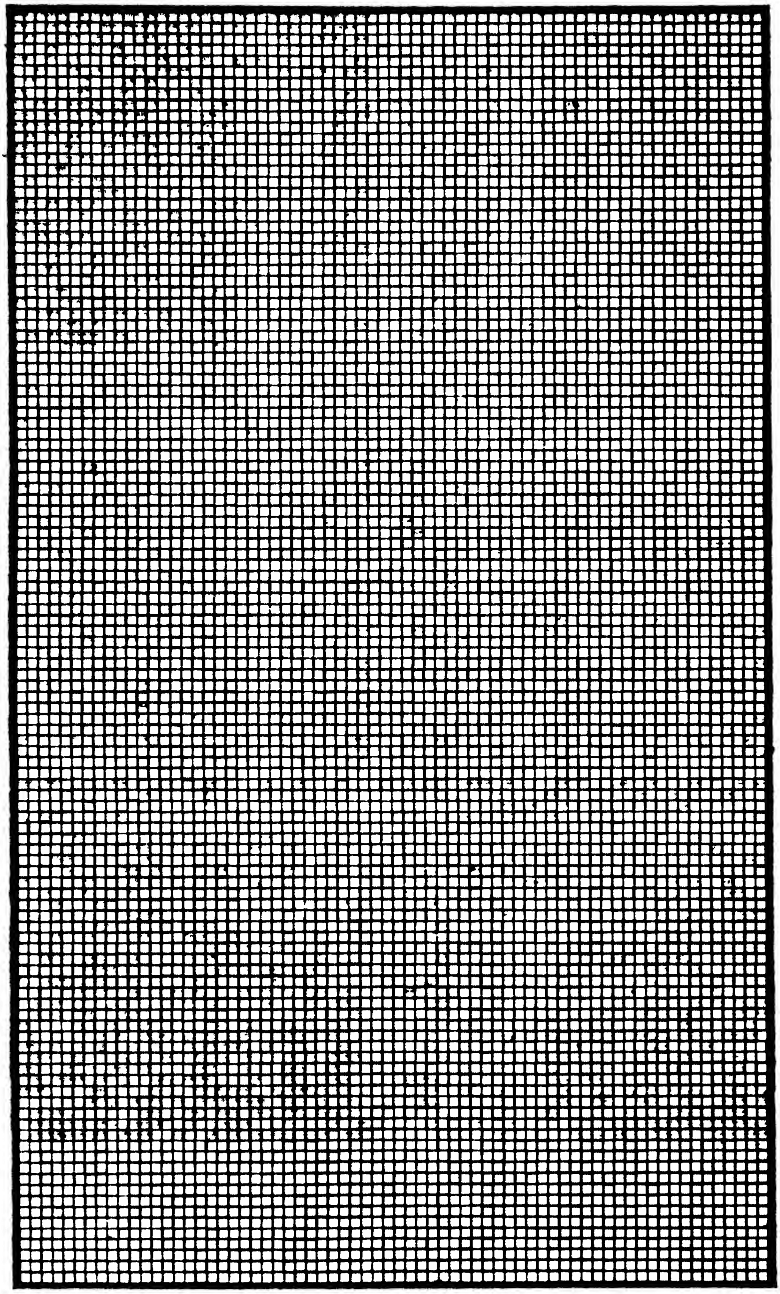

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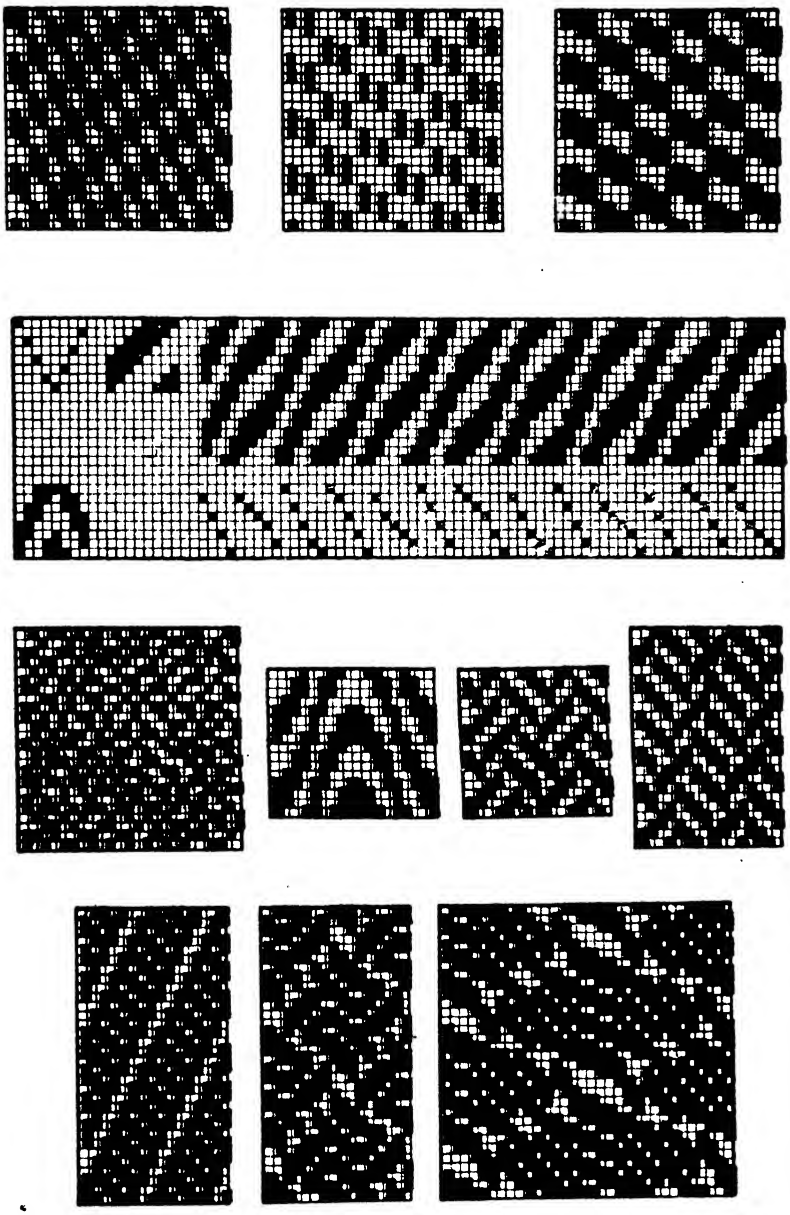

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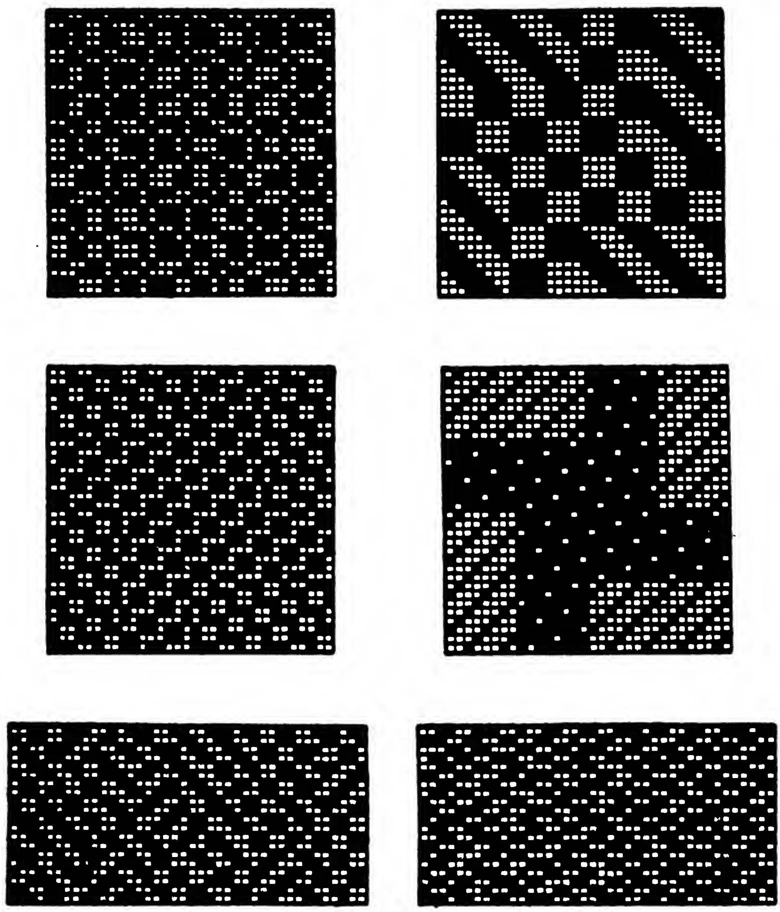

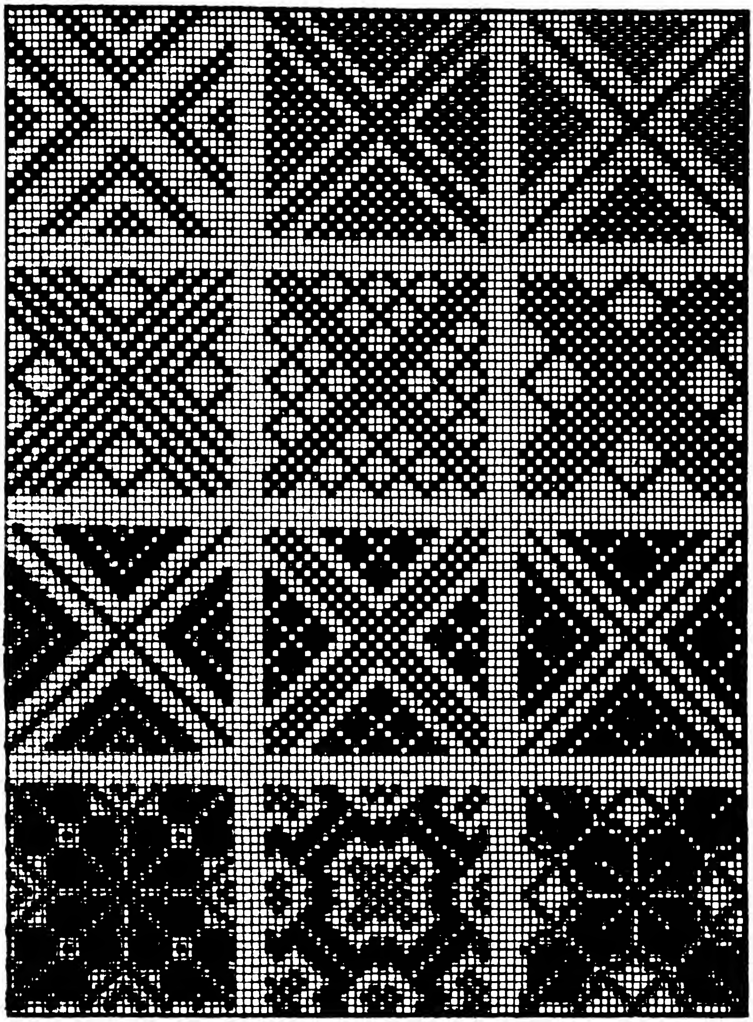

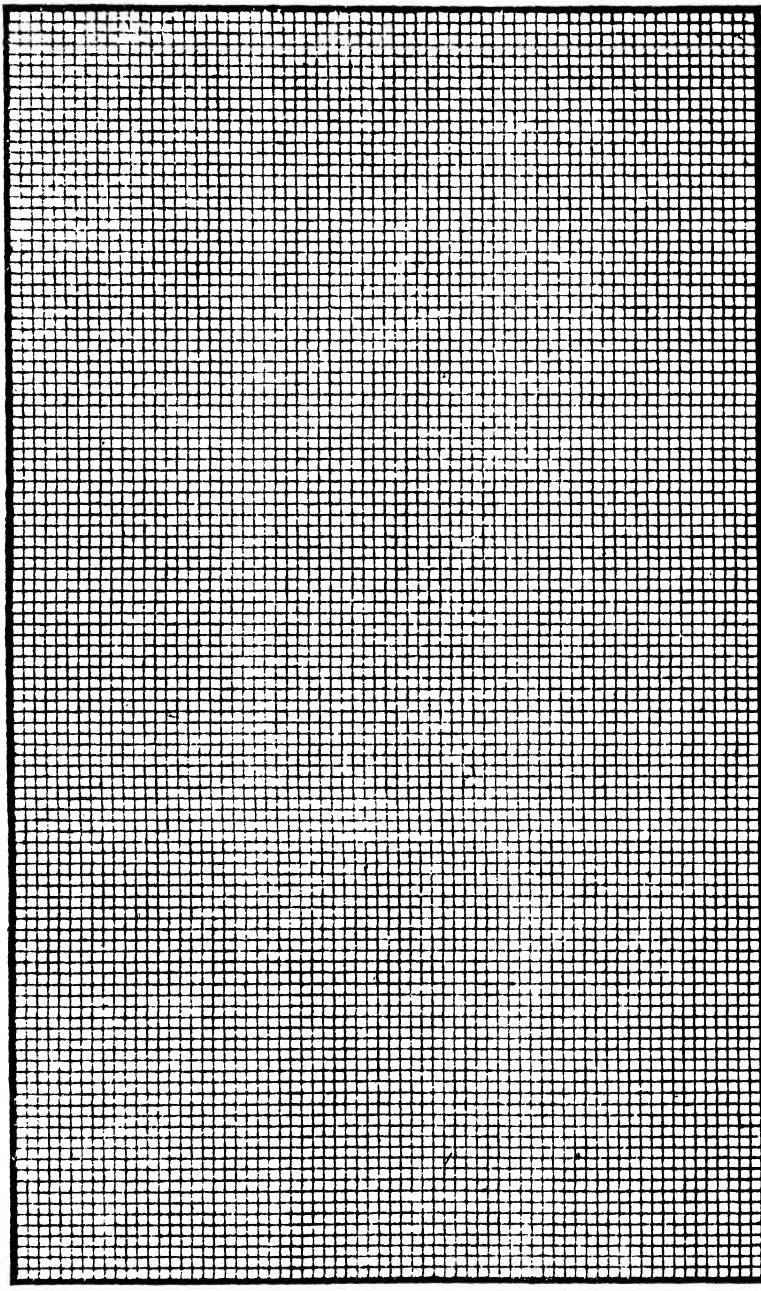

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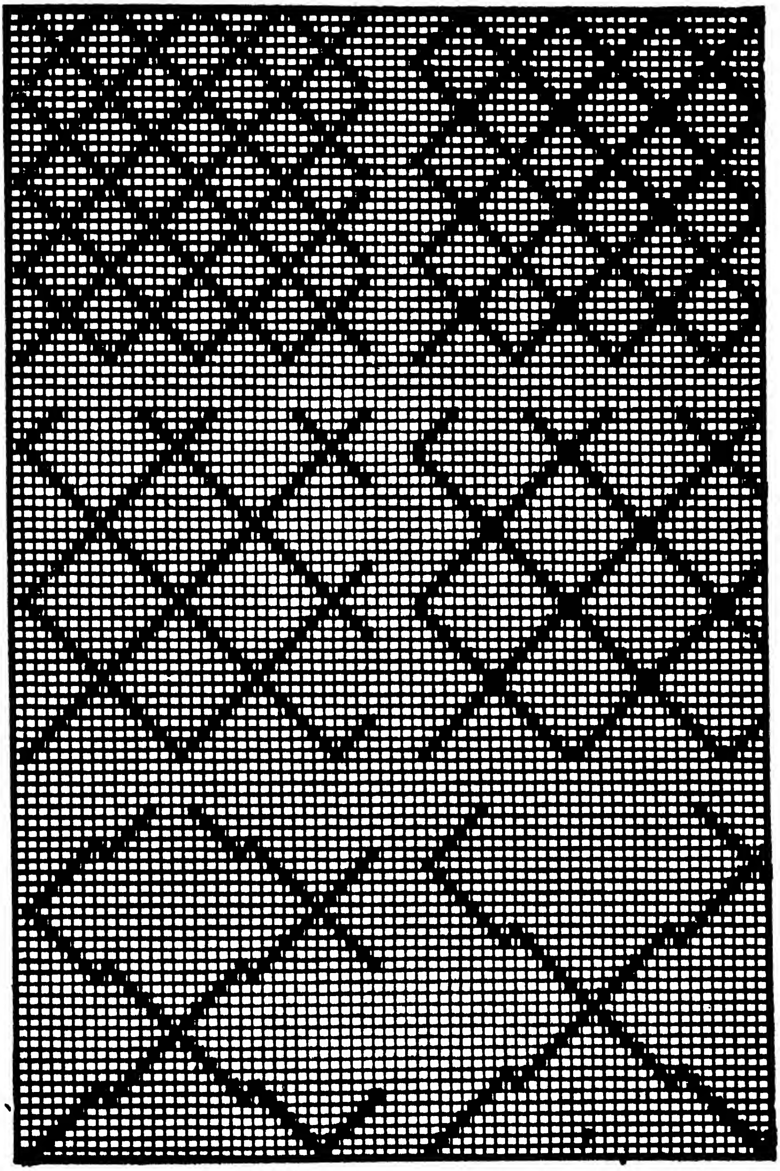

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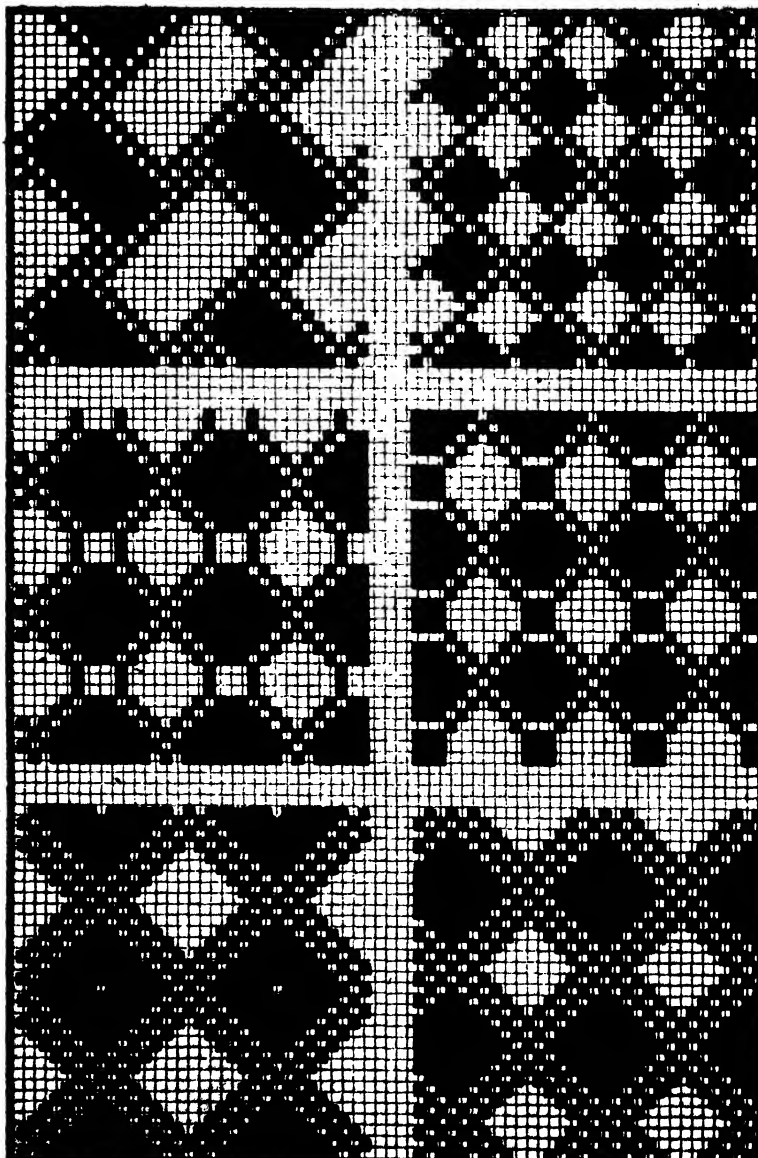

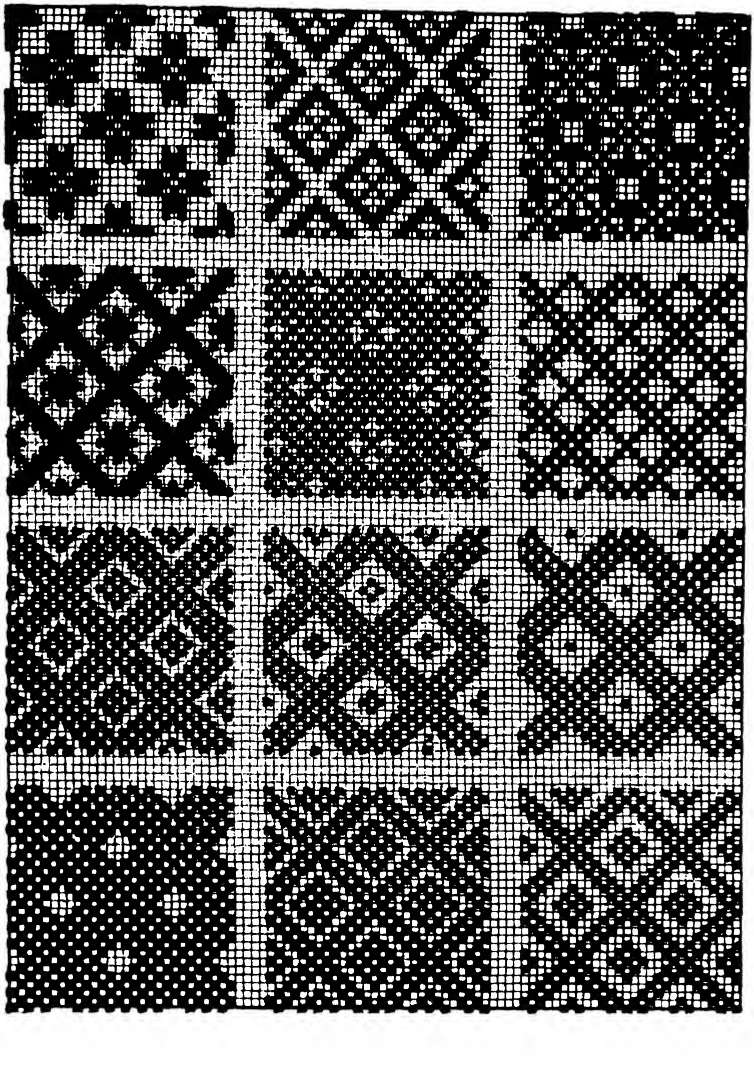

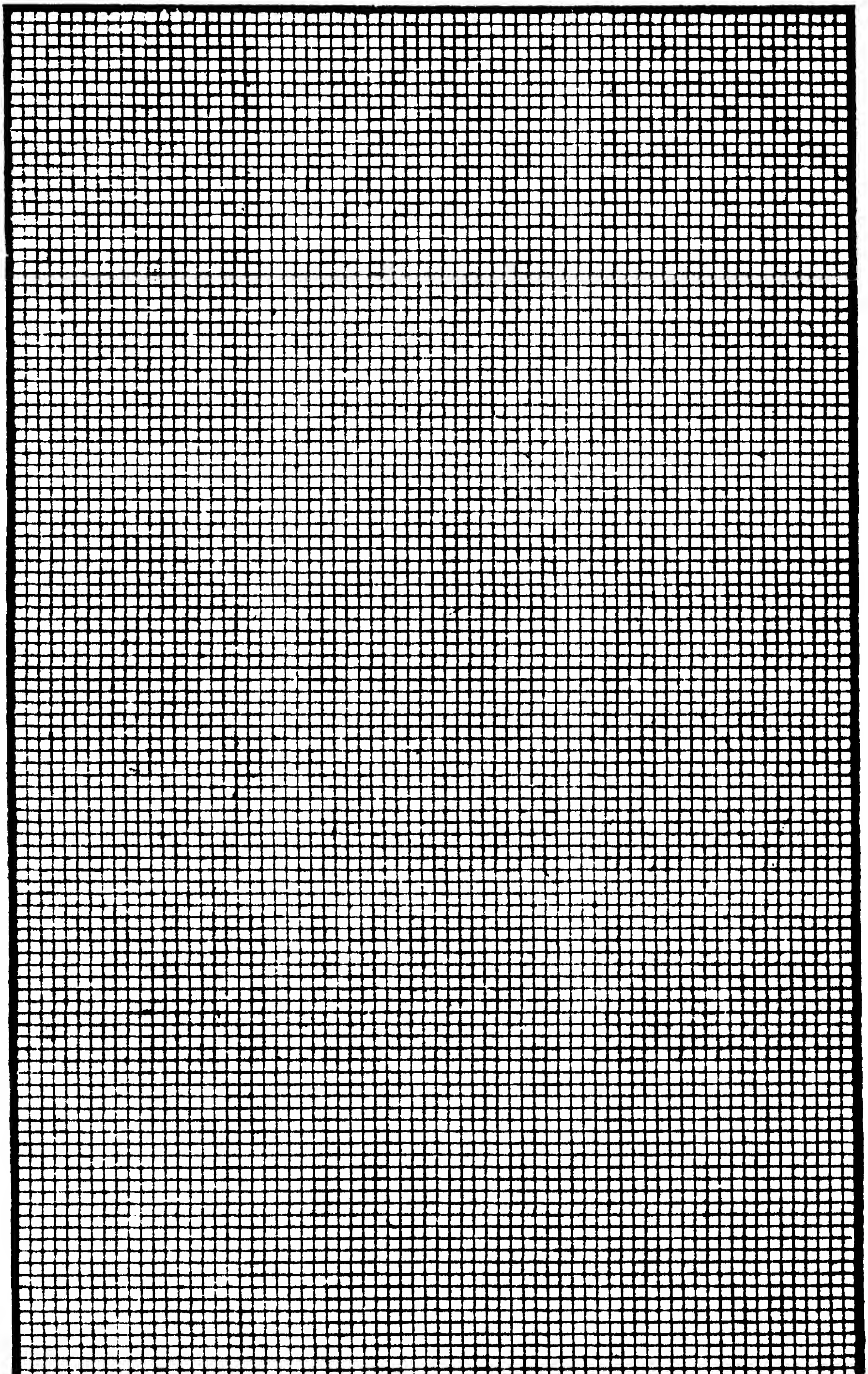

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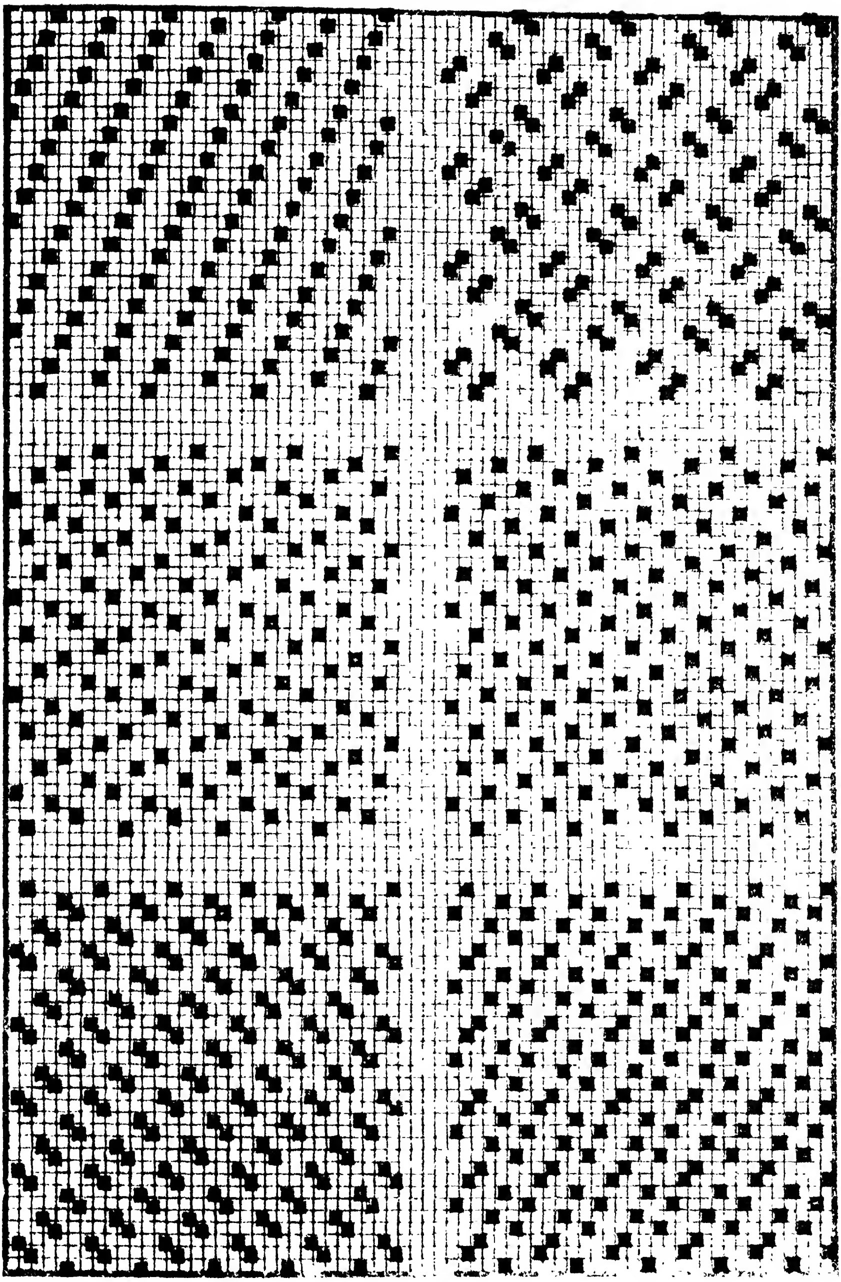

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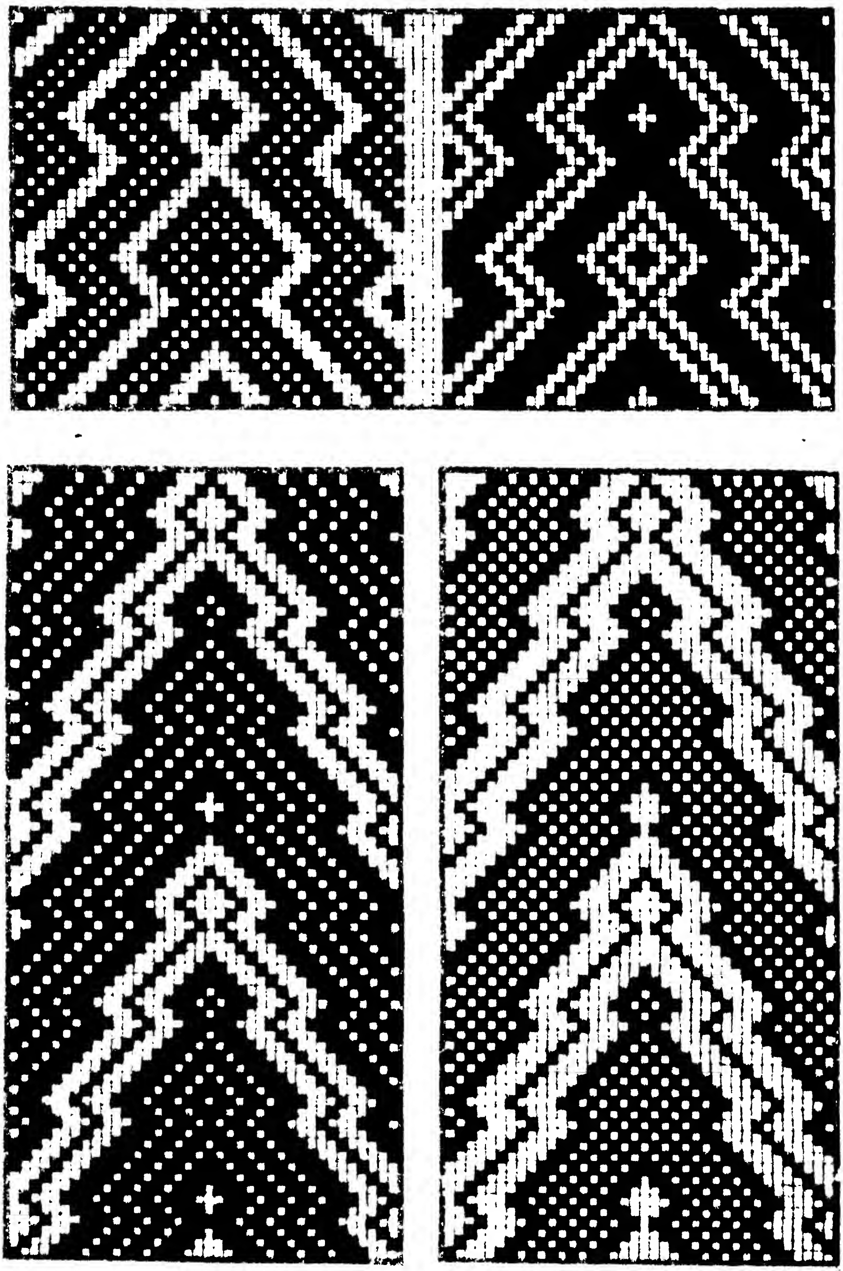

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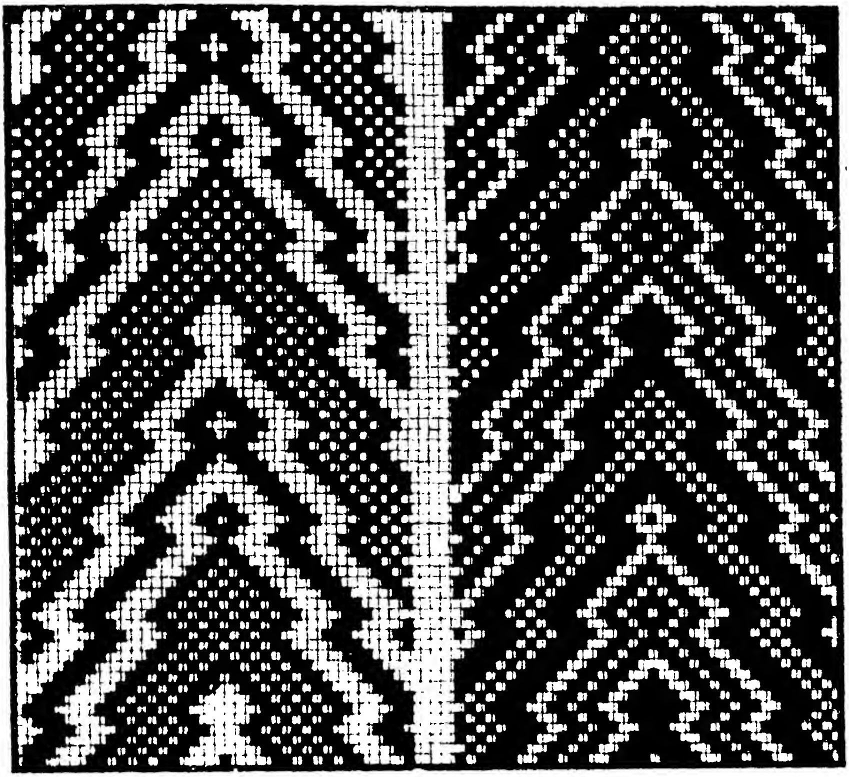

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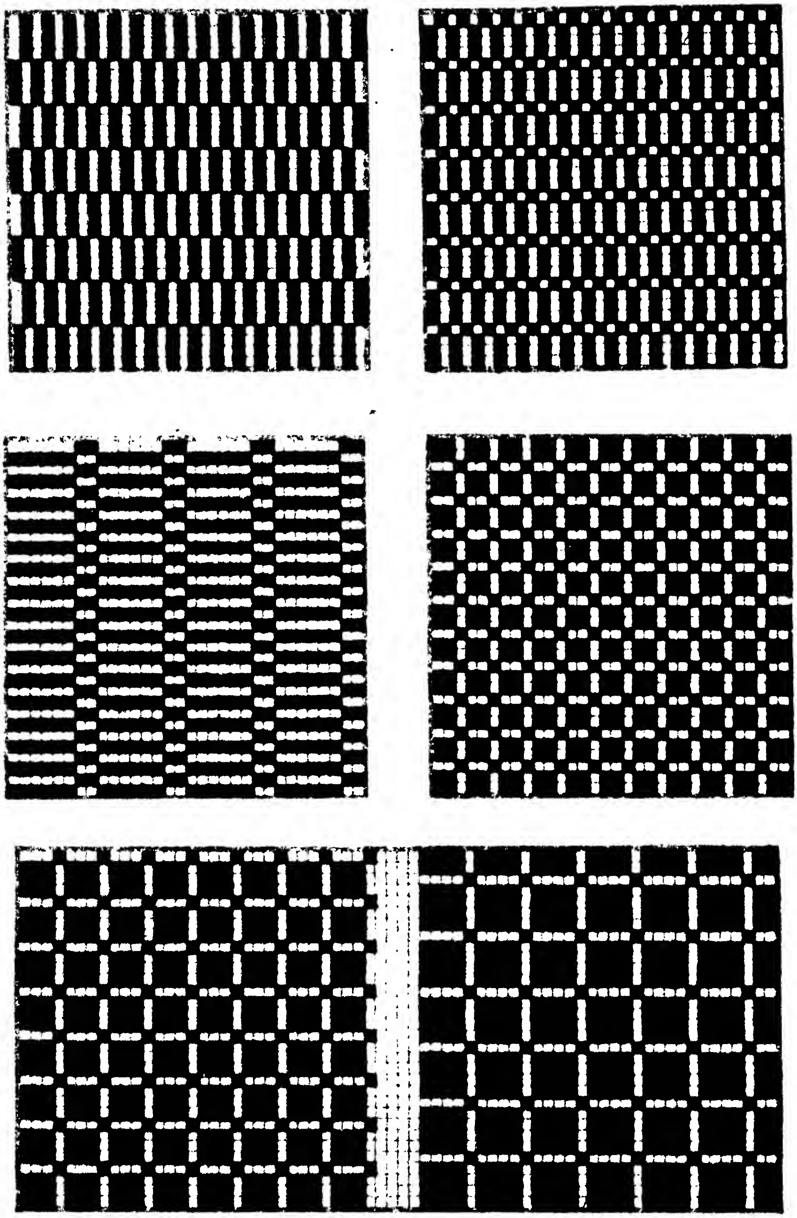

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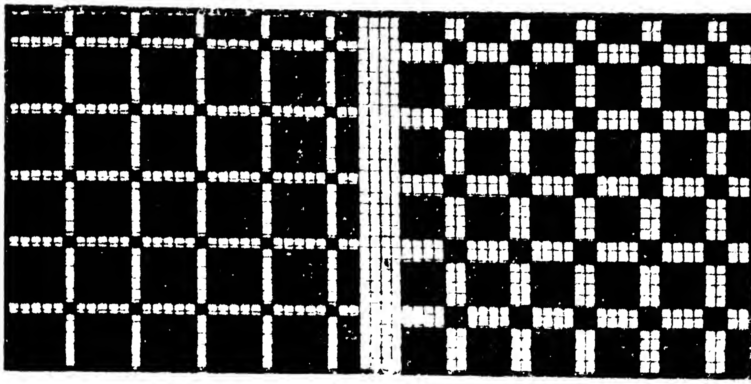

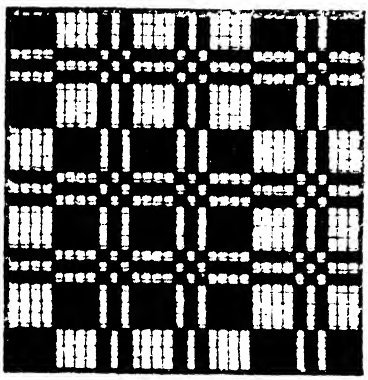

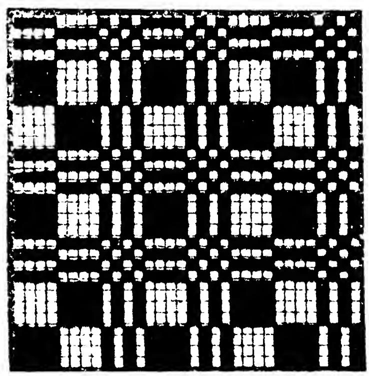

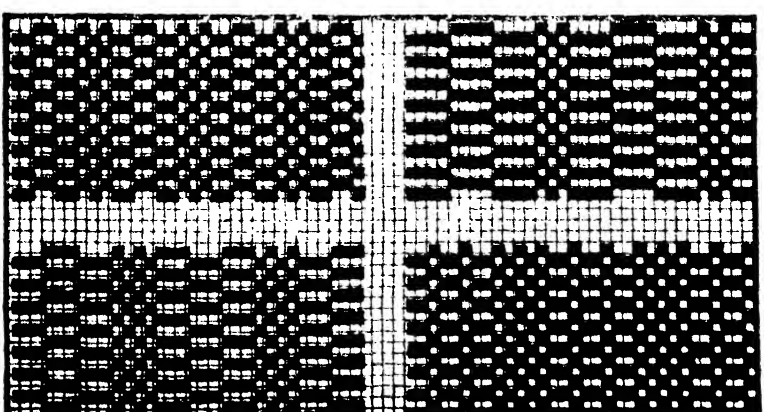

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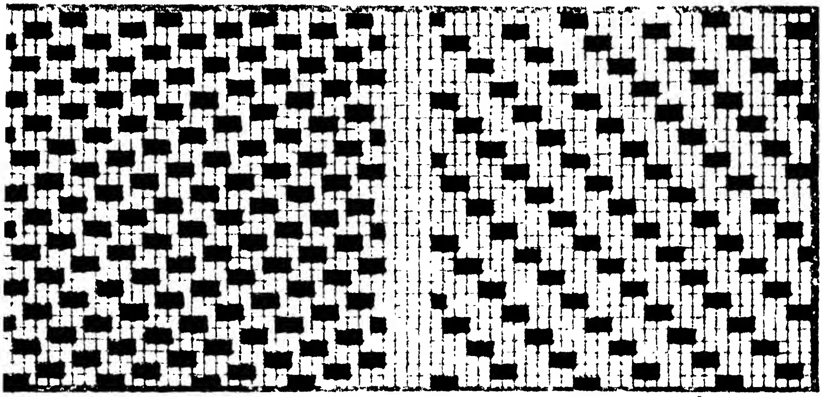

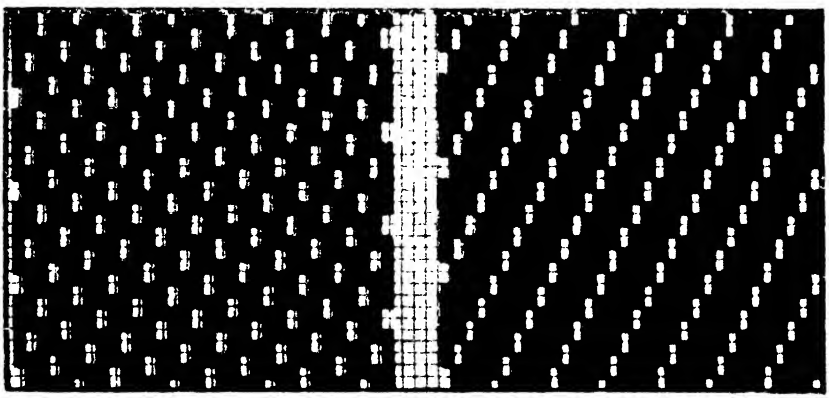

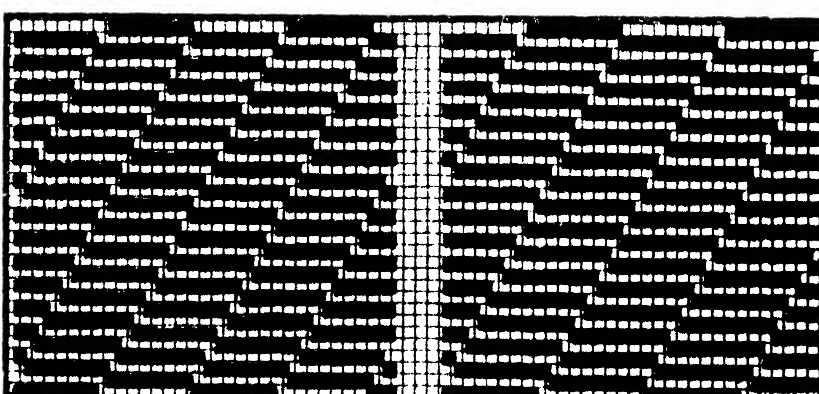

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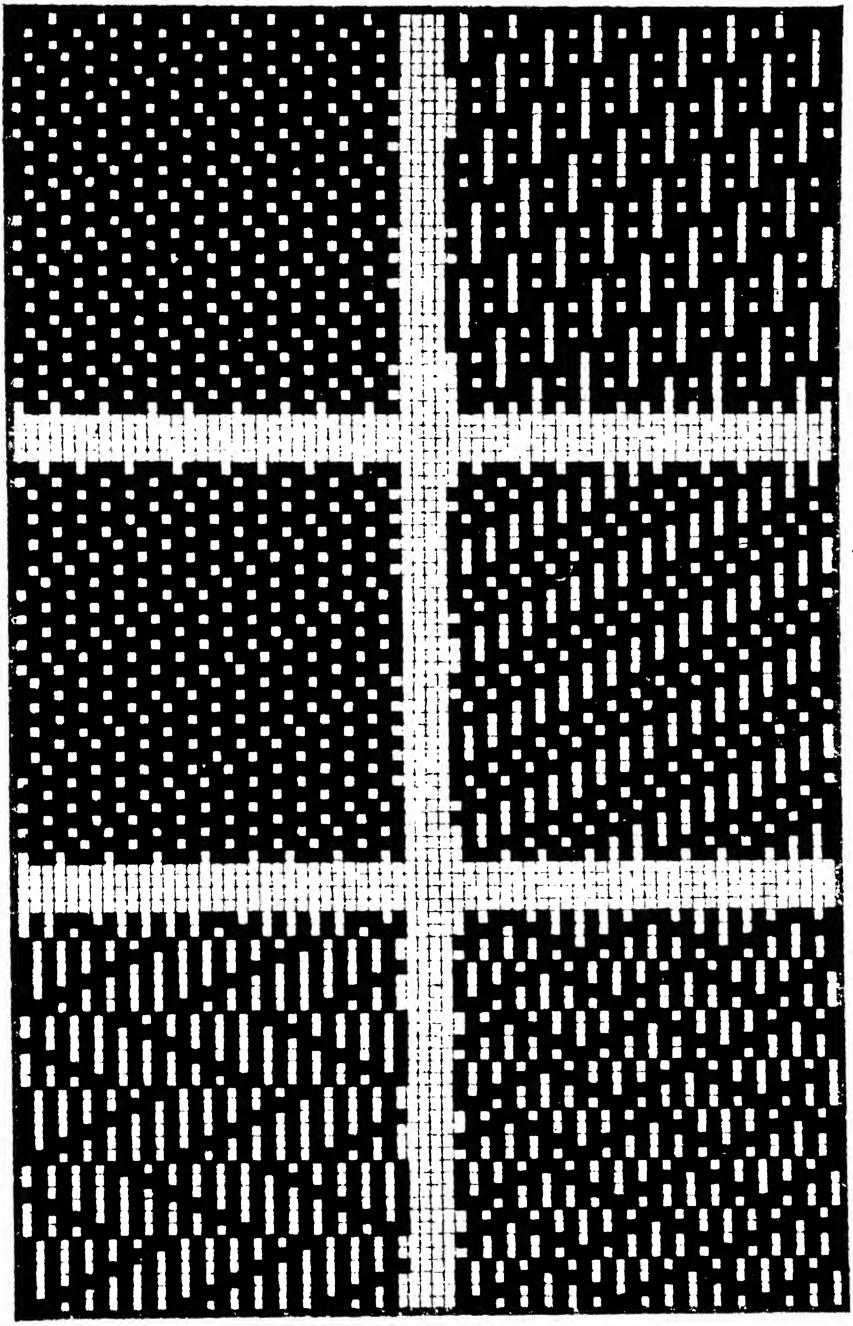

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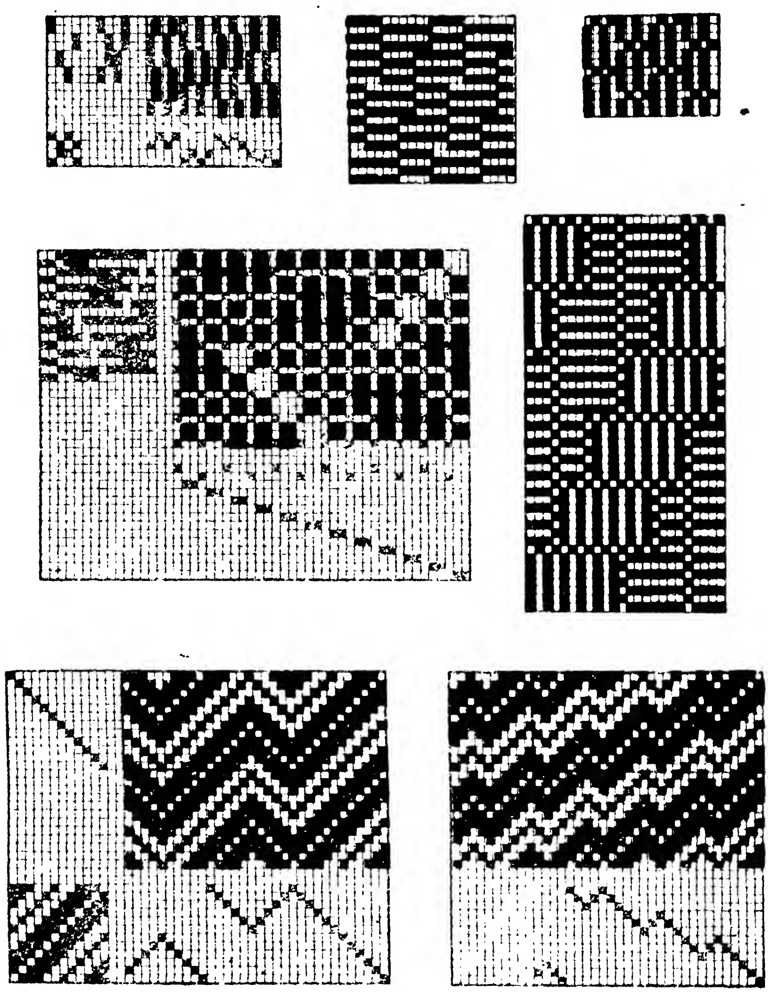

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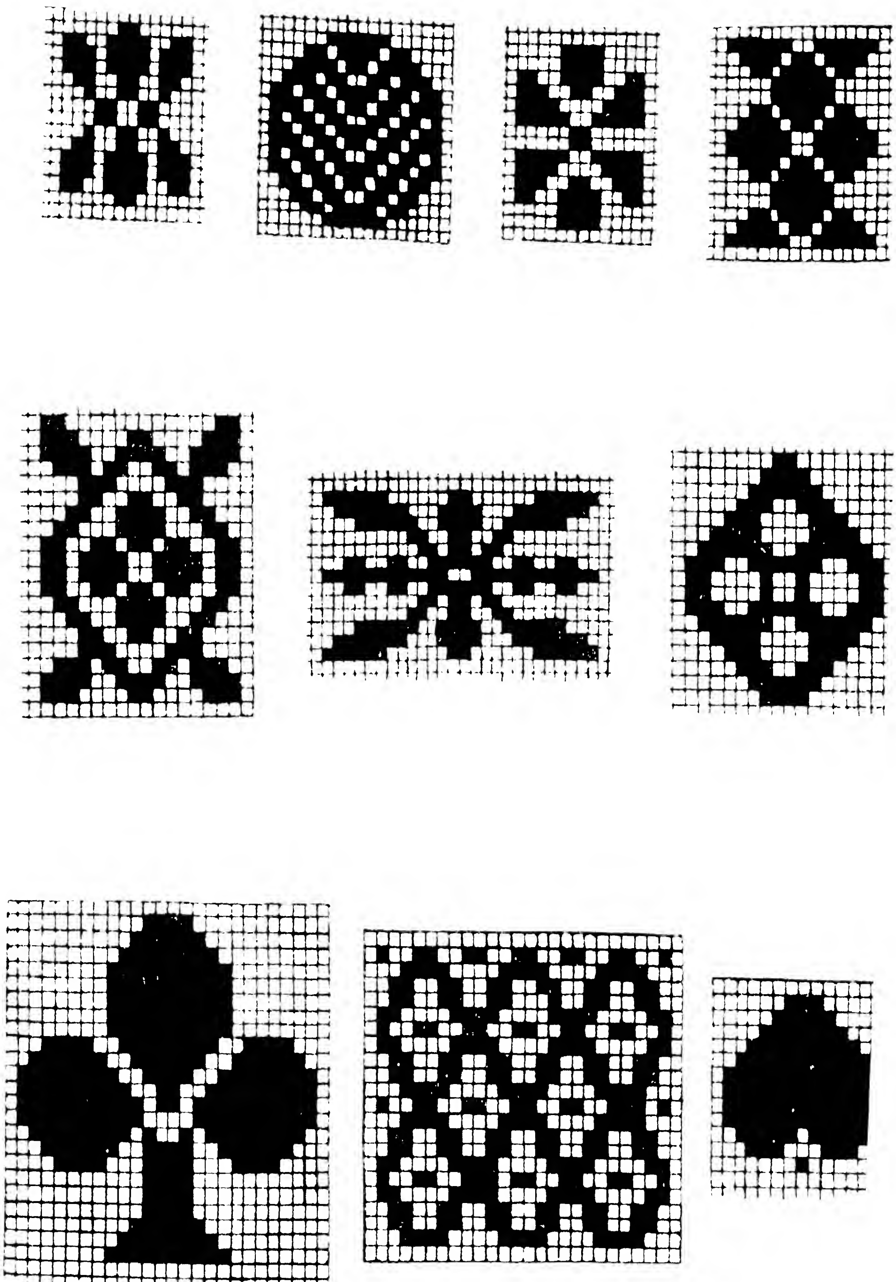

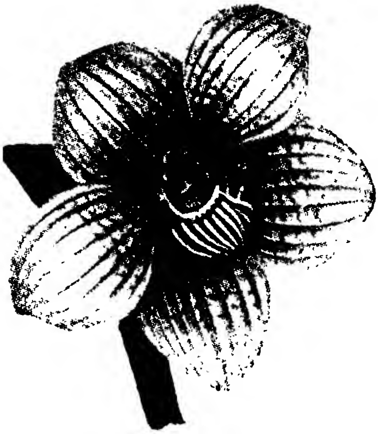

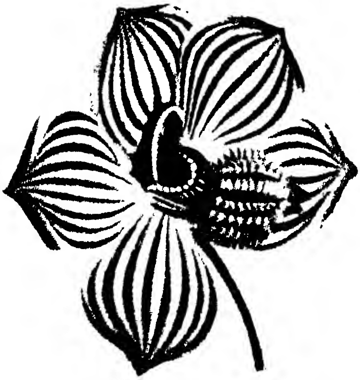

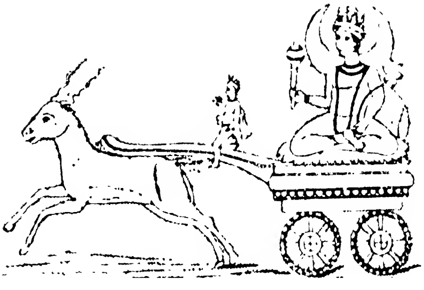

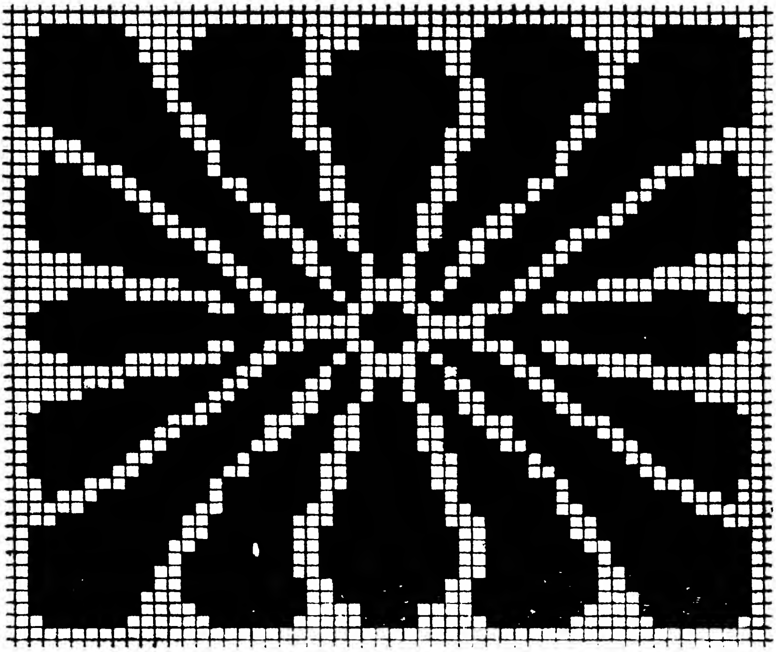

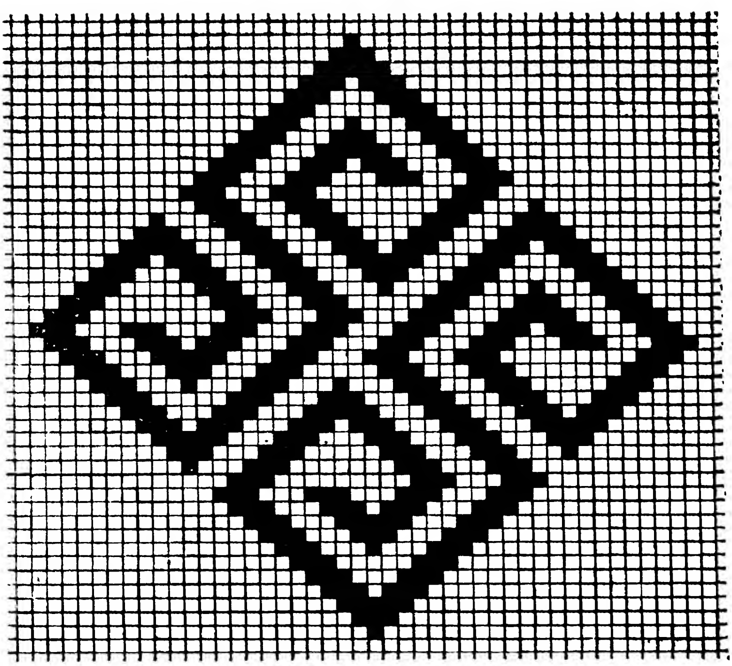

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