GLASS-WORKING FOR BEGINNERS

NEWNES

PRACTICAL MECHANICS

1/-

OCTOBER 1953

OCTOBER, 1953
VOL. XXI
No. 238

PRACTICAL MECHANICS

EDITOR
F. J. CAMM

The "Cyclist," "Practical Motorist," and "Home Movies" are temporarily incorporated.

By The Editor

Fair Comment

SPACE TRAVEL—WHEN ?

IN view of the mass of moonshine which has been written by non-technical writers about space travel to the Moon and Mars being imminent, I am pleased that Sir Edward Appleton, the famous physicist, had some comments to make on the subject in his presidential address to the annual meeting of the British Association. He took as his subject "Finding Out Things With Radio and Rockets," and on the subject of space travel he said that some of the more enthusiastic people who wrote on the subject envisaged a fleet of rocket ships travelling round the earth, to serve as a kind of space terminus station for trips to the Moon and other planetary bodies. Illustrations have been published of men moving about outside in space suits, tied to the space ship to ensure that they kept up the necessary speed. Life inside a space ship would not be as we know it in high-speed aircraft. In eating a meal, for example, food, having no weight, would not stay on the spoon and one would be compelled to use sugar tongs or chop sticks. He did not explain how the joint of beef would be tethered before carving or what would happen when the slice had been carved. The argument he adduced in this respect would, of course, equally apply to the occupants of the ship.

He asked a number of questions, but was wise enough not to give the answers. Could a space man survive such an experiment ? Could he stand the acceleration needed to send him to these great heights ? Could he stand exposure to the heavy cosmic rays from which we are protected at ground level by the atmosphere ? What was the chance of the space ship being punctured by a heavy meteor ?

He thought it foolish to ask the scientists how long it will be before one can take a ten-day trip round the Moon and inspect something no human being has ever seen—the back face of the moon. "Still more foolish is the scientist who tells you this will all certainly happen within 20 or 50 years."

I can answer the first three questions quoted in the affirmative. Presumably, Sir Edward has some doubts himself, but those who have given, perhaps, more time to the study of the subject than this eminent scientist have no doubts upon the matter. As to whether space travel will take place during the present century, I think that highly probable. The time factor will be entirely decided by the amount of money and time devoted to it. It took centuries to develop the aeroplane and the motor car, but science has now equipped itself with magic boots or a magic carpet. Where formerly it took small strides it now travels seven leagues. No longer is it necessary to rely entirely on trial and error because of lack of scientific knowledge. By means of radio control it is possible to conduct initial experiments with space ships which do not carry human beings but which are equipped with recording and photographic apparatus. The loss of life which normally accompanies experiments into the unknown need not be so great because the risk is minimised beforehand.

The same arguments which are now used against space travel were used against flying in the air with heavier-than-air machines. Television was once looked upon as the dream of a lunatic. Not so many years ago it was considered that the limiting speed of aircraft was the speed of sound. We now know, according to Einstein, that the limit is the speed of light. Regarding the acceleration of space ships, it should be remembered that less than 50 years ago doctors stated that no man could withstand a speed in a motor car of 60 miles an hour because he would die of heart failure.

It is somewhat curious in view of the scientific miracles which have happened in the past quarter of a century, when the lid of the Pandora's Box of science was lifted, to find scientists still doubtful regarding space flight. Which reminds me of the words of the late Wilbur Wright when he exhibited his machine to the French authorities. Learned professors inspected the machine, told him where the design was wrong and gave reasons why it could not possibly fly. Wright retorted "Parrots talk—they cannot fly !" He then proceeded to confound that argument by taking the machine in the air and making a perfect take off and landing.

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Editorial and Advertisement Office : "Practical Mechanics," George Newnes, Ltd., Tower House, Southampton Street, Strand, W.C.2
'Phone : Temple Bar 4363
Telegrams : Newnes, Rand, London.
Registered at the G.P.O. for transmission by Canadian Magazine Post.

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In future the Post Office will not, as a general rule, repurchase from publishers and advertisers stamps which have been used for payments ; that is the reason for this change.

ORNAMENTAL TURNING

IN the early part of this century ornamental turning was a widely practised hobby, but it has gradually declined in popularity chiefly because suppliers of ornamental turning lathes and the special chucks necessary have gone out of existence. Ornamental turning lathes, such as the Holtzapffel, are no longer made but are still greatly in demand. A large number of special attachments, such as geometrical chucks for turning irregular shapes, including ovals, were available. Many books were published on the subject, including a series by Holtzapffel himself. I mention this because it is news to me that the Society of Ornamental Turners was inaugurated about five years ago and at present has a membership of 85. It issues a half-yearly bulletin of about 30 pages containing useful articles.—F. J. C.

Glass-working for Beginners

The Properties of Glass, and the Simple Tools and Processes Used for Working It

By E. HARRIS MORGAN, B.Sc.

JUST as the carpenter or the metalworker must know something of the nature and properties of wood and metal, so also should the glassworker know something of the nature and properties of glass, in order that he might appreciate the technique of working in this medium. When the glassworker has a good grasp of this basic knowledge, the reasons for carrying out the various processes involved become clear, and there is less likelihood of material being wasted, with consequent loss of time, money, and temper!

Nature and Properties of Glass

Glass is essentially a fused mixture of the oxides of sodium, potassium, silicon, aluminium, calcium, lead, and boron in various proportions. The result of this fusion is not a straightforward chemical compound, but rather a "solid solution." This gives us a clue as to some of the properties that we might expect glass to possess. A *pure* chemical compound melts at a sharply defined temperature; a mixture on the other hand melts over a range of temperature. Glass, on being heated, behaves as a mixture; it does not melt at one temperature, but passes through a stage when it is soft and plastic. The whole art and technique of the glassworker depends on this latter property. The temperature at which glass softens depends on its constitution, and by varying the proportions of the different oxides different types of glass can be obtained. A typical "soft" glass would contain about 68 per cent. of silica (silicon oxide), 14 per cent. of sodium monoxide, and 7 per cent. of lime (calcium oxide). There may also be present small percentages of alumina (aluminium oxide) and potassium monoxide. A typical hard glass, on the other hand, would contain a greater percentage of potassium monoxide and less sodium monoxide, e.g., 64 per cent. silica, 20 per cent. potassium monoxide and 11 per cent. lime. "Fire-proof" glasses such as Pyrex contain a considerable proportion of boron trioxide, while lead glass, as might be expected, contains a high proportion of lead oxide. Since the proportions of the various ingredients can be varied within quite wide limits, there are a large number of formulae, and glass made in accordance with any particular formula will have different properties from glass made in accordance with another formula. These differences may be of sufficient magnitude to preclude the satisfactory completion of a piece of work when using glass from two different sources, or even glass obtained from the same source at different times (e.g., when joining two pieces of tubing).

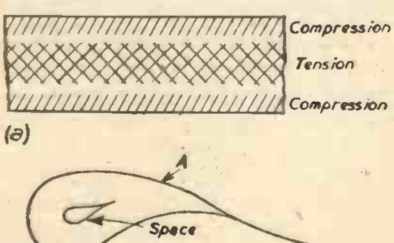


Fig. 1.—(a) Strains produced in sheet glass by rapid cooling. (b) Rupert's drop.

In general, however, glasses can be classified as "soft," "hard," "resistance," "lead," or "optical." This article describes the methods and technique of working in "soft" glass, although some of the methods can also be applied to "hard" glass.

Heating a piece of glass tubing prior to bending. (Note blow-tube and assortment of rubber stoppers in left foreground.)

Manufacture of Glass

The following account of the manufacture of glass does not pretend to be complete, but is merely included so that the reader should have some knowledge of the way in which the process of "fusing" takes place.

Glass is manufactured by melting together in a "pot" furnace the calculated weights of the various constituents, together with a definite quantity of scrap glass, known as "cullet." The heating of the furnace takes place in two stages. At first only moderate heat is applied so that no fusion takes place. This is necessary so that carbon dioxide evolved during the reaction shall be released at a steady rate. (The sodium and potassium oxides in glass are formed from sodium carbonate and potassium carbonate respectively.) The temperature is then raised to about 1,500 deg. C. and maintained at this temperature until the reaction is complete. The glass may then be moulded, or, at a slightly lower temperature, be worked into sheets and tubes.

Annealing

When hot glass is cooled rapidly, the outside surface of the glass hardens first and also contracts. The interior of the glass cools last of all, and of course, also contracts. The result of this is that severe strains are set up in the glass, and a very tough glass is produced; in fact, a specialised method of rapid cooling is used to produce "toughened glass." Fig. 1(a) shows the zones of compression and tension produced in a sheet of toughened glass plate. The exact limits of the zones will depend on the rapidity of cooling. In extreme cases the contraction of the interior of the glass can produce a space. This can be seen in Rupert's drops, shown in Fig. 1(b). These drops of glass, first produced by Prince Rupert of Bavaria, can be made by melting a rod of glass in a blow-lamp flame and allowing the molten glass to fall into a beaker of water or oil. If the tail of the drop is cut off at the point A (Fig. 1(b)) the *balanced* strains are released and the drop flies explosively into small granules having rounded edges. This last operation should be carried out by nipping the tail with a pair of pliers, the drop being held inside an inverted glass jar to protect the operator from flying fragments.

Strains in glass can be released suddenly with consequent rupture of the

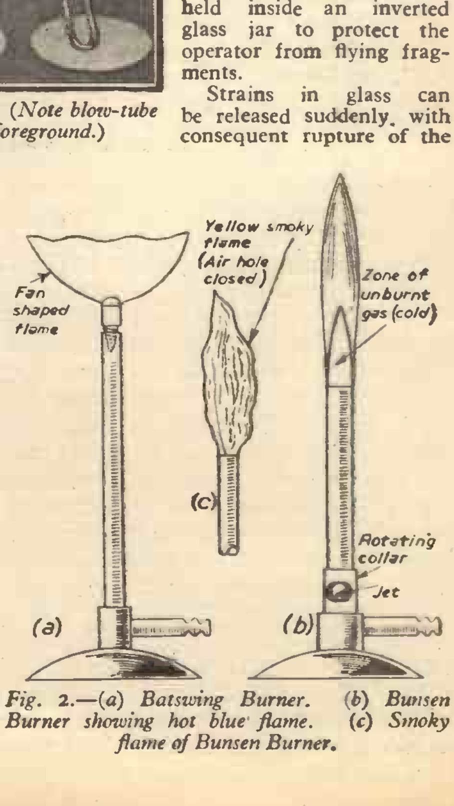


Fig. 2.—(a) Batswing Burner. (b) Bunsen Burner showing hot blue flame. (c) Smoky flame of Bunsen Burner.

glass, through a variety of circumstances, such as heating the glass, scratching it and so on. A strained glass is not suitable for normal purposes, and steps must be taken to release the strains slowly and safely, or to arrange matters in such a way that a strained condition is avoided. This is done by heating the glass *slowly* until it is near the softening point, and then allowing the glass to cool very slowly so that each part of the glass cools at the same rate. This process is known as annealing. On a large scale, special annealing ovens are used. These ovens are long in shape, and through them passes a moving belt. One end of the oven is maintained at a high temperature, and there is a gradual temperature gradient along the oven to the other end which is cool. The glass articles pass slowly through the oven from the hot end to the cool end, thus cooling gradually and evenly. On a small scale, glass articles are annealed by transferring them from the working flame to a smoky flame. They are kept in the smoky flame until a layer of carbon forms on the surface. This layer cannot form until the temperature of the glass has fallen to a certain value, and indicates that the article has cooled sufficiently to be removed from the flame. The work should then be allowed to cool completely in a draught-free atmosphere. It cannot be stressed too strongly that annealing must be carried out thoroughly if satisfactory work is to be turned out.

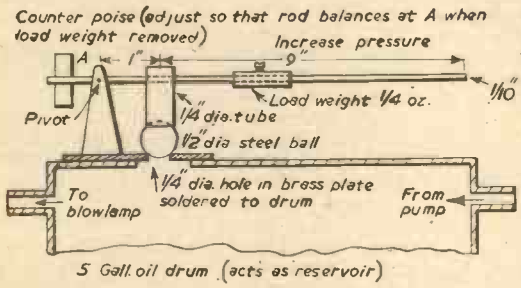


Fig. 5 (*a*).—*Section of a pressure release valve.*

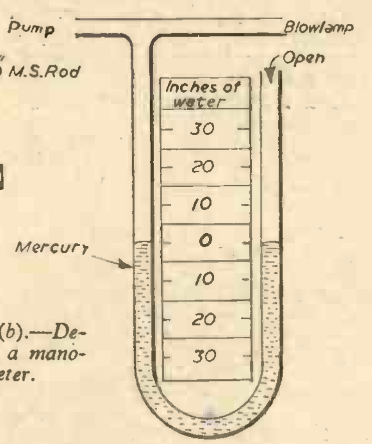


Fig. 5 (*b*).—*Details of a manometer.*

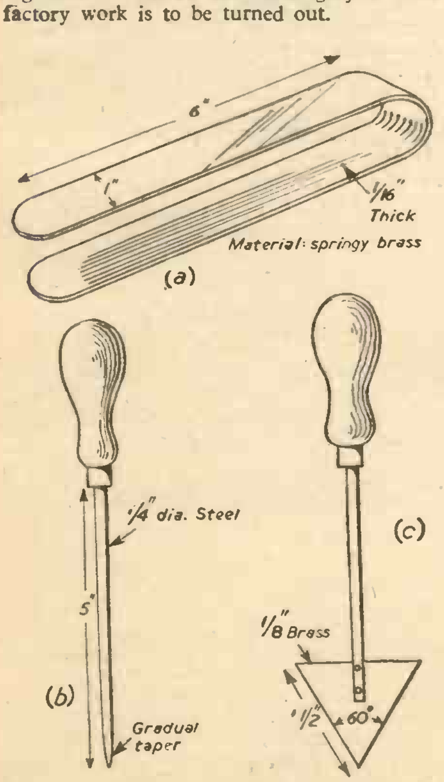


Fig. 3.—*Glassworkers' tools.* (*a*) *Tongs.* (*b*) *Spike.* (*c*) *Rimming tool.*

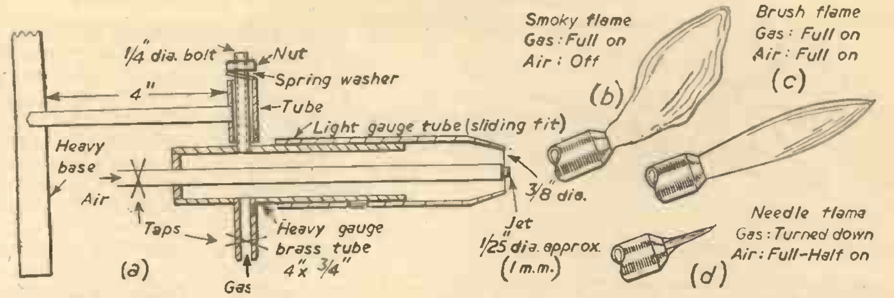


Fig. 4.—(*a*) *Diagram of blast blowpipe.* (*b*) *Smoky flame.* (*c*) *Brush flame.* (*d*) *Small pointed flame.*

Working Bench

The first essential is a workbench of convenient height and size. When working with small easily held pieces, it is customary to sit at the bench, and a height of 28in. is recommended. The chair or stool should be of such a height that the elbows can be rested comfortably on the bench top. Glassworking is a delicate, and at times a tiring, job, and the comfort of the operator is a prime consideration if good work is not to be spoiled. The bench need not be large; a top 30in. by 30in. is big enough for most work. There should, however, be plenty of room around the bench, particularly to the right and left, so that long lengths of glass tubing may be handled. The top of the bench must be protected against burns from hot glass, and should be covered with a sheet of iron or asbestos. Finally, the bench should be placed where it is not in direct light. A position where the light is subdued is advisable for glassworking. As the amateur becomes more experienced in glassworking, he will learn to judge the temperature of the glass by its appearance and by the appearance of the flame, and this is more easily done in subdued light.

Tools

The glassworkers' basic tool is merely a hot flame. Flames come in all shapes and sizes, however, and it is part of the skill of a glassworker to know just what size and shape of flame he requires *and how to produce it.* One instrument cannot possibly produce all the types of flame that are needed; in practice, three types of burner are in common use, and these are described below.

For the simplest jobs, two types of heat-producing source are required. One of these is the batswing burner (approximate cost 4s. 6d.) Fig. 2(a), and the other the Bunsen burner (approximate cost 3s. 6d.) Fig. 2(b). The Bunsen burner can be replaced, for certain operations, by a blowtorch of the type described in PRACTICAL MECHANICS for July, 1953. With these two heat sources, a great deal of simple glassworking can be accomplished, and the beginner is advised to master the technique of simple operations with these sources before proceeding to more advanced work.

The batswing burner and the Bunsen burner are shown diagrammatically in Figs. 2(a) and (b), together with the types of flames produced by each. The batswing burner produces a thin fan of flame of a smoky character. It is used for heating glass tubing prior to bending. The only adjustment possible with the batswing burner is that of varying the size of the flame by varying the amount of gas at the gas tap. This adjustment is of considerable importance when bending glass tubing, as will be seen later. The Bunsen burner can produce two distinct types of flame. These are shown diagrammatically in Figs. 2(b) and (c). At the base of the Bunsen barrel there is a hole which can be covered by a sliding collar. When the collar is arranged so that the hole is open, the rush of gas through the jet sucks in air through the hole. This air mixes with the gas which burns with a clear hot blue flame (Fig. 2(b)).

Particular attention should be paid to the structure of this flame, and it should be noted that the inner zone of unburnt gas is *cold.* The air sucked in through the hole is called "primary air," while the air obtained at the top of the barrel is known as "secondary air." If the primary air is cut off by closing the air-hole, a cooler smoky flame is obtained as shown in Fig 2(c). The height of the flame can be controlled by regulating the amount of gas at the gas tap, but care should be taken not to attempt to obtain too low a flame with the air-hole open, or the burner may "strike back"; that is to say, the flame will travel down the barrel and burn at the jet. This condition can be corrected, without putting the burner out, by turning the gas on full and giving the rubber supply tube a sharp thump with the closed fist. Both the clear flame and the smoky flame have their uses in glassworking.

Other tools needed for even simple operations are a polished iron block about 3in. × 3in. × 1in., a pair of glass tongs (or a pair of pliers fitted with smooth jaws), a spike mounted in a wooden handle, some triangular glass-cutting files (or knife), and a brass rimming tool. These tools (illustrated in Fig. 3) can be purchased from any good laboratory

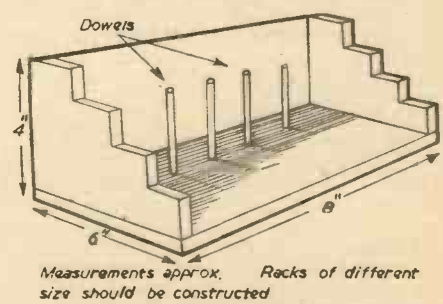


Fig. 6.—*Rack for holding work while cooling.*

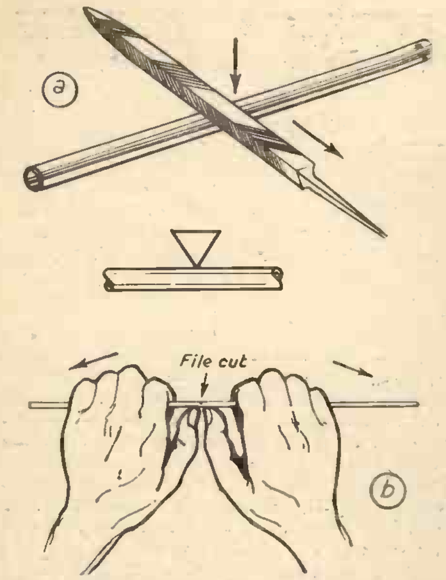


Fig. 7.—(a) Method of using file when cutting glass tube. (b) Position of hands when making a break.

suppliers, or, with the exception of the files, can be made quite easily by any handyman. For this latter purpose, approximate measurements are given in the figure.

When the worker proceeds to more advanced work, he will find the necessity for a piece of apparatus which can produce a small, pointed, very hot flame. Such a piece of apparatus is the blast blowpipe which is shown diagrammatically in Fig. 4. It should not be beyond the capabilities of the handyman accustomed to working in metal to produce an instrument of this type. They can, of course, be purchased from laboratory suppliers at a cost varying from £2 for the simplest type to about £4 for those with special refinements.

It will be seen from Fig. 4 that a blast blowpipe requires a supply of air under pressure. This can be supplied from a foot-bellows, or more conveniently, from a motor-driven airpump. Pumps of suitable types are often advertised in this journal. The important point to note in selecting a pump is that it should deliver air at a pressure of about 48-60 inches of water, under working conditions. If a pump delivers air above this pressure, a simple form of pressure-release valve can be constructed to reduce the pressure to that required. Fig. 5(a) shows one form of valve which can be used. In order to measure the pressure developed, a manometer of the type shown in Fig. 5(b) can be constructed in glass.

The remaining equipment required is racks to hold the store of glass tubing, and a small rack to hold hot work while cooling. Details of this latter rack are shown in Fig. 6. The workshop should also contain bins for waste glass and for recoverable glass. Biscuit tins make suitable containers for this purpose. A few asbestos "toast" mats will be found useful for holding cooling glass. Since, when learning, a few burns are almost inevitable, a tube of "anti-burn" ointment should be within easy reach.

Raw Material

The raw material of the glassworker is glass tubing and glass rod. This can be obtained in a variety of diameters, and, in the case of tubing, in a variety of thicknesses. It is sold by the pound in standard lengths of about five feet. The reader is advised to use standard wall glass tube until the various operations have been mastered. The cost of glass tubing is about 3s. a pound, with slight increases for tubing of large and very small diameter.

The tubing can be stored in either a horizontal or a vertical rack. Vertical storage is suitable when there is rapid turnover of stock; horizontal storage (with the whole length of tube supported), when stock is consumed slowly. In both cases, the storage rack should be dust-proof. One of the most useful sizes of glass tubing and glass rod is that with a diameter of 5 millimetres. When buying glass tube it is probably best to purchase "assorted sizes," with a few additional pounds of 5 millimetre tubing. Remember to specify "soft" glass tubing, unless other grades are required.

Cutting Glass Tubing

One of the most frequent operations that the glassworker is called upon to perform, is that of cutting glass tubing. The instrument used for this purpose is a triangular file. The tubing is placed on a flat surface, and a scratch made in the desired position by *drawing* the file towards the operator and applying *moderate pressure*, the tang of the file being held in the hand (Fig. 7(a)). It is customary to use the file without a handle for this operation. The orthodox method of filing as carried out on metal should NOT be employed as it is decidedly dangerous to do so. The glass tube is then picked up and arranged so that the hands are placed as shown in Fig. 7(b). It should be noted that the cut in the tube is at the opposite side of the tube from the thumbs. The hands

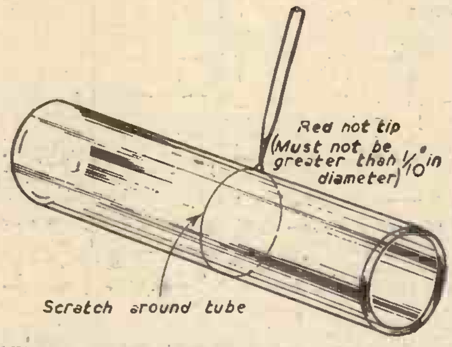


Fig. 8.—Method of cutting large diameter glass tubing.

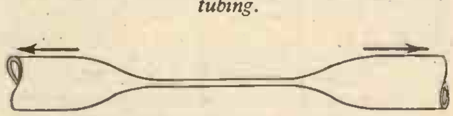


Fig. 9.—"Drawing-off" a glass tube.

are then pulled apart with a *slight* bending motion as indicated in Fig. 7(b). The bending motion must not be overdone. The glass tube is held low in front of the body to minimise the risk of splinters striking the operator. It is important not to force the break, and if a fracture does not occur easily the cut should be deepened with another stroke of the file. This method is suitable for tubes up to a diameter of about three-eighths of an inch. Above this diameter another method must be used. A scratch is made completely around the tube at the required point using a file or a special form of tube cutter. A fine glass rod is then pulled out in a Bunsen flame so that it tapers to a fine point. This point, which should not be more than one-tenth of an inch in diameter, is heated until the glass is red hot and then pressed squarely on the scratch. If successful, a "snick" will be heard and a crack seen following the scratch part way round the tube. The process is repeated, the crack being led around the tube until complete fracture occurs. Fig. 8 shows how the hot rod is applied to the tube. This latter operation needs the exercise of considerable skill and judgment, and the reader is advised to practise on scrap glass until the process is mastered.

Whenever possible, the glassworker avoids the cutting of tubes and "draws-off" instead. This process consists of heating the tube, and, when the tube is soft, drawing the ends apart as shown in Fig. 9. It is essential that the glass be heated evenly throughout, and to obtain this condition, the tube must be rotated in the flame. When the tube is rigid, rotation is performed easily, but when the glass softens, it is possible to rotate the ends at different rates. This must be avoided.

Polishing the Ends of Glass Tube and Rod

When glass tubing is cut, the edges of the cut will be sharp and, as it will be necessary to place the tubes in the mouth occasionally, a means of getting rid of this sharpness is desirable. This can be done by heating the end of the tube in a Bunsen flame until the glass just reaches the melting point. (The glass must be rotated continuously in the flame.) On removal of the tube from the flame, the end of the tube will be found to be smooth. The process is known as fire-polishing. Care should be taken not to overheat the end of the tube, causing it to collapse, with consequent constriction of the bore. The free ends of all made-up apparatus should always be fire-polished.

At this stage the reader can attempt the construction of simple pieces of apparatus, using the processes already described. One such piece of apparatus is a glass "spatula," which, according to its length, can be used as a mustard spoon or a photographic stirring rod. Other uses will, no doubt, suggest themselves. To make the spatula, a piece of glass rod of suitable length is cut. One end of the rod is heated in the Bunsen or blow-lamp flame, and when quite soft, the rod is pressed vertically downwards on the block of iron, as shown in Fig. 10(a). This forms a knob, which, because of its rapid rate of cooling, is in a state of strain. The knob is now heated gently and its temperature *slowly* brought up nearly to the softening point, in order to release the strains. This heating is best carried out by first lowering the knob slowly into a smoky flame, and then gradually increasing the amount of primary air until the flame is at its maximum temperature. The knob is annealed by holding it in a smoky flame, produced by cutting off the supply of primary air to the Bunsen burner, until the glass is covered with a layer of carbon. The rod may then be placed aside in

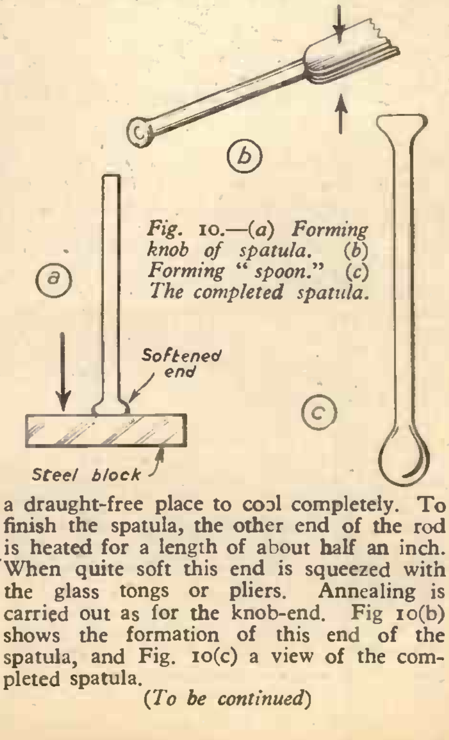
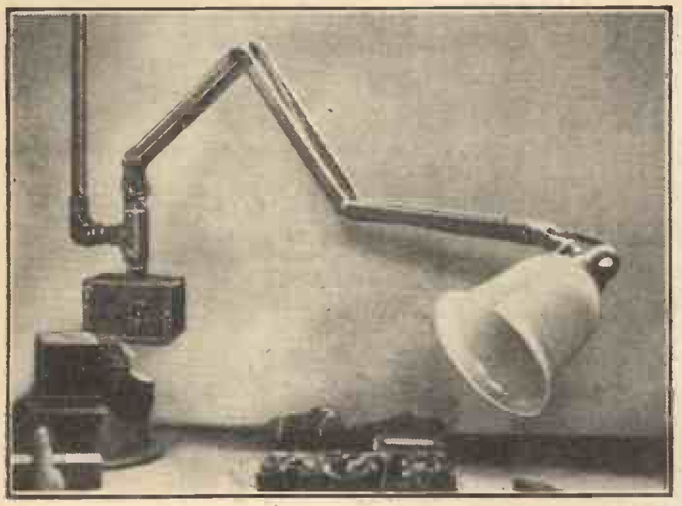


Fig. 10.—(a) Forming knob of spatula. (b) Forming "spoon." (c) The completed spatula.

a draught-free place to cool completely. To finish the spatula, the other end of the rod is heated for a length of about half an inch. When quite soft this end is squeezed with the glass tongs or pliers. Annealing is carried out as for the knob-end. Fig 10(b) shows the formation of this end of the spatula, and Fig. 10(c) a view of the completed spatula.

(*To be continued*)

AN ADJUSTABLE BENCH LAMP



The completed bench lamp in use.

Constructional Details of an Inexpensive Unit for the Workshop

By R. F. WILLIAMS

THE construction of this useful adjustable lamp should present no difficulty to the handyman possessing a bench vice and the usual hand-tools. Although the materials used may vary considerably, the ultimate result will amply repay the few hours spent in construction. The accompanying photograph shows the original lamp as installed in my workshop, and I shall attempt to describe as simply as possible its construction, leaving readers to make or modify according to the materials at their disposal.

The original has given many months of valued service and has proved satisfactory in every respect. The dimensioned drawings are self-explanatory, but to assist construction each component has been numbered in Fig. 1, and, where necessary, I have added a few notes.

LIST OF MATERIALS

5ft. 6in.	½in. wide x ⅛in. thick mild steel strip.
1 piece 6in x 4in. (approx.)	⅛in. thick mild steel plate.
4 (Part No. 10)	Compression springs, 9/32in. dia. x 1⅜in. free length. 10 turns. .064in. wire.
5 (Part No. 9)	¼in. B.S.F. x 1¼in. long hexagon-head steel bolts.
12 (Part No. 11)	¼in. B.S.F. steel locknuts.
1 (Part No. 6)	¾in. conduit ironclad switch.
1 (Part No. 5)	¾in. conduit gland nut.
1 (Part No. 7)	Lampholder.
1	Plastic lamp shade.
1 yd.	230-volt, 5A, rubber-covered cable.
4 pieces	Tinplate, 6in. x 3¼in.
1 (Part No. 8)	¾in. conduit locknut.

Two alternative methods of mounting are described, the former adapts a ¾in. conduit ironclad switch, whilst the latter is more suited to base fixing and needs a lampholder with a built-in switch. Details of various components are given in Fig. 2.

Constructional Details

Mild steel strip ½in. wide x ⅛in. thick was used for the extension arms and lampholder bracket support, and the remaining items were made from ⅛in. thick mild steel plate. Although six extension arms were used in the original, more could be employed as desired. Fig. 3 shows a simple method of obtaining the required offset, and Fig. 4 a way of obtaining the large hole in the lampholder bracket if no large drilling machine is available.

The first method of mounting needs no explanation, the second utilises some ½in. wide x ⅛in. thick mild steel strip as used for the extension arms. The two parts are bent up as shown in Fig. 5, the first piece being screwed to the bench and the second fastened to the lower end of the extension arms. The two pieces pinion about a hexagon-head bolt with a double coil spring washer and a pair of locknuts to retain rigidity.

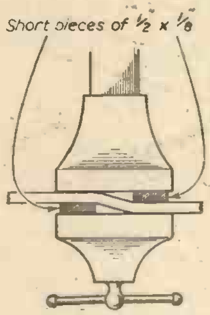


Fig. 3.—Method of obtaining the offset in extension arms.

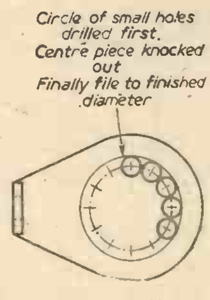


Fig. 4.—Method of making the large hole in the lampholder bracket.

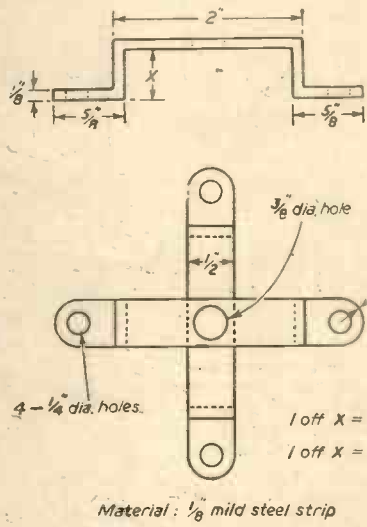
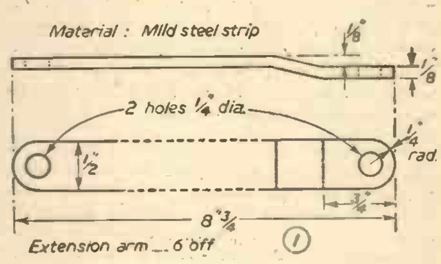


Fig. 5.—Details of metal strip base.

When the lamp was assembled a piece of tinplate measuring 6in. x 3¼in. was wrapped around each pair of extension arms and soldered along its seam. This served to retain the cable and also enhanced the appearance. The lamp was then given a coat of enamel and fitted with lampholder, a plastic shade and a length of 230-volt, grade 5A, rubber-covered cable.



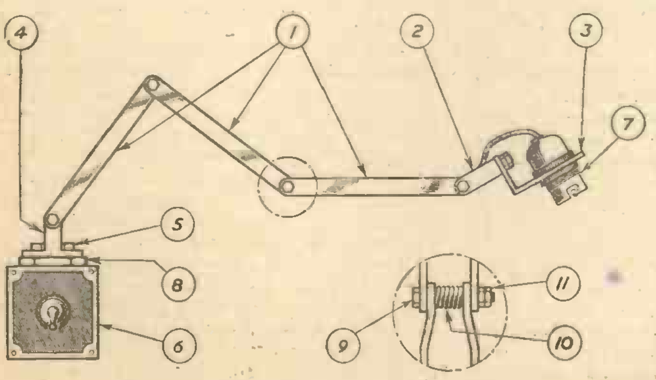


Fig. 1.—General assembly of components.

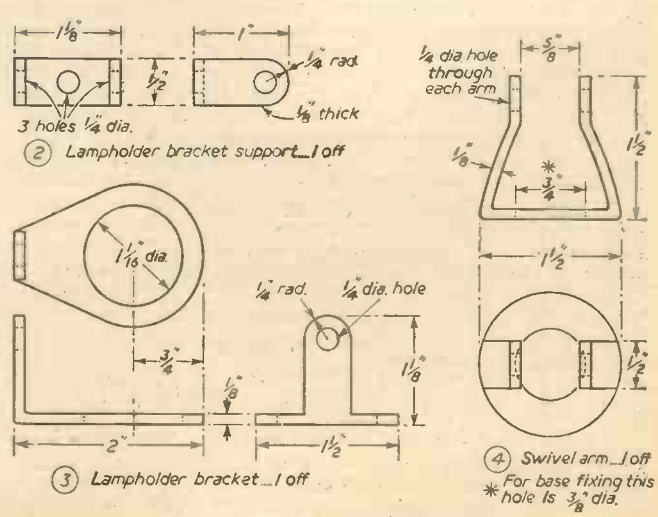
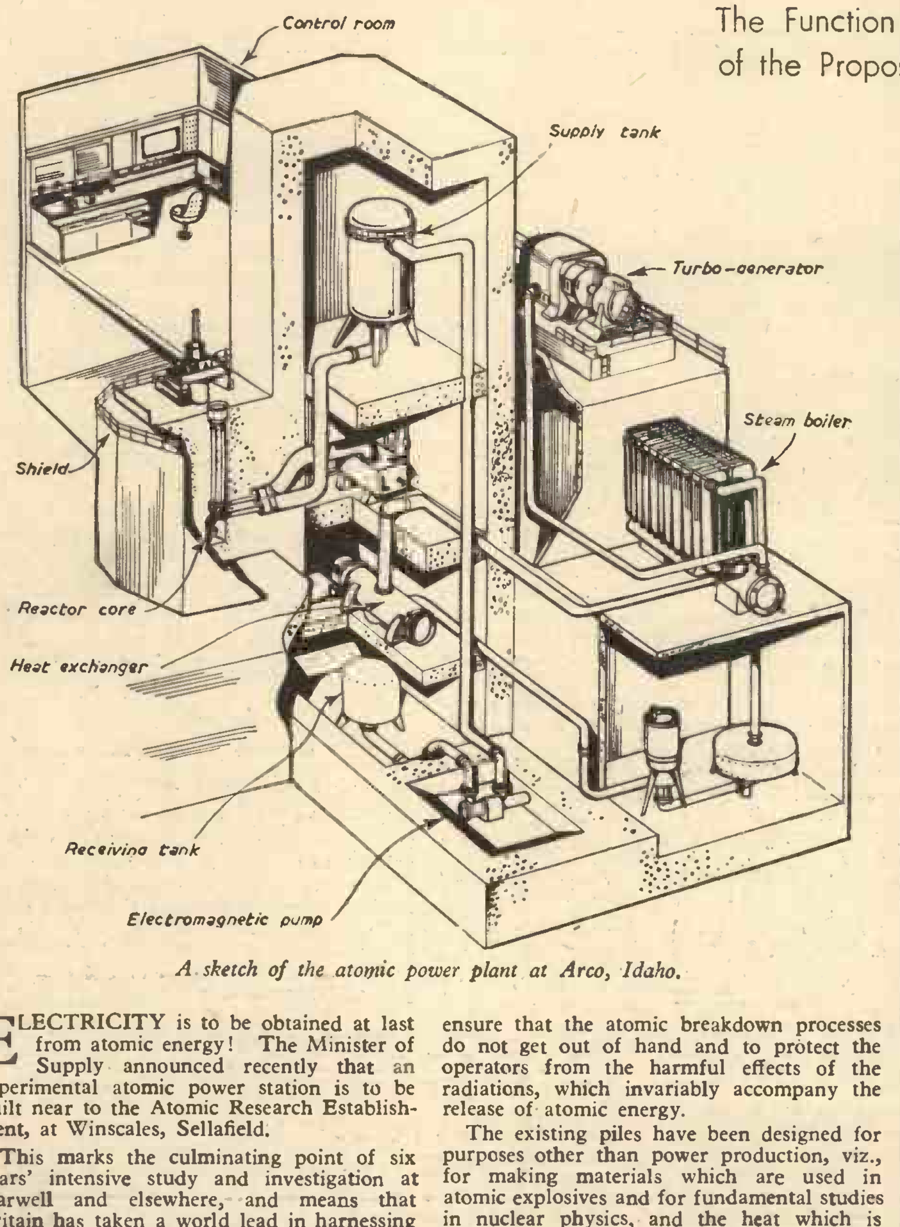


Fig. 2.—Details of component parts.

ELECTRICITY FROM ATOMIC ENERGY

The Function of Atomic Piles and Particulars of the Proposed New Atomic Power Station

By "PHYSICIST"



A sketch of the atomic power plant at Arco, Idaho.

ELECTRICITY is to be obtained at last from atomic energy! The Minister of Supply announced recently that an experimental atomic power station is to be built near to the Atomic Research Establishment, at Winscales, Sellafield.

This marks the culminating point of six years' intensive study and investigation at Harwell and elsewhere, and means that Britain has taken a world lead in harnessing atomic power for peaceful purposes. Whilst the development of atomic power for industrial purposes can no doubt be a decisive factor in solving the immediate shortage of fuel, it also emphasises the anxiety which is being increasingly felt over future fuel supplies in countries like Britain, which has no naturally occurring oil, very little water power, and coal reserves which will not last longer than 300 years, and where the demand for fuel is ever increasing.

It is now well known that in an atomic explosion, the intention is to get the quickest possible release of energy, and so obtain the maximum destructive effect from the terrific heat and pressure which are thus obtained; but for efficient harnessing of this energy in power production, its release has to be controlled.

Atomic Piles

The atomic piles which have been made to secure this controlled release of energy are triumphs of design, engineering and technical skill. They are precision built and elaborate precautions have been taken, both to ensure that the atomic breakdown processes do not get out of hand and to protect the operators from the harmful effects of the radiations, which invariably accompany the release of atomic energy.

The existing piles have been designed for purposes other than power production, viz., for making materials which are used in atomic explosives and for fundamental studies in nuclear physics, and the heat which is liberated during the breakdown processes has never been utilised to any appreciable extent.

Considerable work has been necessary to design a pile in which the heat that is produced can be fully used. Before this could be achieved, materials had to be found which could withstand high temperatures and remain unaffected by intense radiations and atomic particles which are produced in the pile. Few metals have proved satisfactory and those which have are rare and very difficult to extract from their ores and make into suitable containers for atomic fuel.

The type of atomic power generator which is to be erected at Winscales is presumably one in which the heat from the pile will be used to drive a normal electrical generating plant, with additional precautions taken to protect against the harmful radiations from the pile.

Rapid Heat Transfer

Several novel methods of securing rapid heat transfer from the atomic fuel have been disclosed, but perhaps the most unorthodox of all is one in which molten metals are used. Metallic sodium and a mixture of sodium of potassium have been used in a closed circuit to prevent oxidation. It is worth noting in passing that when molten these metals can be pumped round a closed circuit by electro-magnetic pumps which have no moving parts!

Although other means of power production are being sought, the use of atomic fuel is most attractive, because of the enormous release of heat energy from a very small weight of material. It has been calculated that the same amount of power could be obtained from one ton of atomic fuel (uranium) as from 2½ million tons of coal; but, spectacular as this may seem, it is not likely to reduce the cost of electricity to any marked extent, for the distribution costs are an important factor.

Atomic fuel is still extremely valuable and an all too rare commodity at present to be considered solely for the derivation of power supplies, and scientists and geologists are busy seeking out fresh deposits of uranium containing ore and developing economical means of separating it from the non-reactive material and fabricating it into a form suitable for use in atomic piles.

To make the new power plant economically attractive it has therefore been designed so that as the atomic fuel (uranium) is used up, an equally valuable product (plutonium) is produced which is used in atomic explosives and which can be periodically recovered from the pile. If the new power plant proves an industrial success, it will represent a big step forward in the production of atomic explosives and further plants may follow, allowing more electricity to be produced, as the atomic bomb material accumulates.

Huge Experimental Plant

It is predicted that the huge plant will take more than two years to build and that 2,000 workmen will be engaged in its construction; nor is it expected to produce electricity there in under five years. But although this may seem an unnecessarily long time, it must be remembered that this is only an experimental plant and should give much valuable information which will facilitate the building of further power stations.

When electricity is generated, it will be fed into the national grid and it is confidently expected that its output could supply the needs of Cumberland, Westmorland and parts of Lancashire.

This new development has led to renewed speculation over the development of small atomic power plants. A ship driven by such a unit could cruise for years without refuelling and 'planes could encircle the globe several times, but apart from the statement made by the U.S. authorities some time ago that an experimental atomic powered submarine is to be built, there are little further grounds for thinking that these are soon to enter the realms of practical possibility.

Nevertheless, the new project is to be welcomed, and the knowledge that some major non-destructive application of atomic energy is soon to become real is very comforting, especially to the British taxpayer who, one way or the other, has invariably to foot the bill.

Revolving Lampshade Silhouettes

A Novel Idea Where Figures Revolve Round the Lampshade

By L. W. TEW CRAGG

THESE shades for table lamps are a very attractive novelty, and yet very simple to construct. It is very seldom that we are able, so effectively and simply, to use energy that usually goes to waste; for the principle of these shades is the same as the flickering fire effect in electric fires and is accomplished by interposing a propeller, free to rotate between the bottom of the lamp shade and above the electric lamp. As the air in contact with bulb heats and rises, it strikes the propeller and causes it to rotate. This is all that is required in an artificial fire, for the shadow of the vanes produces the flickering effect. It is general practice to have two electric lamps, each with its own vanes, to obtain the best results. In using this means in lampshades the propeller is made to carry arms to which are attached small figures of birds, fish, ships or anything else according to personal preference. The propeller rotates when the lamp is alight and the silhouettes of the moving figures are cast upon the shade. When the light is off the lamp appears to be fitted with an ordinary lampshade. The main point is to balance the propeller and figures well; the bearings which support the vanes must be as frictionless as possible.

Materials

The materials required are wire 3/32 in.-⅛in. dia. in brass, copper or galvanised iron, and pieces of sheet brass or tinplate, no thicker than can be cut with ease. The dimensions of the shades are not given here for there are so many sizes and these must be suited to individual requirements.

Construction

First make the outer frame in wire, working as Fig. 1, and following the arrows. The small half circle is formed around a mandrel about 1in. dia. For the large base circle it may be more difficult to find a suitable mandrel, so draw with compasses a circle the required size on paper, then bend the wire a little at a time around a smaller former, checking from time to time against the pattern. When the outer frame is completely formed and the top bearing soldered into a central position as shown in Fig. 1 the inner frame is made by the same method, forming it first then soldering into it the tapped block (Fig. 1). Now solder together the two frames as shown.

Next cut out the blank of the propeller. Drill the boss centrally and solder the spindle into position. This may be made from 1in. of a darning needle, ground to a point each end, or 1/16in. dia. silver steel, if on hand. Into the boss beneath the vane fit the wires to carry the cutout figures, bending them close to the inner frame, as shown in Fig. 2, so that the figures appear at the desired position on the lampshade. This arrangement helps to obviate the shadow on the shade of the arms carrying the cutouts. On the tips of the arms sweat the figures cut from sheet brass or tinplate. Now warp the propeller, one blade left hand, the other right hand, by about 30 degrees to a shape similar to an aeroplane propeller. To balance the rotary, place the spindle in the cup of the 6 B.A. screw, but do not tighten it into the top cup, the balance should be good as it stands, but, if not, dab the lighter arm with a spot of solder and then file until a correct balance is found, remembering to do this job away from draughts. Screw up the thread until the spindle is just gripped between the cups. It should take no more effort to revolve the vane than a slight puff of breath.

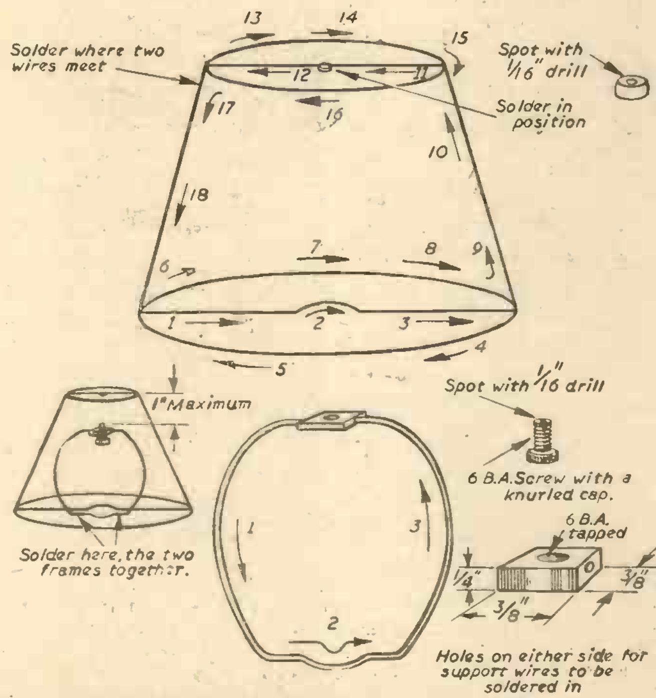


Fig. 1.—Details of the outer wire frame.

Alternative Suspension

A simple form of suspension is by a fine wire and cup-washers, the type used on rubber-powered model aircraft, see Fig. 3. This form is easily fitted into an existing shade. Across the top ring of the shade solder a cross-bar and on to this solder a fine wire, wound one turn round. First place on the vane an attached boss as Fig. 3, and then the two cup-washers, domes together. Curl the end of the suspension wire into the lower cup-washer and solder inside; it is now complete and ready for covering.

The Figures

The cutout figures, are made from small pieces of sheet brass or tinplate. Thin wire was used for such details as the cabin of the aeroplane or the rigging of the ships. A few suggested designs are given in Fig. 4. As an idea of the scope of cutouts, many more are available after a moment's thought.

The Covering of Lampshades

This is usually accomplished by sewing the shade material to the wire frame with silk threads. Take some brown paper and cut this to fit the frame first, then use it as a pattern for the chosen covering material. A great range of these materials can be obtained from handicrafts shops or artists' supply retailers, in any shade.

Make the joint on the shade overlap by ½in. Next required is a series of holes punched around the edges of the material about ⅜in. in depth and ½in. apart, Fig. 5 shows the material laid out flat, or developed, for the usual shaped shade. To punch the holes a punch of the pliers type as used in leather work is useful. If these are not

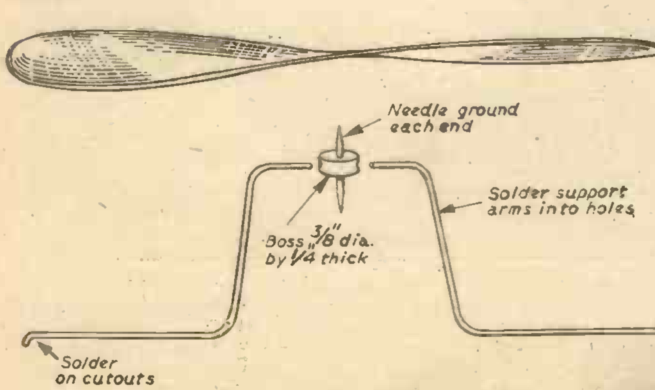


Fig. 2.—The propeller and inner frame.

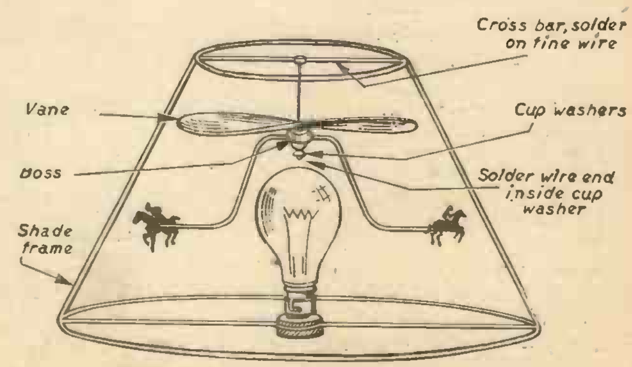


Fig. 3.—Alternative form of suspension.

available, take a piece of steel tube with a 3/32in.-1/8in. bore 3in. long and grind the end to a cutting edge from the outer diameter to the inner diameter, see Fig. 5. Place the material on a wooden board and where a hole is required, locate the punch and strike it sharply with a hammer, neat holes can be cut rapidly by this method. Proceed with the hole punching around the edge of the shade as shown in Fig 5. Sew into position on the frame with needle and silk thread, by taking the thread through the material, behind the frame, over the outer edge and into the next hole, and so on, in a kind of over-stitch. The silk may be ended off by tying a decorative knot, or glueing the end to the inside of the shade and frame.

To finish the job the outside of the shade should be painted to harmonise with the

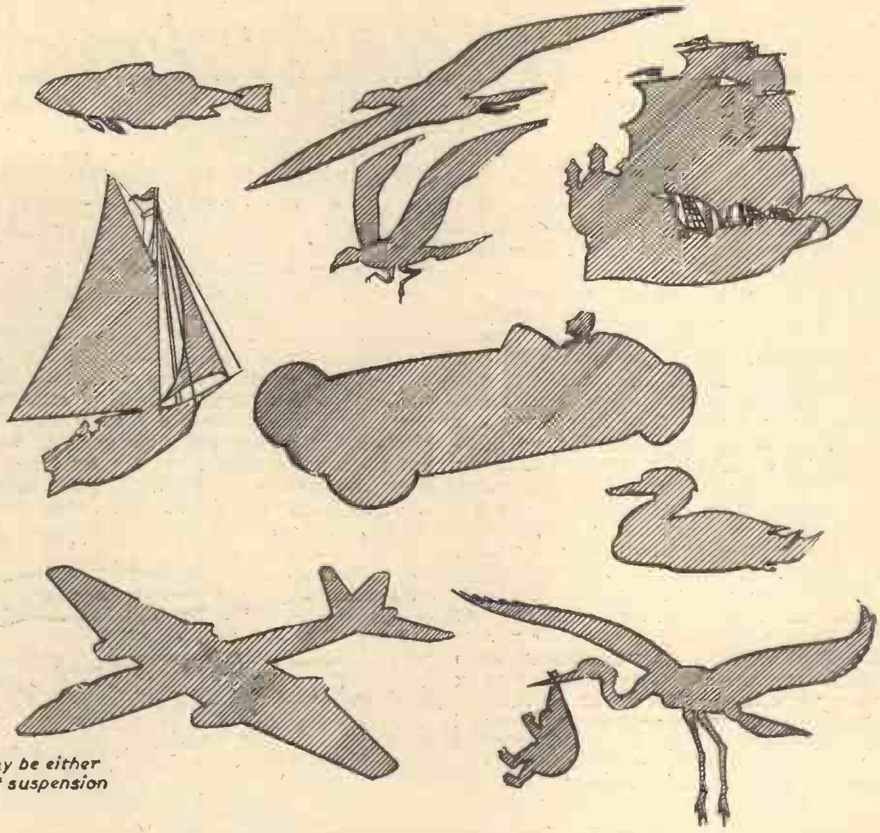


Fig. 4.—Suggested designs for cutouts for which thin sheet brass or tinplate can be used.

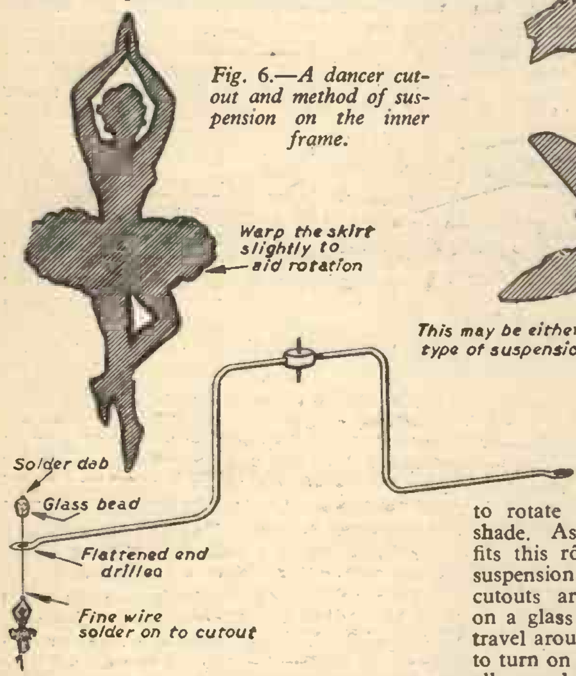


Fig. 6.—A dancer cutout and method of suspension on the inner frame.

revolving figures. If fish have been chosen, then a few sprigs of seaweed would look very well on the shade or in the case of the ships, paint below their waterline the sea. This is not really difficult: practice a little on scrap paper, until you obtain the desired effects. Use good brushes and paints; special paints are marketed for this work, and are readily obtainable from your local artists' suppliers. If this hand painting is

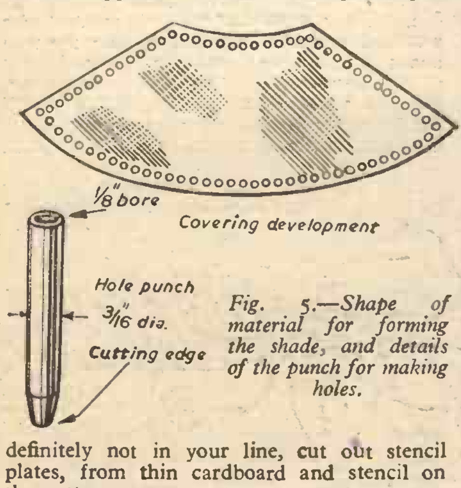


Fig. 5.—Shape of material for forming the shade, and details of the punch for making holes.

definitely not in your line, cut out stencil plates, from thin cardboard and stencil on the pattern.

Rotating Figures

An interesting idea for use with these shades, is to suspend cutout figures on wires to rotate as they turn around within the shade. As shown in Fig. 6. A dancing girl fits this rôle very well. The usual type of suspension from the vane is used, but the cutouts are themselves also free to rotate on a glass bead used as a bearing. As they travel around the shade the silhouettes appear to turn on their toes, producing an exceptionally novel effect.

A word of warning here, as necessary as it is to have the cutouts as close to the inside of the shade as possible, on no account must they touch, for the slightest contact will cause them to stop all movement.

Another variation on this theme is found if a square shade is made, and the cutouts made to traverse a circle within the square, producing an effect where the figures gradually appear and disappear from view as they approach or recede from the sides of the shade.

It may be found an advantage to bend the cutouts a little to fit better to the path they have to circumscribe. The greater the rating of the lamp used the faster will the figures rotate, but a 60-watt lamp is usual.

Excellence in Ship Modelling

THE accompanying illustration shows an exhibition model of ship No. 1,823, "Leda," built to a scale of 1/8in. to 1ft. It is one of four models made to the order of Messrs. Swan Hunter and Wigham Richardson, Ltd., by the well-known firm of model makers, Bassett-Lowke, Ltd., of Northampton. The model, which was completed last May, displays that excellence in craftsmanship often noticed in similar models constructed by this Northampton firm. It is interesting to note that even the loading cranes fore and aft are fully detailed.

RAINMAKING

An Account of the Latest Scientific Methods Used to Artificially Produce Rain

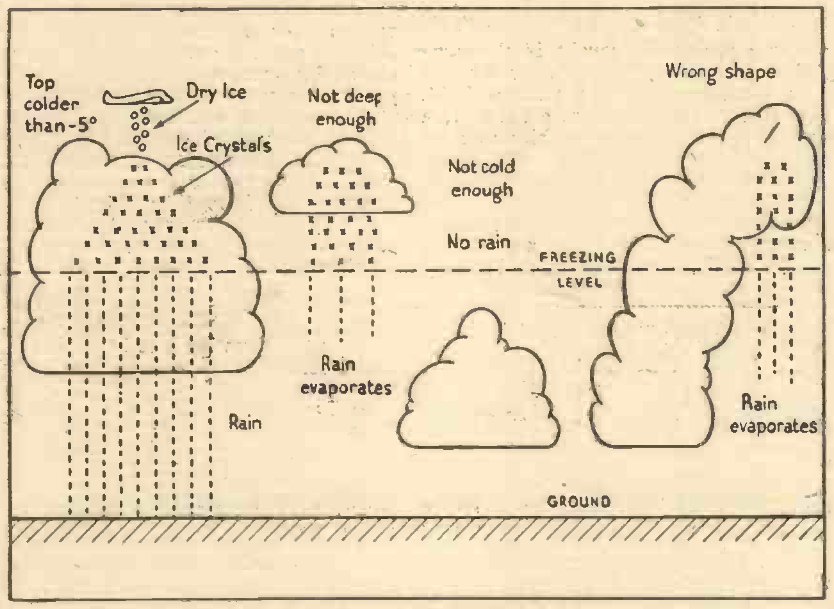
IN the British Isles and other temperate countries "rainmakers" may not be very welcome except perhaps during occasional seasons of drought, but in arid lands a true rainmaker could indeed be an important person.

Since ancient times there have been continuous efforts to assert control over rainfall. Until comparatively recently these efforts were of a "magical" nature, but during the last few years scientific methods have been introduced and many attempts have been made to induce rain to fall by artificial stimulation. Many of these attempts have been successful, and there is no doubt that man has now taken a short but important step towards making the weather serve his purpose.

The first experimental work in this new science of weather-making was carried out by a Dutchman, but the most recent and outstanding work has been done in Australia and the U.S.A., while tests have also been made in a number of other countries, even in Britain.

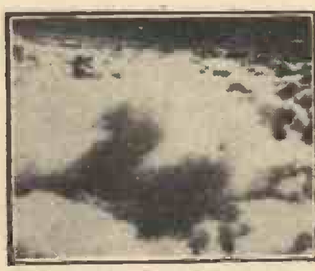
In 1947, scientists of the Division of Radiophysics of the Commonwealth Scientific and Industrial Research Organisation of Australia, in co-operation with the Royal Australian Air Force, produced the first recorded fall of man-made rain to reach the ground, when they flew over thick cumulus clouds and "seeded" them with pellets of dry ice.

Following this historic achievement the C.S.I.R.O. have carried out, and reported upon, numerous tests, and although the results, which have been carefully checked by visual and photographic observations, have proved that by using dry ice precipitation can be released from cumulus or alto-cumulus cloud consisting principally of super-cooled water droplets, their scientists emphasise that they cannot make rain whenever they may wish but only when cloud conditions are suitable. The cloud should be compact with its top vertically above the bottom, so that precipitation particles can grow as they fall through the cloud, and also durable with a life of not less than half an hour. Cloud top must be colder than minus 5 deg. C., and the distance of cloud base from the ground must be less than one-third of the total height of the cloud.

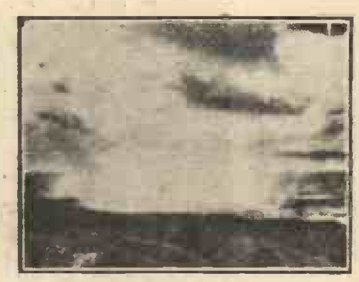


Suitable and unsuitable cloud formations.

Suitable cloud selected.



Dry ice dropped into it; cloud top changes from water drops to ice crystals and rises.



Precipitation falls from cloud.

Australian Rainmaking

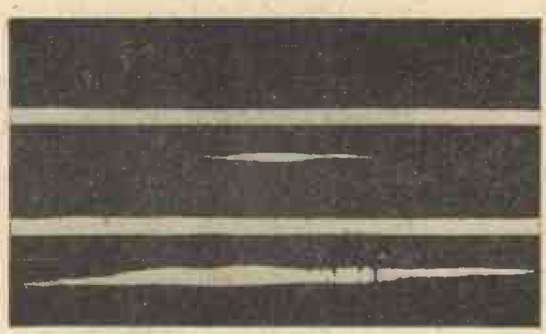
At present, experiments in Australia are focused on the discovery that under certain conditions a low cumulus cloud with a reasonably high water content can be induced to rain by spraying it, just below its base, with water or with powdered hygroscopic materials such as salt or lime. Some initial tests along these lines have already given promising results.

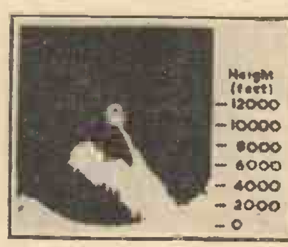
The Australian scientists consider that they have very promising prospects of being able to work, within five years, an economical technique for changing the natural rainfall over wide areas. In the south-eastern part of the Continent alone, it is estimated that the rainfall could be increased by 5 to 10 per cent.

American Experiments

In the U.S.A. a great deal of research has been carried out over a number of years by Dr. Irving Longmuir, winner of a Nobel prize for scientific work, using the dry ice technique and also a silver iodide process. One of Longmuir's claims relates to an experiment made in New Mexico on a day in the summer of 1949, when no substantial amount of rain was forecast. A team of scientists generated silver iodide smoke in a machine on the ground and on allowing it to drift downwind into a large cumulus cloud, a chain reaction evidently took place inside the cloud, filling it with rain drops which were observed on a radar screen. Lightning flashed, thunder rolled and heavy rain fell over a large area, starting a day of rain. Later, new thunderstorms developed nearby and watered other parts of the State. Only 300 grammes of silver iodide were used, and Longmuir offered mathematical proof that it brought down 320,000 m.g. of water.

Longmuir has also applied rainmaking techniques to other forms of weather control. A large fruit farm in Honduras suffered repeated heavy losses when short but fierce storms flattened out thousands of banana trees. The rain, which usually caused the damage, came from large woolly masses of cumulus. By dropping dry ice on to them the rain was





Radar observations showing precipitation growing inside cloud, and extent of precipitation within and under cloud.

made to fall over a wider area and thus reduce the intensity of the downpour.

As a result of the successes of scientific rainmakers, rainmaking is already "Big Business" in the U.S.A. The Water Resources and Development Corporation claims that in 1950 it saved America's notoriously arid Dust Bowl, which was so dry when their work commenced that ranchers were shipping out their cattle. Unfortunately, no one can prove conclusively whether the rain that fell was caused by the Corporation's seedings of clouds or alone by capricious nature.

Tropical Test

Reference is made in a recent annual report of the Overseas Food Corporation to artificial rain precipitation at Kongwa, in Tanganyika. The experiments, which were the first of their kind to be made in the tropics, involved the floating up into clouds of balloons containing silver iodide and exploding them by time fuses. Details of the results of the experiments are not given, but it is stated that they provided sufficiently encouraging data to warrant the carrying out of further trials. It has been said, however, that the local chief was not impressed and offered, if he were given the money to do so, to kill a cock and produce rain in the time-honoured way with far less trouble!

Many tests have also been made in Canada where the great wheat fields of the prairie regions and the hydro-electric schemes, upon which industry almost wholly relies, are partially dependent upon rainfall at just the right seasons. At present the Provincial Government of Alberta is reported to be considering a proposal for a five-year programme of artificial rainmaking in the semi-arid areas of the province. Tentative plans envisage the systematic seeding of clouds over the areas with dry ice or silver iodide crystals, the programme to be financed by what is officially described as a small increase in taxes and lease rates.

Rainmaking in Britain

During a period of drought in the summer of 1949, when industrial water supplies on Tees-side were curtailed, the firm of I.C.I. decided to try to bring about a fall of rain using Drikold, the name they give to solid carbon-dioxide. Three flights were made. On the first, 200lb. of Drikold, prepared at the Billingham-on-Tees works of I.C.I., were dropped into cloud at 10,000ft. west of the Pennines. Shortly afterwards the aircraft flew below the cloud and encountered a sharp shower. For the second attempt a cumulus cloud, at the same altitude, east of the Pennines was chosen and a larger quantity of Drikold dropped into it. The cloud top grew by about 500ft. in eight minutes, and 12 minutes later a rainbow was seen, and below the cloud those in the aircraft found that a heavy shower was falling. The third attempt was not completed as the cloud had become unsuitable for experiments by the time the aeroplane was airborne.

Last summer, research scientists from Imperial College carried out some experiments in the Bedford area, and it is believed that rain which fell, after seeding large cumulus cloud with tiny salt particles, was artificially produced.

Although the claims made by the rainmakers have not always been justified by evidence and their activities not always welcomed by everyone, it would appear that painstaking research may eventually lead to the development of means by which a substantial measure of control might be exercised over the weather in certain circumstances.

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Items of Interest

New Radio Telescope

A GIANT radio telescope, or radar "eye," which will be able to "see" into outer space and pick up messages from mysterious "radio stars," has been designed by a Sheffield engineer, and is being constructed by a local steel firm.

The apparatus, known as a steerable radio telescope, was designed by Mr. Henry C. Husband, senior partner in a firm of chartered civil engineers, to the specifications of Dr. A. C. B. Lovell, professor of radio astronomy at Manchester University.

The new telescope, which will be the largest of its kind in the world, comprises a huge saucer of steel lattice weighing 300 tons and measuring 85 yds. in diameter—big enough to hold nearly 50 two-storey houses—mounted on two steel towers 180ft. high.

The whole telescope will move on a circular railway to track a star across the heavens, being controlled automatically by a sidereal clock.

It will be erected at the Manchester University research station at Jodrell Bank, Cheshire. Reinforced concrete foundations have been laid, and a new power-house is being built, equipped with a diesel-driven generator. The apparatus is expected to be in operation before the end of next year.

Belfast-built Comets

IT is reported that good progress has been made with the preparations for the building of the Comet II jet air-liner at the Belfast factory of Short Brothers and Harland Ltd. Although the first Belfast-built Comet is not expected to fly before 1954, more than 117,000 parts have already been produced ready for assembly into components. As part of an overall expansion programme, planned with Comet production primarily in mind, the company's Hawlmark satellite plant has been extended, giving an additional floor area of 20,000 square feet.

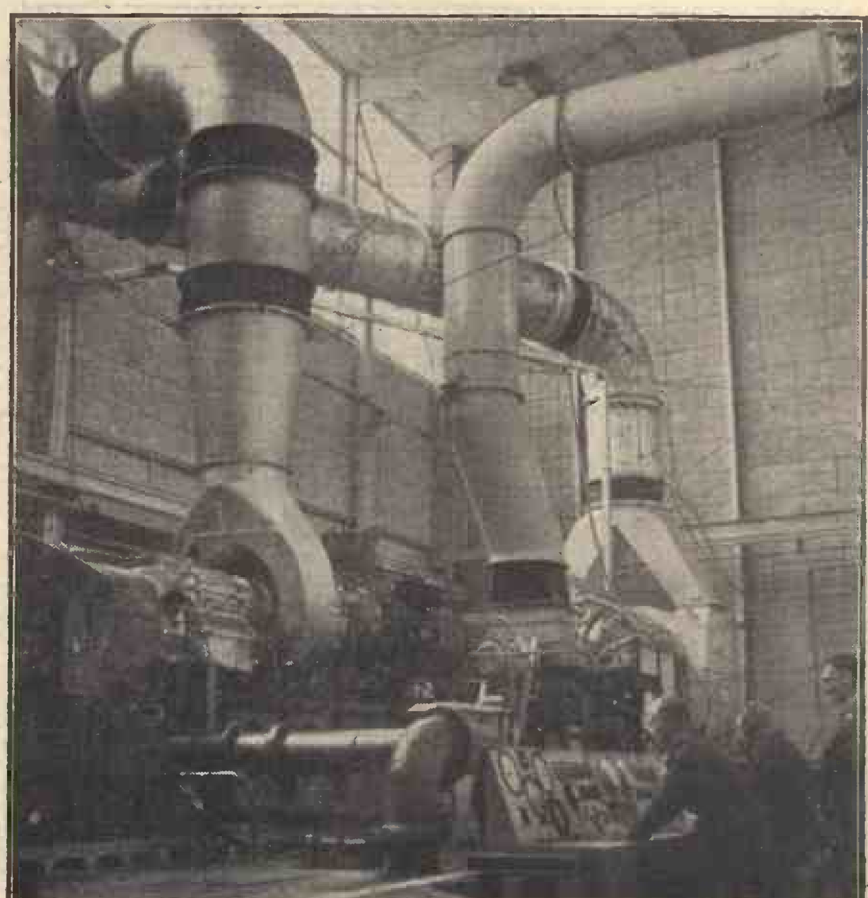
Up-to-date heat treatment is being installed which will be capable of handling parts up to 30ft. long.

An Outsize Casting

A STEEL casting weighing 185 tons, which has taken five days to reach Liverpool docks from Sheffield, was hoisted aboard an American freighter by the Mersey Dock Board's floating crane, Mammoth, recently. The casting is to be used in United States defence projects.

New Gas-turbine Test House

TO assist in maintaining the British lead in marine gas-turbine design, a test house for shore trials of naval gas turbines has been completed at the National Gas Turbine Establishment at Farnborough. The accompanying illustration shows a corner of the test bay with a turbine engine under test.



A gas turbine under test at the new Admiralty test house at Farnborough.

Cinemascope 3-D Film Process

Hollywood's Answer to TV

By MAURICE MOYAL

TAKING a hard look at the steep downwards plunge shown on their graphs since the advent of commercial television, Hollywood film interests have decided to try to recapture at least part of the mass-audience wrestled from them by TV through something as radical in scope as the advent of the "talkies."

They hope to do the trick with third-dimension or 3-D films, and 20th-Century Fox, Metro-Goldwyn-Mayer, Paramount, Warner Bros. and Columbia are each publicising their own 3-D processes, respectively, Cinemascope, Cinerama, Natural Vision, Tri-Opticon, Paravision and the Norling Process—all guaranteed to bring the actors right out of the screen. The big question remains, however, of how to convert the ailing industry to all these 3-D processes without scrapping at least part of the existing movie-making and projecting equipments.

To handle Cinerama, it is estimated that an exhibitor will have to find an estimated £12,000 for the purchase of a new screen, projectors and loudspeakers. At first sight, the Natural Vision, Tri-Opticon and Paravision processes may seem cheaper, calling only for an investment of £350, but their biggest drawback lies in the fact that they require the annoying wear of polarised glasses to permit the spectator to view images not blurred at the edges. In addition, up to 80 per cent. of an audience may not be endowed with stereoscopic vision with both eyes, and for such people the twin image does not get co-ordinated in the brain and they are unable to see in depth.

The Norling Process requires the simultaneous shooting of the film on two strips, with two lenses, so as to simulate human vision. Cinerama requires a movie-camera with three lenses, set fanwise at two 45 deg. angles. Thus, three film-strips are shot simultaneously, each corresponding to a third of the total field. It also calls for three synchronised projectors projecting the three strips on a slightly concave screen three times wider and one-and-half times taller than those in normal use. It also requires nine loudspeakers.

General Details

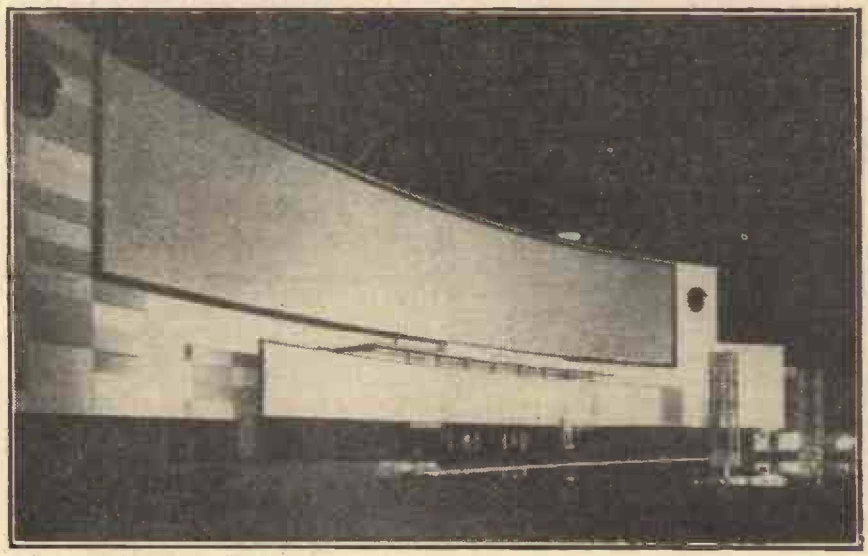
Cinemascope simulates human vision by gathering both images, right and left, according to a wide-angle photography, on one film-strip, either by putting them side by side or superposing them in height. It thus requires only one film-strip and projector and no viewing glasses.

The 20th-Century Fox Corporation is so convinced that Cinemascope is the best and cheapest 3-D process that it signed recently an agreement with France's Prof. Henri Chrétien, part-inventor of the process, for a 10 years' world-wide distribution of the "hypergonar" lenses, for which the Frenchman is responsible. For use in the 20th-Century Fox studios at Hollywood and in up to 3,000 U.S. theatres, affiliated with Mr. Skouras's United Artists theatre circuit, the inventor is to turn out "hypergonar" lenses. To this end, a new 3-D movie business has been set up called the Magna Theatre Corporation.

Over the lens of a normal movie-camera a moderate sized box incorporating such special "hypergonar" lenses is fitted which allow the making of 3-D films. Over a projector, a similar box, though of different dimensions, is fitted to permit the showing of 3-D films. Once the box is removed, the projector reverts to showing "flat" films. Thus, Prof. Chrétien's process allows all the existing equipment to remain in use.

Professor Chrétien is an astronomer, who began life as a printer's devil to grow into the founder and head of the famed Paris Institute of Optics. The inventor, responsible for scores of epoch-making inventions in the optical field, has a knack of formulating the most complicated technical problems in terms which are clear to the layman.

Some years before the war, he was greatly impressed by the showing of Abel Gance's "Napoleon." To achieve greater-than-life images and panoramic views the famous French producer had recourse to using three movie-cameras and showing the film-



Screen with an area of 600 square metres (60 metres wide and 10 metres high) at the Palace of Light at the Universal Exhibition of Paris, 1937, on which was shown the film "Au fil de l'Eau" projected with Professor Chrétien's Hypergonar at the request of the Compagnie Parisienne de Distribution d'Electricite.

Left, view taken with ordinary apparatus with the addition of Hypergonar. The view is anamorphosed horizontally and the field is twice as wide as that taken without Hypergonar. Right, the preceding image projected by ordinary apparatus fitted with Hypergonar which restores the objects to their proper proportions.

strip with three projectors on three screens. Incidentally, all the effects of such a bold experiment have not yet been fully explored. It makes it possible to gather upon an extra-wide, say, 65-mm. film (regular stock being 35mm.) different subjects culled from various negatives so as to obtain the showing of diptyches and even triptyches. This process might be a substitute for the worn-out "back-shots." It would be a great improvement on the time-honoured superimposition technique and permit new and startling effects.

The upshot of Abel Gance's performance was to cause Prof. Chrétien to explore the possibility of using only one movie-camera and showing panoramic views with one projector. To eliminate the costly equipment which the Abel Gance process required the inventor got the idea of recoursing to anamorphosed images, which he had already put to good use for practical applications in the military optical field.

When a cameraman wants to take in a wider field, he must choose a lens with shorter focal length, but, in the process, he is also compelled to take in a higher chunk of the sky or of the foreground.

The answer, according to the inventor, would be to extend the field in width without altering it correspondingly in height or vice versa. To do this, some cameramen resort to the trick of hiding the unwanted part of the image, but this is, at best, a very unsatisfactory and makeshift arrangement.

The Lens Principle

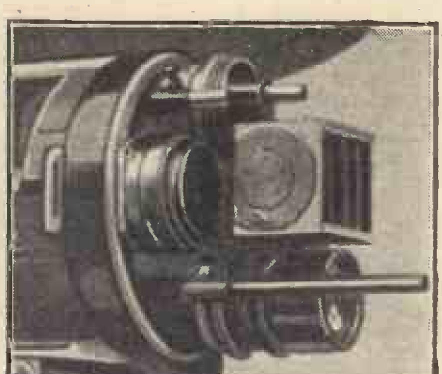
The ideal arrangement would be to devise a lens the focal length of which would be, say, twice as short horizontally as vertically, or vice versa. This contribution seems likely to run foul of all geometrical laws, but the image taken by such a lens would be the anamorphosed reproduction of an object, with two different scales, one for the heights and the other for the widths.

This brings one to the distorting mirrors, that, according to which way they curve, reflect a shortened or elongated image. Prof. Chrétien's "hypergonar" is based on the same lines. It takes in on the film-strip shortened or elongated images. But the big difference is that, on projection, it restores the images undistorted on the screen, but lopping off all unwanted sections of the sky or foreground, be it in length or width.

The advantages of such a compression are obvious. It permits gathering on the same film-strip both right and left images, so as to achieve 3-D illusion. Moreover, the reduction of the images in width allows the inscription on the strip of the multiple sound-grooves as required by stereophony, while maintaining the right proportions of the images. In the same vein, the regular stock of 35-mm. films could be compressed into 16mm., while the sound-track is kept at its normal width. But it length must be then reduced accordingly.

In the process, Professor Chrétien had to eliminate quite a few snags. As far as the distorting mirrors are concerned, the opening to the human eye's pupil adds up to only a few millimetres. Thus, the image reflected on the distorting mirror seems still clear enough. But such images would appear marred by defects, astigmatism among other things, if taken by such large-opening lenses as required by movie-making. Thus, special optical devices have had to be contrived to achieve images capable of being greatly enlarged on the screen, without sacrificing sharpness.

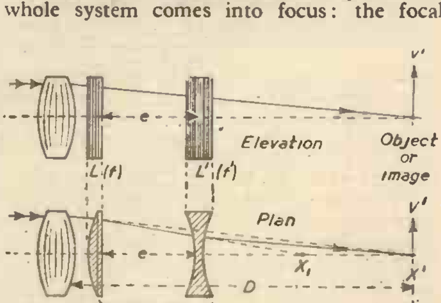
Professor Chrétien's "hypergonar" does



The Hypergonar system mounted on a camera.

just that. It is made up essentially of two relatively thin series of cylindrical lenses, separated by an interval. As these lenses are set parallel, a section of the apparatus will give a good idea of how it works.

When the object to be anamorphosed lies far afield, the interval between the two series of lenses is regulated in such a way that the whole system comes into focus: the focal



The principle of the Hypergonar lens.

lengths of both series then coincide. f and f^1 being the focal lengths of the two series of lenses, the interval e which separates them is $e=f+f^1$.

If the two series both had positive focal lengths, the report Γ would be negative, that is to say, the image would be reversed from left to right (and not upside down). In "hypergonar," the first series of lenses is diverging, f is negative, while the second series being converging, f^1 is positive. Ergo. Γ is positive: the image is not reversed from left to right, e being necessarily positive:

$$f^1-f, \text{ and } e=f^1-(f)$$

Through the choice of a negative f, the total length of the apparatus is much reduced and the width of the first series of lenses cut down. Moreover, shooting can take place, with or without "hypergonar," without having to reverse the film-strip.

Besides, the adoption of a negative power for the first series of lenses contributes to correcting the distortions brought about by the enlargement of the field. Distortions are eliminated by achromatising each series of lenses separately. The converging series, with weaker power, may be made up of only two lenses, respectively made up of crown and flint; but a third lens has had to be added to the second series, which has a double power and a very big relative opening. For both movie-making and projection, both "hypergonars" are based upon the same lines, only their sizes and settings differ.

Making the Lens

Many difficulties have to be solved in the process of turning out high-precision cylindrical lenses, because they require such a perfect smoothing of their surfaces and accurate setting of their axes. Imperfect tools have to be used in such a way as to turn out perfect optical surfaces.

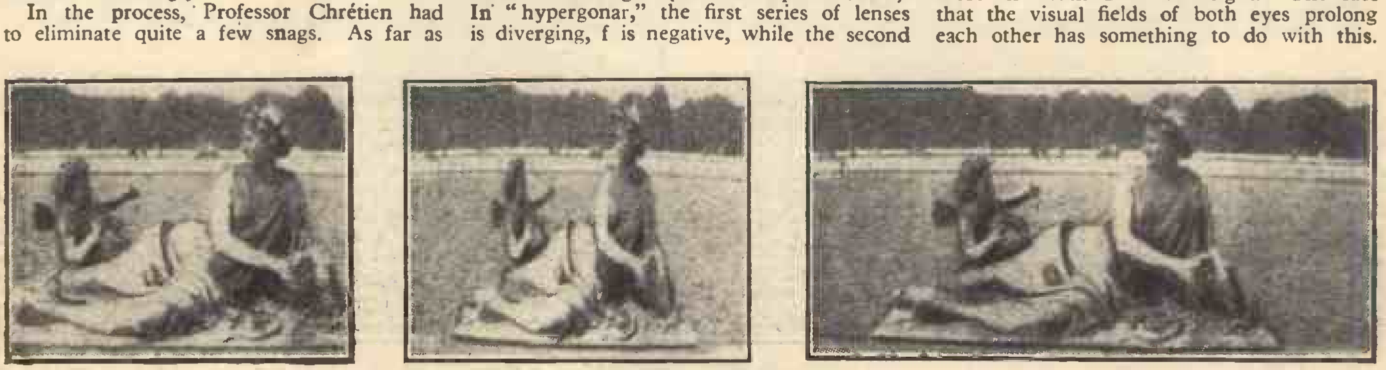
The necessary tools are obtained by mutual friction of the two component parts until they fit close together. Such an operation is not capable of being verified optically. Thus, only a mechanical precision adding up to a hundredth of a millimetre can be obtained.

But in a lens, it is possible to make allowance only for a defect fifty times smaller than in a tool. To achieve in a lens a ½ micron accuracy, Colonel Dévé invented, with typical French ingenuity, a special automatic apparatus capable of smoothing the surface of a cylindrical lens without any rotative movements, for it is imperative, throughout the whole operation, for the axis of the tool to remain strictly parallel to the axes of the lenses. Professor Chrétien has been using this apparatus.

When rough-hewn by hand, it is also imperative for both sides of the same lens to remain parallel between themselves and the axes of the tools. Verification can only take place after finishing.

"Hypergonars" have seven cylindrical surfaces, and all seven must be parallel in the same plane, and this plane must be a symmetrical one. For both movie-making and projection, "hypergonars" have been turned out in laboratory with the precision of one-hundredth of a degree in the orientation of their generators.

The normal field of vision extends far more in width than in height. The fact that the visual fields of both eyes prolong each other has something to do with this.



From left to right: Normal view with ordinary lens; View from the same point, anamorphosed in width by Hypergonar; View with correct proportions restored by the projector.

Professor Chrétien has made the most of this by providing a screen two and a half times wider than those in normal use, curving sufficiently to afford a feeling of engulfment, but without reflecting annoying light. In this way, picturegoers will see practically no limits to the screen and peripheral vision will be simulated.

Depth in Sound

In addition, Professor Chrétien has turned to good account the tricks played by the ear to enhance a feeling of depth. The direction from which the sound comes is perceived by the ear through its frequency. If a sound seems to come from left, it is not because the left ear hears more keenly, for the difference in volume is practically the same for both ears. The left and right ears not being set exactly opposite each other, it is not the difference in volume but in frequency which plays a major role in determining the position from which a sound comes. Thus, if sounds of the same volume are sent to the ears, through modifying their frequencies, they can be made to appear as now coming from left, now from right.

Professor Chrétien's 3-D process thus requires three pairs of coupled loudspeakers per each 100 sq. ft. of floor space. Obviously these are not just placed behind the screen, as is now stock practice, but all over the movie-theatre so as not to limit arbitrarily the source of sounds. The loudspeakers are made to register the sounds by their frequencies. If one loudspeaker in each pair is set with a one second's time-lag, a difference in frequency would be created. This very difference helps to create an illusion of depth, and in this way both sight and hearing are cleverly used "to bring the actors and objects right out of the screen."

Millions of picturegoers will be soon able to see for themselves whether this claim is justified.

A Model Weather-vane

This Working Model Can be Made Chiefly from Odds and Ends

By R. BRIERLEY

IN Fig. 1 is shown the general arrangement of a weather-vane designed for simplicity and ease of construction. For the layman it provides an interesting and amusing model and for the mechanic a handy prototype.

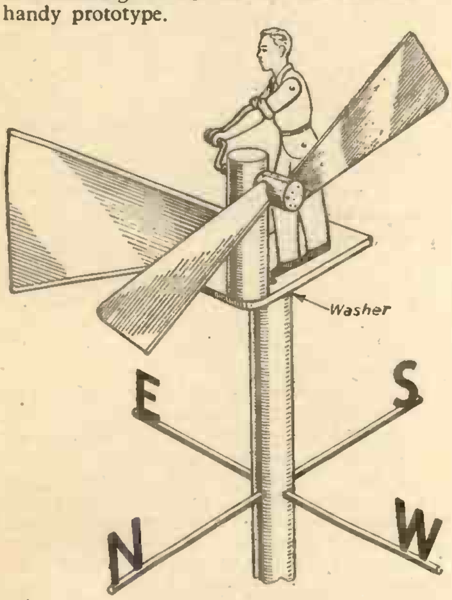


Fig. 1.—General arrangement of the completed weather-vane.

Construction

Cut two sails from cardboard as shown (Fig. 2) and the directional fin from cardboard (Fig. 3). Take a medium-sized cork and pierce the shaft guide hole, about 1/16in. dia., and bore a hole to take the sail stays. Push the sail stays in position and glue in place (Fig. 4). Bend the shaded portion of the sails round the stays and secure with wire paper fasteners (Fig. 5). Next, cut the platform and drill and screw it to the upright. Put a blob of glue in the two holes before pushing the directional fin support arms in position (Fig. 6) and then fasten the directional fin in position in a similar manner to the sail attachment. Mark out the figure of the man on fairly thick cardboard (Fig. 7) and cut out and fasten together with paper fasteners. Bend a 1/8in. dia. nail 3in. long to form a crank and cut a piece of tin to form a bearing 3/16in. by 1/4in. (Fig. 8). File the nail point flat and assemble as shown in Fig. 1, using beads or washers on each side of the upright. The hands of the figure should be placed on the nail and then drawn on to the tin bearing. The feet of the figure may be secured with small nuts and bolts. This arrangement enables the figure to be changed easily. The complete assembly is then screwed to the upright pole through hole "A" (Fig. 6), fitting a washer as shown in Fig. 1. Compass points may be fixed to dowel rods positioned as shown. The unit can be painted in any desired colours and with care in construction will function in even a gentle breeze.

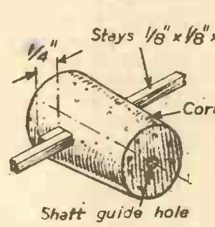


Fig. 4.—The cork hub.

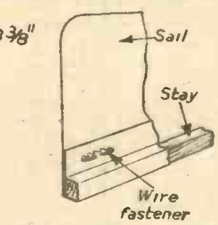


Fig. 5.—How the sails are fixed to the stays.

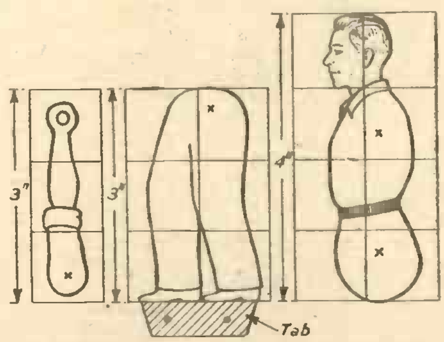
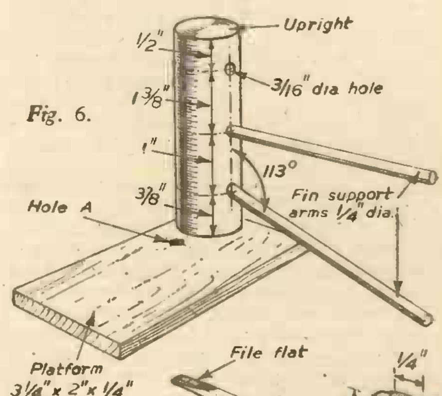


Fig. 7.—Marking out the parts of the figure.



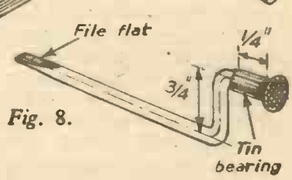
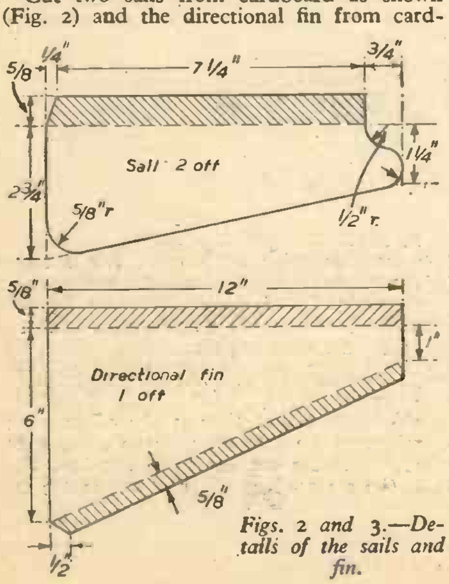


Fig. 6.—The assembly in position. Fig. 8.—Detail of the crank.



Figs. 2 and 3.—Details of the sails and fin.

Unity of Creation Theory

With Particular Reference to Einstein's Theory and the Michelson-Morley Experiment

By ANTONY AVENEL

THE recent correspondence in PRACTICAL MECHANICS seems to show that many readers feel the need for something less coldly mathematical than Einstein's Theory of Relativity and his subsequent theories. Few suggest that Einstein's brilliant calculations and theories are faulty, yet by themselves those essays in pure logic are not comprehensible to the average person.

One cannot gain the "mental picture" of Einstein's Theory because the theory is not in a form which leads to a mental picture. If you read the test performance figures for a new aeroplane, you will know a lot about what the plane can do, but you will be unable to visualise whether its lines are beautiful or ungainly, or anything of its appearance.

Einstein's Theory was before its time. The calculations of, for instance, the precise amount that a material contracts along the direction of its movement seems to be out of place before it has been explained why the contraction occurs.

I suggest that there has been too much mathematical jig-saw puzzle making and solving, and that formulæ have been put forward which, though probably correct, are by themselves without very much meaning to the intellect.

Michelson-Morley Experiment

This experiment aimed at finding the speed of the earth through the ether. Scientists had assigned to the ether descriptions ranging from an elastic solid to a rarified gas. If our speed through the ether could have been determined, it would help us to understand (amongst other things) whether we are labouring through a mass like black treacle, or wafting our way through a substance as thin and delicate as perfume.

Those who rely on this experiment, or on similar experiments, make an assumption which I believe to be false, that is that the ether is a three-dimensional substance—such as a gas. Only if the ether were a material substance would the passage of the earth through it cause an ether drag, or an ether wind, which could be measured.

The result of the Michelson-Morley experiment showed (apparently) that either there was no ether, or that if there was an ether the earth was not moving through it. Neither of these conclusions seemed to be probable; it would be unlikely that the earth should remain stationary in space when all other observed heavenly bodies were moving. Nor was it likely that there was no ether, for how else could the passage of rays through space be explained?

As neither of these conclusions could be welcomed, it was later suggested that the M & M experiment really did show a positive result, but that the measuring rod in the direction of the earth's movement through space contracted by an amount exactly sufficient to remove the positive result from being apparent (the Lorentz contraction). The proposition was of course that all materials contracted in the direction of travel; the supposed contraction was not confined to the measuring rod in the M & M experiment.

The Lorentz contraction at first sight seems to be an artificial and far-fetched theory, yet I think that those who have studied the calculations, and those who care to do so, will agree that the contraction must be accepted as something which actually does take place.

The Theory of Unity suggests reasons why the Lorentz contraction takes place.

Theory of Unity of Creation

The interest shown in PRACTICAL MECHANICS lately in the physical world prompts me to offer an outline of that part of the theory which affects this subject. The theory suggests, among other things, why the phenomena forecast by Einstein's Theories take place. It is unsatisfying to be told that time slows when you travel through space, and even to be informed of the precise amount by which it slows compared with your velocity, before any attempt it made to explain what time is and why it is capable of slowing.

The following statements and arguments are set out in rather a dogmatic and over-simplified form, which I hope will be excused, in order to try to offer an outline of the theory which can be followed without undue effort.

The theory anticipates the ultimate result of the fact that research discovers one unity after another in physical phenomena. One is led to expect that before long it will be proved that there is one basic building material for the whole universe. I do not pretend that there is sufficient data available at present to prove the theory fully, but there are many indications that it is an anticipation of what will be proved by, let us say, the year 2000 A.D.

The theory which I put forward is that the ether and space are the same, and that space is formed out of nothing by a grid of extremely high frequency rays (probably having a wavelength of less than 10^{-13} cm.). Space must be distinguished from "nothing." Space—even if it is empty—possesses the qualities of length, breadth, thickness and time. "Nothing" has no qualities whatsoever, and cannot support any material or ray. In other words, creation of the universe takes the form of making space out of "nothing," and the method adopted for making space is a network or grid of rays, which I call "creative rays."

Outside the Universe

Taking "the universe" to mean all created space, there is "nothing" outside the boundaries of the universe. The old problem of imagining the boundaries of the universe, outside which stretched empty space—which space must have boundaries, and what was outside that?—should not arise. "Endless space" is a contradiction in terms. Space has dimensions and boundaries and cannot be endless. The hand of creation has not touched the "nothing" outside the boundaries of the universe, and that "nothing" has no dimensions and therefore no boundaries.

To put it in another way, space is positive creation, while "nothing" is the absence of space, and thus purely negative. You cannot visualise "nothing" for obvious reasons; it has to be accepted. If anyone particularly wishes to try to relate it to human experience, it could be said that he has had more of it than he has had of space and time. It is what he experienced, or did not experience, before he was born.

Space or ether is formed by the creative rays which emanate from one source in all directions and in all planes. Each creative ray covers a circuit from source back to source, and each circuit is probably the same size. In this way space with boundaries of globular shape is built, and whatever point is taken in space, creative rays travel in all directions towards the source.

By the word "source" I do not imply that the formation of the creative rays operates in only one direction in each circuit; the action may be alternating.

Light is a Modulation of the Creative Rays

All rays of whatever frequency, visible or invisible, detectable or undetectable, are modulations of the creative rays, in the same way as a high-frequency radio wave is modulated by a musical note. As a radio carrier wave can be modulated by a number of separate notes, so can the ether carry between the same two points any number of waves of differing frequencies.

It would appear that rays or modulations are always caused by a disturbance in three-dimensional material, and that they are only of consequence when they encounter other such material. When a ray travels through space it is merely a slight modulation or disturbance of the creative rays and of no importance.

Material Objects

The atom is the building material for all solids, liquids, and gases, and each atom is composed of a nucleus round which revolve electrons at distances from the nucleus which vary with the type of atom. I submit that the atom is not solid fundamentally, but that it is composed of modulations of the creative rays in three planes. Although a modulation is normally a ray which travels in all directions from *its* source toward the source of the creative rays, the chord of modulations forming an atom are locked together in three planes. This lock prevents the modulations travelling in opposing directions as rays. Does not the release of atomic energy show the very close relationship between atoms and rays?

The main point which I want to make is that rays and atoms are both modulations of the creative rays, the former being simple modulations, the latter being complex and static ones.

An atom could in some ways be compared with a ripple caused by a stick in a smoothly flowing stream of water. It remains the same in appearance yet it is formed from a constantly changing medium. If this is correct, the universe is made from the same medium throughout, and what appears to be empty space between the earth and Mars is in reality a connecting medium.

Time

I suggest that time is the effect on our minds of the frequency of the creative rays. If the atoms out of which our brains and bodies are made are formed out of the creative rays, we cannot but be aware of the alternation of the creative rays. We cannot escape from time unless we also escape from space, or, in other words, cease to exist.

It is impossible to look either backward or forward in time from a fixed position in space. If we could travel at the speed of light and thus "keep up with time" we should probably cease to be three dimensional, which would not assist our observations ! In any case, we should find ourselves in a different position in space, so we cannot by any means foresee what is going to happen, or look back on what has happened, on earth.

Alteration of Time

If we were to travel at a very high speed —a substantial proportion of the speed of light—the frequency of the creative rays in the direction of our travel would be increased, because we would be travelling relatively to the pulses of the creative rays. It can be envisaged that something akin to the Doppler effect would take place, with the result that our basic time would be increased in frequency. We should not be aware of this, because the frequency of the creative rays is our only standard of time, and there is nothing *nearby* against which we can test this standard. But a stationary observer could, by rays of light, calculate the difference between our time and his time ; he would say that our clock was going slow compared with his clock, or that our basic time frequency was quicker than his.

Clock time is our way of counting the number of pulses of basic time. If basic time frequency increases, clock time still counts as one million pulses what are now, say, two million, and clock time appears to be going half speed.

Some space travel enthusiasts consider that if you could travel fast enough in a space ship, you could spend twenty earth years away from our planet and come back only a year or two older than when you left. If this is calculated using basic time-space, it is found that the effect on your body, and the impression on your mind, is exactly twenty years' worth of earth time, and that you could not therefore enjoy almost perpetual youth by this very inconvenient method.

Contraction of Length

If an atom moves along the creative rays, the increased frequency referred to before results in a shorter effective wavelength of the creative rays, which decreases the measurement of the atom in the direction of its travel.

For the purpose of simplicity, take it that the material length of an object is formed by the wavelength of the creative rays, while basic time is the frequency of the creative rays; then wavelength x the frequency of the creative rays will remain constant at whatever speed the object travels, because as the frequency increases the wavelength decreases. The product of the length of the object and basic time is unaffected by the velocity of the object, and it is this product which gives to our minds the impression of time and of the proportions of the object.

The creative rays present existence or the possibility of existence, and time and space are a division of that presentation. In whatever proportions the division is made, the whole remains unchanged.

Rays and Materials are Temporary

I would now like to meet the objection of those who say that it is just as difficult to believe that the creative rays travel through "nothing" as it is to accept that light travels through space without an ether to carry it. My reply is that this theory is that the creative rays create space not casually, but permanently: their cause is not casual, like the cause of a ray. The theory proposes that rays and materials are casual and temporary modulations or disturbances of the creative rays. It would seem unreasonable to believe that a special act of creation is necessary every time you choose to switch on an electric torch. The theory of unity holds that you, by switching on the torch, are able slightly to modulate the creative rays, which are permanently present, and that the casual phenomenon of visible light is the result.

Gravity

It is usually accepted (to put it basically) that if in space two masses exist, they *attract* one another. I suggest that this idea is wrong, and that it is impossible for a material object to emit rays which *pull* another object. Nor is there anything other than a ray which could exert the supposed pull. Rays can exert a small amount of pressure on an object in the direction of the ray's travel, but they cannot pull.

An alternative theory is that gravity is due to an increasing velocity, and the analogy of a lift rising at constantly increasing speed is often used. If a person in this lift released a pencil, it would appear to that person to fall to the floor of the lift, and he might well consider that the pencil was attracted by the floor. If this is the explanation, why does gravity act in more than one direction? It requires adjustments which seem to me to be very artificial to answer this.

The theory of unity explains gravity as the material version of the natural travel of a ray towards the source of the creative rays. The modulations forming an atom tend strongly to split up, to break their three-dimensional bond, and to travel in all directions, like ordinary rays, towards S.

Referring to Fig. 1, S represents the source of the creative rays, while the circle represents the circuit of one creative ray. X represents the place at which an atom is formed by the intermodulation of the creative ray shown on the diagram with the creative rays in other planes; the latter cannot clearly be represented on paper, nor, of course, can an attempt be made to draw to scale.

The tendency of X to act as a ray and to travel to S via A and B and via other planes is nullified by the three-dimensional strength of X. The modulations of the creative ray start for practical purposes at A and B, but they do not interlock with modulations in other planes until X is reached. These preliminary modulations in ray form I will call extension modulations; some of them are of a measurable frequency, others are of a frequency too high to be measured by a material device.

So long as X is undisturbed, it remains still in space, the tendency to travel to S via A being balanced exactly by its tendency to travel to S via B. Its tendency to travel to S in other planes is also balanced. But, referring to Fig. 2, if in the position Y (before the extension modulations of X have for practical purposes faded) another atom is formed, the extension modulation of X is interfered with and unbalanced between X and Y. The extension modulation of X in the direction of A is unchanged ; XA and XB are now no longer balanced, and as a result X moves towards Y ; Y also moves towards X, according to the laws formulated by Newton, or approximately so.

Although X moves towards Y, it is not *attracted* by Y, any more than light from the sun is attracted by the earth. (Here I am ignoring the almost negligible element of gravitation between a material object and a ray: the reason why light travels from the sun towards the earth is not because of mutual attraction between the light and the earth.) X moves towards S via Y.

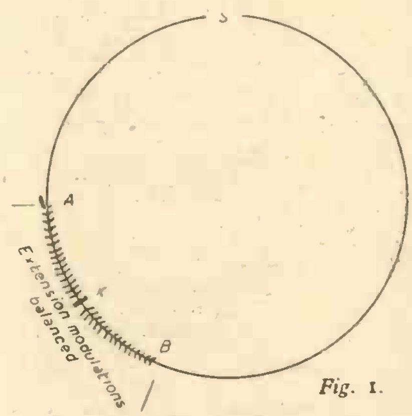


Fig. 1.

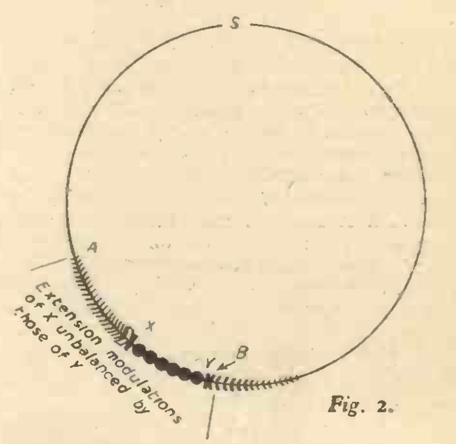


Fig. 2.

Diagrams representing the source and circuit of creative rays.

Magnetism

I suggest that it is not possible for the north pole of a magnet to emit rays which attract the south pole of another magnet, and which repel the north pole of another magnet.

The travel of one magnet is not towards another magnet but towards S. Some atoms of iron are arranged, or can be arranged, so that the extension modulations are not the same in all planes. This lack of symmetry can be encouraged by electrical means. It is quite possible that a single magnet removed from a powerful gravitational field would move through space of its own accord. A single magnet on or near the earth is prevented from moving by the gravitational field of the earth—that is, it is prevented from moving through space of its own accord. If another magnet of opposite polarity or a piece of iron is placed near the first magnet there is apparent attraction, but what actually happens is akin to gravitation. The first magnet moves towards S until it reaches the second magnet or the piece of iron. The strength of the magnet probably depends on the number of atoms in the magnet which have unbalanced extension modulations, the degree of lack of symmetry in each atom remaining constant.

Electricity

I suggest that this is a general disturbance of the extension modulations.

Flying Saucers

True "flying saucers"—that is those which are not the result of the imagination of the observer—are vehicles which are based on the principle of unbalancing the extention modulations of material carried in the vehicles.

Reality

The question arises: "Are these changes in time and space real, or are they only *deemed* to happen?"

The answer to this is, I think, that what you and I and everyone else is concerned with is basic time x length, representing the whole effect of both the frequency and the wavelength of the creative rays. In judging reality before our eyes, we are not concerned with the division of time x space into time and space.

If you want to listen to a concert on the radio it makes no difference to you whether the programme is carried to you by a 500-metre carrier wave or a 1,000-metre carrier wave, and you could detect no difference in the reality of the reception. You might then say that there was no real difference; but an engineer who is more interested in the method of your hearing the programme than in the programme itself would say that one programme was the result of modulating a carrier wave of 500 metres wavelength and frequency of 600 kc/s, while the other programme was brought on a carrier wave of twice the wavelength and double the frequency. To the listener who was unable to go further into the problem than to hear what came out of his loudspeaker, the programmes would be the same.

The answer then is, shortly, that although the change does actually take place in time and space, it is not real in the sense that it could be observed by a human being living within the sphere of the change, for such a person has not the means to measure basic time or basic length as an engineer can measure the wavelength and the frequency of a radio carrier wave.

Making a Voxometer

A Device Which Enables One to See on a Translucent Screen the Endless Variety of Patterns Produced by Music and Speech in a Wireless Receiver

WITH this simple instrument a new field is opened for the amateur wireless experimenter. The voxometer is made by placing a small loud-speaker unit in a tin can as shown in the sketches. A half-pint paint tin, or round cocoa tin, will answer the purpose admirably. Two thin plate brackets are soldered to the can to secure it to the baseboard. Molten paraffin wax is poured into the space between the tin can and the loud-speaker unit in order to produce a dead sound chamber between the loud-speaker unit and the rubber diaphragm.

To obtain the best results the diaphragm must consist of a very thin rubber. In the original voxometer rubber from a toy rubber balloon was used, strong rubber bands being used to bind it over the top of the can.

The degree of tautness of the rubber diaphragm will depend somewhat upon the power of the loud-speaker and the current fed into it, but a little perseverance will produce the desired results.

A small pool of mercury is placed on the rubber diaphragm, and to accommodate this it will be necessary to create a slight depression in the centre. This can be done by fixing a small iron weight in the centre.

Cabinet

The cabinet is constructed of plywood with a $\frac{3}{4}$in. softwood base. The window in the front is cut out with a fret-saw and provided with ground glass.

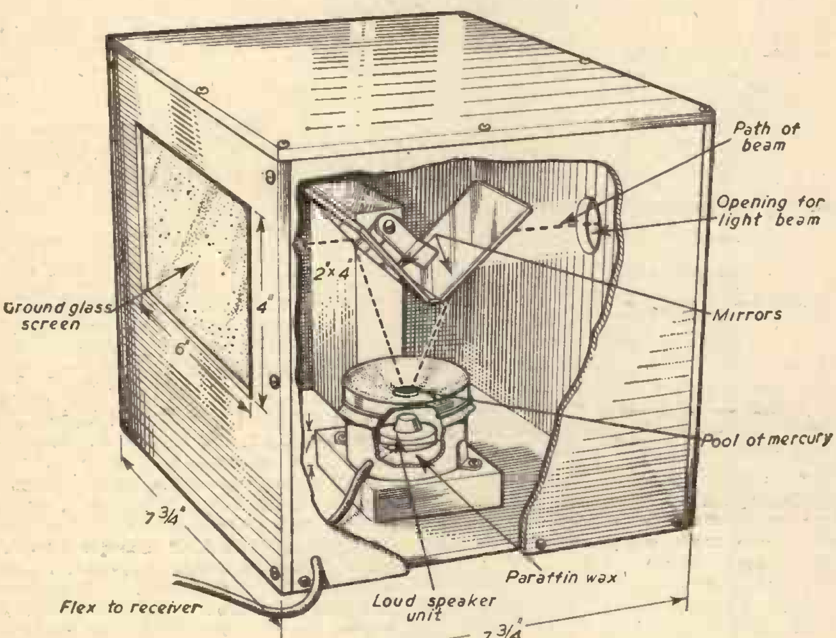


Fig. 1.—A view of the complete Voxometer, with part of the cabinet cut away to show the interior arrangements.

The images of the sound waves are created by the light reflected by a series of mirrors, the mercury itself acting in the capacity of a mirror. These mirrors have tin backs of the size and shape illustrated, and are attached to the post with small angle brackets.

Source of Light

The source of light may come from a small magic lantern, or a small light projector may be constructed by the experimenter himself. The more powerful the source of light the better.

It will be necessary to do a little adjusting to make the device perform perfectly. When arranging the mirrors at the correct angle it should always be borne in mind that the angle of incidence is always equal to the angle of reflection. The inside of the cabinet should be painted with dull, black paint.

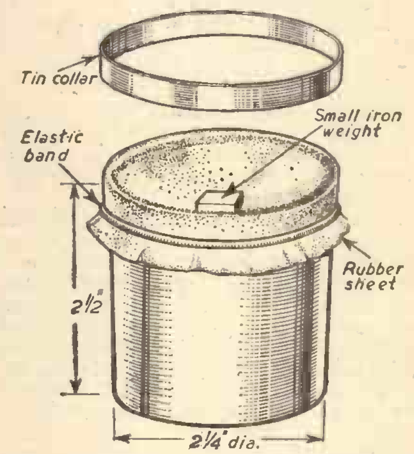


Fig. 2.—The tin can and rubber diaphragm fixed with rubber bands.

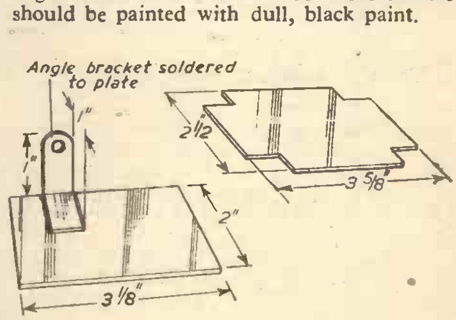


Fig. 3.—Metal backing for the mirrors shown bent to shape and in blank form.

Back to First Principles

9—About Work

By W. J. WESTON

WORK for our purposes has a narrow meaning: "work," in mechanics, is the operation of a force in producing movement or other physical change. It is the overcoming of a resistance. The work done by the force generated in the motor-car is the overcoming through a measurable distance the friction opposed by the road surface; the work done by a crane is the weight drawn vertically a measurable distance. The amount of force applied is always more, usually a good deal more, than the amount of resistance overcome; for we may be obliged to exert the force in a direction different from that of the resistance, and we lose work in overcoming friction, lubricate how we will.

The Problem

Find the minimum horsepower that a fire engine must have if it is to project 150lb. of water per second with an initial velocity of 100ft. per second.

The Comment

When we take into account the time taken in doing work, we concern ourselves with *power*: power is the rate of doing work. The work done is compared with that done in the same time by the brewer's dray horse that Watt used: wishing to indicate how many horses his engines would relieve from labour, he measured the time that the horse took in pulling up a weight of 100lb. from a deep shaft. The horse did it at the rate of two and a half miles an hour and Watt, "to be on the safe side" when lauding his engines, added half to the horse's result. And our convention is: one horsepower is 33000ft./lb. a minute (550ft./lb. a second).

The Answer

To acquire a velocity of 100ft. per second a body falls freely from rest in $\frac{100}{32}$ seconds.

The space fallen is given by the formula $\frac{1}{2}gt^2$, that is, $\frac{1}{2}\times32\times\frac{100}{32}\times\frac{100}{32}$.

The work done by the engine in one second is, therefore, equivalent to the distance multiplied by 150ft./lb.

The horsepower, therefore, is:

$$\frac{1}{2}\times32\times\frac{100}{32}\times\frac{100}{32}\times150\div550=42\frac{27}{44}$$

The Problem

What is the least horsepower needed to pump 1,000 gallons of water per minute from a depth of 50ft., and to deliver it through a pipe of cross-section 6 square inches? (Assume that 1 cubic ft. of water is $6\frac{1}{4}$ gallons, and that 1 gallon of water weighs 10lb.)

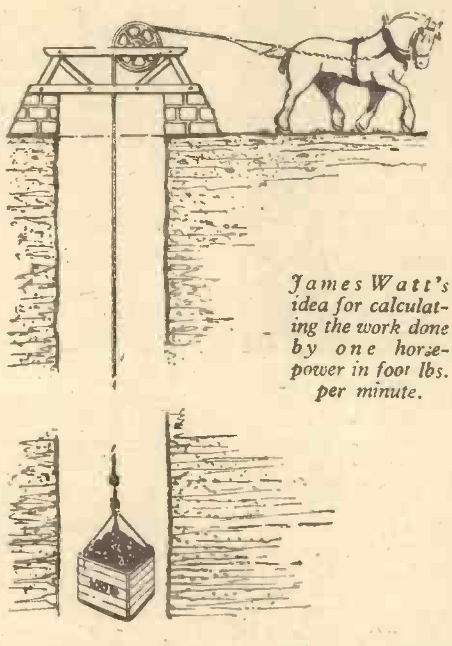
The Comment

The pump gives to the water an added *power to do work by virtue of its position*, **potential energy,** that is: the added potential energy in ft./lb. is measured by Distance Raised × Weight. The pump also gives to the water *power to do work by virtue of movement*, **kinetic energy,** that is: the kinetic energy imparted is measured by Distance Fallen to Produce Velocity × Weight.

The Answer

1. Potential Energy added to water $=(10000\times50)$ ft./lb.

2. Since $\frac{1000}{6\frac{1}{4}}$ or 160 cubic ft. is delivered each minute, and since the delivery pipe is $\frac{6}{144}$



James Watt's idea for calculating the work done by one horsepower in foot lbs. per minute.

or $\frac{1}{24}$ of a square ft., the velocity of the water is 160×24 per minute, or 64ft. per second.

A velocity of 64ft. per second is acquired by a freely falling body in $\frac{64}{32}$ or 2 seconds; and the distance fallen ($\frac{1}{2}gt^2$) is 64ft.

Work done on water to produce kinetic energy $=(10000\times64)$ ft./lb.

3. Total work done in one minute $=10000\times(50+64)$ ft./lb.

Horsepower $=10000\times(114\div33000)=34\frac{6}{11}$

The Problem

1. A man weighing 11 stone climbs a hill 500ft. high in 14 minutes: what is his average rate of working in horsepower?

2. At one place the breadth of a river is 100 yd., its average depth 12ft., and its average velocity 4 m.p.h. What horsepower would it furnish if half its kinetic energy could be transformed into work?

The Comment

This is another interesting instance of translating terms of ordinary speech into terms appropriated to mechanics. The principles applicable are those in the second problem.

The Answer

1. Work done in 14 minutes $=(11\times14)$lb. $\times500$ft.

Work done in 1 minute $=154\times500\div14$.

Horsepower is, therefore, $154\times500\div14\div33000=\frac{1}{6}$

2. Weight of water passing in 1 second is:

$(300\times12\times\frac{44}{15})$ cubic ft. $\times62\frac{1}{2}$lb. ($\frac{44}{15}$ being the speed per second).

To attain a speed of $\frac{44}{15}$ a body drops freely through a distance of $16\times\left(\frac{11}{60}\right)^2$ ft.

Ft./lb. per second, therefore, are given by the product of the weight passing and this distance. Half of these, being transformed into horsepower of 550ft./lb. per second, would give:

$$300\times12\times\frac{44}{15}\times62\frac{1}{2}\times16\times\frac{11}{60}\times\frac{11}{60}\times\frac{1}{2}\times\frac{1}{550}$$

$$=645\frac{1}{3}$$

BOOKS Received

The Motor Year Book, 1953. Compiled by Laurence Pomeroy, M.S.A.E., and R. L. de Burgh Walkerley. Published by Temple Press, Ltd. 212 pages. Price 15s. net.

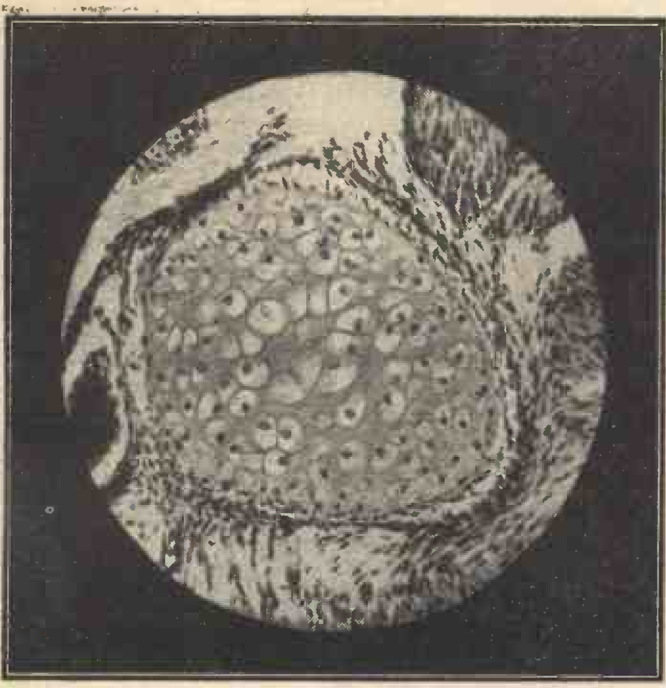
THIS fifth annual issue of "The Motor" Year Book continues the tradition of its predecessors in offering a complete record of all British and major European and American cars introduced in the past twelve months. It also contains a critical article on automatic transmission systems, a summary of road tests, and an analysis of the relative speeds of 1952 racing cars. The results of all the major sporting events of the year are tabulated, together with a brief description of all the first-class events. The book is profusely illustrated and should prove a valuable addition to the enthusiastic motorist's bookshelves.

Modern British Aeroplanes. By Charles Gardner. Published by Temple Press, Ltd. 91 pages. Price 9s. 6d. net.

THIS latest addition to the "Boys' Power and Speed Library" is right up to date and deals with aircraft very recently off the secret list. The book covers the developments in British aviation during the past five years and Charles Gardner, former air correspondent of the B.B.C., explains these in language easily understood by the average boy reader. The basic principles of "Why an Aircraft Flies" form the subject of the opening chapter, while another chapter deals with the piston engine and the airscrew. The jet engine has a complete chapter devoted to it and so have the subjects of modern navigation, primary and advanced trainers and naval aviation. The final chapter is a review of some of the problems and future trends. There are some magnificent photographs of Britain's latest machines and the technical data in the book is illustrated with many line drawings.

Modern Ships. By F. E. Dean. Published by Temple Press, Ltd. 90 pages. Price 9s. 6d. net.

THIS volume, another in the "Boys' Power and Speed Library," is in its second edition and has been revised and brought up to date. Much of the text has been re-written and many illustrations replaced by photographs of the latest type of craft. The first two chapters deal with the planning of the ship and the building of the hull, while the following two are entirely concerned with the engines and boilers. There is one chapter devoted to auxiliary equipment and the remainder each take a special type of ship as their theme. Illustrations take the form of both photographs and line drawings.



A section of a tadpole 10 microns thick, stained with Ehrlich's Hæmatoxylin and Eosin. (Greatly magnified.)

Staining MICRO

A Method of Preparing, Staining and Mounting Th

By B. J. WHITTON

WE read with interest Mr. S. M. Charlett's article upon mounting "whole mount" specimens for microscopical examination and decided that an article explaining the preparation and staining of thin sections of tissue would be of value to those who were stimulated into trying to prepare slides for themselves. The techniques which are here explained will, of necessity, only be sketches of a very complex subject. There are, however, many excellent textbooks on the market which can be purchased quite reasonably.

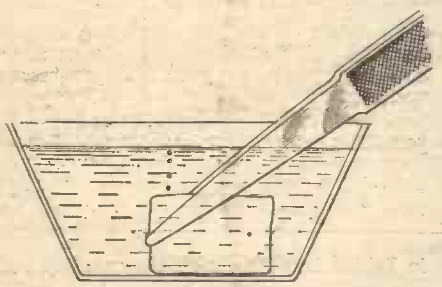


Fig. 1.—The block of tissue in its final wax, showing the method of teasing out air bubbles.

Fixation

The first stage in preparing any tissue for true examination is "fixation"—which should be as soon after death as possible. The object of "fixation" is to preserve the specimen in as near life-like a condition as possible. Fixing agents also prevent any distortion of internal structure when processing.

The best general fixatives are:

1. Commercial Formalin......10 ccs.
   Distilled Water ....90 ccs.

2. Bouins Fluid:
   Commercial Formalin ......25 ccs.
   Glacial Acetic Acid............5 ccs.
   Saturated Picric Acid ......75 ccs.

Specimens are left in the fixative solution for times varying from twenty-four hours, for small pieces of about a quarter of an inch square, to one week for larger pieces up to one inch square.

After fixation the blocks of tissue must be dehydrated—after a thorough rinsing in distilled water—by placing them successively in ascending strengths of alcohol in distilled water, i.e., 70 per cent. alcohol, 90 per cent. alcohol, and two changes of absolute alcohol for times ranging from fifteen minutes to four hours according to size.

The specimens are now placed in chloroform or oil of wintergreen for twenty-four hours, as alcohol is not miscible with the waxes in which they are going to be embedded.

The embedding process enables the blocks to be sectioned easily by impregnating and surrounding them with wax.

Embedding

A quantity of wax is melted and kept at an even temperature. The tissue is then placed in a half-and-half mixture of either oil of wintergreen or chloroform and wax. This mixture is followed by two changes of pure wax to remove the wintergreen or chloroform before the final embedding. Hard blocks are placed in wax with a high melting point (56°C) and soft blocks in wax with a low melting point (45°C). The length of time in the waxes is governed, as usual, by the size of the block and is between fifteen minutes and two hours.

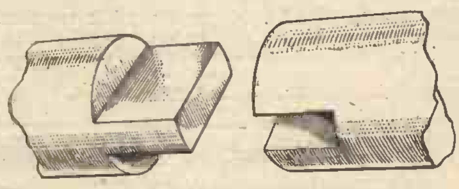


Fig. 3.—The sliding tongue joint which allows the "chuck" to rise or fall when the base of the microtome is rotated.

After the two changes the blocks are immersed in a small trough—which has been lightly greased with glycerine—containing the actual embedding wax.

A warm pair of forceps, or similar article, is drawn slowly about the block to tease out any air bubbles which may lie on the tissue. (See Fig. 1.)

The wax is breathed upon gently and when the surface has skinned over the trough is placed in cold water. If the trough has been uniformly greased the block will float to the surface of the water when hard.

Before embedding insects, the hard chitinous shell which encases them must be softened by boiling them in 5 per cent. caustic soda solution for about twenty minutes.

Cutting

The finished block is trimmed down and cemented, with more wax, on to the "chuck" of the hand microtome, simple constructional diagrams of which are shown in Figs. 2, 3, 4 and 5.

It will be seen that when the base of the microtome is rotated the block will rise sufficiently for a thin section to be cut by sliding a dissecting razor over the platform (Fig. 6). The thinner the section cut the better will be the results.

The thin sections so cut are gently lowered on to the surface of a bowl of warm water to flatten out any wrinkles. They are then eased, with the aid of a small brush (Fig. 7) on to a glass slide which has been rubbed with a half-and-half mixture of egg albumen and glycerine. This mixture makes the sections adhere to the slide. The mounted slides are pressed flat with damp filter paper and placed in a warm oven (42°C) overnight.

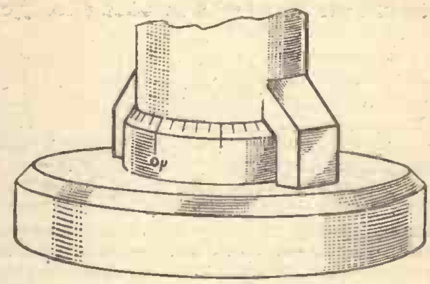


Fig. 4.—Detail of the supports which keep the hollow column of the microtome rigid.

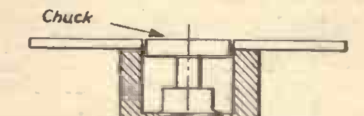
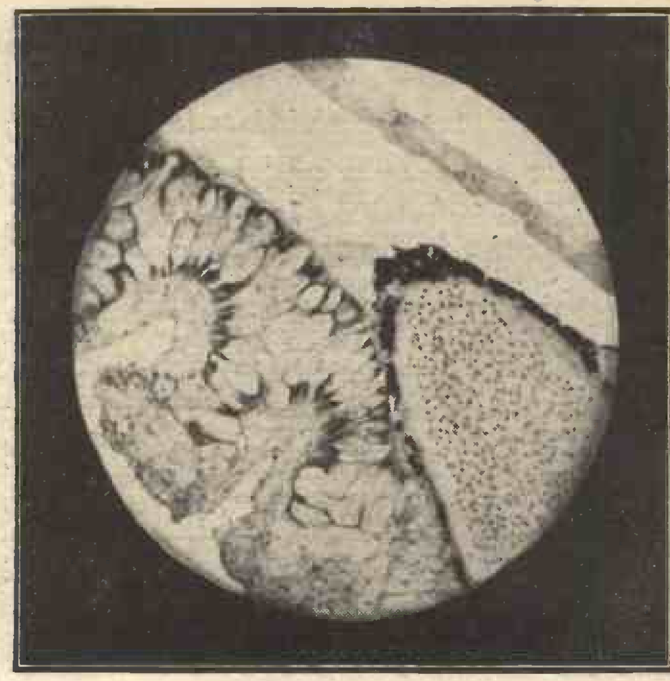


Fig. 2.—The hand microtome. This is easily constructed from brass or similar metal. The instrument can also be purchased for about £2. The finer the screw thread the thinner the sections will be. The top platform must be perfectly plane or the sections will not be of uniform thickness. Note.—The microtome may be calibrated at the rotating base using a micrometer.

SCOPE SPECIMENS

n Sections of Tissue for Microscopical Examination

and R. H. ANSELL



A section of a tadpole 10 microns thick, stained with Toluidine Blue. (Greatly magnified.)

Staining

Of the many hundreds of techniques evolved for staining sections, possibly the most common and most useful one is Ehrlich's Hæmatoxylin and Eosin method.

First the slides are dewaxed by placing them in xylene and then hydrated by reversing the dehydration process. They are then stained in a solution composed of:

Hæmatoxylin .... 2 gms.
Alcohol .... 100 ccs.

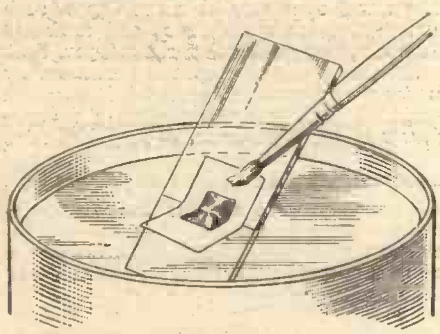


Fig. 7.—Easing the section on to the slide. Care must be taken to touch only the surrounding wax and not the tissue.

Dissolved first together.

Glycerine .... 100 ccs.
Glacial acetic acid .... 10 ccs.
Distilled water .... 100 ccs.

for half an hour at 37°C. The solution will keep indefinitely, and can be used over and over again, but must be left for at least a week to ripen. After this they are placed in gently running tap water until the sections turn blue. They can then be looked at under the microscope and the cell nuclei should be stained. Excess stain is taken out with:

Hydrochloric acid .... 1 cc.
70% alcohol .... 100 ccs.

until the background is colourless. When a satisfactory result has been obtained the slides are counter stained with:

Eosin .... 1 gm.
Glacial acetic acid .... 2 drops
Distilled water .... 100 ccs.

for five minutes. Surplus stain may be taken out with 70 per cent. alcohol.

Another useful method is one using Toluidine Blue. The hydrated slides are stained for five minutes in a 0.1 per cent. solution of Toluidine Blue and are then gently rinsed in distilled water. The colours produced in the tissue by this stain range from blue to violet.

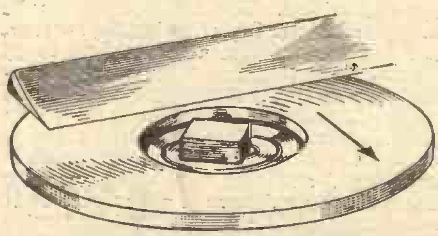


Fig. 6.—Cutting a section through a block by sliding a dissecting razor over the platform.

Mounting

The stained slides are quickly dehydrated once more and placed in xylene, which renders the tissue transparent.

The sections are covered with a clean glass coverslip upon which has been placed a drop of Canada balsam or similar mountant (Fig. 8.)

The finished slides are left in a warm oven (42°C) to dry; this usually takes about two days.

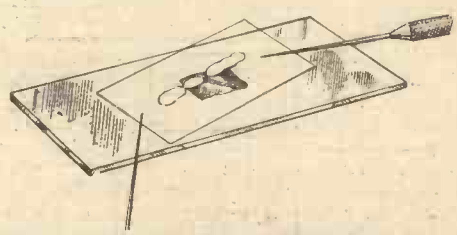


Fig. 8.—The cover slip should be gently lowered on to the sections with a needle. Avoid air bubbles in the mountant. Heat will remove some but is not a good practice to resort to.

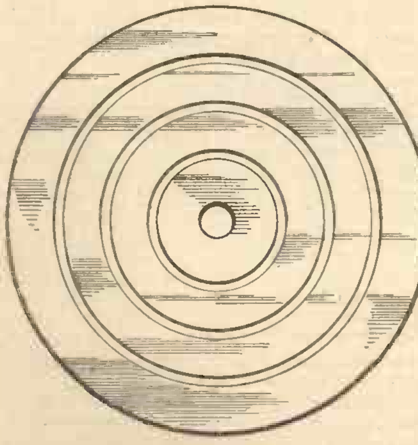


Fig. 5.—The "chuck" of the microtome must have channels scored in it to make the wax grip when the block is cemented to it.

New 16 mm. Sound-film Projector

THE British Thomson-Houston Company recently announced the introduction of a new 16 mm. sound-film projector. The new model, designated Type 401, supersedes its well-known predecessor Type 301 which, itself, when introduced in 1946, caused a minor sensation in the 16 mm. world because of its revolutionary design, and set new standards in the projection of 16 mm. sound-films. The 301 was the outcome of experience gained in the design and manufacture of 16 mm. projectors over a period of some 15 years, dating back to 1931 when B.T.H. gave the world the first successful 16 mm. sound-film projector.

Amongst some of the most interesting features of the 401 is a considerable reduction of mechanical noise; a saving in weight; and the provision of a new amplifier giving an output of 30 watts. The fitting of diamond-hard "Ardoloy" peckers has eliminated any need for replacement of the claw due to wear.

Although the 301 was world famous for its high light-output and brilliant picture, detailed changes in the optical system give the 401 an output of over 300 lumens from a 750 watt, 115 volts tungsten lamp when fitted with a 2in. f1.5 projection lens.

One of the ways in which mechanical noise has been reduced is by replacing the gears driving the picture head by a silent-running belt drive. Further reductions in noise have been effected by the use of a compressed-cotton gearwheel in the intermittent mechanism, and a new cam to reduce "film-click."

By the omission of the sound-absorbing cover and the removal of the amplifier mains transformer, the projector has been reduced in weight by some 15lb. The transformer has been incorporated in the mains unit without any appreciable increase in weight or size of this unit which is now no longer housed in the speaker cabinet for transport (reducing the weight by 20lb.) but is treated as an entirely separate item.

The overall weight of the complete equipment (with the projector in its carrying case) is reduced from 106lb. to 88lb.

ELECTRICAL TIMING CIRCUITS

Some Useful Units for Operating on Batteries or A.C. Mains

By F. G. RAYER

CIRCUITS of the type to be described have a number of practical applications, according to the kind of circuit and the manner in which it is used. Similar circuits are used in some enlarger timers, and the same arrangement can be used with photographic contact-printers, or when an electric lamp is employed as the source of illumination for contact printing. With such circuits, a control resistance may be calibrated in seconds, as will be described, so that the desired exposure may be obtained. Such an arrangement is particularly useful when a number of prints or enlargements are being made from one negative, as the correct exposure can then be repeated time after time, accurately and easily.

The possibility of using decorative or flashing bulbs is an obvious one, and need only be mentioned in passing. When automatic re-energising is employed, the timing cycle is repeated indefinitely. It can be increased in frequency, and thereby used as an electrical metronome so that strict tempo may be maintained in instrumental or vocal musical practice. It will be found that very stable operation can be obtained, with a high degree of constancy in counting or timing.

Timing Circuit

This is shown in Fig. 1, current being derived from a 4½ to 9v. dry battery. The push-switch is of the spring-loaded type which normally remains in the open position. When it is depressed, current flows through the relay winding, thereby attracting the armature. At the same time, the condenser is charged from the battery. When the switch is released, the condenser slowly discharges through the relay winding, thereby keeping the armature down. When the condenser has discharged to a certain extent the relay armature springs back to its previous position, thereby breaking the second circuit. The rate of voltage decay in the relay circuit can be adjusted by means of the 50,000 ohm variable resistor, so that the time elapsing before the relay armature is released can be modified as required.

The relay should be of the high-resistance type, with a coil resistance of 5,000 to 10,000 ohms. This type is available both new and from ex-Service component stockists. The period of delay can be increased, if necessary, by setting the armature return spring to reduced tension, or decreased by tightening the spring. The value of the variable resistance is not critical. However, low values will cause rapid discharging of the condenser; while excessively high values will make accurate control difficult.

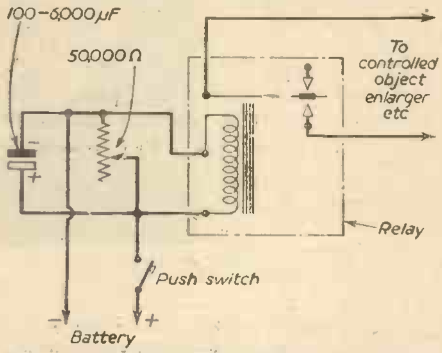


Fig. 1.—Electrical timing circuit for battery operation.

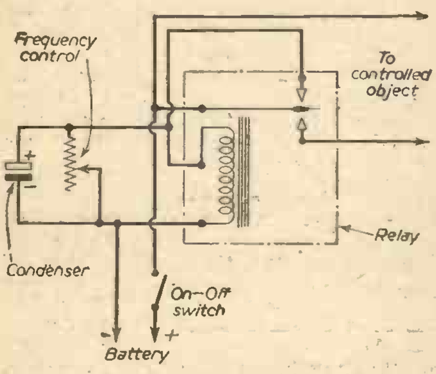


Fig. 2.—Automatic re-energising circuit.

Adjustable Delay Period

The capacity of the condenser is not in any way critical. The delay period can be lengthened at will by increasing the capacity, and it was found that a delay of up to 45 seconds was possible with a 200 mfd. condenser, with 9v. battery and 10,000 ohm relay. A number of condensers may be wired in parallel. Care should be taken to see that the correct polarity of connection is maintained, and that the voltage-working rating of the condensers is not exceeded. If a condenser is to be bought especially for this purpose, then a 1,000 mfd. 6v. working type is suggested. The maximum period of delay, if excessive, can easily be reduced by tightening the armature spring, reducing the battery voltage, or using a resistor of lower value in parallel with the relay winding.

When setting up this circuit, the tension of the armature spring should be adjusted by trial. Once set, the variable resistor may be fitted with a calibrated scale, the markings being found by setting the resistor control knob to various positions and timing with a watch with second-hand. For normal enlarging and printing, times up to 45 seconds are sufficient.

To use this circuit, the control knob is set to the desired exposure time and the push-button operated. The enlarger lamp will then come on and remain burning for the required time.

"Repeating" Circuit

The circuit described may be slightly modified, as shown in Fig. 2. Here, when the on/off switch is closed the relay is energised through one armature contact. This also charges the condenser, as before. When the condenser voltage has decayed sufficiently for the armature to be released, contact is again made, and the sequence repeated. By tightening the armature spring, the sequence may be speeded up so that the variable resistance enables the frequency of operation to be controlled over a much narrower range, as, for example, from two beats per second to one beat each two seconds. The control is infinitely variable, and may be calibrated in beats per minute by counting and marking the pointer position. One application for this rapid counting circuit is in an electrical metronome, used for musical and other purposes.

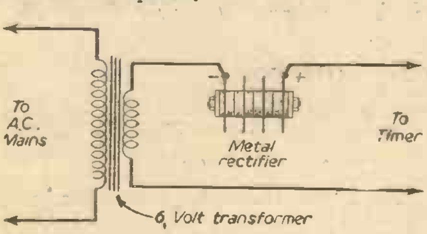


Fig. 3.—Deriving current from A.C. mains.

Using Mains Supplies

With long periods of continuous operation, it is convenient to draw current from the mains. This can be done by using a transformer and rectifier, as illustrated in Fig. 3. The transformer may be a small type, such as intended for models, etc., and it should have a primary suitable for 200/250v. A.C. mains. The voltage output of the secondary is not very important, provided it does not exceed the voltage working rating of the condenser in the relay circuit. A small half-wave metal rectifier is also required—a ¼ amp. 6v. type is satisfactory, for voltages up to six.

The positive and negative leads of the circuit are taken to the relay circuit instead of the battery there indicated. It should be noted that transformers cannot be used with D.C. mains.

Metronome Loudspeaker

When the rapid counting circuit is used for musical purposes, some means of increasing the volume of the armature click is essential. A small dry battery and speaker can be added, as indicated in Fig. 4. The strength of the "tick" heard from the speaker can be adjusted by varying the battery voltage, or by adding a volume control of about 50 ohms in one connection, as shown. Very loud results may be obtained by this means, if necessary.

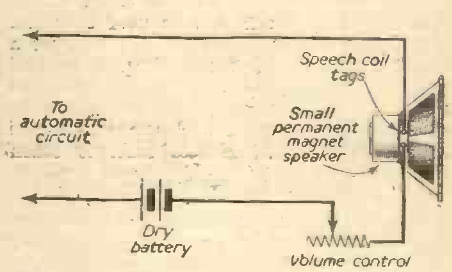


Fig. 4.—Loudspeaker or metronome circuit.

The speaker circuit may be energised by the battery circuit being completed by the relay contacts, or it is feasible to wire a high-impedance speaker directly in parallel with the relay energising coil, when no additional battery is required. If the circuit in

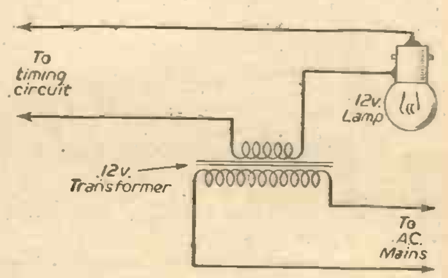


Fig. 5.—Circuit for contact printer or enlarger.

Fig. 4 is adopted, no matching transformer is required on the speaker, which may be of the usual 2/3 ohm or 15 ohm type, according to what is to hand.

Enlarger Circuit

Enlargers are frequently made for low-voltage bulbs, and a circuit for operating such a bulb from the mains is given in Fig. 5. When using the timing circuit shown in Fig. 1, it is necessary to see that the current and voltage rating of the relay contacts is not exceeded. Such relays are not normally suitable for the direct switching of mains-voltage circuits. If such a circuit is to be switched, then the timing relay should be used to control a mains-voltage relay, the contacts of the latter being used to switch the mains circuit. With printing-boxes using one or more mains-voltage lamps, a second relay of this kind becomes essential.

An Ozoniser Unit for a Motor-car

Details for Making and Fitting an Apparatus for Air Conditioning in a Motor-car

By R. W. SHORE

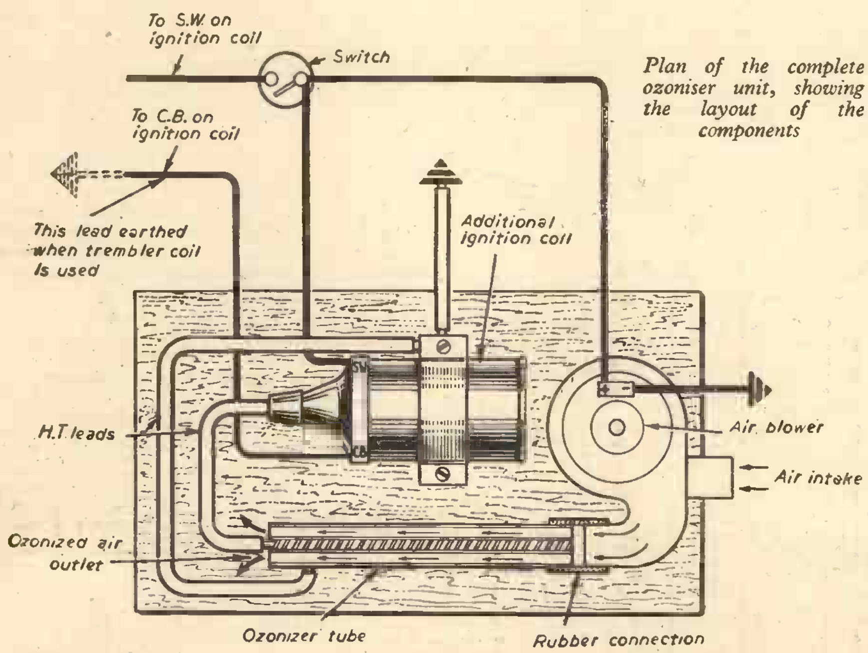
FURTHER to the article entitled "A Household Ozoniser" which appeared in PRACTICAL MECHANICS for July, 1953, details are here given for making up and fitting a similar apparatus to a motor-car.

An ozone tube, similar to the one described in the July issue, will be required. The second type of tube referred to is definitely preferable.

To obtain the H.T. current an additional ignition coil of the same voltage as the car supply will be required. The H.T. terminal of the additional coil should be connected to the centre copper wire of the ozone tube. The outer tube, which is covered with tin foil, should be connected to the carcase of the additional coil, which, in turn, should be connected to the earth of the car, e.g., the frame or engine. It is essential that for this purpose H.T. wire should be used.

The low tension side of the additional coil should be wired in parallel to the ignition coil of the car; i.e., the switch terminal of the additional coil should be connected to the switch terminal of the ignition coil; likewise, the contact breaker terminals should be connected together. The switch terminal on the coil is marked S.W. and the contact breaker terminal C.B.

A switch will be required to operate the ozoniser, and this should be connected into the wire from S.W. side of the additional coil to the switch side of the ignition coil. This switch can be mounted on the instrument board or in any other convenient position. Wired in this manner it will only operate when the ignition is switched on, therefore there is no fear of leaving the car with the ozoniser unit alive.



Plan of the complete ozoniser unit, showing the layout of the components

Producing an Air Flow

As described in the previous article, to make the ozone tube effective a current of air is required to pass through the ozone tube to circulate the ozone into the air. This can be effected by connecting one end of the ozone tube to a small blower or fan, in which case the positive wire of the blower motor should be connected to the switch terminal of the additional coil and the negative wire to earth. With this arrangement of wiring, both the blower motor and the ozone tube can be operated by the one switch. On later model cars, which are fitted with heaters and demisters, it is easy to duct a percentage of air from the heater fan to the ozone tube by means of a piece of rubber tube and a duct fitted over a small portion of the heater lid.

Another way to produce an air flow without the aid of a blower motor is to take a piece of rubber hose from the ozone tube to some external part of the car: the inlet of the tube should be facing towards the front of the car so that forward movement of the car causes an air flow. N.B.—Care should be taken to ensure that the inlet is not placed in such a position that it will draw exhaust or engine fumes into the car.

In order to keep the complete unit compact all the parts can be mounted on a wooden board, as shown in the diagram, which could be fitted on the dashboard behind the instrument panel, or in any other convenient place.

On cars where space is limited the parts can be mounted separately, for example, the additional coil can be mounted under the bonnet and the ozone tube behind the instrument panel or between the seats. Care should be taken to ensure that it is not fitted in such a position that the H.T. current can leak to earth or that a passenger could receive a shock through handling it.

In this set up the make and break is created by the contact breaker of the car. This will, of course, place an extra load on the contact breaker points. If it is found that, due to the extra load, the points are burning slightly, a larger capacity ignition condenser should be fitted, but normally the standard condenser fitted is sufficient to cope with the extra load.

Using a Trembler Coil

The arrangement as described above will only operate when the engine is running. If, however, it is required to operate when the engine is not running, a trembler coil should be fitted in place of the additional ignition coil and wired up in the same manner, except that the return wire from the C.B. terminal on the trembler coil should be connected direct to earth and not to the C.B. terminal of the ignition coil.

The amount of electricity consumed by the ozone tube is approximately 2 amps. on a 12-volt system and about 4 amps on a 6-volt system. The average amount consumed by a small blower motor is approximately 2-3 amps. on a 12-volt system.

The benefits of this air conditioner will soon be appreciated. If the car is an oldish model it will be found that engine fumes, etc., will be overcome.

Making a Microscope Lamp

With Hints on the Construction of Light Filters

By S. M. CHARLETT, F.R.M.S.

THE best light to use for normal microscopic observation is that reflected from white clouds on a bright day, but unfortunately for the microscopist this type of light is very rarely obtainable in this country, and in the winter it is virtually non-existent. Therefore we have to resort to artificial illumination as provided by the electric lamp, which, for the microscope, is usually enclosed in a housing of some description.

The lamp described in this article, which is quite simple to construct, utilises a 100-watt electric bulb and incorporates a light filter holder, the use of which will be described later in the article.

The body can be obtained ready made in the form of a tin (a paint tin was used by the writer) to save the trouble of constructing it from tinplate, and the holes for the lamp holder and light aperture can be cut with a wad punch, or by drilling and filing to shape. The lamp holder is best attached to the lid as this facilitates the easy removal and replacement of the bulb. A number of holes should be made symmetrically around the top of the lid to provide ventilation, and to prevent the lamp from becoming excessively hot. (Fig. 1.)

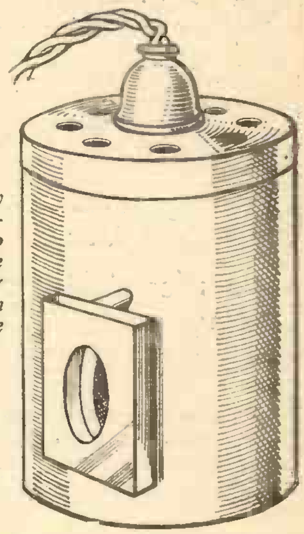
The filter holder is made up from a piece of tinplate, the joints being soldered. (Fig. 2.) The holder is attached to the lamp body by soldering on two pieces of ¼in. copper rod. This rod acts as a spacer to prevent the filter holder getting overhot and spoiling the filter itself.

Finally, the whole should be given a coat of black lacquer, which provides a smart finish, and at the same time increases radiation, thus helping to keep the lamp cool.

Light Filters

When the lamp is in use the microscopist would be well advised to try the effects of various light filters inserted in the holder whilst examining objects under the microscope. Filters serve a double purpose, they help to reduce the eyestrain often experienced when using the microscope, and they can be used to increase the contrast between an object and its background. For instance, a green filter should always be used when looking at an object under the microscope. Green being a restful colour will be found to make prolonged observation less fatiguing than when performed without a filter. If a blue coloured object is being examined and a red filter is used, it will be found that the contrast between object and background will be increased. This is because red and blue supplement each other, and thus give a very dark object on a light background. If an orange filter is used the contrast will be even sharper, as blue and orange cut out all light and give the effect of a black object on a light ground.

A list of suitable contrast filters is given in the following table:—



General view of the completed lamp showing the filter holder and ventilation holes in the top.

Object Colour	*Contrast Filter*
Red	Green
Orange	Blue
Yellow	Indigo
Greenish-Yellow	Violet
Green	Red
Blue	Orange
Indigo	Yellow
Violet	Greenish-Yellow

If, by any chance, you have reached the stage of applying stains to your microscopical preparations the following filters will be found very useful when using the microscope:—

Stain used on Object	*Contrast Filter*
Haematoxylin	Blue-Green
Gentian Violet	Yellow
Methylene Blue	Orange
Fuchsin	Green
Malachite Green	Red

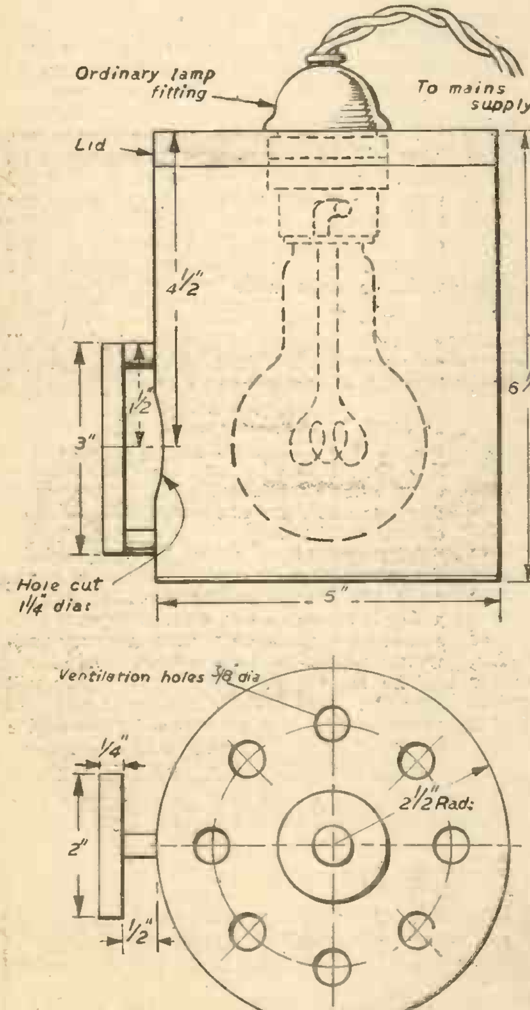
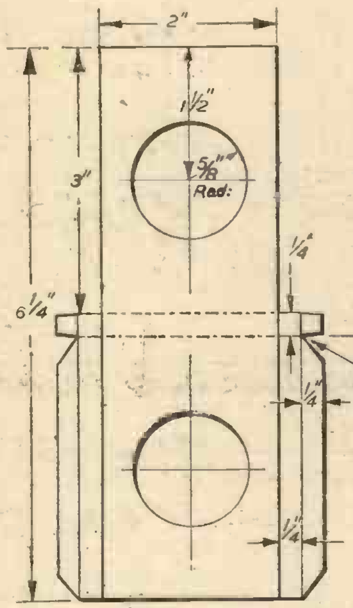


Fig. 1.—Side view and plan of lamp.



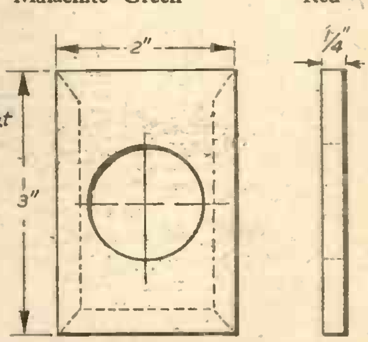
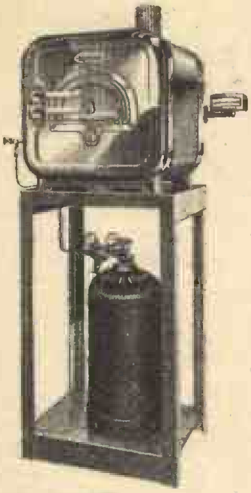


Fig. 2.—Method of forming the filter holder from one piece of tinplate.

Mounting the Filters

All these filters can be constructed at home quite easily, using glass from old photographic plates which you can probably buy from your local photographer quite cheaply. The actual filter can be made in accordance with cost. If a cheap and not absolutely pure filter will do for the time being then it can be made from the strips of coloured cellophane that can be purchased from any stationers. On the other hand if one can afford it, and a sensitive filter is required, then the best thing is to obtain graded light filters from a photographic company, such as Kodak or Ilford. The filters are delivered in the form of coloured strips of gelatine and it is important to remember not to touch them with the fingers as this will make them blurry and render them almost useless. The

(Continued on page 41)



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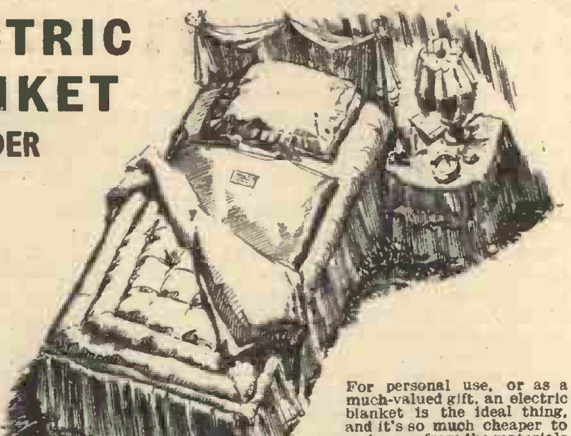

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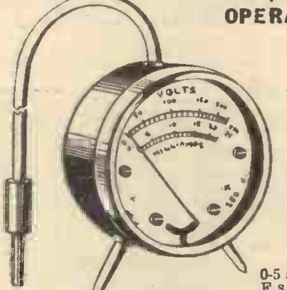

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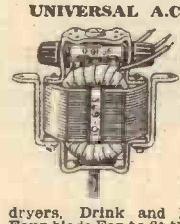

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Modern Oil Refining

The Various Processes of an Oil Refinery, Including "Cracking"

As a general rule, crude oil must be refined before it can be used either as fuel or lubricant. Only in rare cases can some crude oils be used in their natural state ; one Borneo crude, for example, is sold as boiler fuel. Certain kinds of bunker fuel and similar heavy products are sometimes mistakenly called "crude," whereas they are really residual products obtained during refining.

Crude petroleum is a complex mixture of many different solids, liquids and gases, but nearly all these have one thing in common: they are hydrocarbons, that is, compounds of hydrogen and carbon only. Small but significant amounts of impurities are also present, principally sulphur, with traces of oxygen, nitrogen and chlorine. Three main types of hydrocarbons occur in petroleum ; paraffins (this chemical term describing the paraffinic series of hydrocarbons should not be confused with the domestic paraffin oil), naphthenes, and aromatics. The varying proportions of these which are present in different crude oils largely govern their quality and decide to some extent the refining process to be employed in extracting usable products from them. The first main stage of processing all crudes is their division, by distillation, into groups of similar hydrocarbons, or "fractions." Refinery processes have therefore to be more complex than "refining" in its ordinary dictionary meaning of "the removal of dross or impurities."

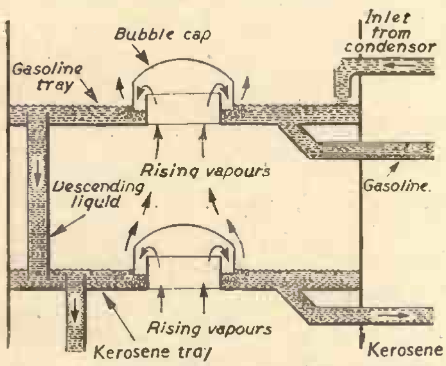


Fig. 1.—Simplified diagram to show the action of a bubble cap, a group of which is installed on each of the trays.

Most of the natural gas, which is made up of the lightest group of hydrocarbons, is extracted before the oil reaches the refinery proper. This gas often comes from the ground alone, and as it carries some of the light *liquid* hydrocarbons in suspension, these are removed to form "natural gasoline," which can be used as petrol. The "dry" gas is used as an industrial or domestic fuel, or as a raw material for chemical products. Natural gas may also be found dissolved in crude oil, under the force of subterranean pressure. Much of this gas is freed from the crude when pressure is reduced as the oil reaches the wellhead, and various processes are used to make the separation of liquid and gas more complete before the crude oil is passed to refinery storage tanks.

The division of the oil into primary products or "fractions" is carried out in a fractionating tower, a tall, cylindrical, metal tower which is divided into a series of chambers or "floors" by perforated trays. The crude oil, now carrying only small quantities of dissolved gas, is heated to, say, 300 deg. C. partly by being piped through a preheater, which is similar in principle to a water-tube boiler, and partly by utilising the heat from products already processed. It is then pumped continuously into a chamber near the base of the fractionating tower, where further heat is usually applied. All except the heaviest hydrocarbons now form a mixture of vapours which can be separated as they rise in the column by cooling to different temperatures in the various trays, to give condensate or distilled primary products.

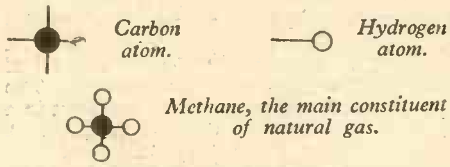


Fig. 2.—The key to the construction of the lightest hydrocarbon molecule.

The top of the tower is cooler than the rest, and from here the lighter, lower-boiling hydrocarbons are led away to be condensed outside the column, to give a gasoline (or petrol) fraction. Some of this liquid is returned to the top of the tower, to help to cool it. One stage lower, the temperature is somewhat higher ; the gasoline component remains as a vapour, but hydrocarbons within the boiling range of kerosene (paraffin oil) here condense. So in stages down the column come products with progressively higher boiling-points.

To make the process of separation more efficient, "bubble caps" partly cover the perforations in each tray and force the rising vapours to bubble through the liquid already collected in the tray (see Fig. 1).

The vapours bubbling through the kerosene tray are hotter than the liquid, so they expel any gasoline component wrongly present in the liquid and carry it up to the next tray in the form of vapour. Kerosene in the vapours condenses in the cooler liquid and so remains in the tray: some may find its way up to the gasoline level, but as condensed liquid gasoline is constantly overflowing from the gasoline tray back to the kerosene level, the kerosene eventually returns to the correct tray.

This distillation process, called "continuous rectification," extends throughout the tower. The liquid in each tray is distilled and redistilled, each fraction steadily growing richer in its correct components, losing lighter hydrocarbons to upper levels and heavier hydrocarbons to the trays below. Low in the tower near the point of entry of the heated crude oil, or "feed-stock," the heaviest compounds flow to the bottom of the tower as a viscous mass from which the various asphalts will be obtained. Sometimes this residue also is made to flow through trays of bubble-caps while a carrier-gas, usually steam, is forced through it to carry small amounts of volatile material up into the lighter oils and vapours.

Crude oil distillation is usually carried out in three stages, for the range of temperatures necessary would be too great for one fractionating tower. "Sidestrippers" receive the liquid from each tray and distil each "fraction" in a small tower of its own, to increase still further the efficiency of separation. In distillation the components undergo no chemical change.

Cracking

The proportions of the various primary products obtained by distillation are very close to those originally present in the crude oil, but these rarely correspond with the relative quantities of the different products which are required by consumers. With the great growth of the internal combustion engine, refiners soon found that when they treated a sufficient quantity of crude oil to produce the volume of gasoline needed, there remained more of the higher boiling-point products than they could sell. A way had to be found to break down these heavier hydrocarbons into the lighter gasoline, and this was successfully accomplished by the process aptly termed "cracking." A chemical change is involved in this method.

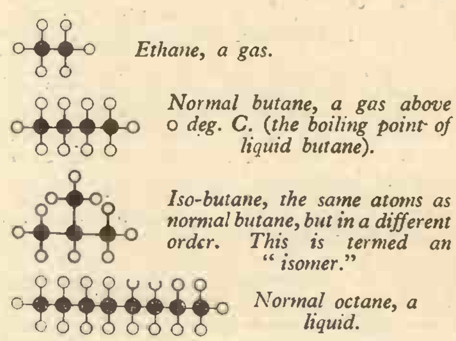


Fig. 3.—The series known as the paraffins, all with the termination -ane.

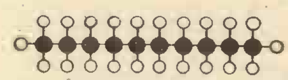


Fig. 4.—Ten carbon atoms in a straight chain with 22 hydrogens.

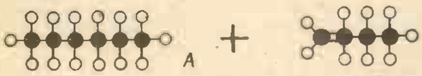
To understand the process, the structure of the smallest imaginable particle of these hydrocarbons (a molecule) must be considered. (There is no such thing as "a gasoline molecule" or "a kerosene molecule": these finished products are mixtures of various hydrocarbons, each of which has its own typical molecules.) All hydrocarbon molecules are made up of atoms of carbon and hydrogen; the key to their structure is that one carbon atom has the power to link with four hydrogen atoms, and this can be represented as shown in Fig. 2. This formation is known as methane, and is the main constituent of natural gas.

From this point the structure of a hydrocarbon molecule can be built up in many ways, but the simplest and, as it happens, the commonest examples are those which form a series known as the paraffins, with the termination "ane" (see Fig. 3). Further reference to Fig. 3 will show that iso-butane has the same atoms as normal butane, but in a different order. This is termed an "isomer." While iso-butane is an "isomer" of normal butane, so normal butane is an "isomer" of iso-butane. Thus, in general, any iso-paraffin is an isomer of a normal paraffin and vice versa.

The paraffin series can be extended to chains many times the lengths shown in Fig. 3, and the longer the chain the more isomers are possible. As previously mentioned, other types of hydrocarbons, chiefly naphthenes and aromatics, are also present in crude oils, but the paraffins will suffice for the present analysis.

The original "cracking" process was carried out in a special plant known as a "reactor" by the use of high temperatures (say, 500 deg. C.) and high pressures (say, 50-100 times atmospheric pressure).

Heat increases the energy of the molecules



A paraffin normal hexane. *An olefine-normal butylene (compare butane).*

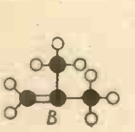


Fig. 5.—(Above) One way in which a fairly heavy paraffin hydrocarbon molecule may be split into two other paraffins. (Left) An isomer of the olefine might also be formed (iso-butylene).

so that they move faster; if they develop sufficient speed they break free from the liquid, i.e., they boil off. Increased pressure outside the liquid limits this tendency to break free, and if the temperature is high enough the energy of the molecule is such that it "cracks."

Consider a moderately heavy paraffin hydrocarbon molecule: 10 carbon atoms in a straight chain, with 22 hydrogens (Fig. 4). It cannot be split into two other paraffins, for there are not enough hydrogen atoms to make this possible. The break may occur in different ways: one example is illustrated in Fig 5A. An entirely new type of hydrocarbon, the olefine, not present in crude oil, has thus appeared. Its molecule is characterised by the double link, necessary because there is not enough hydrogen to hold or "saturate" all four carbon "arms." It may be noted that an isomer of the olefine might also be formed (see Fig 5B).

The olefines always tend to link their spare carbon arm with another atom; for this reason they are markedly more reactive than the paraffins, and are hence very useful in building up chemical products.

Although the formation of a paraffin and an olefine is the main result of cracking, other reactions also occur. For example, one olefine may link with a similar olefine to form a "polymer"; thus compounds heavier than the original can be produced. Other compounds will polymerise into aromatics, such as benzene.

Cracking thus produces a mixture containing new types of hydrocarbons which are not present in crude oil, but the greater part of this mixture is suitable for gasoline. The necessary separation is again carried out in a fractionating tower. Cracked gasolines in general have a better anti-knock value than those produced by ordinary distillation; that is, they give smoother engine performance without "knocking" or "pinking," and they can be satisfactorily used in engines with higher compression ratios, which give more power for their size.

Thermal and Catalytic Cracking

While there are many variants, cracking processes fall into two main divisions. "Thermal" cracking relies on temperature and pressure alone. "Catalytic" cracking (the more recent process) does not necessarily use high pressure but employs a catalyst, that is, a substance which aids and speeds the reaction without undergoing any change.

One important advantage of the catalytic process is that it forms more "branched" iso-paraffins (like iso-butane above) and also rather more aromatics, such as benzene, than the thermal method produces, and thus gives greater quantities of motor spirit than those obtained in thermal cracking. Both iso-paraffins and aromatics further improve the anti-knock value of gasoline.

One of the most recent developments in catalytic cracking is the use of fluid catalysts, i.e., catalysts in the form of finely divided powders. As the oil vapours enter a reactor they pick up the powdered catalyst and as they rise they keep this constantly in a state of violent agitation. At the top of the reactor most of the entrained catalyst is separated from the vapours, which then pass to a conventional fractionating tower.

Of the many other modern processes the following, which have been developed mainly to meet the need for high-grade gasolines, may be briefly mentioned.

Reforming

In this process a limited degree of cracking is applied to a gasoline in order to improve its anti-knock qualities. Thus it may be applied to the heavier gasoline produced during distillation, which generally has a low anti-knock value compared with the light gasoline.

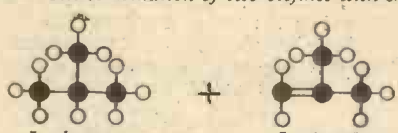
Polymerisation

Some olefines are gases, and are, therefore, unsuitable for gasoline as they tend to

(*Continued on page 37.*)

Iso-butylene. + *Iso-butylene.* + *Hydrogen.* = *Iso-octane. Ideal for gasoline with excellent anti-knock properties.*

Fig. 6.—The combination of two olefines with the aid of a catalyst to form a polymer of the original.



Iso-butane. + *Iso-butylene.* = *Iso-octane as above (no extra hydrogen required in this case).*

Fig. 7.—The combination of two dissimilar light hydrocarbons.

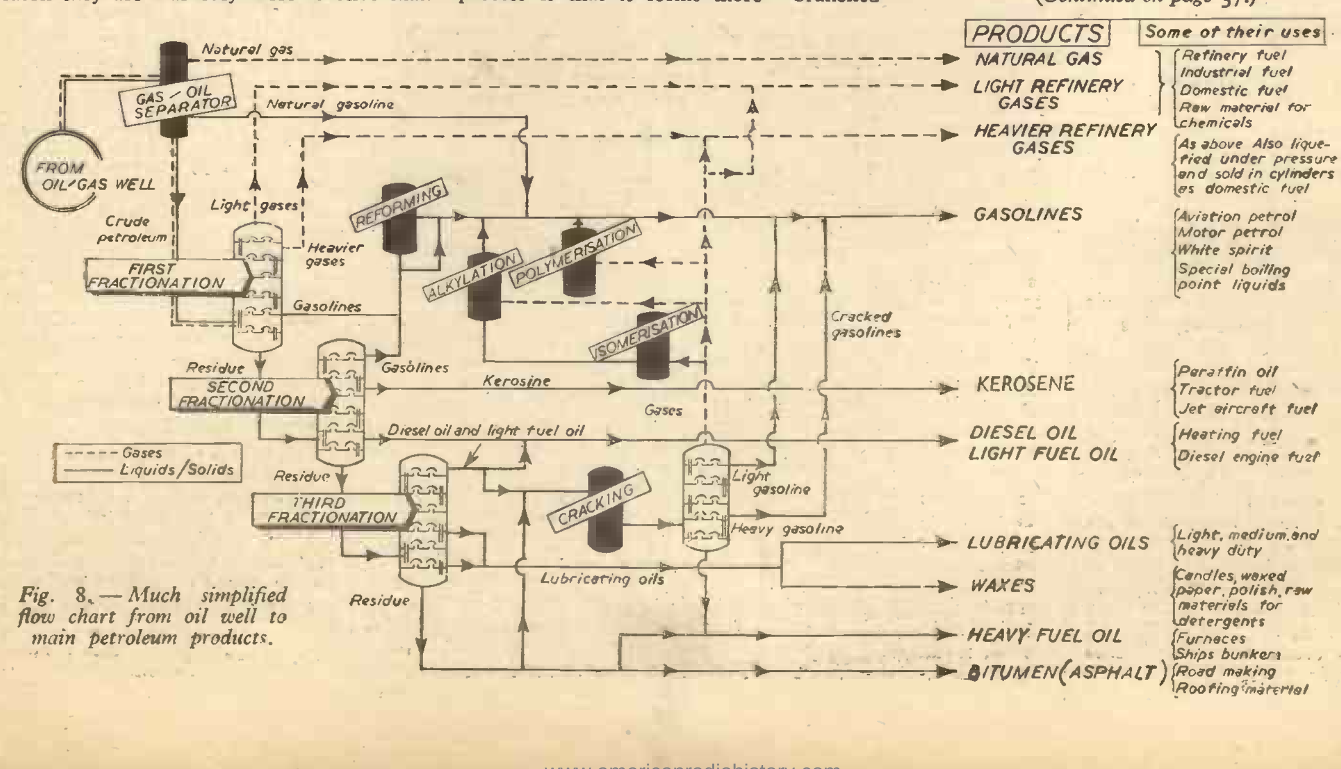


Fig. 8.—Much simplified flow chart from oil well to main petroleum products.

form vapour locks in an engine's petrol feed system. If two similar molecules of such olefines are made to combine, with the aid of a catalyst, the product, known as a polymer of the original, is generally a liquid. Extra hydrogen is supplied to form one of the paraffinic series. One example is shown in Fig. 7.

Alkylation

This is not unlike polymerisation. Two dissimilar light hydrocarbons are made to combine (thermally or catalytically). A typical example, which is really the reverse of cracking, is shown in Fig. 8.

Isomerisation

We have already referred to iso-butane (an isomer of the paraffin normal octane) which has very high anti-knock properties. Other iso-paraffins can be obtained direct from normal paraffins with the help of a suitable catalyst. For example, normal butane can be changed to iso-butane, which can then be used in alkylation to produce iso-octane.

To ensure that the products will be of the highest quality and will give optimum performance, refineries employ many other processes; three of these may be mentioned.

Removal of Sulphur Compounds

Reference has been made to impurities in crude oil: the most important are sulphur compounds and the commonest of these is the gas, sulphuretted hydrogen (H_2S). Most of this is removed on initial distillation, and any which remains can be extracted by the use of suitable alkali. H_2S can corrode metals, and so can the evil-smelling "mercaptans," which are also sulphur compounds. Mercaptans are often present in some fractions, but they are either converted into harmless sulphur compounds (a process known as "sweetening") or, in the case of aviation gasoline, which must be of exceptionally high purity, they are removed altogether.

Extraction of Aromatics

Aromatic hydrocarbons, like benzene, which are present in some crude oils, must be removed from kerosene if this is to be used as an illuminant, for they would make a smoky paraffin oil. If kerosene is to be used as a fuel for tractors, however, the aromatics are left in because of their anti-knock quality.

De-waxing

Paraffin waxes are often present in the heavy residual oils used in making lubricating oils, in which they would be harmful. When the mixture is chilled, the waxes tend to crystallise out. The separation is often aided by using a solvent which will dissolve only the oil, and so free it from wax. In either case the final separation is by filtration, under pressure, through cloth which keeps back the wax.

Oil refineries, small and large, simple and complex, for ordinary distillation or with cracking and many specialist units, are spread over the world. The personnel must be highly trained, the plant must be of the finest material, able to withstand intense heat and pressure, and utmost precautions must be taken against fire and explosion.

In closest co-operation with the refineries work the vital research centres, where scientists improve plant and product and devise new processes, guiding the next steps in this vast industry which is always changing, always looking ahead, always finding new products and new uses for those products.

[Reproduced by courtesy of the Petroleum Information Bureau.]

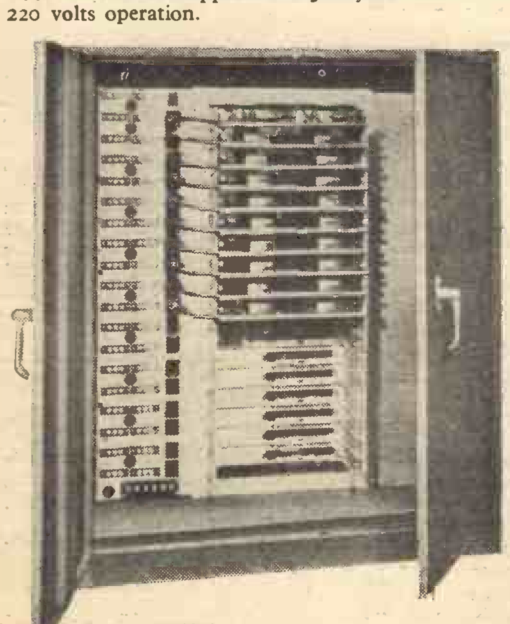
Trade Notes

New Automatic Dial Telephone System

THE Stromberg-Carlson Company of America announces the "Dial-X," a completely automatic, private inter-communication telephone system, suitable for both small and large installations, and costing less than installing a corresponding number of "extension" lines on an "outside" telephone system.

Important features are: Simplicity of installation, and provision for easy future expansion. A compact control cabinet contains all the equipment, completely wired. It may be placed in an out-of-the-way corner. The system is put into operation by merely running a three-wire line from the terminals in the control cabinet to each phone. No multi-wire cables are used. Power supply to the control cabinet is 110 volts, 60 cycles A.C. It can be supplied for 50 cycles and 220 volts operation.

(Above) The modern "Dial-X" desk-phone. Below the same instrument is shown converted to a wall-phone.



(Left) Control cabinet of the 36-line Stromberg-Carlson "Dial-X" automatic dial telephone system, shown with 10 plug-in "dual selectors" in place, making 20 lines ready for use. The remaining 16 lines are for expansion. Each additional "dual selector" plugged in, automatically adds two more lines to the part of the system already in use.

Two sizes are available, with a maximum capacity of either 16 lines or 36 lines. Either size may be started in operation with two phones. Additional phones are added by running a three-wire line from terminals in the control cabinet to each new phone, and plugging in a "dual selector." This automatically interconnects the new phones with every other phone in the system.

Other features are: Provision for conference calls of any size. "Executive Right-of-Way," permitting cut-in on a line by selected phones. A paging unit is available as an accessory. Plugging it into the control cabinet permits paging from any phone, through an existing paging system. Any number of extension phones may be used on a line. The newly-designed desk-phone can be converted into a wall-phone by a simple and inexpensive conversion kit.

Geology Materials

THE firm of Stanley L. Toyne has sent us some leaflets describing their work. They specialise in making thin section petrological slides; make and prepare rock and mineral collections; slides of industrial materials and those required for technical purposes. They make slides from customers own materials, including the polishing and etching of specimens for microscopic examination, and can make every type of micro-slide and mount needed both for geology and biological purposes.

They are the only firm in the country—and one of the only three in the world who make such thin sections for amateur, scientific and commercial use.

They prepare and polish granite and all allied rocks and minerals, either from customers own specimens or from their own extensive stock of some 2,500 different types of materials. They prepare such items as oriented mineral slides, used in conjunction with the microscope for the illustration and demonstration of optical phenomena interference figures, types of optical sign, refraction, birefringence, cleavage, pleochroism, extinction angles, etc., etc., in all the various forms.

Finally, they employ an advisory and identification service for geologists and mineralogists, etc.; the sight of a specimen will enable them to identify it and, provided some information is given, they can often place its exact locality very quickly. Their own comparison sets of rocks, minerals, fossils and slides comprises some 15,000 different types, covering the whole world's geological deposits and formations.

All enquiries should be addressed to Stanley L. Toyne, 15, Stamford Road, Chorlton-cum-Hardy, Manchester 21.

LETTERS TO THE EDITOR

The Editor does not necessarily agree with the views of his correspondents.

"Threats From the Conjurors"

SIR,—I wish to add a point to your "Fair Comment" in the February issue on "Threats by Conjurors." A conjuror is a displayer of technique, not a magician. Everyone realises that the tricks done by these people are impossible if taken at face value; a woman cannot disappear in a puff of smoke from a cage or be sawn in half. The enjoyment of these illusions comes from the appreciation of the smoothness with which they are carried out, even though the mechanics may be well known. Examine the work of a great painter, it is simply lumps of paint on a piece of canvas; but how many of us can put lumps of paint on a piece of canvas and create the same effect? The same applies to any art, including illusion.

Perhaps the illusionists are afraid that their art has no need of technique and could be copied by anyone. That may explain why they wish their mechanics to "remain secret." If this is so, I believe they have nothing to fear, because it is a pleasure for any amateur to see his hobby or interest demonstrated by an expert. It may be fun to be fooled, but it is better fun to be able to appreciate an artist.—D. L. PRIESTLEY (Watson's Bay, N.S.W., Australia).

Restoring Stained Negatives

SIR,—Concerning the reply in a recent issue to Mr. C. H. Thomas, who asked about removing stains from imperfectly fixed or washed negatives, I would suggest that after refixing and before using any further chemical processes, he duplicates the negatives. He will thus insure his originals against accident, and will probably eliminate the stains during the duplication, if he uses the following method:—

Using a 15-watt ruby bulb as an exposing lamp, make a contact positive from the original on an Ilford soft gradation pan plate (or similar material). For good definition the printing frame must be at least 3ft. from the bulb, and the exposure will be a few seconds. Develop in D.76 or similar borax developer (not a fine grain solvent developer, which develops the deep layers of the emulsion and reduces definition in this case). The finished positive should be rather denser than a normal lantern slide. Any general brown stain will be completely eliminated, but any small patches still visible may be darkened with very dilute retouching dye, or a soft pencil.

Make a new negative from this, using white light, and, if possible, ordinary or diapositive material. This method is more reliable and permanent than the chemical removal of stains. Other colour stains may be eliminated similarly by using the appropriate hue of printing light, and the contrast may be reduced or increased if desired.—G. SAXBY (Oxfordshire).

Antifungus Creosote

SIR,—I would like to comment on two points in the reply to Mr. Young's enquiry in a recent issue referring to creosote as a fungicide.

Sodium fluoride, although poisonous, does *not* etch glass. The hydrofluoric acid and the acid fluorides (e.g., aluminium bifluoride) attack glass, but sodium fluoride can be kept in glass bottles without difficulty. It should *not* be mixed with acids.

It would be preferable to apply the sodium fluoride solution first and follow this with creosote rather than applying them in the reverse order, as the creosote would prevent the penetration of the fluoride.—K. C. CLIFTON (The Leeds Cleaning Co. (Buildings) Ltd., Leeds, 10).

Interplanetary Space Travel

SIR,—I feel I must attempt to clarify some points raised by Mr. W. J. Land, in your April issue, on the question of space travel. His letter dealt with the problems of heat transference in a vacuum.

We are taught at school that heat may be transferred from one point to another by any of three methods: conduction, convection, and radiation. Heat is conducted along a bar of metal by means of the vibrational energy of its molecules; it is transferred by convection when a warm wind blows across the land, or by the currents set up when a kettle of water is heated. Both these methods need the presence of some material substance by which the heat may be carried. Radiation, however, can go on even in a perfect vacuum, since the heat travels in the form of electro-magnetic rays, very much akin to light rays, and no matter is required for its propagation. The efficiency of a vacuum flask depends not only on the fact that the double-walled container is evacuated, thus preventing loss of heat by conduction and convection, but because the inside surfaces of the vessel are silvered The principle underlying this procedure is that a warm silvered surface radiates far less heat than a dull one (this is why the radiators of a central heating system are usually finished with a matt paint), and that a cold, shiny surface reflects back a large amount of the radiated heat striking it, absorbing only some 2 or 3 per cent. Thus, the inside wall of a flask gives off only a little of its heat by radiation, and the outside wall sends back virtually all of this heat, the temperature of the flask remaining nearly constant.

To apply these principles, now, to space travel. A space ship is, of necessity, highly polished, and this would prevent a rapid temperature rise due to the sun's rays. Against this must be put the fact that the ship would radiate only a little of its internal heat owing to the surface finish. This is not all, however, since "space," as it is called, is not a true vacuum, although it is a far better one than can be produced on earth. Also the temperature of the highly rarefied matter in space is very near to absolute zero. The ship, then, would lose heat to this matter in its journey through space. A balance between these and other possible effects would be the result, but I leave it to a far better mathematician than myself to compute the final temperature of the ship! It seems not unreasonable to assume, however, that this temperature would be little different from that found on earth. As to the heat produced by the jet motors, most of this would be carried away by the propulsion substance as it left the ship.

Similar considerations apply to a "vacuum" filament lamp. Radiant heat strikes the bulb, thus raising its temperature. These lamps nowadays, however, are not evacuated, being filled at low pressure with an inert gas in order to prevent the evaporation of the filament and consequent deposition of metal on the glass. The bulb is, therefore, additionally heated by conduction and convection through the medium of this gas.

Your correspondent's last query was in regard to meteors. In spite of his disbelief, it *is* a fact that meteorites are raised to red or white heat solely by their rapid passage through the earth's atmosphere, otherwise they would obviously be visible before coming near the earth. The height at which these bodies first appear may be accurately measured, and in all cases this height is found to agree with the estimated height of the earth's atmosphere.—C. N. BANWELL (London, S.E.).

Copying Without a Camera

SIR,—Re the article in your August issue "Copying Without a Camera," it would appear that your contributor experimented with the method described and thought it was something new, but it has been in use for a long time and the principal makers sell it as Document-copying paper. It is a slow, high contrast paper on a thin, grainless base. The author of your article used bromide paper and says it fogs, but bromide paper is unsuitable. Document paper will give dead blacks and clear whites when used as negative and positive. An ordinary bromide developer is also not suitable. A high-contrast developer is necessary. A slightly tinted yellow screen to make the paper negative would be useless; it would either increase the exposure without advantage or it would prevent any image being formed at all, according to the depth of the tint.

It is obvious your contributor experimented on his own ignorant of the protographic papers on the market and the fact that the process is in regular use, not only by the making of single copies, but there are machines in use for copying documents in quantities.

Document copying papers are available in the flat from 5¾in. x 8¼in. to 33¾in. x 46⅞in., and in rolls from 8in. x 60ft. to 40in. x 120ft., from one maker. An "Autopositive Document Paper" will give positive prints direct from positive originals.—"PHOTO PRINTER," (Swansea).

Bubble Display Device

SIR,—In reply to S. L. Holmes in the August issue, this bubble device is an Andrews display novelty. A glass with a pierced base stands on a platform and through it is a tube connected to an electric aerator and it is this which gives the constant stream of bubbles. These are usually obtainable at an aquarium requisites store and cost about 25/-. They consist of what appears to be a neat box containing a delicate diaphragm subjected to electric impulses and thus acting as a jerky pump of air. If the correspondent asks the chemist he may oblige and let him inspect the back of the display.—D. BLUNDELL (London, W.).

Polishing Granite

SIR,—We have read with interest the enquiry published on page 482 of PRACTICAL MECHANICS, August, 1953, issue with regard to the polishing of granite, etc.

We should like to mention that we supply all the necessary powders and equipment required for this purpose and also prepare and supply everything needed by those

(*Continued on page 41*)

READERS' SALES AND WANTS

The pre-paid charge for small advertisements is 6d. per word, with box number 1/6 extra (minimum order 6/-). Advertisements, together with remittance, should be sent to the Advertisement Director, PRACTICAL MECHANICS, Tower House, Southampton Street, London, W.C.2, for insertion in the next available issue.

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WIN THAT CUP. Model Engines, Motor-cycles, etc., can be tuned using our fan dynamometer and chart. Bench tests without friction; no cooling water required. The Gearmark Co., Farnborough Way, Farnborough, Kent.

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PERSPEX for all purposes, clear or coloured, dials, discs, engraving. Denny, 15, Netherwood Road, W.14. (SHE. 1426. 5152.)

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COMPRESSOR EQUIPMENT. Miscellaneous Items; catalogue, 1½d. Pryce, 157, Malden Road, Cheam.

COMPRESSORS for sale, 3 CFM, 180lbs. sq. in., on metal base, with driving wheel and receiver, price £3; ¼ h.p. Heavy Duty Motors, price £3; carriage forward. Wheelhouse, 1, The Grove, Isleworth. (Phone: Hounslow 7558.)

HACKSAW BLADES, genuine surplus by leading Sheffield manufacturer; 12 Blades, 10in. and 12in., 3/3; 24 blades, 6/-, post paid. Sawyers Ltd., 115, St. Sepulchre Gate, Doncaster.

"PICADOR" ROTOSAW. Portable circular saw attachment for your electric drill fitted with 4in. circular saw blade, adjustable fence to cut up to 1in. in depth, ideal for wood, plastic, or soft metals; 33/-, each, post paid. Lambs-wool polishing Bonnets, 5in., 4/3 each; Rubber Backing Discs, 5in., complete with key, 4/6 each; Abrasive Discs, 5in., 6 assorted grades, 2/-. Send 2½d. for lists of Saw spindles, Vee Pulleys and Belts, Plummer Blocks, etc. Sawyers, Ltd., St. Sepulchre Gate, Doncaster.

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TYLER Spiral Hacksaw Blades cut in any direction at conventional hacksaw speed without turning the work. 10in. Hacksaw Blades 4d. each from leading tool dealers. Write to Spiral Saws, Ltd., Trading Estate, Slough, for details.

HOUSE SERVICE METERS, credit and prepayment; available from stock. Universal Electrical, 221, City Road, London, E.C.1.

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MYFORD 3½in. ML. Lathe, motorised, on stand, complete with chucks and tools; unused, £75. Buck and Hickman ½in. motorised drill; height 3ft.; 3-speed; complete; very slightly used, £25. Bayne, 4, Scillonian Road, Guildford, (62468.)

WRINKLE or Crackle Finish for metal products, fishing reels, enlargers, models, etc., etc.; easy to use; instructions with every tin; colours: black, red, blue; prices: 6/3 ¼pt., 11/6 pint, 19/6 quart; sample ¼pt. of each colour 15/6; carriage paid. Russell Development Co., Russell House, Little Russell Street, Brighton, Sussex.

LATEX FOAM UPHOLSTERY, 6ft. x 2ft. x 4in., covered, £5/15/-; carr. and pkg., 5/-; 2ft. x 1ft. 6in. x 4in., £1/10/-; c. and p., 2/-; 32in. x 16in. x 1½in., 14/-; c. and p., 1/-; s.a.e. complete list. B. & M. (Latex) Sales, 16, Hamm Moor Lane, Weybridge, Surrey. (Weybridge 3311.)

REJUVENATE your Water Softener. New Zeolite, 2/3 lb.; 10lbs. post paid. C. G. Nelson, 118, Anchorway Rd., Coventry.

AIR RECEIVERS, 22in. x 10in., £4; 15in. v 12in., £2; 20in. x 4in., £1. Oxygen Bottles, 16in. x 7in, 20/-. Safety Valves, 8/6. Moisture Filters, 7/6. 50lbs. Gauges, 12/6. C. G. Nelson, 118, Anchorway Rd., Coventry.

SOLID WOOL FELT PADS, approx. 3in. x 1¼in. x 1¼in.; ideal polishers; 8/3 per 50 box; post paid U.K.; terms: cash with order. Wyllan Equipment Co., Wyllan House, 37-39, Houldsworth St., Manchester, 1.

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ANTI-RADAR STRIP DISPENSER UNITS. These comprise two 1/20th h.p. 24v. shunt wound motors, with train of gears, both 25 and 50 to 1 reduction. The unit is mounted in an aluminium chassis and consists of over 100 gears, pinion shafts, etc., of the Meccano pattern, with variable speed switch and indicator light, bag of spares, and electrical diagram. These are all new and in original waterproof packages. They are something entirely new and never been offered before. Price 30/- each, carr. paid. H. MIDDLETON, 639, Abbeydale Road, Sheffield, 7.

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EVERY APPROVED CANDIDATE graded in the Technical Engineering and Allied Classes (administrative, executive, technical) is eligible for membership of the Institute of Executive Engineers and Officers; admission fees reasonable. Give age, industry and post held for full particulars of entry to the Secretary, Executive Chambers, 241, Bristol Road, Birmingham, 5.

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ENLARGER and Camera Bellows supplied; also fitted. Beers, St. Cuthbert's Road, Derby.

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HOBBIES

DOLLS HOUSE FITTINGS and Papers; Wooden and Metal Toy Wheels (trade supplied); illustrated brochure; s.a.e. Jasons, 135, Nags Head Road, Enfield, Middlesex.

TOY CASTING MOULDS, soldiers, sailors, airmen, animals, etc. Rubber Moulding Compound, 8/6 per lb. Moulds for Plasticwork, plaques, ornaments and Coronation souvenirs. Moulds from 3/6 each; catalogue 9d.; s.a.e. for list. F. W. Nuthall, 69, St. Marks Road, Hanwell, London, W.7.

CASTING MOULDS for lead soldiers, animals, etc. Complete illustrated catalogue 6d. Sample mould 6/-. G. F. Rhead, Hartest, Suffolk.

PLASTICWORK, Perspex pieces, fittings etc., Formica, handicraft parts and similar. Hardy's, Bishop Street, Stockton-on-Tees.

RUBBER MOULDS from 1/9; Animals; Figurines, Xmas Novelties. Send 2/6 for beginner's kit, or s.a.e. for full list and particulars of Special Mould Exchange Service. Burleigh Artware Supplies, Burleigh Street, Hull.

WOODWORKING

WOODWORKING MACHINES, Saw Benches, complete, 7in. £4/15/-; 8in. £5/10/-; Lathes, £7/10/-; Bowl Turning Heads, £7/10/-; Combination Lathes, £10/10/-; Planers, Saw Spindles, Motors, etc. 4d. stamp for illustrated booklet; h.p. available. James Inns (Engineers), Dept. P., Sherwood, Nottingham.

MAHOGANY PLYWOOD, new, any parcel £1 delivered, c.w.o. 6 at 11¼ x 60 x ⅛in.; 7 at 42 x 12 x ⅛in.; 6 at 23 x 20 x ⅛in.; 14 at 14 x 23 x ⅛in.; 20 at 14 x 17 x ⅛in.; 14 at 12 x 27 x ⅛in.; 20 at 42 x 5½ x ⅛in.; 25 at 60 x 4 x ⅛in.; 30 at 12 x 9 x ⅛in.; 14 at 6 x 40 x ⅛in.; 30 at 6 x 23 x ⅛in. Birch 30 at 5½ x 78 x 4mm. Small mixed sizes £1 ½ cwt. Following one side slightly glue stained, 7 at 23 x 23 x 3/16in.; 10 at 20 x 20 x 3/16in. M. Leader (1920), Gosford Street, Middlesbrough.

ELECTRICAL

THE DYNALITE FLUORESCENT CONTROL KITS enable you to build fluorescent into your home or to make your own fittings at very low cost; kits for 2ft., 3ft., 4ft. tubes 27/6. 5ft. 35/-; many other types available; state voltage. Dynalite Electrical (PM), 38, Stevedale Road, Welling, Kent.

BARGAINS FOR ELECTRICIANS.—Brand new Cables in 25-100yd. lengths; T.R.S. twin, 1/044, 42/-; 3/029, 60/-; 7/029, 95/-; 3/029 with earth, 72/6; 7/029 with earth, 117/6; P.V.C. twin, 1/044, 38/6; 3/029, 56/-; Transparent Flex, 14/36 twin, 17/6. All per 100yds.; carriage paid. Fully wired Ballast Units, 38/6; c.w.o.; request list. Jaylow Supplies Ltd., 93, Fairholt Road, London, N.16. (Tel.: STAmford Hill 4384.)

WATCHMAKERS

WATCH CASES, Movements, Dials, Wheels, Pinions; return post service, Gleave, Albemarle Way, E.C.1. Write for list No. 7/53.

UNCARDED WATCH STRAPS for sale, min. sample 3 dozen for 18/-; trade only. Watch Movements, many lever, jewelled, £2/12/6 for 50; assorted wrist and pocket. 39A, Victoria St., Hereford.

GET YOUR TOOLS, Materials and Spare Parts from Western Watch Supplies Ltd., 17, Yorke St., Wrexham. Send 6d. for lists.

WE CAN HELP YOU. Every member of our staff is a skilled watchmaker and as such he understands your difficulties and trials. Why not send for our latest material and tool lists gratis and post free? Interchangeable Balance Staffs, Winding Stems, Buttons, Hands, complete Balance Assemblies, Escape Wheels, Pallets, in fact, everything the watchmaker requires. No inquiry too trival, we are here for your benefit. H. S. Walsh, 28, Anerley Station Road, London, S.E.20.

INTERCHANGEABLE Watch Parts: Staffs, 1/-; Stems, 9d.; Buttons, 5d.; other material quoted for; make and cal. no. or movement required. Every description repairs undertaken. J. H. Young & Son, Wholesalers, 133, London Road, Chippenham, Wilts.

MISCELLANEOUS

BUILD YOUR OWN REFRIGERATOR, all components available at reasonable prices. Frigidaire flowing cold units, £5; small units, Kelvinator, etc., £4; ¼ h.p. heavy duty Motors, £3; Chrome Cabinet fittings, new, £1; money back guarantee; s.a.e. for list and schematic diagram. Wheelhouse, 1, The Grove, Isleworth, Middx. (Phone: Hounslow 7558.)

BOOKLETS "How to use ex-Gov. Lenses and Prisms," Nos. 1 and 2 price 2/6 ea.; ex-Gov. Optical lists free for s.a.e. H. English, Rayleigh Road, Hutton, Brentwood, Essex.

"FORTUNES IN FORMULAS." 900 pages containing 10,000 formulæ, processes, etc., 25/-; American magazines, hobby, technical, etc.; stamp for lists. Herga, Ltd., Hastings.

MAKE YOUR OWN RANGEFINDER. Full instructions and all material, 11/-. Elgin, 12, Margravine Gardens, Barons Court, London, W.6.

RADIO

CAN YOU SOLDER? That's all you need to make a really good Radio or Tape-recorder from guaranteed Osmor components; send 5d. (stamps) to-day for free circuits and lists. Dept. P.M.C.I., Osmor Radio Products Ltd., Borough Hill, Croydon, Surrey (Croydon 5148-9.)

10,000 RADIO AND TV VALVES from 2/-; Master Contactors, 10/-; Electric Toasters, 15/-; Fractional A.C. Motors, 12/6; Tool Boxes, 1/6; P.M. Cabinet Speakers, 29/6; Volume Controls, 1/-; Moving Coil Speaker Chassis, 13/6; and many other snips. S.A.E. for list. Chorlmet Radio, 480, Oldham Rd., Manchester, 10.

DRAWING SERVICES

DRAWING COMPASSES, New design, from 11/6 to 27/6 a set; free leaflet from Newform, 33, Chandos Road, Luton, Beds.

TEBBY'S Reversible Adjustable Set Square; easily used in all corners of the board; packs flat; half degree graduations; 10in., 26/6; bevelled both sides, 32/6; post free. Nomograms quickly constructed with our log divider. Don't spoil your slide rule with divider points. More accurate than paper scales. Trade enquiries invited. The Gearmark Co., Farnborough Way, Farnborough, Kent.

SITUATIONS VACANT

The engagement of persons answering these advertisements must be made through a Local Office of the Ministry of Labour or a scheduled Employment Agency if the applicant is a man aged 18-64 inclusive or a woman aged 18-59 inclusive unless he or she, or the employment, is excepted from the provisions of the Notification of Vacancies Order 1952.

ASSISTANT in Engineroom British works abroad to learn refrigeration, Diesels, plant maintenance, etc., and to take charge when proficient; must be able to use lathe; travelling and holidays in U.K. paid; reply air mail to, Jervis, Casilla 21-D., Punta Arenas, Chile.

WANTED

WANTED.—4 or less Zamboni Piles. Munnion, 26, Green Lane, Northwood. 436.

www.americanradiohistory.com

(*Continued from page* 38)

interested in geology and its allied sciences.—STANLEY L. TOYN (Manchester, 21).

[*A short review of the products of Stanley L. Toyn is included in "Trade Notes" in this issue.*—ED.]

Einstein's Theory

SIR,—With reference to Mr. A. M. Cook's reply (August issue) to my letter (May issue), while his diagram and remarks may show the diagonal line on which a 'plane must fly in order to keep on its ground course when travelling across wind, he has overlooked the fact that the 'plane must face *some* part of the wind pressure. I suggest that the fraction of the full wind speed which the 'plane would directly meet in Mr. Cook's example can be arrived by the rule suggested in the second paragraph of my May letter, viz. :

$\frac{60 \text{ (wind speed)}}{100 \text{ ('plane speed)}}$ of the full wind speed of 60 knots, i.e., 36 knots.

Thus the speed of a 'plane capable of 100 knots in still air would be reduced to 64 knots along the 80-knot course which, for the out and back journey of 160 knots would require two-and-a-half hours—precisely that required for the out and back journey parallel with the wind.

With regard to Mr. F. O. Brownson's letter (August issue) I have no doubt that Michelson and Morley had their satisfactory reasons for concluding that an out and back journey parallel to a flow stream would require a longer time than an equal length journey on a transverse course. What I am seeking is a clear explanation of the factor which gives rise to the difference in times. No account I have read of the Michelson-Morley experiment has attempted any such explanation of what seems to me to be a mechanical anomaly. It should be possible to explain *why* a moving body can escape some part of the effect of opposing forces when it travels at an angle to their direction. To assume such a theory seems tantamount to an assumption that some less foot-pounds of power are required to raise a given weight up an incline than to lift it directly against gravity to the same height—all friction, of course, being ignored.

If Mr. Brownson can afford us a simple mechanical explanation of the discrepancy in the times it would be of great interest to such doubting Thomases as myself.

I am with Mr. Brownson in having doubt on the question of the "aether." Several other interesting matters concerning Einstein's Theory raise questions in my mind, but I have delayed putting them forward pending an acceptable explanation of the apparent anomaly on which the Michelson-Morley experiment was based.—C. W. CARR (Eastbourne).

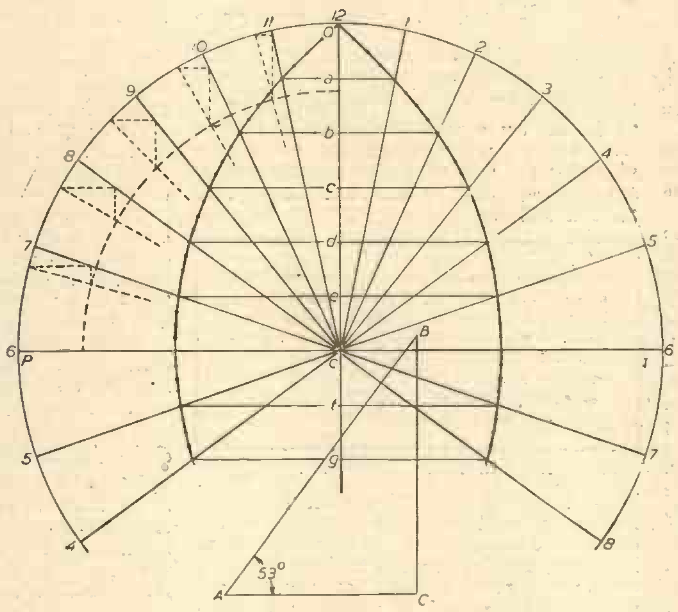
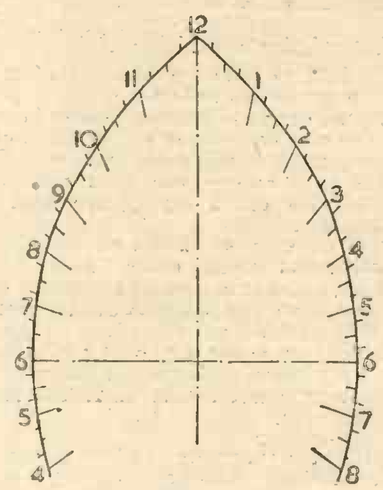


Fig. 1.



A method of marking out the sub-divisions of hour angles for a sundial.

Fig. 2.

Marking Out Sundials

SIR,—In the very interesting and instructive article "Making Sundials," in the August issue of PRACTICAL MECHANICS, the geometrical construction shown in Fig. 2 for drawing the radiating hour lines requires, in my opinion, one correction to be made. The radius of the inner circle should be CB, and not CA, since the dial is to be horizontal. CA is the radius if the dial is to be set vertically in the East-West direction.

The following additional construction, which is the result of attempts on my part to find a method of accurate subdivision of the hour angles in Fig. 3 of the article, may be of interest to other readers.

Using ordinary ruled writing paper (preferably with narrow spacing of about ¼in.), and taking the width of a space as the unit of measurement, draw Fig. 1 to the following dimensions. In triangle ABC, $\angle A$=latitude, AB=24 units, $\angle C$=90 deg. Then the radii of the two circles will be 24 units and CB respectively. When the hour lines have been completed, divide the noon line QC into six equal parts, i.e., 4 units each, as shown by the points a, b, c, d, e. Also mark two similar divisions below PCJ as shown at f, g.

Mark where the printed ruled lines through a, b, c, d, e, f, g cut the hour lines 11 and 1, 10 and 2, 9 and 3, 8 and 4, 7 and 5, 5 and 7, 4 and 8 respectively. It is noticed that these points lie on two curves intersecting at Q, and cutting PCJ at a distance from C which can be proved theoretically to be equal to 7/11ths of the radius of the inner circle. Join these points by two smooth curves as shown in the diagram. The intersections of the printed lines of the paper with these curves will form an accurate scale of quarter-hours.

Similarly, using graph paper with 1/10in. divisions and making CQ=7.2in., a scale of 5-minute intervals can be accurately set out.

The final appearance of the dial is shown in Fig. 2.—I. E. HOPKIN (Swansea).

MAKING A MICROSCOPE LAMP

(*Continued from page* 30)

best way to handle the filters is to hold them between two pieces of clean white paper. The gelatine filters are delivered in sections two inches square and for the purposes of the construction of the assembly described below they do not need to be cut in any way. To assemble the filters first cut the photographic glass into pieces 1¾in. by 3¼in. Then mount one of the gelatine strips between two of these pieces, arranging it at a point about equidistant from each end of the glass plates. Once the strip is satisfactorily arranged the edges of the glass may be sealed together with Scotch tape; it is best to use this as the filter may easily be stripped down if it is not satisfactory, and then reassembled.

The most important points to remember in handling filters are that they should never be handled with bare fingers, and on no account should they ever be allowed to get wet. Handle them gently and treat them properly, and they will give years of service, and many hours of enjoyment.

Club Reports

Coventry Model Engineering Society

THE activities of the club so far this year have included a Model night, Rummage sale, Film show, Track night, Visit to main signal box at Rugby, and several interesting talks and lectures.

Future activities are as follow: October 16th, Photographic night. Members and friends are invited to bring photos of interest to the society and say a few words about them; the photographs are displayed by episcope. November 13th, Film show. November 27th, Annual dinner. December 11th, Annual General Meeting.

The railway section has been very busy this year. The portable track has been in use at many local works sports events, and the permanent track at the Memorial Park has been busy at week-ends. This track is 3½in. and 5in. gauge, and visitors are invited to bring their locomotives along there, but it is a condition of use that the boiler must have had a hydraulic test to the satisfaction of the two members approved by the insurance company and who issue a test certificate. These two members are: Mr. D. Gardiner, 2, Belgrave Road, Wyken, Coventry, and Mr. L. Bedder, 105, Butt Lane, Allesley, Coventry.

Prospective members and visitors are welcome at all activities of the club and new members are needed to help run the railway in the Memorial Park.

There is also an active small gauge railway group, who are busy making a scenic multi-gauge track for use at exhibitions.

Hon. Secretary, L. J. Bedder, 105, Butt Lane, Allesley, Coventry.

QUERIES and ENQUIRIES

A stamped, addressed envelope, a sixpenny, crossed postal order, and the query coupon from the current issue, which appears on the inside of back cover, must be enclosed with every letter containing a query. Every query and drawing which is sent must bear the name and address of the reader. Send your queries to the Editor, PRACTICAL MECHANICS, Geo. Newnes, Ltd., Tower House, Southampton Street, Strand, London, W.C.2.

Electroplating as a Hobby

I WISH to take up electroplating as a profitable hobby.

As an example I would like to be able to attempt the plating of the headlamps on my small family car. In view of this, could you supply me with names of firms who could supply me with the following :

Vat or vats, as shown on PRACTICAL MECHANICS front cover, May issue, about 18in. x 12in. x 12in.; resistance with approximate cost; suitable thermometer; acids (smallest quantities).

I propose using a 12-volt car battery, do you think this would supply the necessary power ?—Mr. R. R. Matthews (Tulse Hill).

ALL the necessary apparatus can be obtained from any good firm of laboratory suppliers, such as Messrs. Griffin and Tatlock Ltd., Kemble Street, Kingsway, London, W.C.2.

The above firm advertises a vat (pneumatic trough), 16in. × 11in. × 11in., at about £2 15s. Suitable thermometers cost about 6s. to 8s.

The cost of sliding resistances depends on the current they are designed to carry and their resistance. There are literally hundreds of different ranges available. To determine the range you require you must first calculate the maximum current you are likely to use. This gives you the current range of the sliding resistance. The next step is to determine the minimum current you are likely to use and to divide the voltage of your battery by this value. This gives the resistance range of the sliding resistance.

Example :

Maximum area to be silver-plated = 100 sq. in.

Current required = 100 × 0.02 = 2 amps.

Minimum area to be silver-plated = 10 sq. ins.

Current required = 10 × 0.02 = 0.2 amps.

Battery voltage = 12 volts.

Battery voltage ÷ minimum current = resistance range.

12 ÷ 0.2 = 60 ohms.

Therefore, the sliding resistance required must be capable of carrying 2 amps and have a resistance of 60 ohms. The approximate cost in this instance is about £4.

A vat of the size suggested would hold about seven gallons of solution. Using this figure, it is quite simple to calculate the quantities of each chemical required.

A 12-volt car battery would be quite suitable for use when copper or silver plating, but it is doubtful if it would stand up to supplying the much larger currents necessary for nickel or chromium plating. The area of a car reflector is of the order of 100 sq. in. This requires a current of only 2 amps when silver plating compared with 50 amps for chromium plating and 150 amps when nickel plating. A car battery would certainly be able to deliver 50 amps for short periods, but a continuous discharge at this rate will soon lead to the partial, if not complete, destruction of the battery.

Oil-burning Unit for Stoves

HAVING made up the above, as per specifications in your January issue of PRACTICAL MECHANICS, I find that the tube running through the fire carbons up solid after about three hours' burning. A larger pipe has been fitted. This also carbons up after longer running; old engine oil is used, passed through a filter.

Can you inform me if there is any modification I can make to overcome the defect ?—R. J. G. Outing (Essex).

THERE are a number of possible reasons for excessive carbon deposit in the vaporiser, although we have never experienced anything approaching complete stoppage in three hours.

Readers are asked to note that we have discontinued our electrical query service. Replies that appear in these pages from time to time are old ones and are published as being of general interest. Will readers requiring information on other subjects please be as brief as possible with their enquiries.

Very dirty oil is the most obvious cause. Waste sump oil as collected from the garage is, of course, black in colour due to the carbon and other particles held in suspension. However, five gallons left undisturbed in a drum would precipitate most of this unwanted material in a matter of 24 hours at room temperature, and the quite clear golden oil could then be poured off the top. If the day's fuel requirements are pumped into the feed tank the previous evening a very noticeable improvement will result.

Water, in conjunction with the semi-solid residue from the tank bottom, has the effect of completing the stoppage of an already foul vaporising tube, and, for this reason, it is essential for the feed pipe to project into the tank as described. The tank should be cleaned out whenever water or deposit shows signs of overflowing down the feed pipe.

Is too much heat impinging on a localised part of the vaporiser ? Burning and scaling of the part will indicate this, which would result in carbon being built up solidly for an inch or two, leaving the remainder of the tube clear. The remedy would be to re-arrange the bricks slightly in order to spread the flame.

An increase in the incline of the vaporising tube to about 2in. in 1ft. would effect some improvement if the use of very muddy oil cannot be avoided.

The burner described in the article is in constant use 10 hours a day, five and a-half days a week, and in order to avoid the daily cleaning a duplicate vaporiser and nozzle has been made and the two used alternately. The regular change-over, which is effected in a few minutes, is carried out only once each week and stoppages are unknown. After removal the tubes are cleaned out ready for the following week's use.

Colouring Billiards Balls

I HAVE a number of billiards balls that I wish to make into a snooker set; they are mostly ivory (all red) and the remainder are composite. Can you give me instructions for colouring these ivory balls, also for removing the colour from some ? Is it possible to colour composite balls ?—A. H. Sheath (West Wickham).

IT is perfectly simple and satisfactory to colour *ivory* billiards balls by immersing them in an aniline dye of the appropriate colour. The colour can be removed by a chloride of lime bleach.

It is quite impossible to colour composite balls satisfactorily. The colour will be blotchy and will not last. Composite balls are compressed with material that is homogeneously coloured and the colour is constant right through the ball section.

For professional advice about this matter we advise you to contact : Messrs. Weildings, Ltd., Billiards Ball Manufacturers, Bollo Lane, Acton, W.3.

Black Light

COULD you please give any information on ultra-violet light apparatus or "black light" used for fluorescency tests ? I understand that the so-called "black light" is the product of infra-red rays. Is this correct ?—John S. Crow (Fulham, S.W.6).

THE term "black light" may apply to either infra-red or ultra-violet rays. We take it to apply to electro-magnetic rays outside the visible spectrum and which will excite certain phosphors.

Black glass, opaque to visible light, having a content of nickel oxide is very old, and used to have the term a Wood filter and would, we believe, transmit U. V. between 4,000 and 3,200 A°. Mercury lamps are still made fitted with Wood filters, under the names—analytical lamps, purple X-ray lamps, etc.

Corning glass also produce a Corning red-purple filter 587.

We recommend you to read "Luminescence," by P. Pringsheim and M. Vogel, Interscience Pub. Inc., N.Y., 1943.

(Continued on page 44.)

Writing on Lantern Slides

I WISH to prepare some 3¼in. square lantern slides for a school Christmas party—mainly popular songs. I find that Indian ink flows too freely from a mapping pen; is this suitable? Is there a special ink? Is the glass surface treated at all?—S. G. Moore (Co. Durham).

THERE are several ways in which writing (carols and songs) can be got on to lantern slides. The best is to use a ¼ plate camera (the dark slide will just take a 3¼in. square plate) and photograph the original type on to the plate; develop and fix in the usual way. The result will be a negative giving white type on black. If this is not considered satisfactory make a contact print on another plate and thus produce a positive.

Another way is to use an exactly similar plate but, without exposing it, fix it in a hypo solution, wash and dry it, and write the wording on the emulsion side.

A third method is to stretch a piece of Cellophane film (from a packet of cereals or a box of chocolates) down on to a white surface. Write with Indian ink and mapping pen on this, cut to 3¼in. square and mount between two lantern-slide cover glasses bound around with black gummed strip paper.

Double Image in Binoculars

PLEASE tell me why I can see a double image when using my prismatic binoculars and how I can cure it? I do not wear glasses and my eyesight is very good.—R. Robinson (Surrey).

IF the image yielded by each side of the binocular, when viewed separately, is perfect, then the double image is produced by a mechanical fault; that is to say, that the optical axes of the two telescopes are not parallel. In other words, there is a twist in the framing of the instrument and it should be possible to detect the amount of twist from the outside. It is not a very difficult matter to put this right by counter-twisting in the hands, but if the lack of alignment is very pronounced it may be better to take the binoculars to an optical instrument maker and have it put right.

Microscope Illumination

I HAVE a small microscope, but find that I can only view transparent objects as the light source is reflected from a mirror through the specimen, and thence to the lenses.

How can I modify this microscope to view opaque subjects such as a piece of steel, etc.?—J. H. Donohue (Yorks).

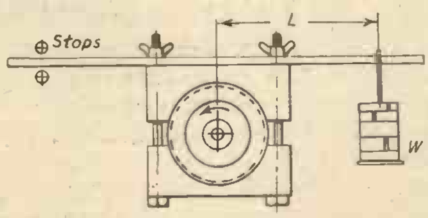
WHAT you want to do is to obtain brilliant top illumination on the object on the stage and to do this you will require a small powerful lens to act as a condenser and concentrate the rays from a window or a lamp down on to the object. Turn the mirror so that it throws no light upwards, black the back of the mirror with black paper or black velvet. Then arrange the condenser lens, which must have a stand to carry it on the table alongside the microscope, so that it is above the level of the stage. You must bring the light from the window, or the lamp, to the sharpest possible focus on the object, moving the microscope or the condenser or the lamp until the best vision is obtained. Such a condenser as is referred to here can be bought ready made from an optical instrument makers, such as Broadhurst, Clarkson and Co., Ltd., 63, Farringdon Road, London, E.C.1. For your instrument you will not need a large condenser. You will not have to make any alteration in the microscope; only see that you have a black background to the object.

A Simple Dynamometer

I HAVE some b.h.p. tests to carry out on a two-stroke engine, and wish to construct a simple dynamometer.

Could you give me any information on building and operating one, please?—P. Pottinger (Berks).

WE presume that it is your intention to build a mechanical type of dynamometer in which the output of the engine is absorbed by friction. For this purpose you could use a light arm carrying at the centre two blocks of wood, or of metal lined with friction material, which are clamped round the engine pulley by means of two wing nuts. It is desirable that the engine pulley should have a hollow rim so that water can be poured into the rim to keep it cool. Stops should be arranged to limit the movement of the arm within a few degrees of the horizontal. A spring balance can be attached to the arm so that it pulls the arm vertically, or a weight can be hung vertically from the arm, at a distance L feet from the centre of the pulley.



Mechanical type of dynamometer

The engine is started up and the wing nuts tightened to apply frictional load to the engine pulley, the spring balance or weight being adjusted to apply a pull of W lb. to keep the arm in equilibrium in a horizontal position between the stops. Under these conditions the torque developed by the frictional load will be equal to $W \times L$ lb. ft.

The work done per revolution will be $2 \times 3.142 \times W \times L$ ft. lb.

The work done per minute will be $2 \times 3.142 \times W \times L \times N$ ft. lb., where N is the speed of the pulley in r.p.m.

The horsepower will be equal to

$$\frac{2 \times 3.142 \times W \times L \times N}{33{,}000} \text{ h.p.}$$

Projecting Pond Life

ABOUT 20 years ago I had much pleasure in a "scientific toy"; it was in the box form of the magic lantern with the protruding lens for magnification. Instead of a space or slot to insert films there was a specially-constructed space to hold a slim, rounded bottle which could be filled with pond water (the "livelier" the better), and on being illuminated and magnified on to a screen a marvellous performance of pond life was available.—J. West (Salford).

WE have never seen such a lantern for the projection of images of living organisms, or pond life, but the best plan would be to purchase, either new or second-hand, an ordinary magic lantern and where the ordinary lantern slides are passed into place use slides made by yourself. These can be built up of two square pieces (say, 3¼in. × 3¼in.) of thin, flat clear glass separated at their edges (on three edges only) by narrow strips of thicker glass, say 3/32in. thick. These strips are cemented to both the square glasses with Canada Baalsam, Japan Gold Size or an oil varnish. The top edge is left open for filling with the pond water and emptying when the organisms are dead. We do not think that the bottles which you recollect were shaped lenses, the flatter the "slides" are the better. It will be advisable to place a piece of plain glass at the front of the box portion of the lantern to ensure keeping the slides cool, otherwise the heat would quickly destroy all life in the slide.

Converting Van to Utility

I HAVE purchased a van and intend to convert it into a utility. Please advise me on the best method of cutting the metal body to put windows in; the marking, etc., will not be difficult.

Is it practical to fit sliding windows or would you advise the usual rubber channel and safety glass?—J. MacKenzie (Kent).

WE think the most satisfactory tool to buy would be a pair of snips. Dressing is not a formidable problem and although a grinding wheel may cut and dress simultaneously, you can obtain equal results with snips and a file. If you do not wish to purchase a pair of snips, a further idea is the time-honoured chisel and file method; it is slow, we agree, but nevertheless just as effective and cheap in view of the fact that only one vehicle is to be converted.

In your second query we are not sure whether you refer to the usual sliding windows for the car doors or if the side lights are to be made in this manner. We do not advise the latter course as we think it would unnecessarily complicate matters; the door windows are adequate for normal purposes. If, however, you deem it essential to install this type of window, you will undoubtedly find it very easy to fit the car door type which you could purchase either new or second-hand from a "spares" dealer.

Bubble Solution

I PURCHASED some bubble solution with a small wire ring which is dipped in the liquid and blown through. I have since tried to make a similar liquid, using various soaps and detergents but without success. Could you give me the composition of such a liquid?—G. Benniston (Derby).

THE solution is made by dissolving 1oz. of sodium oleate in 1½ pints of boiling water. When this has cooled off, add four tablespoonsful of glycerine. Sodium oleate is obtainable from all chemists quite cheaply.

Information Sought

Readers are invited to supply the required information to answer the following queries.

The following is an extract from a letter from J. F. Ford (Newport): "Please send me information on pocket type hand warmers, and any constructional details available. Can you inform me the name and address of any firm marketing them?"

In his letter, R. Buckle (Staffs) says: "Please tell me details of a water-pipe heating system, in a shed approximately 7ft. x 5ft. x 6ft. high, and also to an adjoining shed later on, 8ft. x 7ft. x 7ft. high. It is necessary to avoid fumes."

M. Hurley, of Wigan, writes: "I have some blackthorn sticks and would like to be able to dress them up to give to friends. Can you tell me how to straighten them, how to season them, also how to varnish and finish them?"