PRACTICAL MECHANICS AND SCIENCE

MAR 1963

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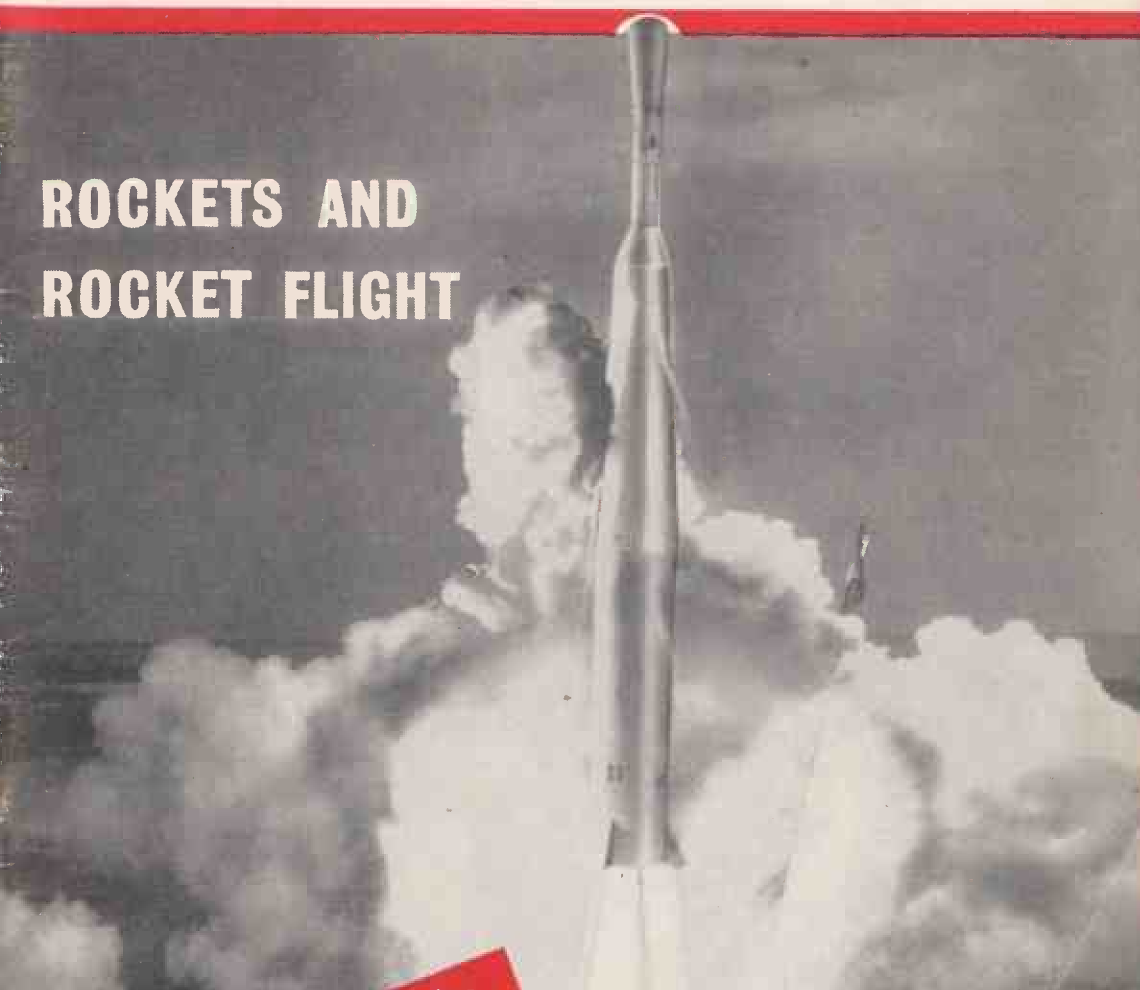

ROCKETS AND ROCKET FLIGHT

Also Inside

PORTABLE PROJECTION SET
MAKING YOUR OWN MIRRORS
AUTOMATION AND TIMBER

PRACTICAL MECHANICS AND SCIENCE

Vol. XXX March, 1963 No. 347

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TALKING POINT

First practical steamship

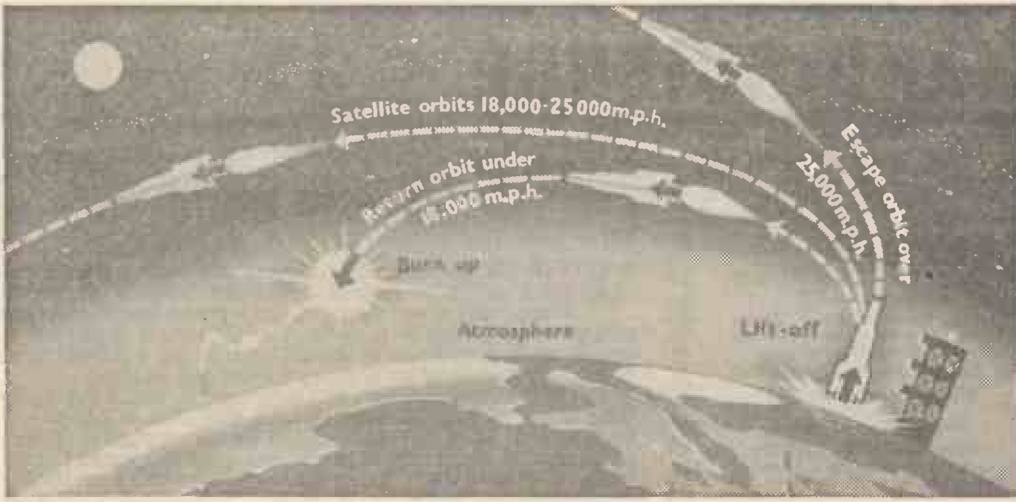
WITH all the new scientific and engineering developments there are to be seen at exhibitions today, a glimpse into history will always attract a large proportion of the visitors whenever such an exhibit is made. A true example of this was seen at this year's Boat Show at Earls Court, where a full-size replica of Europe's first commercial steamship was put on show.

This was known as Henry Bell's "Comet", which was built by John Wood, of Port Glasgow, in 1812, and from this have grown the leviathans which are commonplace on the seas today. It hardly seems credible that a ship so small—you could line up 25 "Comets" along the deck of the "Queen Elizabeth"—started a revolution in shipping and virtually a new shipbuilding industry in Britain. These are very big claims for such a small ship but they are confirmed in a Government White Paper of 1822 which gives the whole credit for the first practical steamship to Henry Bell, the Scotsman, who decided he could succeed where others had failed. He was particularly impressed by the efforts of a countryman of his, William Symington, a marine engineer of great talent who undoubtedly would have been recognised as the father of the steamship had he not been the victim of a political move. His ship "Charlotte Dundas" towed two 70-ton barges 19½ miles along the Firth and Clyde Canal in 1801 before she was stopped by the canal owners, who complained that the paddles of the ship were damaging the banks of the canal. This, however, was thought to be a spiteful move against William Symington's backers.

The "Comet" is born

It was then that Henry Bell moved in. He was a trained engineer and his imagination had been stirred by the performance of a steam engine designed by James Watt (who is believed to have stated himself that a practical marine steam engine was an impossibility). Perhaps it is just as well that Henry Bell did not agree with Watt's theory. In fact it appears he took little notice of anyone and was inclined to have his head in the clouds. His business sense, we are told, was appalling. One day in 1811 Bell looked in to see John Wood, an enterprising Clyde shipbuilder in Port Glasgow. The upshot was that Wood agreed to build this novel ship and Bell set about looking for a steam engine to drive it. He bought one for £165 but did not have enough money for the boiler and finally got this on credit, but the "Comet" never made sufficient money for him to pay the debt. When the ship was completed she was used to take passengers from Glasgow and Greenock to Helensburgh but was too small to pay her way. Nevertheless she was an undoubted engineering success. On her trial run on August 6, 1812, the "Comet" churned her way down river from Glasgow to Greenock in 3½ hours. The normal service took between 10 and 12 hours. The days of sail were numbered.

Almost overnight Bell found himself faced by rival steamship services. In fact within four years 20 new steamships had been built. "Comet" was lengthened by 20ft, but eventually was put on the less competitive trip from Glasgow to Inverness, a four day return trip. On her way to Glasgow in the winter of 1820 she was hit by a tide-rip and wrecked without loss of life. The engine was salvaged and drove factory machinery for many years after. In 1862 Robert Napier bought it for the Science Museum, London, where it can be seen today.



Rockets and

By B. C. MacDonald

ROCKETS are the most expensive means of flight ever devised. For instance the cost of launching a Saturn C1 rocket is said to be £7,000,000 a shot. A rocket can be used once only, like a gigantic firework, and once it has carried its satellite into space it is gone for good. This is like using an air liner for one flight only. If a vehicle could be made that would fly out into space and then return to be used again, the cost of space research would be a mere fraction of what it is now. Why can this not be done?

The effects of gravity

The problem of all forms of flight is to overcome gravitation. The earth attracts everything towards it as if it were a powerful magnet, only the effect is due to gravitation and not to magnetism. All very large bodies exercise a powerful pull on smaller bodies and upon each other. If you throw a stone upwards it will come back because the pull of the earth will begin to slow it down from the moment it leaves your hand, and will finally stop it and then accelerate it back to earth. Gravitation is strongest near the earth's suface, and the further we go from the earth the weaker the force of gravity becomes. After some thousands of miles it finally becomes so small as to have virtually no effect at all, so that everything becomes weightless. If you could throw a stone upwards with sufficient initial velocity, gravitation would slow it down but would not be able to stop it and bring it back again. It would go out into space. The velocity needed to do this, known as escape velocity, is about 25,000 miles an hour. Once a body is beyond the reach of the earth's gravitational field, continued motion requires no power at all and the body will continue in motion for ever, in accordance with Newton's first law of motion.

Orthodox flight

The orthodox aircraft achieves flight by means of wings which are forced through the air. Owing to the cross-section of the wings the airflow above and below them is distorted in such a way as to produce a reduced pressure over the top surface and increased pressure below the wing. A lifting force is thus created on the wing structure. This process requires the continual expenditure of power and, of course, air is necessary. As there is no air in space, wings are useless for space flight. All forms of flight from the earth require power to overcome the earth's gravitation, and in all cases so far used, this power is obtained by burning a fuel so that the heat produced expands the resulting gases rapidly and so gives the force from which the power is obtained. In the piston engine the fuel is petrol and the gas is air, which contains the oxygen necessary to support combustion. The engine rotates a propeller, which pulls, or in a few cases pushes, the aircraft through the air. The jet engine also uses air with paraffin as the fuel. The air is compressed and the fuel is then burned in it. The resulting expansion produces an extremely fast moving rearward jet of gas which produces a forward thrust. The jet does not work by pushing on the air behind it, but by reaction, as in the case of the rocket. We shall explain what reaction is when dealing with the rocket motor. The jet engine will not work without air and so, like the piston engine, is no use for space flight.

The rocket

Rockets are different from other flight vehicles in one very important respect, they are accelerated very rapidly to an extremely high velocity during the very short time for which their engines operate. Thereafter the rocket is dependent upon the

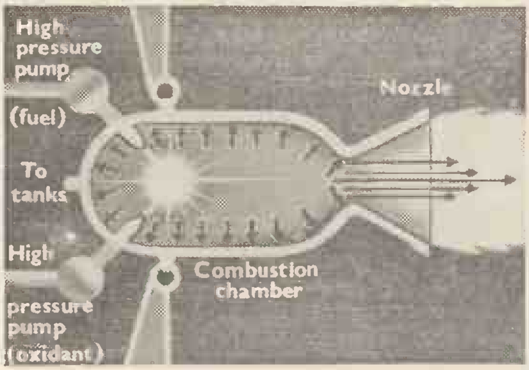
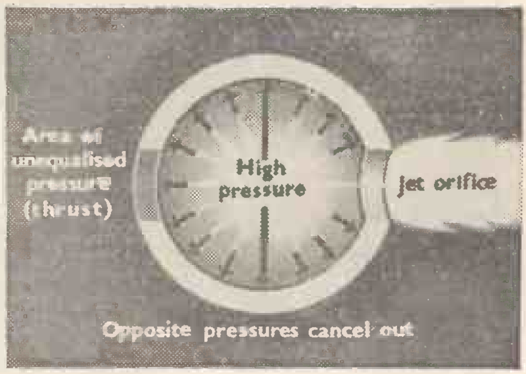


Fig. 1.—A diagram of the essential parts of a rocket engine.

Fig. 2.—How the combustion chamber pressure produces thrust.



Rocket Flight

momentum it has acquired. That is to say, it is a ballistic vehicle, like a shell fired from a gun, rather than an orthodox aircraft which requires the continual expenditure of power to keep it up. The power required to lift and accelerate even a small rocket is very great indeed. The German V2 rocket, used during the last war, was by modern standards a very small rocket and only attained a speed of 5,000 m.p.h. and an altitude of 100 miles, yet the engine used the total fuel load of eight and a half tons of liquid oxygen and alcohol in 70 seconds. A modern rocket would carry at least ten times this quantity of fuel.

Most space rockets have liquid fuel motors although the Polaris military rocket uses solid fuel. By far the largest portions of any liquid fuel rocket motor are the two fuel tanks, one holding the oxidant, which replaces the air used in a jet engine, and the other the fuel. A wide variety of fuel combinations have been used, from the alcohol and liquid oxygen used in the V2 to combinations such as hydrazine and concentrated nitric acid. The Saturn C1 rocket will use liquid oxygen and liquid hydrogen and when the snags inherent in such a tricky combination have been ironed out this should be a potent vehicle.

The remainder of the rocket engine is comparitively small. Very high capacity pumps and driving turbines are needed to pump the fuels into the combustion chamber or chambers at fantastic rates of flow. The combustion chamber itself has to be immensely strong to withstand the huge pressures produced as well as extremely high temperatures. Below the combustion chamber is the jet nozzle.

Many people do not understand the principle on which a rocket engine produces its thrust. In fact it obtains it by two methods. Fig. 2 shows a spherical pressure vessel or combustion chamber with a jet orifice. If fuel is burned in this, a high pressure can be produced. This pressure acts all over the interior surface of the chamber. The forces on opposite parts of the chamber wall equalise each other as can be seen, except for that portion of wall opposite the jet orifice. No, or very little, pressure can build up at the jet so the pressure on the wall opposite is unequalised and forms the main thrust pushing the rocket forward. This shows why it is that the rocket does not get its thrust by pushing against the external air. In fact the less air outside the better.

The other method by which the motor obtains thrust is the reaction from the jet of hot gases leaving the combustion chamber. This is not so easy to understand. Fig. 3 shows a cross section of a gun firing a shell. When the charge explodes it pushes the shell forwards but it also pushes the gun backwards—the recoil. The principle of conservation of momentum requires that the momentum (mass x velocity) of the gun be equal to that of the shell. Thus if the gun weighs 4,000lb and the shell weighs 25lb and leaves the gun at 1,000ft/second the rearward velocity of the gun x 4,000 = 25x 1,000. The gun thus moves backwards at 6·25ft/second. In a rocket engine the shell is represented by the stream of jet gases and the faster this leaves the jet the greater will be the reaction on the combustion chamber. In space rocket boosters the reaction thrust, though very important, is the smaller of the two, but in the plasma or electronic rocket motors being developed for orientating satellites and other space vehicles it comprises the whole of the thrust as there is no pressure in the "combustion chamber". It is solely the electrical acceleration of a stream of electrons or other particles which make these motors function.

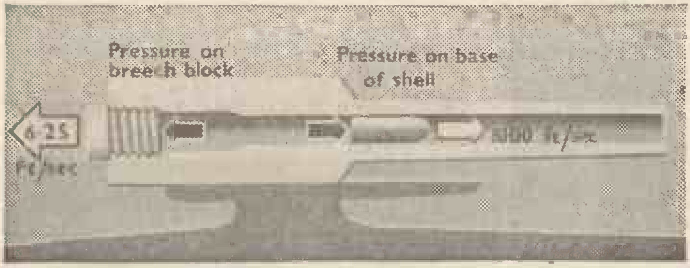


Fig. 3.—The principle of reaction thrust.

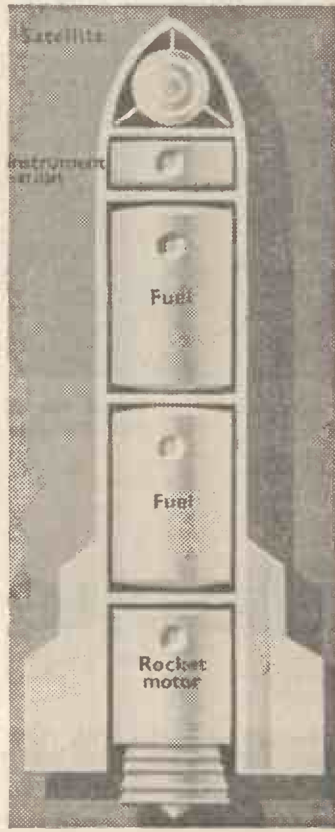


Fig. 5.—The payload carried by a rocket is very small. Most of the rocket is taken up by fuel.

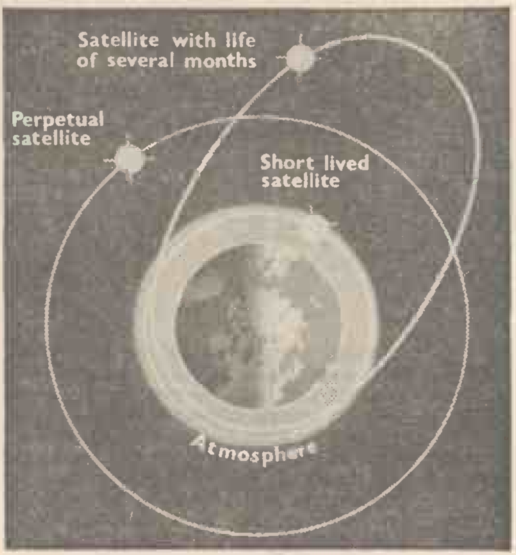


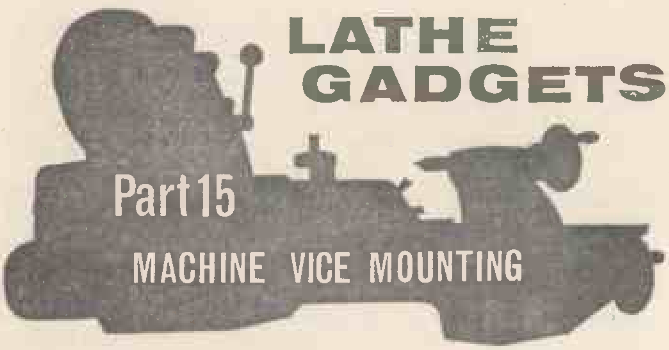
Fig. 4.—A satellite will stay in orbit only if it is completely clear of the atmosphere, otherwise it will slow down, fall into the denser atmosphere and burn up. (Not to scale.)

If the final speed of a rocket is less than 18,000 m.p.h. gravitation will bring it back to earth. When it enters the atmosphere at this high speed it will burn up like a meteor, Fig. 4. If the rocket attains 18,000 miles per hour it still cannot escape from the earth but becomes a satellite, rotating round the earth at a distance from the earth depending on its speed, the "fly away" or centrifugal force due to the circular path or orbit balancing the earth's pull. Such a satellite will exist for ever, if completely clear of the earth's atmosphere, even for a short part of its orbit, it will be slowed down and finally pulled in (Fig. 4). If a rocket can attain a speed of 25,000 m.p.h. it escapes earth's gravitation altogether and goes off into space.

The staged rocket

A large rocket may weigh anything between 100 and 200 tons. 70% of this weight is fuel (Fig. 5). The lighter the rocket the higher the speed it will attain. The two-stage rocket is really two rockets joined together, one on top of the other. The rockets are joined by hollow bolts, containing explosive which can be electrically detonated. In this way the two rockets can be separated. When the first stage has expended all its fuel it is detached, thus freeing the second stage of a great deal of weight and allowing it to obtain a much higher velocity than would otherwise be possible.

It is possible that the nuclear rocket, when it comes, will have sufficient power to fly out into space in one piece, to slow itself right down by retro rockets for the return journey. It would be provided with wings and fly in the atmosphere like an ordinary aircraft. Such a vehicle could fly out into space and return at will, but this is looking a very long way into the future.



LATHE GADGETS

Part 15

MACHINE VICE MOUNTING

BY L. C. MASON

WHILE this is not strictly a gadget used on the lathe itself, it was thought worthy of inclusion in this series as it makes use in a novel way of a regular Myford accessory produced for use with the ML7. Furthermore it has on occasions proved useful in helping out on a machining job.

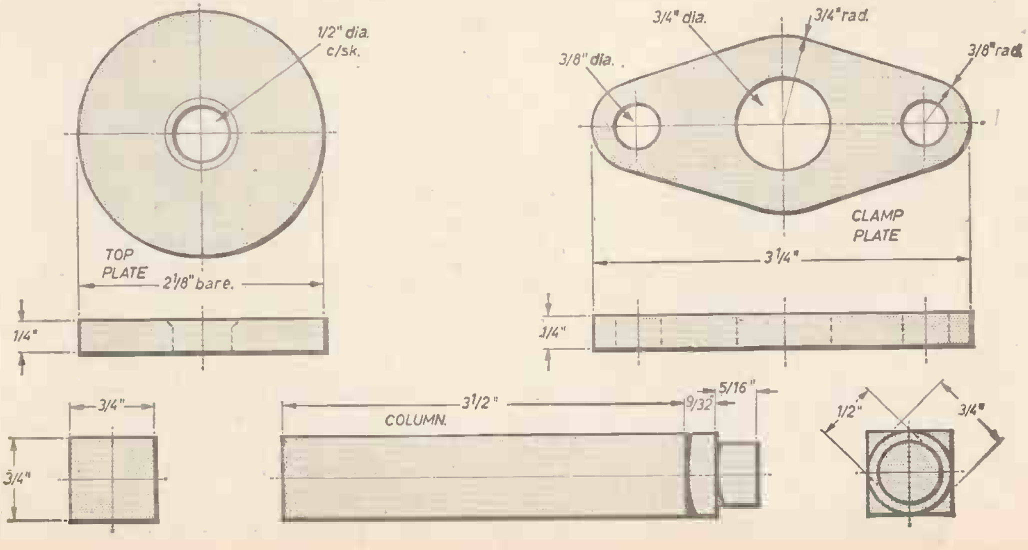
This fitment very much extends the usefulness of the machine vice, enabling it to be used in the same way as a universally mounted instrument vice. It consists of a mounting, on which the vice can be adjusted and clamped, which itself can be held in the bench vice in a variety of positions. In this way it provides a full 360° of horizontal movement, and well over 180° of tilt in the vertical plane.

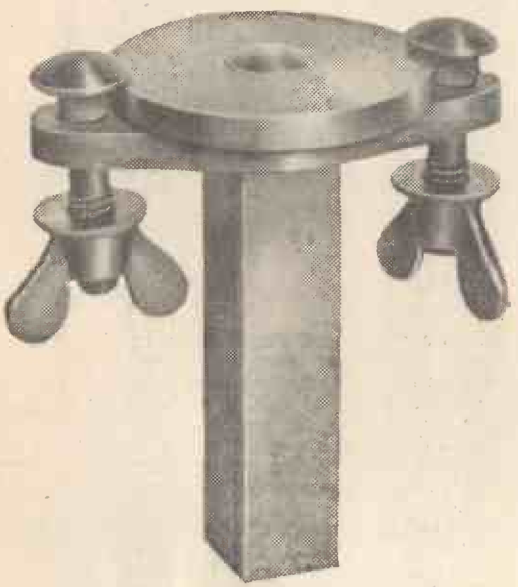
This can be of great use, for example when the machine vice is used to hold a milling job on which some hand work is required between machining operations. Without disturbing the position of the job in the vice the whole thing can be transferred from the cross slide or vertical slide to the bench to carry out the hand operation. After this the machine vice, complete with job, can be remounted in the lathe for further machining, still preserving the accuracy of the original setting.

It is a robust and simple affair, consisting of a square column for clamping in the bench vice, having a thick disc rivetted on the top end. Under the disc and free to turn, is a plate carrying two bolts for attaching the machine vice. The vice is clipped lightly on top of the round plate, turned to the appropriate position, and then tightened down solid on to the column by wing nuts on the two bolts.

The two clamp bolts can be either ⅜in. or $\frac{5}{16}$in. coach bolts, 1½in. long. Coach bolts are used here because of the square portions directly under the heads; these fit the slots in the vice bolting lugs and prevent the bolts turning on tightening the wing nuts. The Shallow round heads also have a neat appearance. If ⅜in. bolts are used, the squares will probably need to be cleaned up to fit nicely in the slots, preferably with two corners rounded off to a D section to allow them to get well into the slots. Check too, that the head diameter allows this.

The distance apart of the bolt holes under the vice fixes the maximum diameter of the round top plate and also the spacing for the bolts in the lower free plate. This is pointed out for the benefit





Adjustable vice mounting ready for use.

of those who may wish to make a similar fitting for a vice other than the Myford, to which the drawings apply. So prepare the bolts first, then you know the main dimensions for the other pieces. To make the top disc, drill a ½in. diameter hole in a suitable piece of ¼in. plate, then mount it on a bolt held in the three-jaw chuck and turn it to size. Re-chuck it by the outside edge and turn a countersink to the ½in. hole on one face, which will the top.

Make the column from a short length of ¾in. square mild steel bar, either black or bright. There is no particular point in spending any time on getting a nice finish on the sides of the bar, as it will very soon be liberally marked from the bench vice jaws. Hence black bar "as it comes" is quite suitable. Face the ends and turn down one end to a tightish fit in the ½in. hole in the top plate, making the turned down portion about $\frac{5}{16}$in. long. Leave a nice square shoulder with a sharp corner at the end of the round portion. Turn down the next $\frac{9}{32}$in. or so to ¾in., which means in effect, turn off the corners. The $\frac{9}{32}$in. is by no means critical and can be anything over ¼in., sufficient to let the lower plate turn freely.

On another piece of ¼in. plate mark out the shape of the lower clamp plate and drill the various holes. Depending on the spacing of the clamp bolt holes, they may not be far enough apart to permit using them to clamp the plate on the faceplate for boring out the centre hole. If so, rough cut the plate to shape and hold it in the four-jaw to bore the middle hole to be an easy fit on the ¾in. round part of the column. Finally, file the plate to finished size and shape.

To assemble the fitment, slip the clamp plate over the end of the column followed by the round top plate, countersink uppermost. Tap this down firmly and rivet over the stub of protruding column into the countersink, making sure the plate is solidly held. The completed job can be chucked in the four-jaw if necessary to clean up the riveted end. In any case, any metal spread far enough sideways to interfere with the flat seating of the vice should be filed down flush with the top plate.

The few components of the universal vice mounting before assembly.

Myford machine vice mounted on the attachment in the bench vice.

Anvils

BY A.W.NEAL

Fig. 1

WE are told that as far back as when man was using flint tools he devised an anvil to support the materials that he was shaping under his crude hammer. With the development of the art of forging hot metals with the hammer, the metal anvil appeared. Its ultimate shape has been evolved almost solely from consideration of its convenience in use.

During the 16th century William Gilbert carried out an investigation into the different types of compass then in use. The anvil shown in Fig. 1 is of the type that smiths used when making a magnet by the process of hammering a piece of iron placed along the magnetic meridian.

The present day shape is well known for its smooth top working surface, the projecting conical beak or " bick " at one end and a rectangular bick at the other. A square hole and a round hole are provided in the face, into which a variety of swaging, forming and working tools can be inserted with their working edges uppermost. Anvils are made of many metals including wrought iron, steels, and cast iron with a smooth face of hardened steel.

There are now two main types of smiths' or engineers' anvils, the single bick and the double bick, made in a great range of sizes. Fig. 2 shows a standard single bick anvil. This particular example is all-steel of a high quality—high carbon steel—to give the required hardness for the working face.

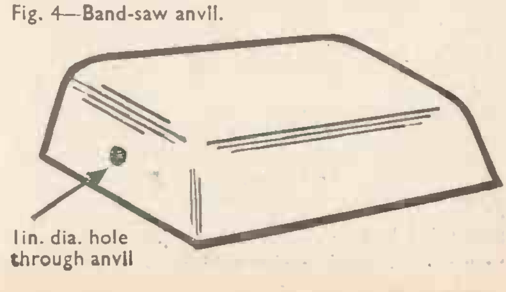
In general, anvil steel is manufactured by the Bessemer process, under laboratory control to ensure the necessary physical and chemical requirements. The molten steel is poured into ladles, which are taken by gantry cranes to the casting area, where the anvils are cast.

Fig. 2—Single bick anvil.

Fig. 3—Saw-maker's anvil.

Next, the anvils are annealed in electric annealing ovens which are thermostatically controlled to maintain the correct temperatures during the annealing process. After shot blasting and final dressing they are conveyed to the machine shop. Here, they are machined to shape and inspected before passing to the hardening shop where they are hardened and tempered. Here the working face is given its final grinding. Each anvil is separately inspected in a crack detection machine and is given a Brinell hardness test at several places along the

Fig. 4—Band-saw anvil.



A

Fig. 5

B

45lb anvil.

20lb round-ended anvil stake.

Fig. 6—8lb Beck Iron or Extinguisher stake.

face. These all-steel anvils are made in 17 different weights ranging from 11lb to as much as 5cwt. Other kinds of anvil include those having a steel face welded to a body of softer steel or wrought iron.

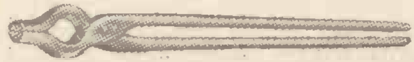
The anvil shown in Fig. 3 is a special one which sawmakers use and, as will be seen, it has no bick. Sawmakers' anvils are cast in the same kind of hard wearing steels as are employed in the more orthodox anvils, and they receive the same treatment. They are cast in one piece and have either convex or flat working surfaces. Weights vary between 1cwt 3qr 6lb to 5cwt 0qr 7lb. Fig. 4 shows a bandsaw anvil, which has a 1in. diameter hole passing through it. Sizes for this variety of anvil vary between 8in. and 14in. long by 6in. to 8in.

Further examples of anvils are shown in Figs. 5a and 5b, both being of the kind used by sheet metal workers. The one shown in Fig. 5a is a 45lb anvil and that of Fig. 5b is a 20lb round-ended anvil with stake. Fig. 6 is a near relation to the anvil, it being a beck or beak iron, sometimes called an extinguisher stake. This is a tinsmith's shaping tool.

Power hammers incorporate a special kind of anvil of considerable mass, often weighing as much as 200 tons for a 12 ton hammer. These rest on heavy foundations of mass concrete to absorb the huge blows they have to take.

It would not be out of place to mention a few of the tools used in conjunction with blacksmiths' anvils, although there are so many that it is quite out of the question to mention them all here. A variety of tongs, sets, punches, and gouges are shown. In general the "bottom" tool, for instance the bottom swage as distinct from the top swage, fits into the square of the anvil. The shape of these tools is the outcome of the development of the forging art and their names must be equally as old. Every year thousands of hand anvils are made and sold, yet they are implements which are not likely to wear out, go astray, or be lost. About 90% of the production is appropriated for export, to something like 70 different countries, an indication of a healthy state of affairs in every respect.

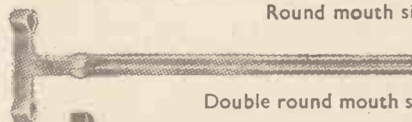
Open mouth tongs.



Chisel or bolt tongs.

Round mouth tongs.

Round mouth side tongs.



Double round mouth side tongs.

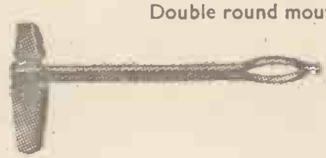


Fig. 7.

Hot set.

Top and bottom fullers.

Top and bottom swages.

Fig. 8—Finish grinding an anvil.

A GREENHOUSE FAN HEATER

N.W. DUNCAN

THE greenhouse was finished; it was a lean-to building, 14ft long, by 8ft broad with a roof running up to a height of 9ft where it joined the wall against which the house was built. It is exposed to the South West and, although it is sheltered from the full force of the wind, it gets quite enough to make the problem of warming it a matter for serious consideration.

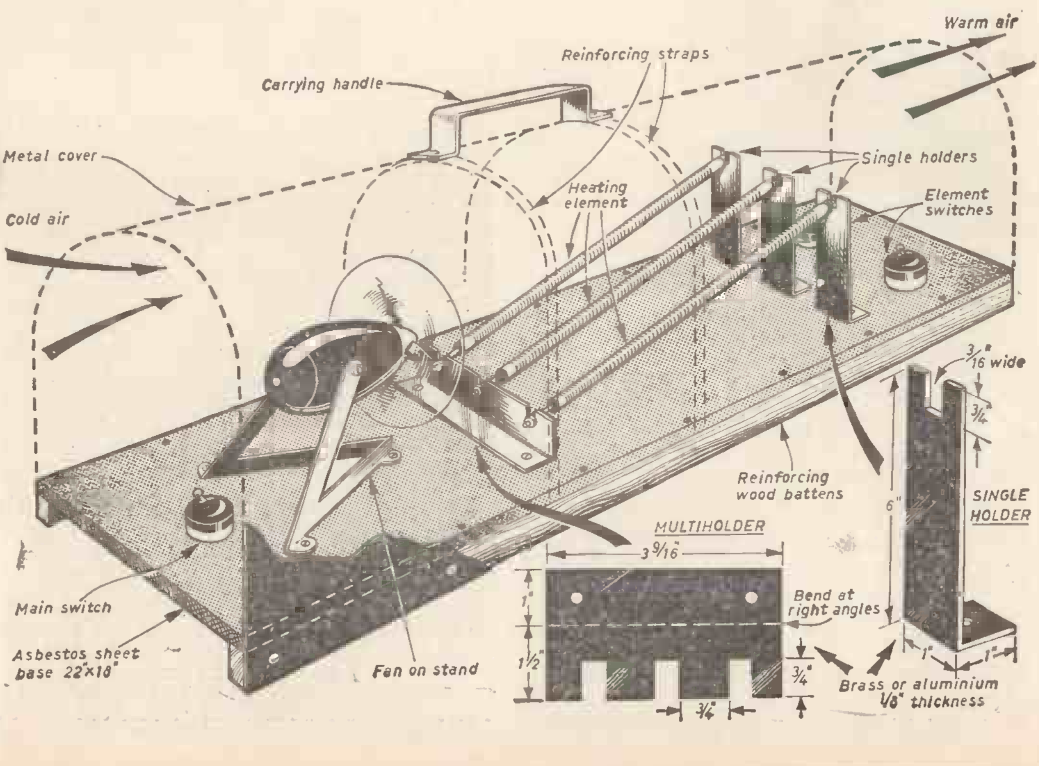
The conventional solid fuel boiler and paraffin heaters were both ruled out, principally on maintenance grounds, and it was decided to use electricity in one form or another. The problem was to keep the temperature of the air inside the house sufficiently high to ensure that the plants in it would not be affected by external conditions or temperatures.

Tubular heaters and soil warming cables were considered; both have good points but neither provided a definite circulation of hot air through the house. What was wanted was some machine to make hot air and to blow it through the house by an electric fan. The commercial patterns were mainly designed for bigger houses and in any case were expensive. The diagrams illustrate the construction of a home-made heater which has proved entirely satisfactory over a season's running.

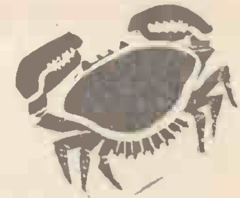
It consists of a nylon bladed fan, 6in. in diameter, driven by a small induction motor, which blows air over three 500 watt heating elements of the pattern used in an ordinary electric fire. These elements should be connected in parallel, two of them being individually controlled by switches to regulate the total heat available.

The fan, switches and heating elements should all be mounted on a $\frac{3}{16}$in. thick sheet of asbestos, reinforced by 1in. x 1in. battens screwed all round

(Continued on page 285)



A Tidal Fishtank



THE author was asked some months ago if he could suggest a simple fool-proof method of making artificial tides in a fishtank. The purpose of this was so that marine life from on or near the sea shore could live under almost natural conditions. After much experimentation with pumps, syphons, displacement vessels and tank tilting it was decided to use either an archimedian screw water lift or dredger type buckets. Further experiment showed that an archimedian screw frequently became fouled with marine growth and

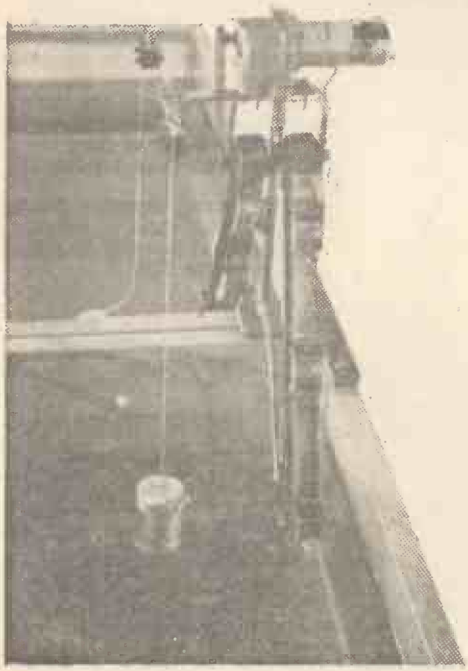


Fig. 1.—The complete tidal unit.

became inoperative. In short, the dredger type water lift to be described proved reliable even when covered in marine growth. If operations should stop for any reason it can be seen at once.

Effects of salt water

Since a tidal tank will almost certainly contain salt (sea) water readers not familiar with marine tanks should read some reliable work on the subject. Generally, copper, brass and zinc should be kept out of the tank, while lead is fairly safe and iron and steel seem safe if covered in paint or asphaltum varnish. Plastics on the whole are quite safe to use. In making this tidal tank device readers

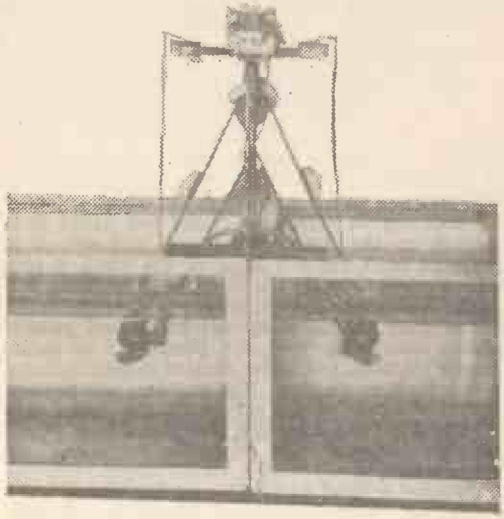


Fig. 2.—Front view of the unit and tanks.

By E. V. King

should make sure that any brass used is either properly painted, or tinned all over with a high lead content solder. Readers skilled in the use of plastics or wood such as teak should use these materials wherever possible. Metal dissolved in the water will poison the fish, and if even minute amounts of brass are dissolved the water will have to be changed more often.

How the tank works

The system can be seen in operation in Figs. 1 and 2 whilst the mechanical parts are shown in Fig. 3. Two tanks are required, although one need not contain fish and can be placed in a cupboard lower down than the other tank if desired. Using two tanks, high and low water may be seen at the same time.

Two plastic belts are continually and very slowly moving in the direction shown in Fig. 3, by means of a small quiet electric motor. Water is thus raised and poured silently into a tank A from tank B. No chutes are required if the design is followed fairly accurately. Glass float No. 2 is floating and the cord connecting it to change-over micro switch No. 2 is loose and the switch is "normal". Glass float No. 1 is suspended by its cord which is keeping the micro switch No. 1 away from "normal". The switches are wired to an electric control box which thus "senses" the tidal position and keeps the drive motor going in the direction indicated.

However, when the float positions reverse, the sensing gear reverses the motor direction. A special design feature prevents oscillation of the motor direction at the change-over position. Readers will realise that the heart of this design is the sensing unit, floats, micro-switches and cord lengths.

The unit is fully automatic and the time period between tides can be adjusted by adding or taking away buckets, by altering their size, by altering the voltage supply to the motor, or by altering the cord lengths.

The roller and motor support

Angle iron, strip or rod is suitable. In Fig. 4 the important dimensions are shown. However, these may be altered provided a trial is arranged to make sure the water "pours" well and that the buckets do not foul any metalwork. The prototype has a main pillar of ½in. diameter which is a push fit in a piece of marine plywood which rests on the tanks. The jockey pulley supports are ¼in. rod and the driven pulley spindle support of ½in. x ⅛in. metal.

When completed, it is convenient to screw the base on a box while arranging the parts and fixing the motor.

The pulleys

These are of hard wood or rubber. The prototype used tapered 40mm rubber bungs obtainable from laboratory suppliers or some chemists. The bungs were rubbed down with coarse carborundum paper until slightly radiused as in Fig. 5. This will keep the belt in place without side washers.

The two driven bungs are a push fit on the ¼in. drive shaft on which is fitted a drilled out meccano chain sprocket of ¾in. outside diameter. Solder makes quite a good fixture. Other size sprockets may be used to alter the tidal period.

The rollers should then be fitted as in Fig. 4. The jockey rollers, if of rubber, are best sleeved internally with metal or plastic tube and are kept in place with split pins or by using nuts on a tapped rod.

The belts and buckets

The belting is thermoplastic material (polythene) 1in. x $\frac{1}{16}$in. and is made so that the complete loop just grips the rollers when in place. The two belts are identical. The plastic material is cut to length and the two ends welded quite simply by gently melting them over the gas stove, pushing the melted ends together to make a butt joint.

The buckets could well be made from small plastic cups filed away to give a long pouring lip, which is essential to prevent water running down the working parts. The prototype used metal cups made from sheet metal which was bent, soldered, painted and attached to the belt with nuts and bolts, countersunk on the belt side to prevent fouling of the pulleys.

Fig. 6a shows the shape of metal required for each bucket and Fig. 6b how it should be bent for

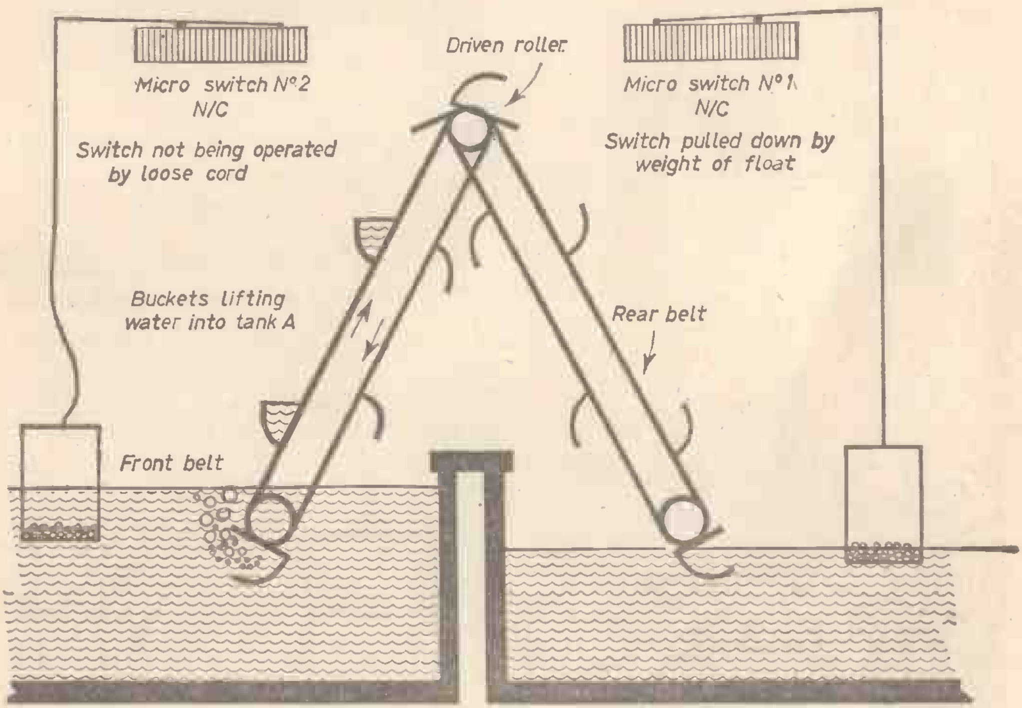


Fig. 3.—Diagram illustrating the principle of operation of the unit.

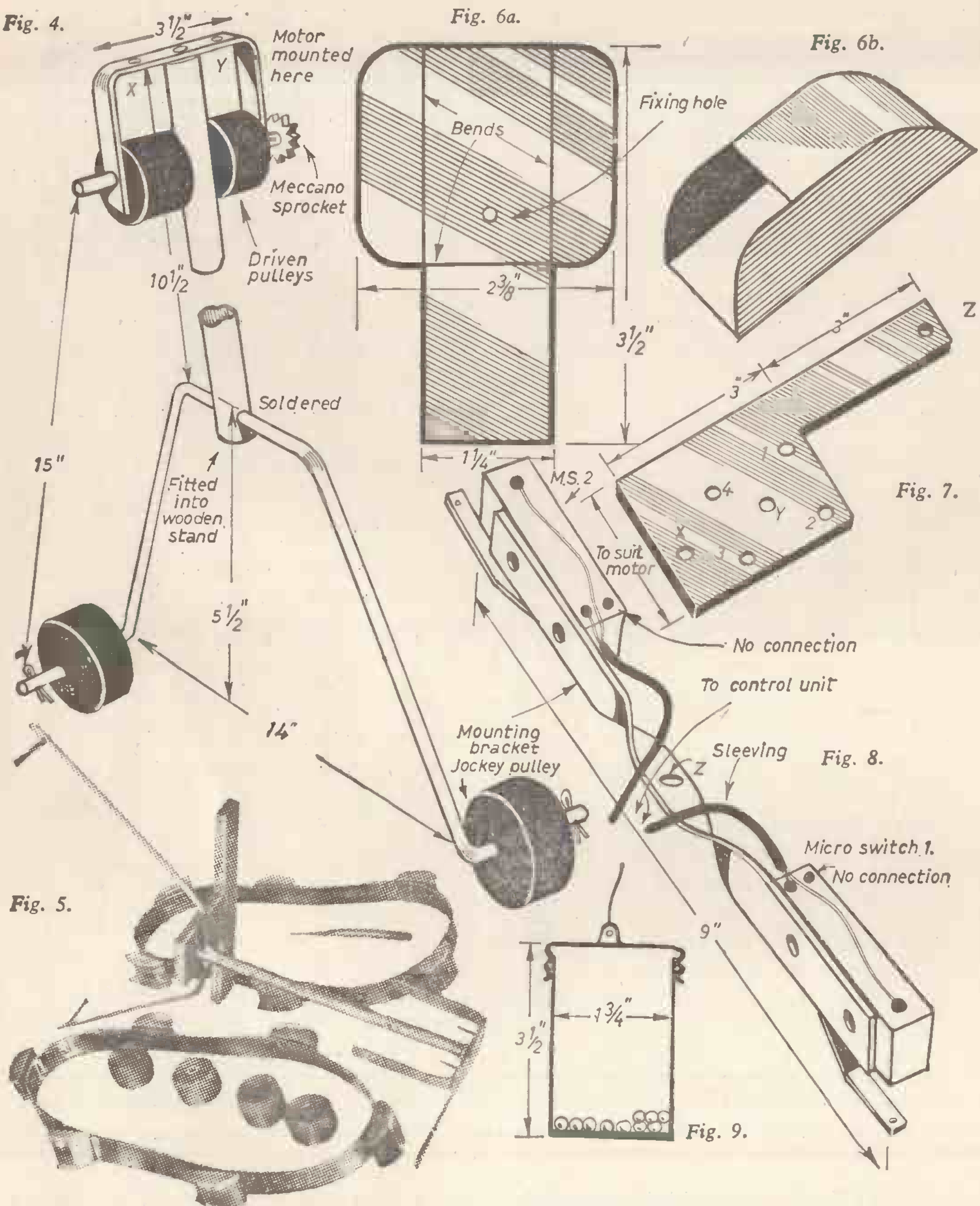


Fig. 4.

Fig. 6a.

Fig. 6b.

Fig. 7.

Fig. 8.

Fig. 9.

Fig. 5.

soldering. Note that the fixing hole is near the closed end of the bucket so that the lip sticks out at the top of the run (as shown in Fig. 3) to give a good pour of water, away from the belt, etc.

The apparatus may now be assembled, fitted over a tank or sink and tested by turning the sprocket by hand.

The electric motor

This must be one that revolves slowly via a gear box. The readily available surplus "Oster Motor" is suitable (Fig. 12). The gear box should first be removed. The cams and all levers, etc. should then also be removed. Removal of the cams is best accomplished by drilling out the tapered pins and the Allen screws as well if need be. One shaft should be cut short and metal projections cut off. The sprocket should be soldered on the other shaft and the motor re-fitted to the gear box.

The motor may be mounted in any place where a chain drive will allow it to work the pulleys. Generally it is best to have the motor high up to avoid contamination with salt water. The author fitted his motor on top of the mechanical assembly. A metal plate was screwed on top and the motor screwed to the plate as shown in the various photographs. A suitable plate is shown in Fig. 7. The holes 1, 2, 3 and 4 must suit the motor used. X and Y match up with Fig. 4.

When fitting the motor, care must be taken to get the chain and sprockets in line. The chain need not be dead tight. The chain should be lightly greased and the arrangement can then be tested on a 24 volt or 12 volt supply (a car battery will do). The mechanical unit is now complete.

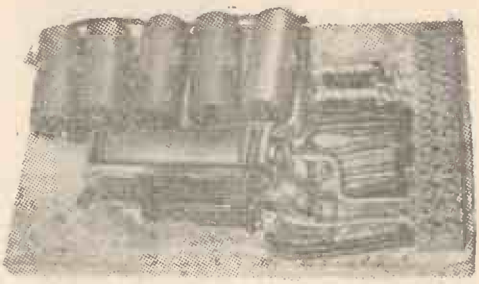


Fig. 10.—The layout of the control box.

The micro-switches and floats

The motor plate should be made with a 3in. projection as in Fig. 7. To this should be fixed a bracket about 9in. long which supports the micro switches. A suitable arrangement is shown in Fig. 8 and may be seen in the various photographs. The bracket can be made from brass, twisted by using a vice and an adjustable spanner. The two holes "Z" of Figs. 7 and 8 mate up when assembling the unit. Note that Fig. 8 is upside down to show the wiring.

The floats are metal topped jars of the approximate size shown in Fig. 9. A solder tag or wire loop should be soldered to the top, and stones or lead shot placed in the jar to make it float upright. Smaller jars may be used provided the weight is sufficient to operate the micro-switches. The cotton lengths are fairly critical and can be adjusted by trial and error. The model photographed gave a tidal depth alteration of 5½in. Float No. 2 in tank B (Fig. 3) had a cotton length of exactly 16in. and cord No. 1 in tank A a length of 15½in. In general tank B cord should be longer than that in tank A, the cord length governing the tidal change. The change cannot be greater than 5½in. in this design unless the dimensions of the jockey pulley rods in Fig. 4 are lengthened to take the buckets further into the water.

The control box

This should be made up on a piece of soft wood about 8in. x 5in. It operates from a 12 or 24 volt

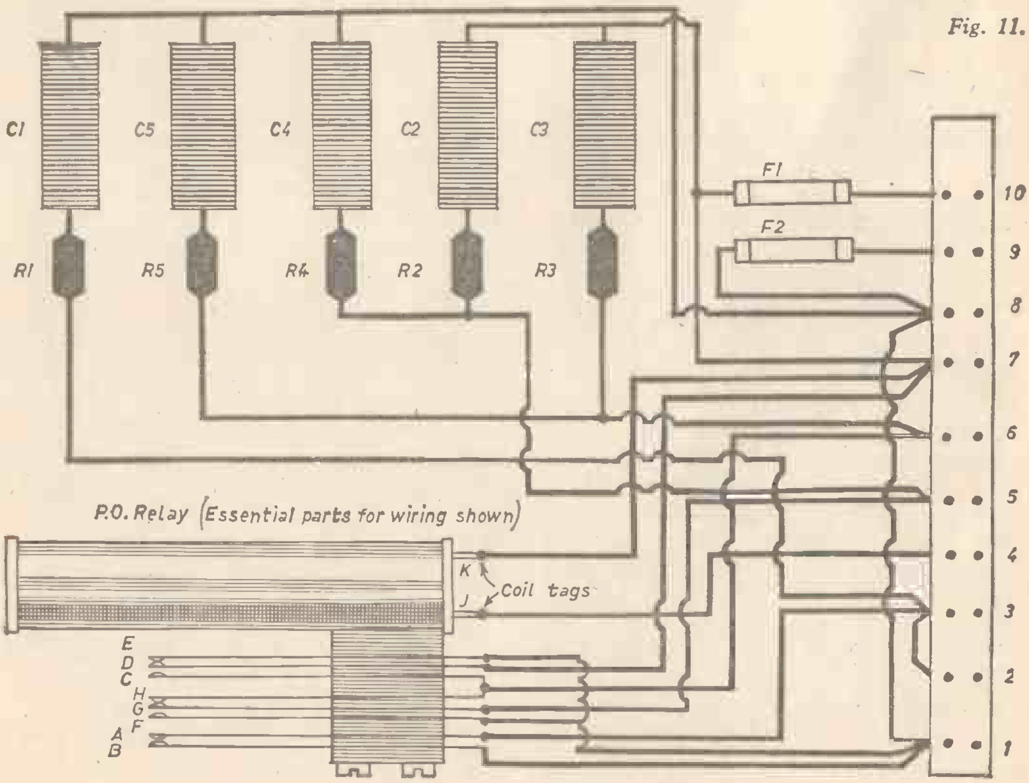


Fig. 11.

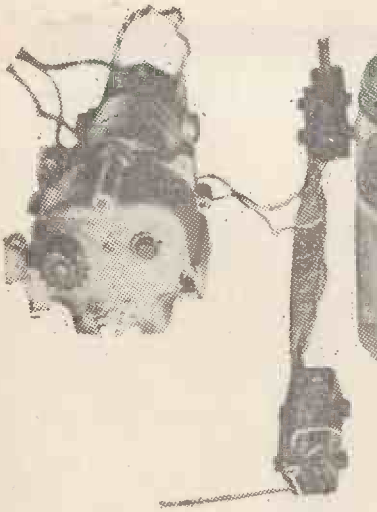


Fig. 12.—The Oster motor, switch bracket and floats.

d.c. supply giving about 1 amp. Any ordinary battery charger or model train supply will suit, or a simple transformer and rectifier system may be incorporated in the box. Mains voltage must not reach the mechanism, and for additional safety the tanks and mechanism should be earthed with thick wire. The parts are mounted as shown in Fig. 10. Terry Clips will hold the condensers but a metal bracket will have to be made to fix the relay. Lable the terminal block from 1 to 10. Inspect the relay and label the tags with A to K inclusive. No guess work is permissible. The drawings show the relay "normal", *i.e.* not energised.

Parts list

MECHANICAL

Plastic belting: Messrs. Whiston, New Mills, Stockport.

Rubber bungs: Messrs. Griffin and George, Ealing Road, Alperton, Middx., or most chemists to order.

1. 24 volt motor with gear box and field winding ends accessible. John Oster Motor is used on prototype and is available from Messrs. Whiston, or Milligans, 2 Harford Street, Liverpool 6.
2. Meccano Sprockets with 14 teeth on each on prototype.
2. Bulgin Micro Switches No. S.511. Messrs. Bulgin Ltd., Bypass Road, Barking, Essex.

18in. Meccano chain to fit sprockets. Various pieces of metal etc. as in text.

CONTROL BOX

1. 10-way terminal strip (Radiospares or similar).
1. Double bank cartridge fuse holder.
5. 0·5 mfd paper condensers 350 volt working.
5. 220 ohm resistors, ¼ watt 20% tolerance.
1. P.O. relay. Coil resistance 200 ohm, 2 sets of change-over contacts and 1 set of normally open contacts. (Other contacts may be present, unused.)

A few yards of p.v.c. covered connecting wire similar to Radiospares 7/40. Messrs. Sallis, 93 North Road, Brighton, Sussex.

The radio type components may be obtained from Messrs. Henries Radio Ltd., 5 Harrow Road, Edgware Road, London W2.

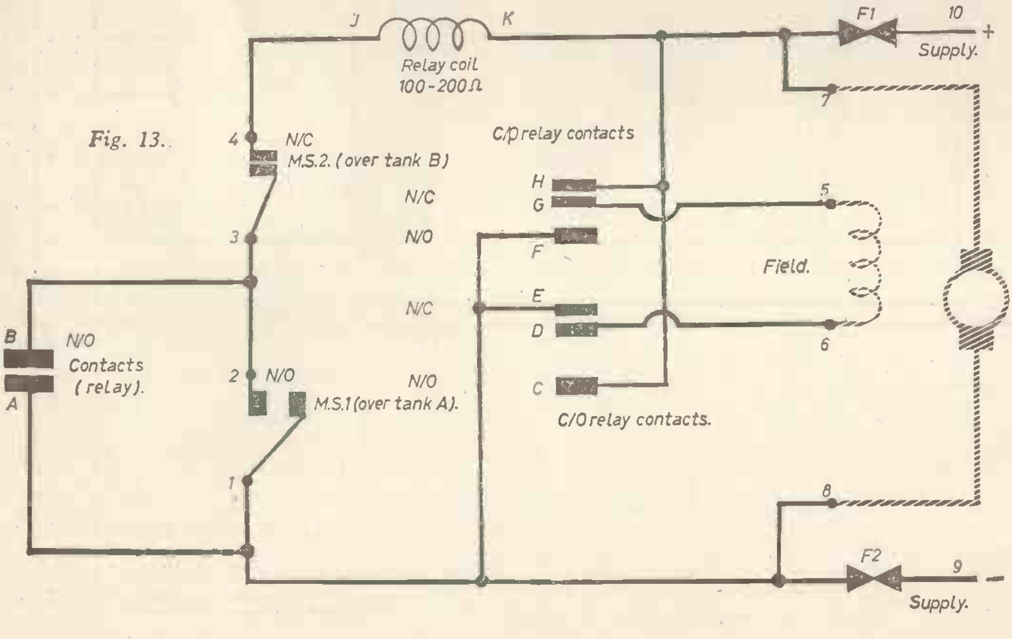


Fig. 13.

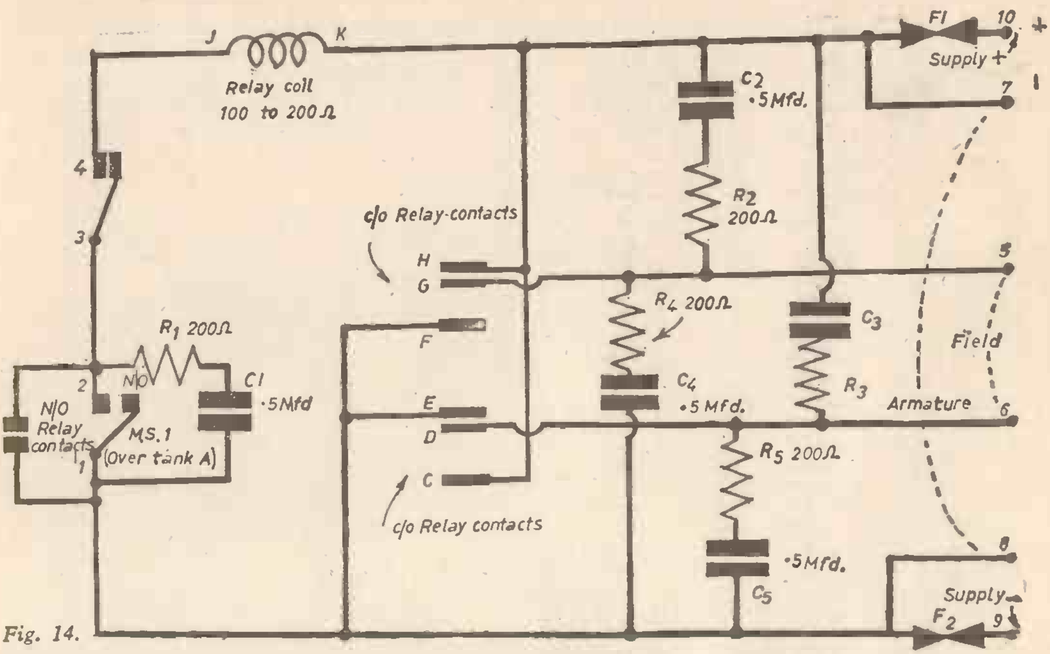


Fig. 14.

The wiring

Use tinned copper wire and systoflex sleeving. Flux cored solder should be used to make all connections except at the terminal block. Wire up as in Fig. 13, *i.e.* as in Fig. 14 with the spark suppressing condensers and resistors left out. At this stage the unit will work and be satisfactory. However it is good practice to fit the spark quenchers to increase the life of the relay. Resistors and condensers should then be added to make up the circuits to that of Fig. 14.

Testing the unit

Using thin plastic covered wire of the tye used for wiring radio receivers the terminals of the supply unit are wired as follows:—

1—To micro switch No. 1 n/o terminal } See Fig. 11.
2—To micro switch No. 1 common terminal
3—To micro switch No. 2 common terminal
4—To micro switch No. 2 n/c terminal.
5 and 6—These are wired to the field coils of the motor. To get to the field coil connections a small metal plate should be removed from the motor body. The flex leads to the field coils should be cut and the leads to terminals 5 and 6 soldered to them. The joints should be taped.
7 and 8—These are wired to the motor main terminals.
9 and 10—These are wired to the d.c. supply.

The unit will now work, but the motor may be going the wrong way, *i.e.* when a micro switch has its float "up" the belt must be lifting water from that tank into the one with its float down. If this proves not to be the case then all that has to be done is to reverse the leads to terminals 7 and 8.

It is useful to test the unit using two polythene buckets which do not take long to empty.

Adjusting the tidal period

The motor on the model described, running from a 12 volt supply, takes the belt round once in 2½ minutes, and moves ⅛ pint of water in that time. In 11 hours it will move about 4 gallons of water. It is usual to have a tidal movement of about ⅓ the tank capacity and so the tanks can have a capacity of about 12 gallons, or more if much solid matter is used to make up a "shore". In smaller tanks all that is necessary is to remove buckets or cut them to smaller dimensions, or use plastic thimbles bolted to the belt instead of buckets of the size shown.

Once operating, the unit will continue to work without trouble provided the tank water is topped up now and again to a predetermined level. The cost for electricity is about 3d. per week. No aeration is required as air is bubbled through the water as the buckets fill with water (Fig. 3).

An opal glass, plastic or lead screen may be made to fit round the mechanism so that it is not visible. The prototype was made for use in a school classroom and it was thought that the mechanism had some educational value and was left visible. Likewise the control box, being low voltage circuitry was not covered, but it could be.

How the control unit works

Refer to Figs. 3 and 13.

1. Tank B full, tank A low tide. Micro-switches are both closed and thus relay is energised and motor field coils have terminal 5— and terminal 6+ and motor takes water from B into A.

2. Tank B level now falling, but the cord is longer and loose. Tank A rising and micro-switch No. 1 clicks over to the open position. This makes

(Continued on page 278)

PICTURE NEWS

FROM THE WORLD OF SCIENCE

Canada's new cobalt source

A NEW, 11,000-curie supply of cobalt slugs has been activated by Atomic Energy of Canada Limited, at Chalk River, Ontario, in their NRU reactor, the most powerful in Canada, and one of the most powerful in the world, for Goodyear, U.S.A.

By increasing its source of Cobalt-60 to 11,000 curies—measurement units for radioactivity—the Goodyear Tyre and Rubber Company has tripled its supply of radioactive Cobalt-60 in a stepped-up programme to explore the effects of nuclear energy upon rubber and plastics.

The firm has set up a four-fold goal for its intensified radiation research programme:

(1) To perfect methods of vulcanising rubber by radiation, the first basically new vulcanising method since Charles Goodyear discovered the conventional heat-and-sulphur method 122 years ago.

(2) To create entirely new types of rubbers and plastics by using radiation as a polymerisation catalyst, joining molecules of basic materials to form the large, more complex rubber molecules.

(3) To develop rubber compounds not easily damaged by intense radiation, from which such products as belts, hoses and gaskets can be made for use in highly radioactive environments.

(4) To test space projects, such as an experimental manned space station built for the National Aeronautics and Space Administration by Goodyear Aircraft Corporation. The rubberised fabric station can be folded into a small package, boosted into orbit, then inflated into shape. In space, it would be bombarded by cosmic rays, similar in effect to the gamma rays emitted by cobalt, making it essential to know the effect radiation may have upon its construction.

Goodyear installed its first cobalt source in 1956, ten years after it first entered the radiation research field by developing a beta gauge for production gauging of packaging film.

Although the radioactive cobalt atoms themselves weigh only 3/10ths of an ounce, they are shipped from Canada in an 8,000lb. steel and lead container. On arrival, the cobalt is housed in the bottom of a concrete and aluminium-lined well under 17ft of water which, like lead, acts as a protective shield. When in use, it is raised by a remote-controlled lift to a concrete cave, whose 4ft thick walls safely contain its powers.

Goodyear, which is licensed by the U.S. Atomic Energy Commission to handle the radioactive material, also operates the Government's $800 million gaseous diffusion plant at Portsmouth, Ohio, where atomic fuel is prepared for the world's first atomic powered merchant ship, the N.S. *Savannah*.

Radiation hazards inspector checks the tightness of the cobalt shipping container with a "cutie pie" monitor.

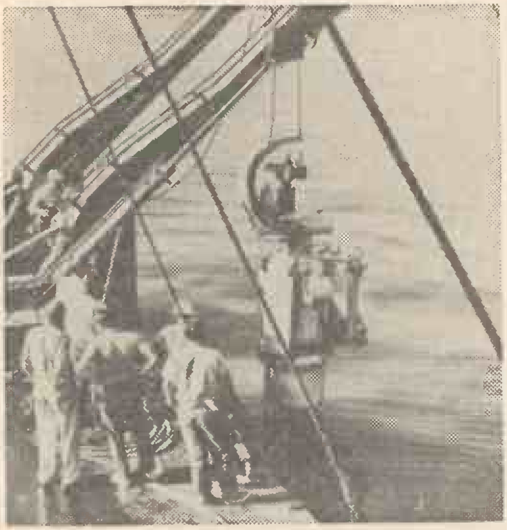
Building with porus clay filler concrete

TALL blocks of flats from large panels have been built in the Soviet Union entirely from porous clay filler concrete, a new building material obtained by roasting clay.

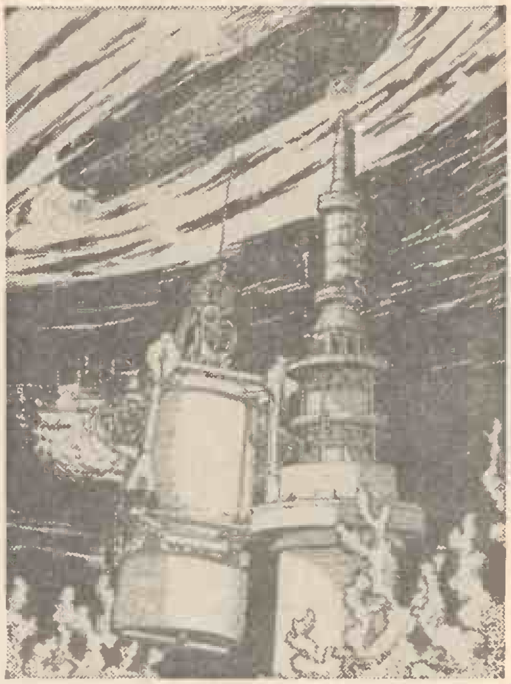
This material is 75% lighter than brick and its production costs are much less. The construction of a 14-storey building from porous clay filler without a framework will begin in Moscow in 1963. Calculations have shown that the load at ground floor level will be only slightly bigger than in five-storey buildings made of conventional concrete.

Annual production of porous clay filler concrete in the Soviet Union is now 2,800,000 cubic metres, and within two years the planned output is to be 4,000,000 cubic metres—more than in the United States. By 1965 production is to be 10,000,000 cubic metres.

A group of Soviet specialists and builders who have studied the application of new types of porous clay filler concrete in construction have been recommended for a 1963 Lenin Prize.



Mobot is lowered into the ocean off the coast of California for a task on a sea-bottom well head.



Artist's impression of Mobot manoeuvring into position near the sea floor.

"Mobot" the robot can work on oil wells 1,000ft under water

A ROBOT which can work on oil wells 1,000ft down on the ocean bed has been developed by Shell Oil Company in the United States. Called "Mobot", it can swim, see, hear, and has a nose that can turn lock screws, work valves, and grip pipe and hoses. It can also wield a wire brush and other tools.

The robot's first assignment was the completion of a well last month off the coast of Santa Barbara, California.

Mobot forms part of yet another Shell system, which took three years to develop, for drilling and completing wells in deep water far from shore. Because most of the promising areas on land have already been explored, drilling in the open sea has become the oil companies' biggest hope of finding new oil and gas fields.

Exploration at great depths rules out the use of conventional well head equipment, placed on a platform projecting above the water. The well head components must now be assembled on the ocean bed itself and the well put into production remotely.

Mobot can carry out these tasks at greater depths, and for longer periods, than a human deep sea diver can withstand at present. It is also an efficient tool for finding, and coupling pipes to, existing ocean-floor wells.

Swims with adjustable propellers

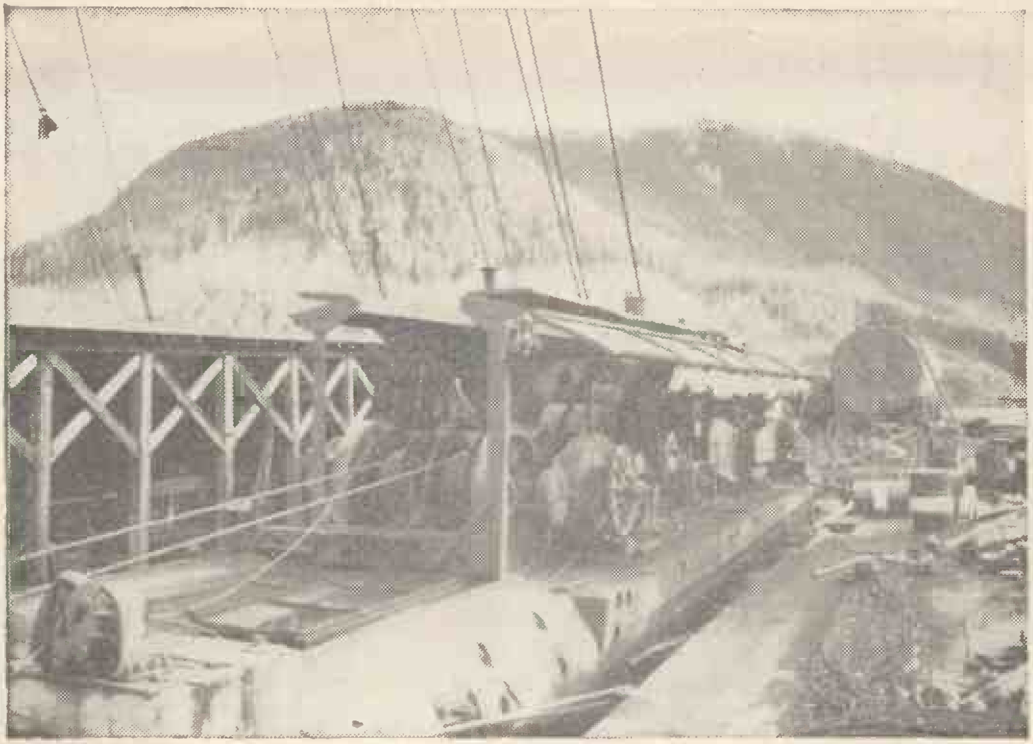
Mobot is electro-hydraulically operated from a master control centre aboard the drilling vessel, and swims down to its work using two adjustable propellers. A gyroscope gives it a sense of equilibrium.

The device can see up to 30ft by means of self-contained lighting and a TV camera, which transmits its field of view to a screen in the control centre. Sonar acoustic equipment—which squeaks like a bat—is used to locate well head or other metal objects at greater distances. A sensitive microphone enables the robot to listen to the operations it performs.

The well head employs the proven blowout preventers and "Christmas tree" assembly of valves and fittings used on land, but adapted and simplified for the robot's benefit. Design is so modified that most of the components can be attached or uncoupled by means of the socket wrench which the robot carries on its "nose". Many other tools can be substituted. A circular track is provided on the well head around which Mobot rides as it works.

Mobot was built for Shell Oil by Hughes Aircraft Company, who also helped develop the instrument.

Shell Oil Company will make the components available to industry through equipment manufacturing companies and other firms.



The working deck of the slackline-skidder.

Automation and Timber

by Donald S. Fraser

AUTOMATION in the timber industry is, among other things, ending the role of the colourful lumberjack. It is also saving thousands of dollars for the pulp companies that operate along the Pacific coastline of Canada and the United States.

One of the most difficult problems to be solved was that of "yarding" logs from Alaska's mountainous shores. Now, inaccessible timber can be reached with what is called a slackline-skidder. This powerful piece of equipment, which is mounted on a float capable of containing nearly a million feet of timber, is able to reach out 3,200ft and drag logs off the hillsides. It then yards the logs directly into salt water.

This combination slackline and interlocking skidder equipment weighs 135,000lbs. (bare weight without ropes and floats), is 47½ft long and 12ft wide. The power plant consists of two Model 6-110 General Motors diesel engines of 300 h.p., each driving through Twin Disc torque converters and Western Gear two speed Torq-Master transmissions, providing a wide and flexible range of speeds and giving more than ample power to the winding drums.

The machine's ten drums provide, in addition to normal operating lines, the necessary drums for rigging and changing lines as the float-mounted unit moves along shore to change "landings". Two special side drums provide the means to move the rig to new settings along shore, and to hold the float in position while operating. A master one-lever "brain box" controls all skidding and interlocking functions for fast and smooth operation. Other features of the machine include all roller bearing shafts, Quincy air compressors and Aeroquip hose.

On the front of the huge log raft, beneath the 167ft A-frame, is a track loader on a stationary mount which is equipped with an 80ft straight boom and a 60in. log grapple. Between the raft and the shore is placed an additional permament raft to form a deck for landing the logs being yarded in. The logs are dropped on this floating log deck, permitting chokers to be unhooked with greater speed and safety.

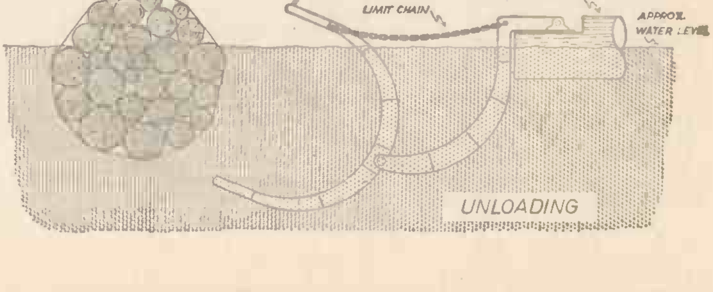
The grapple-equipped track-loader then picks up the logs from the floating log deck and places them in a specially constructed cradle for bundling. This lies just beneath the surface of the water. Individual steel arms support capsizing cradles of heavy fabricated steel, semi-circular in shape and hinged to the stationary supporting arms. Once the cradle is filled with logs, cables are wrapped around the bundle, tightened and secured. The filled cradle is then turned on its hinges, capsizing the log bundle and freeing it for towing. By yarding logs in this new manner, directly into the water, it minimizes the need for temporary roads and conventional land-based machinery. The log "bundles" which are now being used, instead of the flat fields of logs, gives greater ease of towing without losses due to rough water, sinkers and straying logs. A chemical is added to increase floatation.

Engineers of the Ketchikan Pulp Company originated the idea for this automated equipment which was then designed and developed by Washington Iron Works of Seattle.

(top right) As the skidder brings a load of logs down to the water, the track-loader is transferring the previous load to the cradle. Note how the track-loader is guyed from the top of the A-frame to the raft. The centre-mounted A-frame permits guying without interfering with the swinging of the loader. The partially filled cradle is located in the left foreground beneath the water.

(top left) With the cradle fully loaded, cables are strung around the logs for bundling. The only visible portion of the cradle is the supporting arm on which the man is standing. Capsizing the hinged cradle floats the bundle free and the cradle falls back in position for the next load.

(left) This sketch of the bundling cradle shows its construction, location and operation. Attached to the log raft, and lying even with the water, the hinged cradle is held upright as the logs are positioned.



(right) Once filled, cables are strung around the logs and tightened. The cradle is then turned on its hinges, "capsizing" the log bundle and letting it float free. The log bundles are then included in a raft and towed to the pulp mill.

an INSPECTION LAMP

by JOHN WALLER

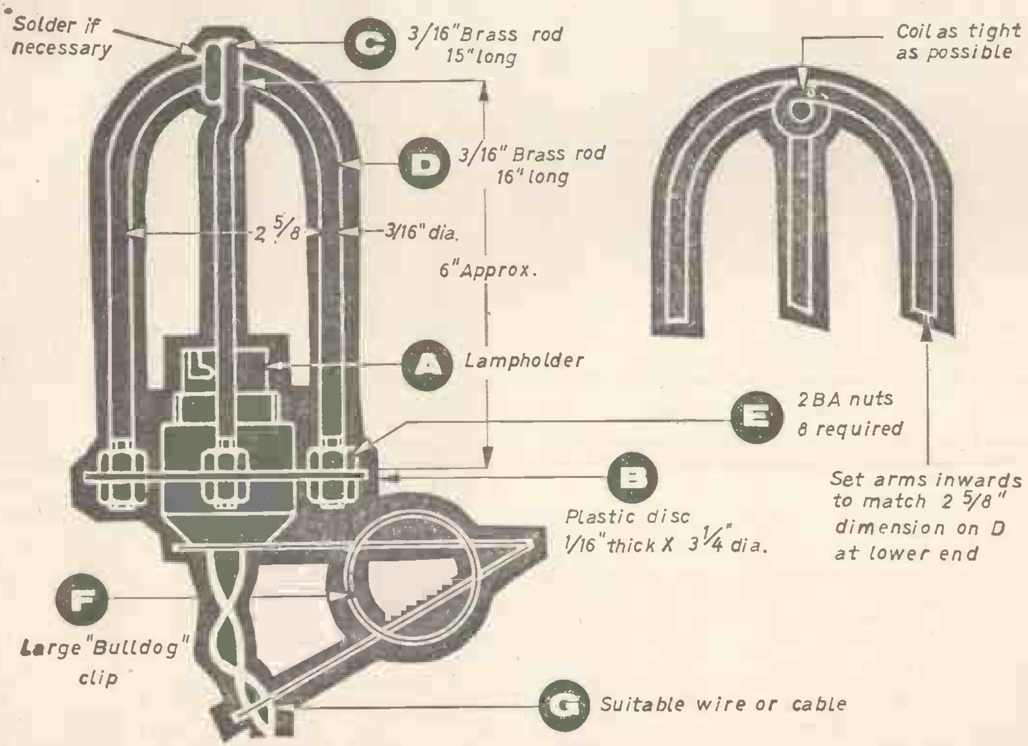
SIMPLE articles, especially those made from a few odds and ends of scrap material, give a considerable degree of satisfaction despite the fact that the finish accomplished may not quite equal that of a purchased item. Yet there are often times when a home-made item is more robust and usually much easier to dismantle and repair when the time comes for this.

The uses of an inspection lamp need no elaboration—in the garage or on the road at night, inside dark cupboards or in the loft space when endeavouring to trace some lost article, are all situations the normal household faces from time to time. Although a trailing cable with a lamp suspended from a hook or laid on the floor may suffice, protection of the lamp is essential for safety purposes besides proving an economy in time, as lamps are vulnerable to having heavy pieces of wood or feet placed on them. As most of this protection can be achieved by merely spacing four wires round the lamp the construction of a suitable and simple holder is not a difficult task for anyone having the minimum of tools.

The drawing illustrates the orthodox type of lampholder "A" fitted to a disc "B"—a piece of plastic about $\frac{1}{16}$in. thick. Sheet brass will do just as well however, because, as it cannot come in contact with any wires there is no risk of the plate becoming live. A series of small holes should be drilled inside a scribed circle the size of the hole that the holder will eventually fit into. The waste metal should be broken out, followed by a filing operation to remove the burrs. This completes the major work on the disc as the shaping of the outer circle is a task easily accomplished with a file.

Before bending the steel or brass cage members the ends should be threaded. A 2B.A. thread is a

(Continued on page 285)



HOME MADE PORTABLE PROJECTION SET FOR 2 x 2 SLIDES

THE portable projection set described here incorporates a projector, screen, and slide boxes for 90 slides, all in one compact unit which can easily be folded up and transported from place to place. It occupies no more space than an average portable record player, its outside dimensions being 13¼in. x 12¾in. x 9⅛in. Using a 100 watt lamp and 35mm slides it gives a 10in. wide picture of sufficient brilliance to be quite acceptable in a shady room, even in daylight.

The following notes and the drawing are intended to convey the general principle only. The dimensions given apply to the model made by the writer and may have to be varied to suit the characteristics of the particular projection lens available as well as the requirements of the constructor. It must be appreciated, however, that most of the dimensions are vitally interdependent on each other, and an alteration to any one of them may require a recalculation of all the others. Any dimensions not given are comparatively unimportant.

So that constructors are not limited to the size of lens used by the writer the following is the method used to obtain the exact projector dimensions having formed a mental picture of the size and shape. First I obtained the lens (secondhand), a pair of 2½in. plano-convex condensers and a 100 watt projection lamp. On the end of a board about 3ft by 9in. I fixed a vertical sheet of white card with a 10in. square drawn on, as this was the screen size I wanted. Two parallel strips of wood along the plank formed rough guides. Primitive wood support blocks for the lenses and lamp were made to fit the guides, keeping the screen and lens centres and the lamp filament in line. A transparency taped to a card surround was similarly mounted. A box with a hole in it kept stray light from the lamp in check. The transparency and projection lens were moved to give a picture of the desired size and the lamp and condensers to give maximum brilliance and evenness. Distances were then measured from this mock-up and the drawings prepared.

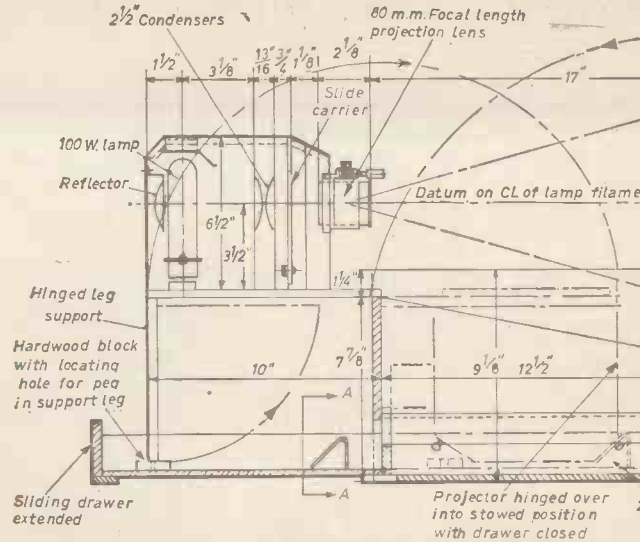
The projector should be made from 16g aluminium with a ⅜in. thick hardwood base, the latter having a 1¾in. wide hole extending along most of its length for ventilation. A small amount of light also shines through this hole into the slide boxes below. The removable top cover, which is secured with two 4B.A. stud plates and terminal nuts, should also be provided with a number of ventilation holes. A light trap should be rivetted to the top cover immediately above the lamp, as shown.

The lamp holder can be made as shown, from a brass plate cut to suit the stem fitting of the bulb, two brass 4B.A. studs, a block of Tufnol, and part of an old household lampholder with one spring plunger removed. The Tufnol base block should be provided with slotted holes to allow adjustment of the bulb and should be fixed to the base by woodscrews. Alternatively a suitable lampholder can be purchased.

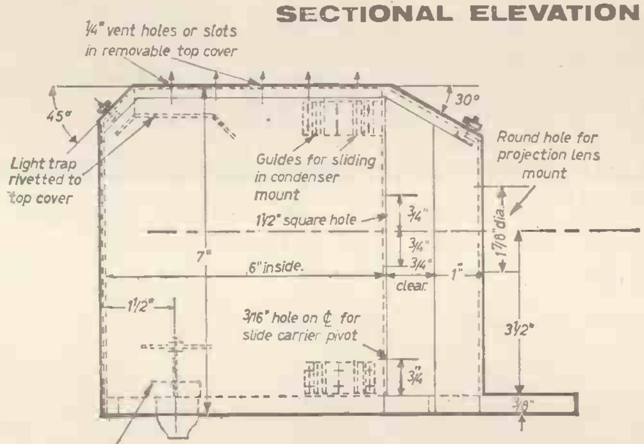
The 2½in. diameter condenser lenses should be mounted on thin metal plates, each being held in position by bending over three tongues of metal as shown on the drawing. The edges of the mounting plates should be folded over for extra stiffness, and slide between angles rivetted to the lamp house body as shown. The reflector should be mounted in the same way as the condensers, on a plate bent to set it forward from the back of the lamp house. It should be fixed to the latter with a single 6B.A. screw and nut. To enable the reflector to be lined up precisely behind the lamp filament, make the fixing screw hole in the lamp house oversize and cover it with a washer plate under the screw head.

In the front of the lamp house cut a hole 1½in. square, exactly on the centre line of the lamp filament and lenses. 2¾in. below this drill a hole for the pivot bolt on which the slide carrier rocks backwards and forwards. It is advisable to provide

HOME MADE PORTABLE PROJECTION SET



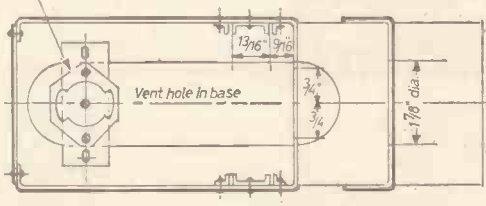
SECTIONAL ELEVATION



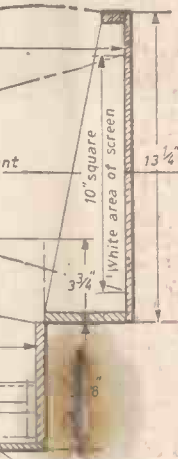
ELEVATION OF PROJECTOR HOU

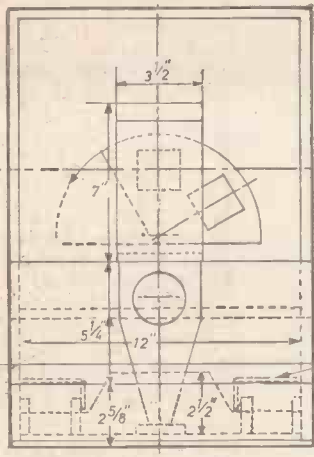
Lamp holder

PLAN WITH COVER REMOVED



By B. M. White

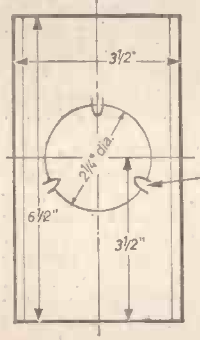


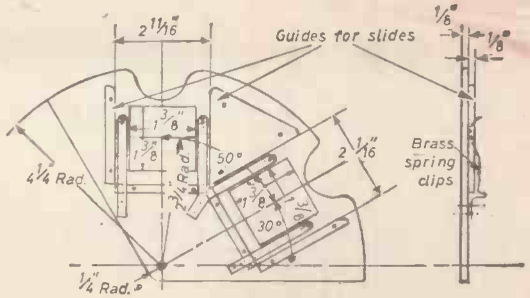


FRONT ELEVATION

PLAN

CONDENSER MOUNT



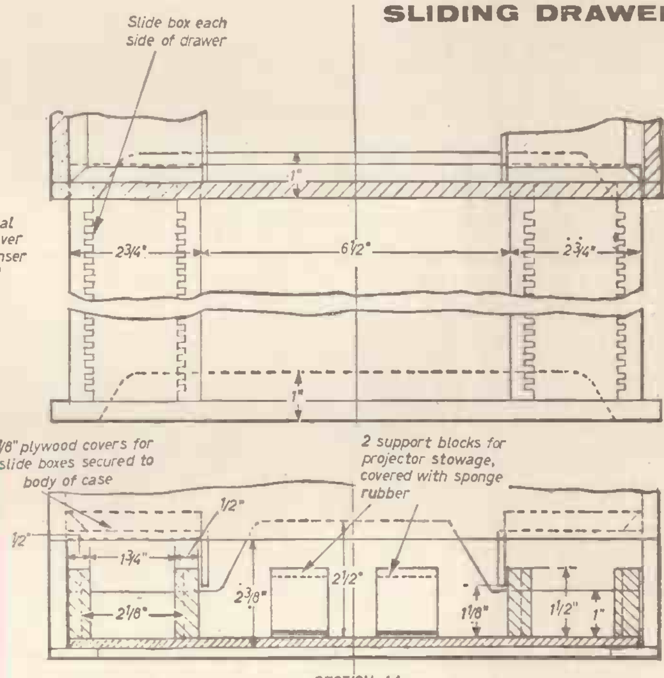


SLIDE CARRIER

1/8" plywood covers for slide boxes secured to body of case

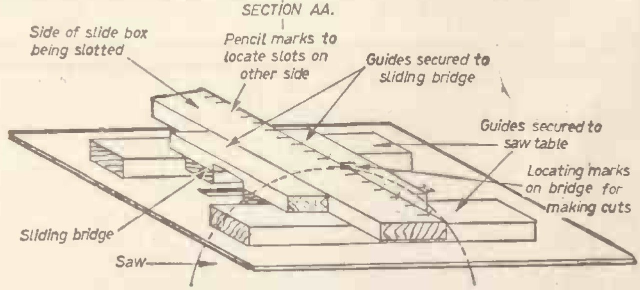
SECTION BB

VIEWS OF SLIDING DRAWER



USE

FOR 2 x 2 SLIDES



JIG FOR CUTTING SLIDE BOX SLOTS WITH CIRCULAR SAW

a rubbing strip for the back of the slide carrier by cementing a narrow strip of $\frac{1}{16}$in. thick plastic, cut in the form of an arc to match the outer radius of the slide carrier, to the front of the lamp house. A fairly large washer of the same material should be cemented round the pivot hole. The pivot bolt should permit free movement of the slide carrier but must be tight enough to hold it back against the rubbing strap. It should therefore be fitted with a lock nut. Two cheese headed 2B.A. bolts in the front of the lamp house, near the bottom, provide stops for the slide carrier.

The front portion of the projector, which is attached to the lamp house only by the base and the top cover, should be drilled to suit the projection lens mounting. The writer was able to pick up an 80mm projection lens complete with mounting and focusing screw for 7/6d. from a second-hand shop. This gives very satisfactory results and only required the cutting of a $1\frac{7}{8}$in. diameter hole in the front plate of the projector. It is, of course, important that the projection lens should be mounted accurately on, and parallel to, the datum line from the lamp filament to the centre of the screen.

The slide carrier should be cut from a piece of $\frac{1}{8}$in. thick ebonite or similar material (obtainable at any radio shop handling construction kits), to the dimensions given on the drawing. The guides for the slides should be made from strips of similar material secured by $\frac{1}{16}$in. copper rivets countersunk flush on the back of the carrier. The slides are held in place by springs cut from brass strip bent as shown and similarly secured. It pays to take special care to ensure accuracy in making this part.

The sides of the case and lid should be made from good quality $\frac{3}{8}$in. thick plywood, dovetailed and glued at the corners, no pins or screws being needed. The bottom of the case and the top of the lid should be made from $\frac{1}{4}$in. plywood secured by glue and panel pins. Inside the case are two shields or covers for the slide boxes in the drawer. These should be made from $\frac{1}{8}$in. plywood secured in position with glue and small brass screws. The lid, the case, the projector base and the support leg for the latter, should all be fastened together with brass hinges, care being taken to ensure correct alignment. The inside of the lid should be lined with a piece of white card such as used by water colour artists, to form the screen. This can be held in place by narrow strips of wood and small brass screws. It is advisable not to fit this finally until after painting operations are completed, otherwise it is liable to become soiled.

The drawer should be made from similar materials to the case, except for the sides of the slide boxes which should be made from $1\frac{1}{2}$in. x $\frac{1}{2}$in. strips of a close-grained hardwood such as beech. Between the slide boxes are two 45° chocks, with strips of sponge rubber glued over them, carefully located to form shock absorbing supports for the projector in its stowed position. Also between the slide boxes, on the centre line of the drawer, fit a small hardwood block with a hole in it to receive the peg in the end of the projector support leg when in its operating position with the drawer extended. The peg in the end of the support leg is merely a No. 8 wood screw with the head sawn off after insertion.

The tedious operation of cutting the slots for the slides can be considerably eased if a small circular saw is available by making a simple jig as illustrated on the drawing. First fit two parallel strips of wood to the saw table about 3in. apart, to form guides. To slide between these, construct a sliding bridge consisting of two strips the appropriate distance apart, crossed exactly at right angles by two strips $\frac{1}{2}$in. thick and $1\frac{1}{2}$in. apart to form guides for the side of the slide box being made. On one of these two bridge guides make a clear pencil mark above the position of the saw blade. As two saw cuts will be needed to produce a slot of sufficient width to take glass-mounted slides freely, a second pencil mark should be made about $\frac{1}{16}$in. from the first. Its exact location can be found by making experimental cuts in a waste strip of wood. While making these experimental cuts also determine the exact height to set the saw above the table, so that it will penetrate $\frac{3}{16}$in. into the underside of the strip being slotted.

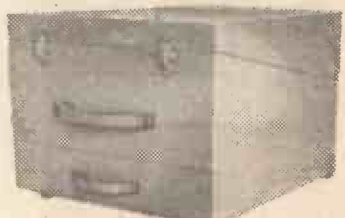
Now take the four strips which will be the sides of the slide boxes (it is recommended that at this stage they be cut at least $\frac{1}{2}$in. longer than their final length), lay them side by side and across the backs mark a number of pencil lines exactly equally spaced. The actual spacing selected can be a matter of choice but should not be less than $\frac{1}{4}$in. Insert one strip between the bridge guides and locate the first mark against the first mark on the guide. Hold the strip firmly in position and slide the bridge gently over the rotating saw. Return the bridge to its original position and slide the strip to bring the same mark in line with the next mark on the guide. Repeat the passage over the saw, thus completing one slot. Repeat this sequence for each of the pencil marks on the back of the strip. One side of a slide box can be completed in about 10 minutes by this method.

When all four are finished, pair them off so that the slots are exactly opposite each other and trim

(Continued on page 283)

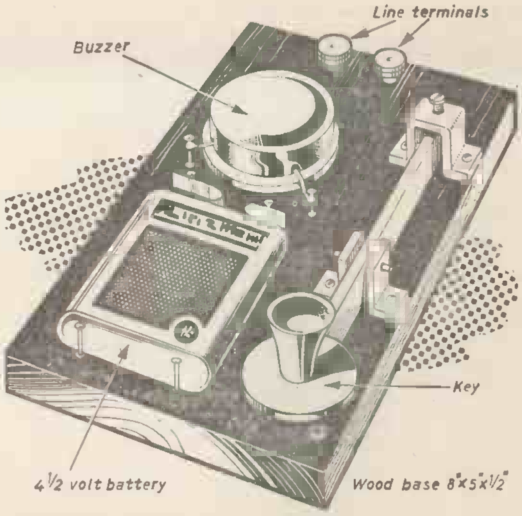
The projection set erected for use. The slide drawers containing up to 90 slides are conveniently placed for the projectionist.

The neat appearance of the set when folded up for carrying.



Learn MORSE with this simple SET

By G. A. W. PARTRIDGE



SPEECH and high speed telegraphy have taken the place of the old time morse key and sounder. However, signalling by morse code is still practised. Morse signalling has the great advantage that it can be tapped out on almost anything from an elaborate wireless transmitter to a tin can. It can also be flashed out with a lamp at night, and sent by flag signals in daylight. Today morse is mainly used in lamp signalling at sea, and in cable and wireless telegraphy. Quite cheap apparatus can transmit morse about three times the distance speech would travel on the same equipment. The radio amateur's licence requires a test speed of about 12 words per minute and it is with the idea of achieving this in mind that this simple practice set is described here.

Fig. 1 shows one of the sets (two are required) complete. A buzzer, 4½ volt dry battery, and a key should be mounted on a wooden board as shown. Fig. 2 illustrates the circuit including the line connections to the distant station. All the equipment is obtainable at most amateur radio shops or surplus stores. The keys must be the double contact types so that it is possible to "buzz" the distant station without wasting battery power on the home buzzer as well. The same advantage applies when the distant station is operating. It "buzzes" the home station and not its own.

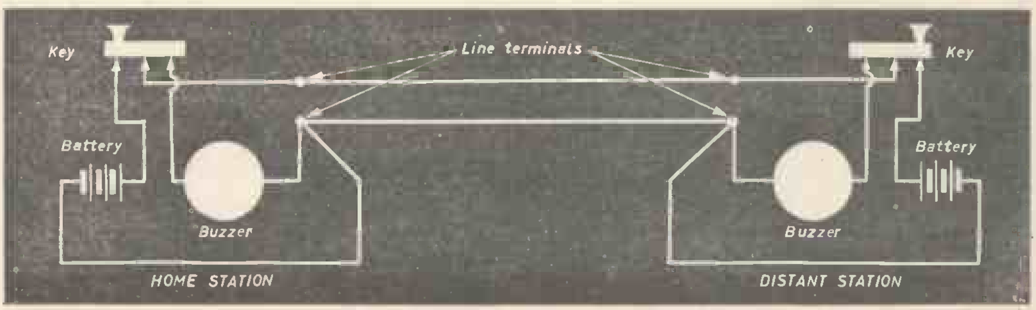
The key should have a $\frac{1}{16}$in. gap and the tension of the spring should not be so great that it has to be forced down, or so slack that the movement feels like a limp handshake. Hold the knob lightly by resting the index and middle fingers on top, with the thumb resting naturally against the side of the knob. American practice is to rest the fore-arm along the table top whereas British instructors favour having the key at the edge of the table with the fore-arm unsupported. In either case the operator's seat must be high enough for the fore-arm to rest naturally in a horizontal position. When sending, do so with the wrist only. Using the whole arm is known as "nerve sending" and if persisted in will result in "telegraphist's cramp" as the nerves and muscles of the arm become fatigued. Once this condition has occurred its effects can be permanent and prevent the operator from ever reaching the higher speeds.

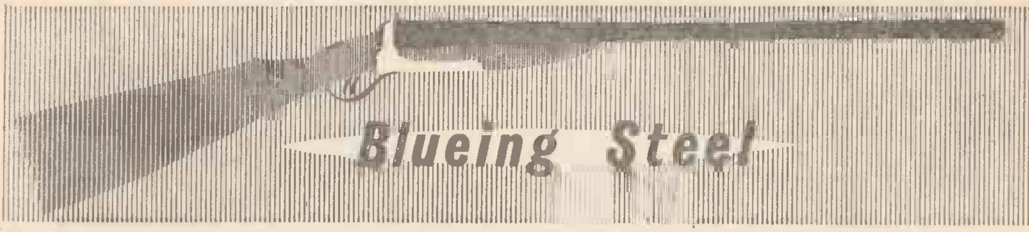
The dot should be about one third the length of a dash; the space between words about three times longer than the space between letters. Each dot and dash should be sent at clearly as possible. "Slurring" one letter into another is a bad habit that should be avoided from the start. After learning the code, constant practice in sending and reading is required until a steady 12 words a

(Continued on page 268)

The Morse Code

A ·–	J ·–––	S ···	2 ··–––
B –···	K –·–	T –	3 ···––
C –·–·	L ·–··	U ··–	4 ····–
D –··	M ––	V ···–	5 ·····
E ·	N –·	W ·––	6 –····
F ··–·	O –––	X –··–	7 ––···
G ––·	P ·––·	Y –·––	8 –––··
H ····	Q ––·–	Z ––··	9 ––––·
I ··	R ·–·	1 ·––––	0 –––––





Blueing Steel

THE blueing of steel frequently puzzles the amateur engineer. When examining the mechanism of sporting guns and similar articles and noting the fine finish and even texture achieved he feels that the process is difficult and requires considerable equipment before he can commence operations on even a small scale. Consequently he often turns to the time-honoured method of heating the parts over a gas flame and tipping them into oil in an endeavour to give the parts some form of protective coating.

Two blueing processes are possible for the home worker—hot and cold rusting. As the latter is not used much these days it is suggested that he concentrates on the hot rusting method which also gives the most satisfactory results.

The first essential is cleanliness and on no account should you touch the pieces once the process has commenced. So arrange to hold them with wire or by a pair of stout rubber gloves. Clean off as much oil and grease as you can, using petrol and rag, and when evaporation has taken place give the parts a good boil for 20 minutes in a solution of caustic soda. Use a bucket or deep tin for this operation and then give the part a thorough wash to rid the surfaces of caustic.

A solution for the process is then mixed, dissolving the chemicals one at a time. NEVER grind these materials together, otherwise you are likely to experience a realistic explosion of rather frightening proportions. Warm the water until it becomes just too hot to bear when a finger is inserted and add the spirits of nitre last.

Water (distilled), 10 fluid ounces; sodium nitrate, 100 grain; potassium nitrate, 100 grain; potassium chlorate, 200 grain; mercuric chloride, 200 grain; Spirits of nitre, one-third ounce, always add last. Store either in an earthenware bottle or in one of a dark colour.

Stand a jam jar in a suitable container and part fill the container with water. Add a quantity of solution to the jam jar—a depth of about 1in. is generally ample—and bring both to the boil. On no account should you allow the solution to come in contact with the water. While boiling is going on make up a series of small swabs from odd pieces of clean rag or cotton wool and tie them to sticks. A few lengths of dowel about $\frac{3}{4}$in. diameter cut to about 6 to 8in. long are ideal for these items.

I have found that suspending the parts to be treated by means of wires hooked over a rod placed across the container is the best way of handling them. You can lift out the hot pieces without fear of burning yourself and hold the wire while brushing on the solution. Do not let the part come in contact with the workbench but hold it aloft away from anything greasy. Let the surface water on the part dry off. If you hold it near the heat the surfaces will dry in a few seconds. Now paint on the solution, endeavouring to keep an even layer on all the faces. Do not overdo matters but err on the thin side rather than smothering the parts. A distinct rust will appear as the solution evaporates. When the solution has dried off, gently rub the faces with fine steel wool, and the emphasis is on that word *gently* during this stage. When this has been done the surface will appear a nice blue colour. It is doubtful whether you will have obtained the correct degree of blue at the first attempt, so repeat the work of heating and swabbing until that deep blue you admire has been attained.

I would suggest that you do not attempt this work under artificial light as a blue can look different in daylight, so wait until a bright day arrives and endeavour to carry out the work by a north light as this gives the best working conditions.

If the article you are treating has an intricate shape which makes it difficult to hold whilst swabbing it, a sheet of drawing paper will make an excellent backing. Lay the part on the sheet while still retaining a grip with the wire. However, discard each piece when that particular swabbing is completed as a deposit left on the surface can affect the result of a later operation.

Once blueing is finished dip each part in thin oil to neutralise the solution. While some sources suggest heating the oil I have not noticed any difference in the result if the lubricant is cold. Drop the parts in a glass jar of oil and leave each part for an hour or so.

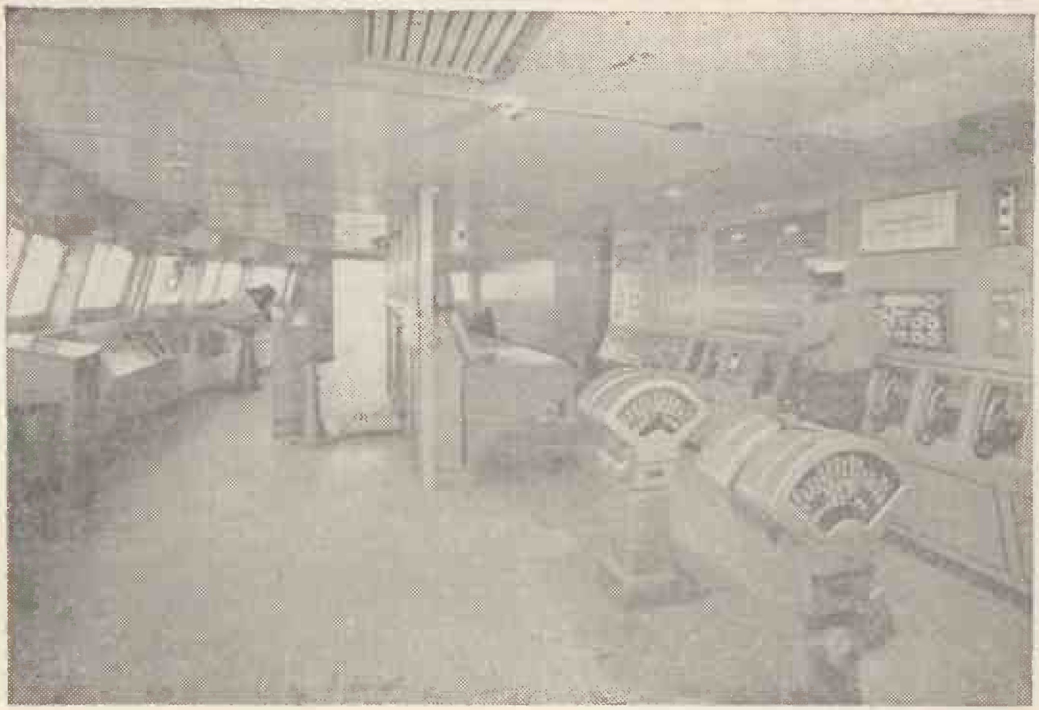
The crux of this work is absolute freedom from oil and grease (except at the end). Remember that seldom are the hands free from grease despite many attempts at washing. Wire or pliers which have been boiled properly make admirable holding tools, so never pick up a part with the fingers and keep the tools wrapped in a rag which is never allowed in the workshop. Then you can be assured of excellent results from this process.

LEARN MORSE WITH THIS SIMPLE SET

(Continued from page 267)

minute has been achieved. For examination purposes it is better to learn to work at a slightly higher speed than is required by the examiners. The buzzer should be adjusted to a high pitched note which is easy to read, especially when other noises are tending to distract the reader's attention.

Morse may be a little difficult to master at first but when a speed of about 20 words (five letter words) a minute is reached it becomes as easy as reading and writing. The dots and dashes of whole words are automatically recognized whenever they are heard.



The wheelhouse of the P. and O. liner *Canberra.*

ELECTRONIC SEAMANSHIP

By our science correspondent

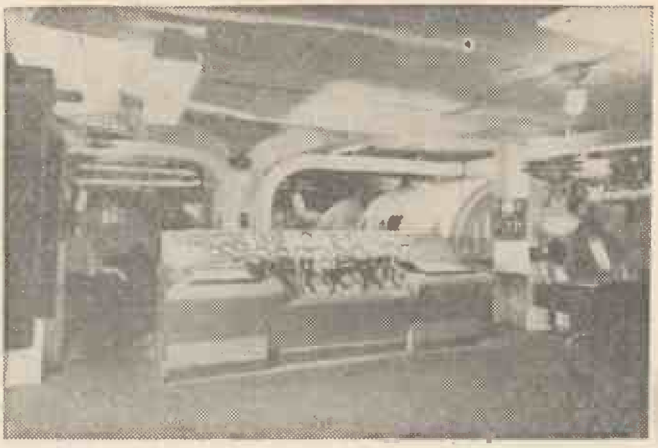
ELECTRONICS and the sea are becoming more closely allied every year. Navigational aids and other electronic devices have helped seamanship tremendously. Even the new Canadian destroyer escort H.M.C.S. *Mackenzie,* commissioned in October, 1962, has automatic electronic guns. She is also fitted with two three-barrelled omni-directional Limbo anti-submarine mortars. Electronically controlled, these lock on to the target and never lose it. Other apparatus on the destroyer includes navigational, surface, and air warning radars and the latest type of Sonar for submarine detection.

Possibly the most comprehensive and versatile radar system ever fitted to a merchant vessel is on the *Canberra.* It represents an entirely new conception of marine radar. Basically the installation consists of two "true motion" radar systems, each complete with its own basic units and controls. There are two scanners, two transmitters, two display units, two motor alternator assemblies, and an additional slave display is provided to work remotely from either of the master displays. The two systems are arranged so that they can be operated separately or simultaneously, without interference, and changeover switches enable any unit of either system to be used with units of the other system if required. One of the main displays is a 16in. PPI with reflection plotter and the other is a 24in. display employing the rapid photographic technique developed for defence purposes. This equipment presents PPI information by projecting on a 24in. display surface a sequence of rapidly processed "photographs" of a special cathode ray tube. In this manner direct plotting is possible. This is the first installation of this kind on board any ship.

Two special radio-telephone terminals in the *Canberra* enable passengers to make calls from their cabins and from the ship's two kiosks. The privacy of radio-telephone conversations is ensured by the provision of speech inverters. Two Redifon v.h.f. radio-telephone sets link the bridge with the telephone kiosks and the whole telephone system. All inputs and outputs go through a special unit designed and made by the owners.

Shipboard broadcasts are provided through a Tannoy system with loudspeakers in all cabins, including crew cabins. This allows the selection of either of two programmes, radio or pre-recorded music and news. An outstanding feature of this communications system is that for boat orders, featuring call-back facilities which enable the bridge to speak to each lifeboat station and vice-versa. This is achieved through special transistorised amplifiers and control panels designed by Tannoy.

The ship is also equipped with a completely co-ordinated internal television service. The receivers provide for the reception of television broadcasts employing the 405-line (50 frame) system used in the U.K., the 625-line (50 frame) system used in Australia and the greater part of Europe and the 625-line (60 frame) system used in the United States, Canada and Japan. Incoming programmes are processed as appropriate in a central TV control room. A camera can be plugged in, to screen plays, interviews and amateur shows produced on board.



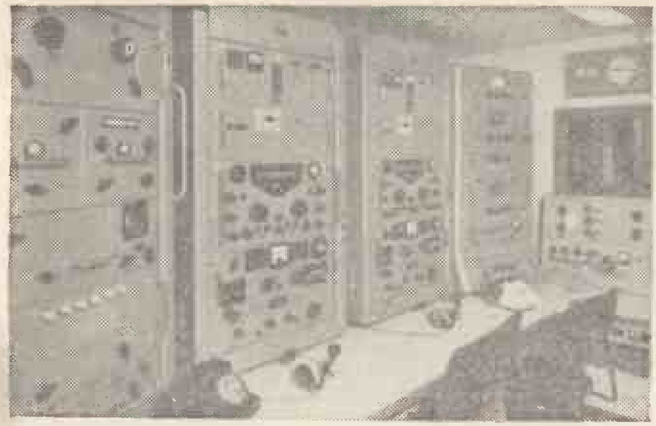
The engine room starting platform.

What is claimed to be the most comprehensive auto-electric steering control system in the world is fitted in the *Canberra*. It is an adaptation of the auto-electric steering control system developed by S. G. Brown Ltd., of Watford, Hertfordshire. A complete unit is installed on the bridge and also at a point aft. The equipment includes the Arma-Brown master transmitting gyro compass, a typewriter-sized instrument weighing 40lb. An unusual feature is that in place of the normal steering wheel of spoked type a small wheel with no projections is used, no wider in diameter than that of a car's steering wheel.

The system has been designed to provide three methods of steering control from one small wheelhouse unit for ships fitted with electro-hydraulic or steam-operated steering gear. Rudder application is brought about by two S. G. Brown aft power units directly coupled to the control valve of the steering gear, controlled primarily from the single wheelhouse unit.

The system provides electro-mechanical as well as completely automatic steering control, with the further advantage that only one after power unit is used at a time, the other being in the stand-by condition ready for instant use if necessary. Hydraulic piping from the steering engine, the wheelhouse telemotor transmitter and a large wheel are not required. The three methods of steering control provided by the main wheelhouse unit are as follows: MAIN CONTROL (hand/electric) by means of a hand wheel. Movement of the hand wheel operates port or starboard switches which in turn operate breaker switches. These breaker switches, situated in the wheelhouse unit, govern the operating field circuit in whichever aft power unit is selected. AUTO CONTROL by means of the "brain box" situated in the wheelhouse unit and operated from a datum provided by the Arma-Brown gyro compass. The "brain box" provides an impulse to operate the breaker switches in the control unit as before. SECONDARY CONTROL (hand/electric) by means of a lever located on the front of the unit. When the lever is moved to port or starboard, switches are operated which in turn operate a second system of breaker switches. These breaker switches govern the operating field circuit in the other aft power unit to that used for main or auto control. EMERGENCY CONTROL. To provide a complete secondary steering control position within the complete system a second control unit can be incorporated. This provides two separate methods of hand/electric steering control similar in

The 45,270 ton P. & O. passenger liner *Canberra*.

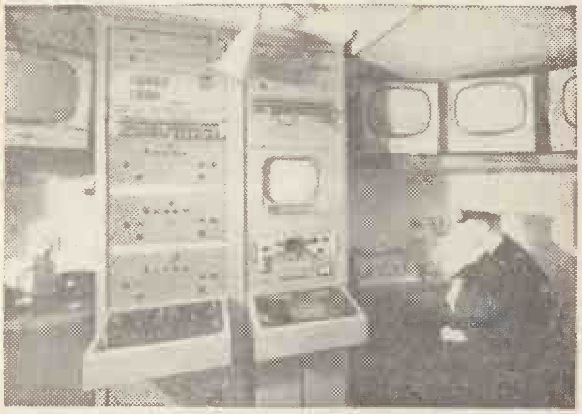


The radio receiving and transmitting room.

inputs are duplicated. Automatic steering facilities can be included in the secondary control column if required. A rudder movement indicator is also embodied. The two steering positions operate entirely independently of one another within the complete system, selection of the control position being made by a special change-over switch.

Other electronic devices installed on this ship include a Marconi Lodestar automatic direction finder and a Merton echo sounder which shows the depth of water beneath the vessel. In conjunction with the latter a Seagraph III dry paper recording echometer tells the difference between true bottom echos and spurious responses.

Streamlined, precision engined and with all the latest electronic equipment available, the P. and O. liner *Canberra* does much to prove that Britannia still rules the waves. Despite early teething troubles she remains one of the world's most remarkable vessels.



The television control room.

The projection radar plotting screen on the bridge of *Canberra*.

every respect to those provided at the primary control position but using entirely separate breaker switches to control either of the two aft power units. As with the primary control, the power supply

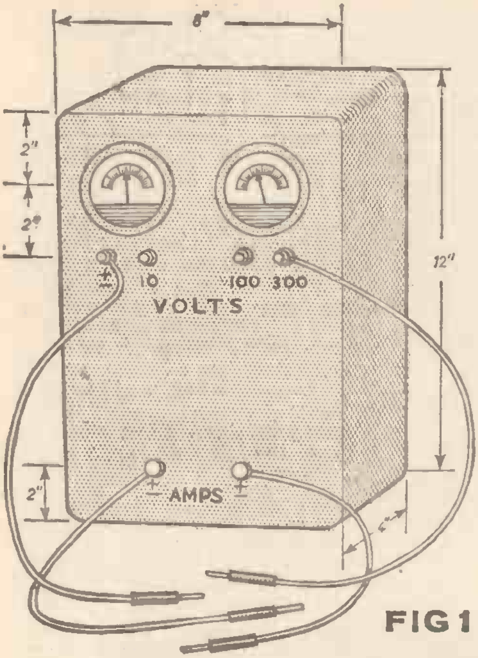


FIG 1

volts or amps. If there is difficulty in obtaining meters with these ranges, a 0-100 voltmeter and a 0-5 ammeter could be used instead. This means that the 10 volt range would have to be left out, and the ammeter would be of rather limited use. The instruments should be mounted in a wooden box as shown in Fig. 1. The sides can be made from ½in. wood while the panel can be made from ordinary three-ply. The holes for the meters should be cut just large enough to allow them to be pressed firmly into place. Fig. 1 clearly shows the positions of the terminals which should be evenly spaced along two straight lines.

Fig. 2 shows the simple circuit which is self explanatory. The ammeter is connected directly to the AMPS terminal. Different voltmeters require different multiplier values so the value of each multiplier will have to be calculated for the particular meter used. Let us assume that the voltmeter has a sensitivity of 20 ohms per volt. Value of multiplier=(ohms per volt × voltage range required)−voltage resistance=$(20\times100)-(20\times10)$ =1,800 ohms. The voltmeter in this case has an internal resistance of 20×10 ohms because its sensitivity is 20 ohms per volt and its basic reading is from 0-10 volts.

The wattage of the multiplier must also be calculated. In order to do this the full scale current consumption must be known.

A MULTI-METER FOR ELECTRICAL WORK

THERE are many multi-range test meters on the market but, with the exception of a few, most of them are more suitable for electronic than electrical testing. In other words they have no a.c. current range which is not used much in radio work, but is most useful when repairing motors, heaters, and so on.

The instrument illustrated in Fig. 1 was made up for general electrical testing where exceptional accuracy is not too important. Two separate movements are incorporated, one for voltage and the other for current measurements. This arrangement simplifies the internal wiring and also enables voltage and current readings to be taken at the same time, which is helpful when resistance and power measurements are necessary. Both movements are of the moving-iron type which makes either d.c. or a.c. measurements possible without the need of a rectifier. There is, however, a difference of accuracy between the d.c. and a.c. readings because of this. Most moving-iron meters are calibrated on a.c. which is an advantage as much electrical work deals with a.c. circuits. If greater accuracy is required on d.c., however, the error may have to be found by comparison with an accurate d.c. meter. Both meters should read from 0-10

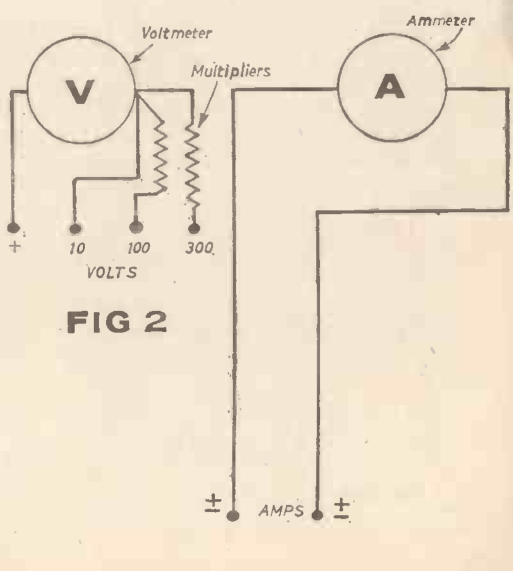


FIG 2

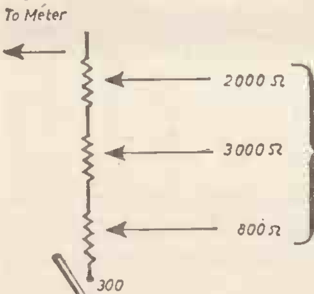


FIG 3

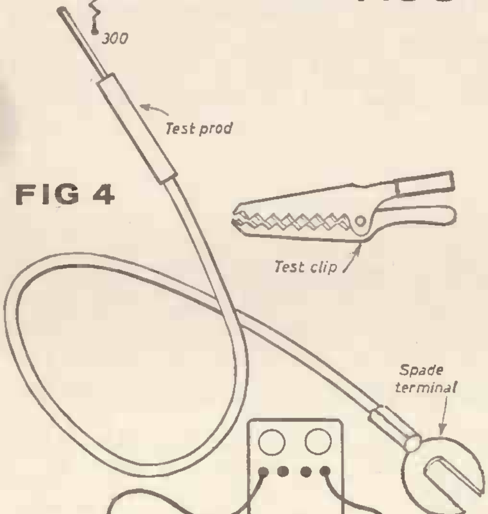


FIG 4

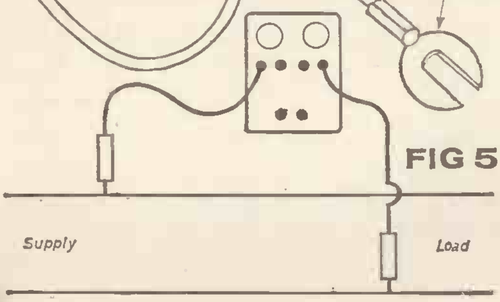


FIG 5

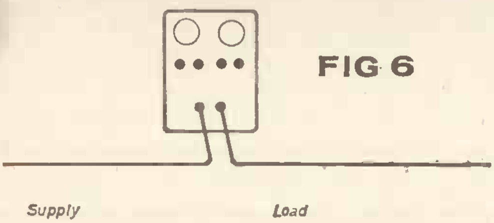


FIG 6

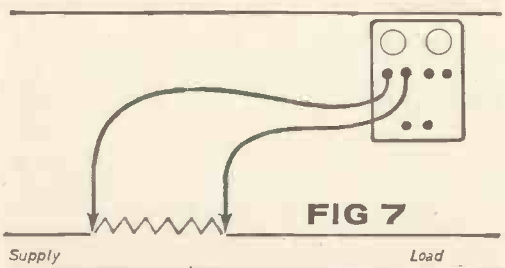


FIG 7

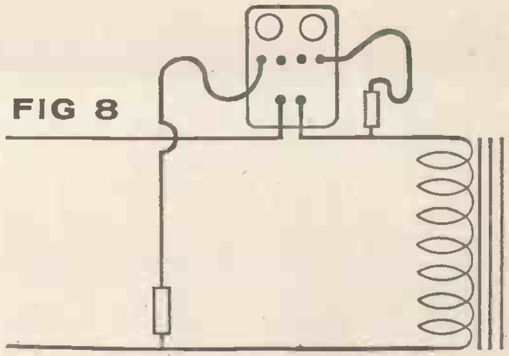


FIG 8

$$\text{Current} = \frac{\text{voltage}}{\text{resistance}} \qquad \left(I = \frac{E}{R} \right)$$

$$= \frac{200 \text{ ohms (resistance of meter)}}{10 \text{ volts (full scale deflection)}}$$

$$= 1/20 \text{ ampere.}$$

$$\text{Wattage} = \text{current}^2 \times \text{resistance} \qquad (W = I^2R)$$

$$= \frac{20 \times 20}{1 \times 1 \times 18000}$$

$$= 4{\cdot}5 \text{ watt.}$$

Therefore a 5 watt multiplier will be suitable.

The 300 volt range for the meter used in these calculations requires a 5,800 ohm, 15 watt multiplier. If it is not possible to obtain multipliers of the exact value, the correct resistance can be made by connecting several multipliers in series (Fig. 3). Multipliers must be non-inductive so as to avoid serious errors on a.c. Allow for as much air space between them as possible although there should be little difficulty in mounting them in the box specified. Special supporting lugs are usually supplied for this purpose.

The test leads should be made from four 24in. lengths of single core plastic flex (Fig. 4). Spade connectors and test prods must be fitted. Try to obtain test prods that can have clips attached to them so that they can be left in circuit if necessary.

Fig. 5 illustrates a typical voltage test. Note that voltmeters are always connected across the circuit and remember to select the correct range.

Current is measured by connecting the ammeter in series with the circuit (Fig. 6). If the current is too low to operate the ammeter sufficiently, connect a resistance of a known small value in series in the circuit, say about 10 ohm, and connect the voltmeter set to the 0-10 volt range, across it (Fig. 7). Then for example, if the voltmeter reads 3·2 volts, the current will be 3·2÷10=0·32 ampere.

In more accurate working the resistance of the voltmeter should be taken into consideration. In this example it is on the 0-10 range and its sensitivity is 20 ohms per volt. Therefore its resistance is 200 ohms. The effective resistance of both voltmeter and resistor is found from the following formula.

$$\frac{1}{R} = \frac{1}{r_V} + \frac{1}{r}$$

where R = combined resistance
r_V = resistance of voltmeter
r = resistance in parallel.

(Continued on page 286)

After experiencing the enjoyment derived from viewing stereoscopic pairs of colour film transparencies of proprietary manufacture, and also looking for a more economical method of obtaining personal slides than the cheaper forms of '8-on' roll film cameras provide—the author constructed the following camera which should prove of interest to those keen on photography and not averse to 'tinkering about' with surplus photographic equipment.

THE main body of the camera was constructed from an old folding bellows type, size 120 roll film camera. The bellows were removed and the back suitably masked off with card as shown in Fig. 1. In order to adhere to the requisite stereo-pair centre distance of 2½in., and also to obtain the maximum economy from available film space, a format of 1in. square was chosen as shown in Fig. 2.

The winding-on process is as follows. First exposure, frames A and B, No. 1 in single centre red window at rear of case. Second exposure, frames C and D, arrow start "X" in red window. Third exposure, No. 3 in red window. Fourth, arrow start after No. 3 and so on.

When 12 exposures have been made, *i.e.* 12 stereo pairs obtained—the film must be turned round and run through the camera backwards. The film must be turned round in total darkness. If a darkroom or changing bag is not available it can be done quite well under the bedclothes in a darkened bedroom at night. Open the camera back and lift out both spools, still connected by a length of film. Be sure to keep both spools tightly wound whilst doing this. Now place the film back in the camera, reversing the positions of the spools so that the almost empty one is now in the winding chamber where the full one was. In this way the film will run back through the camera without trouble providing that the unattached trailing end of the film itself has not been allowed to escape from the almost empty spool. A further twelve exposures can now be made.

In practice the numbering sequence works out quite simply, as follows. Denoting the broad end of the warning arrow immediately following an odd number in the central red window by 1′, 3′ etc., the sequence of exposures is 1, 1′, 3, 3′, 5, 5′, 7, 7′, 9, 9′, 11, 11′. After exposure 11′ no more exposures should be made, nor should the film be wound on, but the whole film together with spools should be turned round in the dark as described previously. After re-inserting the film a further exposure should be made on position 11′. The film then winds back to its original spool in the exposure sequence:—11, 9′, 9, 7′, 7, 5′, 5, 3′, 3, 1′, 1—off. Note that on the wind-back a complete arrow following each odd number is by-passed, together with all even numbers. A small diagram carried in the pocket of the camera case serves as a useful reminder of the sequence.

By J. E. Jones

Construction

Fig. 3 shows the general layout of the camera. The shutters are of the inexpensive Vario type which can be obtained minus lenses. The drawbar was made from aluminium tubing and facilitates simultaneous triggering of the shutters. The apertures on each shutter must of course be made identical by manual setting prior to exposure, although it would appear possible to devise some form of coupling bar for the control levers; this however is not an essential requirement.

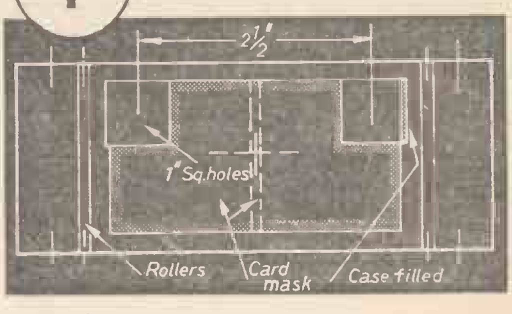
The relatively short focal length of lens required for the format employed means that a large "depth of field" is obtained, and thus it was possible to use a fixed-focus lens arrangement which simplified the construction.

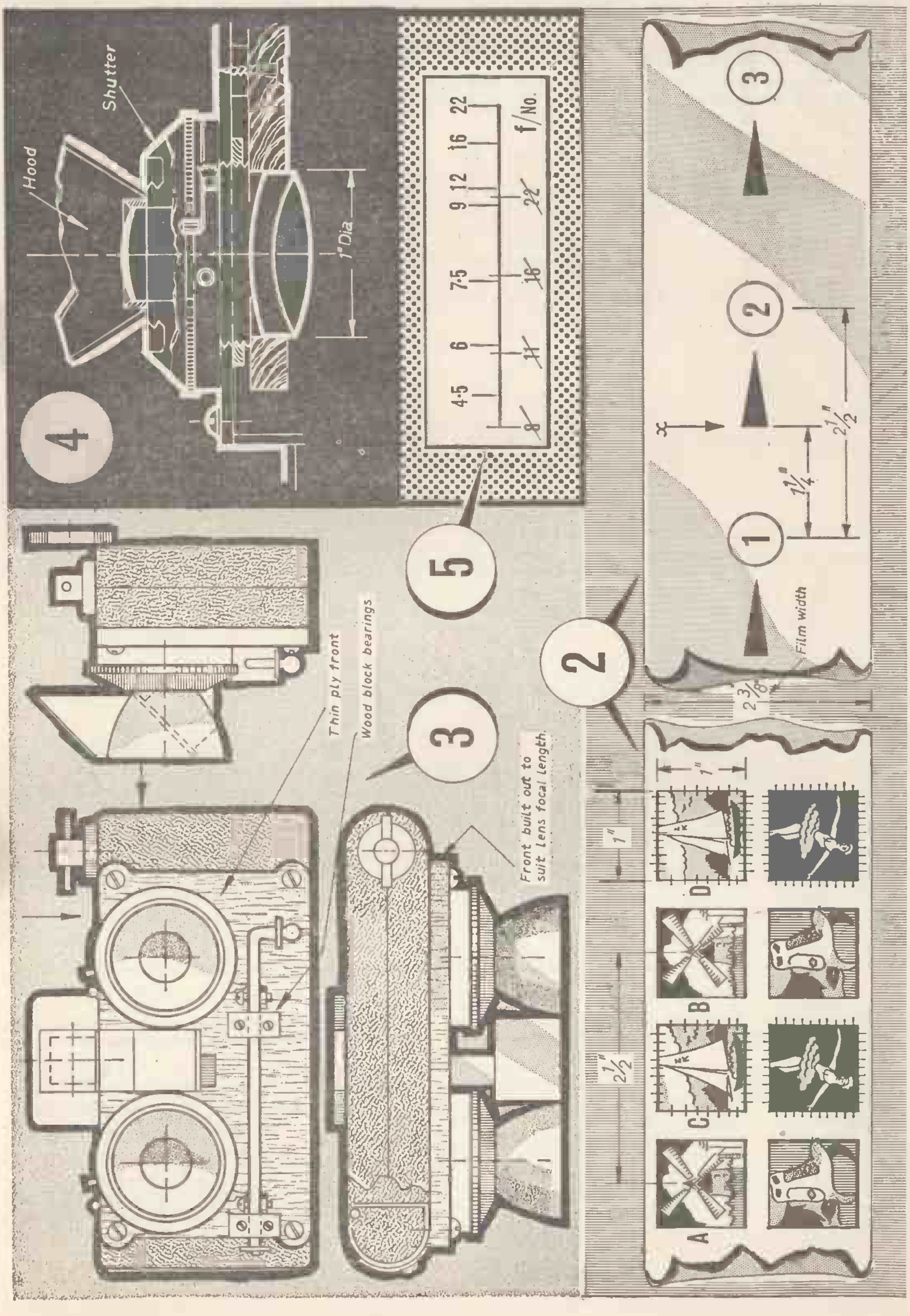
The correct lens to film plane distance was determined by focusing upon a ground glass screen placed over the camera back masking card and keeping the shutter open by means of the "Bulb" setting.

Lens

As with any camera this is the most important component, and the owner of a pair of identical

1




4
Hood
Shutter
1" Dia
5
4·5 6 7·5 9 12 16 22
8 11 16 22
f/No.
3
Thin ply front
Wood block bearings
Front built out to
suit Lens focal length.
2
1
2
3
x
1¼"
2½"
Film width
2⅜"
1"
1"
2½"
A
B
C
D

lenses of focal length 35mm or thereabouts is indeed fortunate. However, lenses can be constructed with surplus components and experiments in this direction can be well worthwhile.

The author's camera was originally fitted with solid double-convex glasses which formed the viewfinders of a large old box camera. These gave quite acceptable results when used at very small apertures *i.e.* large f/numbers, but the majority of shots suffered from spherical aberration.

The lens finally adopted was built up as shown in Fig. 4. The larger two-element lenses at the rear of the shutters were taken from ex-W.D. gun sights and the smaller meniscus elements positioned in front of the shutters were obtained from old box cameras. The former trouble of aberration disappeared and the lenses work satisfactorily down to low f/numbers.

Incidentally it should be noted that the aperture scale marked on the shutters will no longer be applicable, and a comparative scale similar to that shown in Fig. 5 will have to be made; this can be stuck on the top of the camera body for easy reference. The calibration of this scale is simply accomplished by dividing the focal length of the complete lens system by the different iris diaphragm diameters.

Viewfinders

The simple frame type of viewfinder originally constructed was found to suffer badly from parallax error, and beheadings of people and objects were quite common. This fault was overcome by making a periscope system as shown in the diagram. 1in. square mirrors have recently become available in the large stores affixed to a linen backing and are sold for decorative purposes. The reflected image in the mirror is an effective aid in centralising the main subject, whilst the rear window to which the eye is placed shows the outer limits of the view obtained.

The lens hoods shown prevent unwanted reflections through the camera lens and also serve to strengthen the attachment of the periscope; these were made from plastic "cruet sets" and cemented in position.

Viewer

For viewing the finished transparencies a suitable "Stereoscope" is, of course, essential. This can be easily constructed from stout card and wood as shown in Fig. 6.

The lenses are from easily obtainable watchmakers eyeglasses. The dished-out ends for comfortable viewing were fashioned from plastic egg cups and the light-diffusing screens are 2in. x 2in. translucent frames available as slide tilting kits. Note that these latter items are positioned some distance away from the plane of the transparency in order to throw the "grain" of the diffuser out of focus.

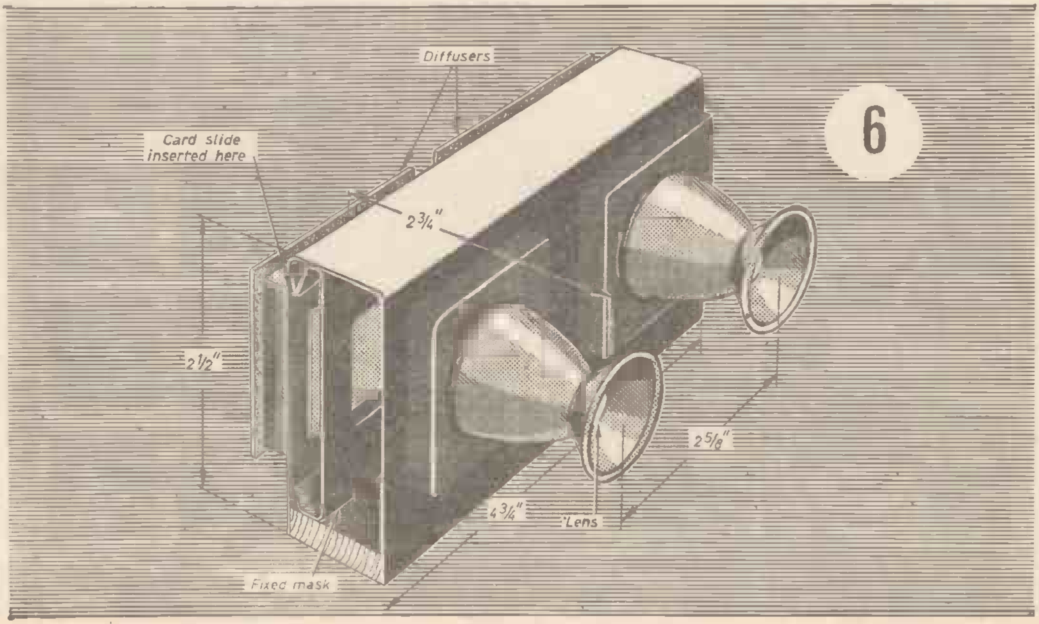
Mounting

The transparencies should be mounted on strips of card measuring 5½in. x 1¾in. with suitable square holes cut out, and should be fixed along top and bottom edges by means of Sellotape. Accurate aligning of the pairs is important and this is achieved by working over a white surface and using the top corners as guides since these usually have some clear sky area.

Transposing

This is most important, and in effect means that the right-hand transparency, as viewed from the shiny side of the film, must be transferred to the left-hand side of the mounting card, and the left-hand view put on the right-hand of the card. The reason for this is that the camera lens produces

(*Continued on page 285*)



ELECTRONICALLY CONTROLLED BUS-TRAINS

By G. Haydock

THE idea of an electronically guided fleet of buses, linked together and speeding at 60 m.p.h. along a motorway, is a revolutionary means of transportation being developed by the Chicago Transit Authority. This new conception of commuter to city service is a further development of Chicago's far seeing transport venture, the Congress Expressway, a super motorway which combines motor lanes and a rail track.

The combination of a multi-lane motorway with a form of passenger carrying pubic transport has increased the capacity of the Congress Expressway three to five fold. The Expressway automobile lanes, although completed only a short time ago, are jammed to capacity at peak travel time. The rail facility alongside the motorway is still working well below its full potential, which can be increased by simply adding more railcars, or increasing the number of tracks in the right-of-way space available.

The practicability of combining a rail service on the other expressways of the comprehensive transport system programmed for Chicago have been investigated. It was found that the cost could not be justified in the South-west Expressway, which is to serve an area of relatively low population density. This led the Chicago Transit Authority to consider an idea for self-guided bus-trains controlled by guide wires. This proposal had the advantages of efficiency, economy and increased passenger carrying capacity derived from combining public transport with a motorway, with the additional benefits of the low operating noise level offered by pneumatic tyres and flexibility, a quality that is lacking in fixed rail facilities.

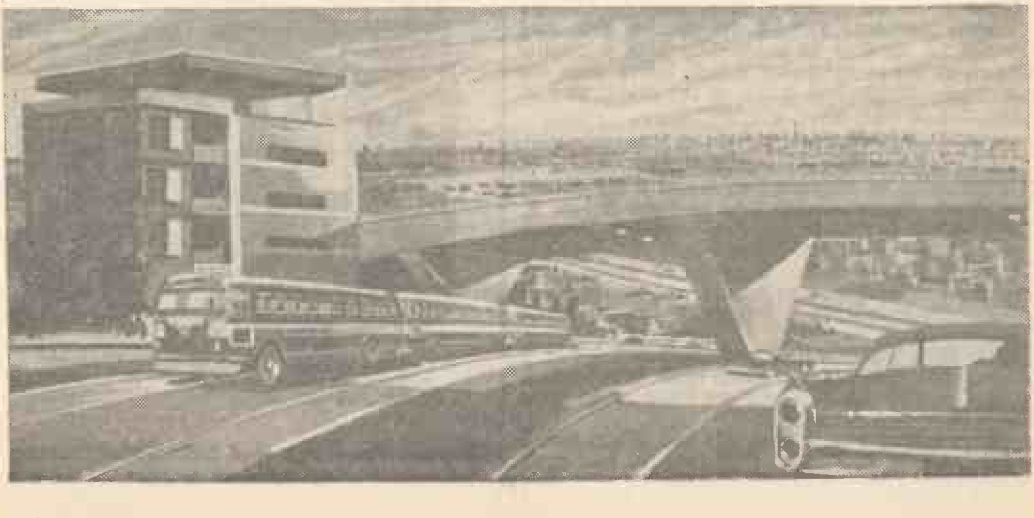
The bus-train operating procedure would be unique. In the outlying sections of the metropolis, buses, acting individually, would carry out the usual function of operating over scheduled routes. The schedules would end at an assembly point alongside the motorway. There the buses would be coupled up into trains. Each train of buses would then proceed on its way to the city at speeds up to 60 m.p.h. Only one driver would be assigned to each bus-train, to control the motive power and braking facilities from a position at the wheel of the leading bus.

The bus-train would leave the motorway at a point near the business district of the city. Here the bus-train would be decoupled into single units, manned to operate individual schedules throughout the city and giving a fast, convenient delivery of passengers. The same procedure would be carried out in the reverse direction to serve the outlying areas.

Twelve thousand dollars' worth of electronic equipment was used for initial tests in the C.T.A.'s workshops. The techniques adopted included low frequency radio induction fields for automatic guidance and control of vehicle operations. A low-frequency induction field was established in a continuous cable taped to, or buried in, the floor or paving in a closed loop nearly one-third mile in length in the maintenance and stores area of the workshop. The guidance equipment which sensed the signal was mounted on a Laher electric tractor.

"Sensing the course" is done by a magnetic sense unit which consists of two tuned coils at right-angles to each other. These coils pick up the sense signals by induction from the field surround-

Artist's impression of the super motorway combining motor lanes and a rail track.



ing the guide wire. The output of the magnetic sense unit is a pair of a.c. signals, one for each coil. One is an error signal, the other a reference signal. The error signal is normally zero when the signal unit is directly centred over the guide wire.

From the sense unit the error and reference signals pass into the guide box and on to a plug-in dual-channel amplifier unit. The signals are amplified and applied to a special detector circuit. The detector circuitry produces three d.c. output signals, two steering signals and a monitor signal. The monitor signal represents the fundamental safety signal which ensures that the tractor will be in motion only while a signal of sufficient strength to provide guidance is obtained. The monitor signal closes the monitor relay and this in turn controls the forward motion of the tractor. When the error signal is present it passes on the signal to steer right or left.

The steering motor is an electro-mechanical servo motor which consists of a d.c. motor which runs continuously when the tractor is set for automatic operation and a dual-clutch system to engage the motor in either of two directions, left or right. When no steering signal is present the steering is locked, thus preventing random motion of the steering assembly.

Automatic programmed stopping is accomplished by a mobile beacon receiver. The purpose of this receiver is to provide the tractor with a signal when it passes over a specific point along the course. The beacon receiver does not have the ability to distinguish one point from a similar point along the guide path except by sequential counting.

The signal along the guide path is provided to the tractor by bringing the guide wire out from its normal route a specific distance, making one or more turns to form a loop and returning it to resume its normal path. As the tractor passes over the loop a separate sensing unit receives the signal which is fed into the mobile beacon receiver. The output of the beacon receiver is used to stop the vehicle. When loading and unloading is completed a push button again starts the vehicle. Stopping points are selected before the tractor leaves the home base.

On the test course the industrial tractor operated without any manual controls whatever, making programmed stops for a predetermined period of time. From the results of these tests the Chicago Transit Authority formed the opinion that they would be justified in proceeding with a further series of tests—equipping transit buses with the electronic devices and installing the guide cable in a section of highway.

A TIDAL FISHTANK *(Continued from page 257)*
no difference as relay contacts A and B are already touching. Water continues to go from B into A.

3. Tank B now at low tide level and Tank A full. Micro-switch No. 2 now opens and the relay contacts change over. The motor immediately reverses, as terminal 5 is now + and terminal 6 is —. Micro-switch No. 1 still remains open. Water now goes from A into B.

4. Tank B fills a little and micro-switch No. 2 closes but this has no effect since micro-switch No. 1 is still open. Water continues to go from A to B.

5. Tank A gets to low tide and Micro-switch No. 1 closes, the motor thus reverses and cycle commences again as in No. 1 above.

Removing a Bush from a Blind Hole

THE removal of a bush from a blind hole is seldom an easy task for the home worker because he often lacks that useful piece of equipment, a lathe. With this tool he could turn a short piece of bar material to fit the bush and by filling the bottom of the hole with about a teaspoonful of oil and then inserting the plug, a few taps with a hammer will lift the bush from the hole. More oil may be required as the bush lifts whilst a piece of rag over it will prevent splashing. The bush will be forced out by the resulting hydraulic pressure.

If, however, a lathe is not available and such an occasion arises, there is no need to despair. The local cycle shop may be able to assist you in this task. Drop some tiny steel balls into the cavity—if you can secure them as small as $\frac{1}{32}$in. diameter there will be few bushes which will remain obstinate—and see that they reach to about halfway up the inside wall of the bush. Insert a plug—it does not matter if it happens to be a slack fit provided the balls cannot rise past it—and give this a few sharp taps with a hammer. The sketch indicates what happens as the balls get behind the bush and force it upwards from its seating.

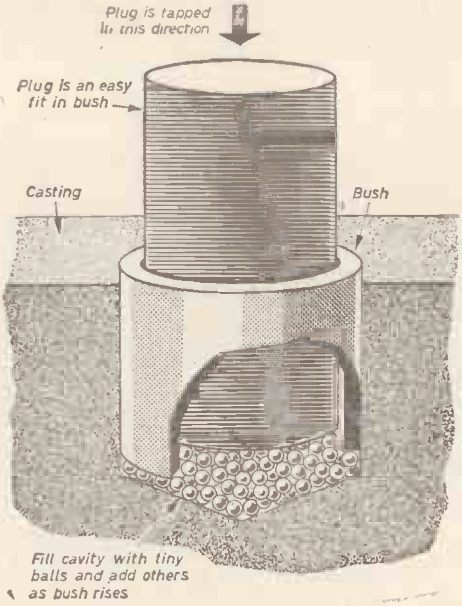


Diagram shows tiny steel balls loaded into cavity forcing bush to rise.

MIRRORS

By C. SUTTON, B.Sc., A.M.I.Chem.E.

NARCISSUS gazed at his own image in the reflecting surface of a pellucid pool. But here was no permanent mirror, for the ripples set up by a falling stone would have caused immediate effacement. History does not recall the first permanent mirror but we suspect that it may have been the burnished lid of some cooking vessel. Glass was known to the early Egyptians some 3,000 years ago and glass is now the basic substance upon the surface of which man now makes artificial mirrors.

Mirrors were formerly coated with an amalgam of tin. Tinfoil was covered with mercury and the glass, carefully cleaned, was laid on the amalgam. Excess of mercury was forced out at the sides, leaving the amalgam adhering firmly to the glass.

The modern method of making mirror is to coat the surface of glass with metallic silver. This calls for a chemical procedure which involves the release of metallic silver from a silver salt by a process known as reduction. Throughout this article we will assume that we wish to silver the surface of a rectangular piece of glass approximately 5in. square. First the surface which is to be silvered must be freed from all traces of grease. This can be done by rinsing the slide in a vessel containing either industrial spirit, which is about 98% ethyl alcohol, or in one containing trichlorethylene. Whichever degreasing fluid is used it must be remembered that further contamination must be avoided by taking care not to touch the cleansed surface with the fingers. This cleaning process should be carried out immediately prior to starting the actual silvering process, so it is as well to have the silvering solutions already prepared.

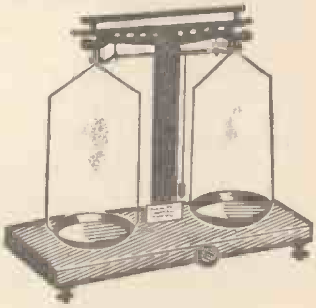
In all silvering processes the production of the silver film is brought about by mixing, just when required, an ammoniacal solution containing a silver salt and one containing a reducing agent. These reducing agents can be either (1) the invert sugars, dextrose and laevulose ($C_6H_{12}O_6$), which are formed by treating cane sugar (sucrose) $C_{12}H_{22}O_{11}$ with dilute acids; (2) Rochelle salt (sodium potassium tartrate) $NaKC_4H_4O_6{\cdot}4H_2O$; (3) formaldehyde HCHO; or (4) hydrazine N_2H_4 (or its salts).

It is now necessary to give the nature and the concentrations of the various chemicals that are used for carrying out the actual silvering process.

Sugar method

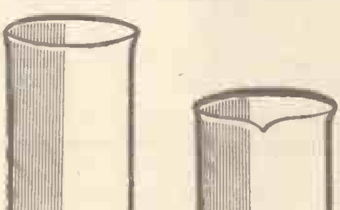
I. Silver solutions

	grammes per litre	*ounces per gallon*
A		
Silver nitrate, $AgNO_3$	50	7
Potassium hydroxide, KOH	25	$3\frac{1}{2}$
B		
Silver nitrate, $AgNO_3$	65	9



A chemical balance.

Glass beakers of various sizes.



Solution A must be rendered ammoniacal as next described. The solution is prepared by adding just enough ammonium hydroxide (Sp. gr. 0·90) to silver nitrate solution A to redissolve the precipitate of silver oxide, Ag_2O, that was first formed by the addition of KOH. If too much ammonia is added, subsequent deposition of silver will be prevented, whilst too little ammonia leaves a black precipitate that may cause faulty silver films. If too much ammonia is added by accident, silver nitrate solution B should be carefully added drop by drop to combine with any excess of ammonia and produce a slight darkening only of the solution.

At this point a caution must be given. It must be remembered that when ammoniacal silver solutions evaporate to dryness the residues are explosive and may cause serious accidents. All waste solutions should be poured away as soon as discarded. As an alternative the addition of hydrochloric acid to any silver salt solution will precipitate silver chloride from which silver can be recovered. Stock bottles not so treated should be stoppered so as to prevent evaporation.

We can now resume description of the methods of preparing the solutions that will produce the silvered glass.

2. Reducing solution

	grammes per litre	ounces per gallon
Granulated sugar	90	12
Nitric acid, HNO_3 (s.g. 1·42)	4 (ml)	½ (fl. oz.)

Solution No. 2 should be boiled for five minutes and allowed to cool. To preserve this solution about 180 millilitres per litre of ethyl alcohol can be added.

For use, one part by volume of the reducing solution should be mixed with four parts by volume of the ammoniacal silver solution as described later.

Rochelle salt method

1. Silver solutions

	grammes per litre	ounces per gallon
A		
Silver nitrate, $AgNO_3$	100	13
Potassium hydroxide, KOH	50	7
B		
Silver nitrate, $AgNO_3$	100	13

2. Reducing solution

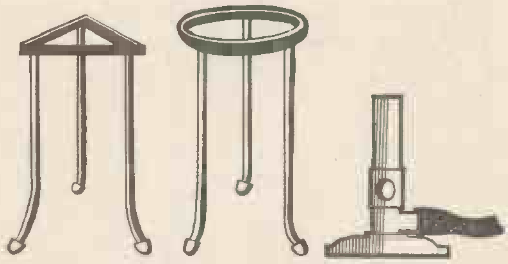
	grammes per litre	ounces per gallon
Silver nitrate, $AgNO_3$	2	¼
Rochelle Salt, $NaKC_4H_4O_6 . 4H_2O$	1·7	¼

Silver solution A should be rendered ammoniacal as for the sugar method. For use, equal volumes of ammoniacal silver solution and the reducing solution should be mixed.

Formaldehyde method

1. Silver solutions

	grammes per litre	ounces per gallon
A		
Silver nitrate, $AgNO_3$	20	2½
Potassium hydroxide, KOH	10	1¼
B		
Silver nitrate, $AgNO_3$	20	2½



Tripod stands and a Bunsen burner.

2. Reducing solution

Formaldehyde, HCHO, 40% solution	200 (ml)	27(fl. oz.)

The silver solution A should be rendered ammoniacal as before. For use, one volume of reducing solution is required for five volumes of the ammoniacal silver solution.

Sensitising the glass

Immediately before the actual silvering solutions are used the degreased piece of glass must be immersed for about a minute in a solution of stannous chloride. This is made up as follows:

Stannous chloride, $SnCl_2 \cdot 2H_2O$, 10 g/l.
Hydrochloric acid, HCl (conc.), 40 ml/l.

Carefully lift the glass object from this solution and rinse momentarily (not too thoroughly) in a vessel of water or under a tap. Then place the glass slide into the vessel in which the actual silvering process is to take place and then pour from two separate beakers, at approximately equal rates of flow, the silver nitrate solution (A) and the reducing solution (B).

The silver mirror will form very quickly upon both the immersed object and also upon the inside surface of the glass vessel in which the reaction is taking place. When the surface of the glass slide appears to be evenly coated, which should be in about four to ten minutes, remove the slide from the reaction vessel, wash the surface gently under a tap of running cold water and allow to dry. The silver deposit found upon the sides of the reaction vessel can be readily dissolved by swirling a 10 to 15% solution of nitric acid round the vessel.

Apparatus required

1. A simple chemical balance capable of weighing to 2 mg.
2. One five-litre glass beaker and three or four smaller beakers of one litre and 500 ml. capacity.
3. One tripod stand and wire gauze.
4. One methylated spirit lamp or gas-operated Bunsen burner.

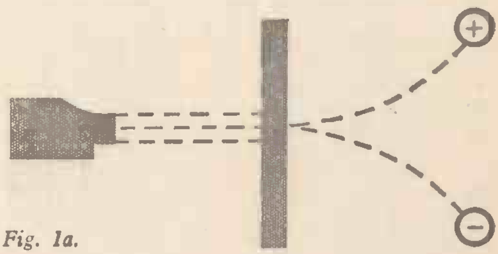


Fig. 1a.

FURTHER THOUGHTS ON ELECTRO-GRAVITICS

By I. A. van As

ELECTRO-GRAVITICS has been classified along with such absurdities as perpetual motion machines, the alchemist's vain endeavours to make the philosopher's stone and the elixir of life. There is sufficient evidence, as I hope to show in this paper, that an electro-gravitic machine is not entirely inconceivable in the light of modern physics. Even the alchemist's dream of producing gold from base metal is today possible by rearrangement of atomic structure, it is a costly process and is unlikely that we will produce gold in this fashion for economic purposes.

The idea of an anti-gravity machine appears to have been conceived by that prolific writer of science and science fiction—H. G. Wells. In his fantasy "The First Men in the Moon" readers will recall that the mechanism of the machine was the material "cavorite" which was opaque to gravitational radiation. Electro-gravitics will not be possible by the use of such a passive screen as it is contrary to the natural fundamental laws of physics such as those of the conservation of energy and that of thermodynamics. It is clear then that any anti-gravity device must be an active repelling agent consuming energy.

Anti-matter

At this point I should like to introduce the readers to the concept of negative weight as associated with anti-matter or negative matter, a substance which would not be unlike the fanciful "cavorite".

As far back as 1927 Dirac applied Einstein's relativity theory to the electron and came to the amazing conclusion that an electron could have negative states of energy. This gave rise to the discovery of the positron in 1932 by C. D. Anderson. The positron is a positive electron and arises when gamma radiation of sufficient energy passes through matter. The positron appears together with normal electrons but its lifetime is short for it soon combines with a normal electron and both are annihilated and reappear as energy in the form of gamma radiation. This was the first encounter with an anti-particle. Figs. 1a, 1b, 1c demonstrate this happening in a Wilson cloud chamber. In Fig. 1a the tracks of the electron and position diverge owing to the magnetic field.

It was natural that after this amazing discovery a search would be made for a negative proton. The

Fig. 1b.

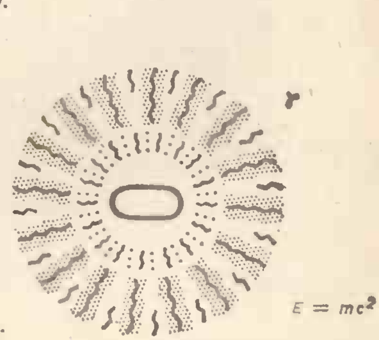


Fig. 1c.

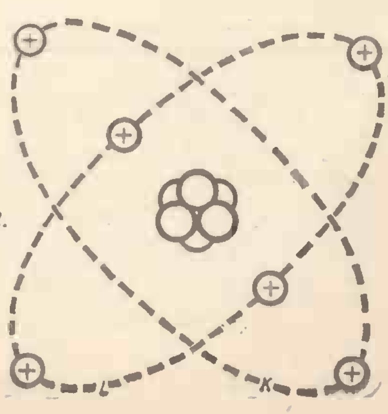


Fig. 2.

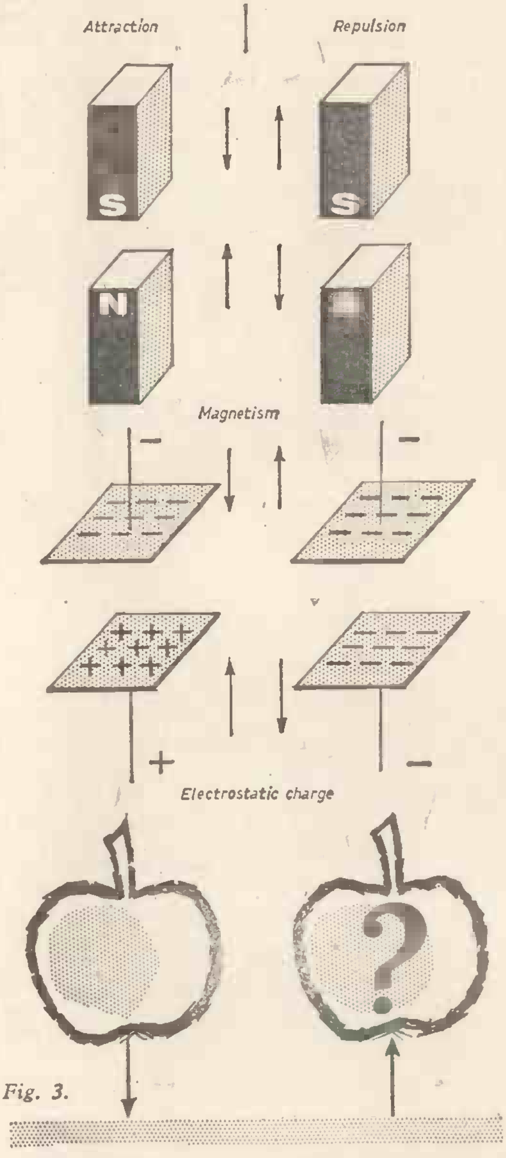


Fig. 3.

theorists had to wait until 1955 for experimental verification of their mathematical assumptions which were necessary to account for certain nuclear behaviour. Later the anti-neutrino was found. One can envisage an anti-atom of iron with 26 negative protons in its nucleus and its 26 attendant positrons in their respective orbits. Matter of this nature may well have negative weight and instead of falling in our gravity field will be repelled. This, according to Professor H. Bondi (an authority on gravitation) is compatible with the relativistic theories as it can be shown that positive matter will attract all matter and negative matter will repel all matter. Fig. 2 shows a hypothetical anti-atom of carbon with negative protons surrounded by six positrons.

Anti-particles have also been found in the cosmic rays bombarding us and it has been suggested that there may be galaxies which consist of anti-matter. It is known that in the constellation of Cygnus two galaxies are colliding which has resulted in the generation of powerful radio waves. This however is not two different types of matter being attracted to one another, for, as we have already indicated negative matter would repel all matter. This is not supposition but can be shown to be the result of exact solutions of certain field equations.

It is not suggested that we will be able to produce negative matter to be used in the production of an electro-gravitic machine. The introduction of anti-matter has been used to show that there are reasons to believe that *another form of gravity,* namely that which repels matter, probably exists.

Gravitation and the Unifield theory

Our lack of experimental data on the gravitational field is one of the retarding factors in the development of electro-gravitics. We are unable to destroy or create a gravity field other than an artificial one produced by centrifugal force. It is not even certain that there are gravitational waves and so far we have been unable to build an instrument sensitive enough to detect them. The reason for this, it is assumed, is that the power of gravitational waves is extremely small. A Russian investigator, V. Fock, has calculated that the output of power of gravitational waves of the Solar system is in the region of 450 watts. On seeing such a small figure one is apt to become encouraged in our conquest of gravity for we are able to generate power by the hundreds of killowatts. However, let it be a sobering thought that the same 450 watts keeps our Solar system in perfect balance.

Investigators have already mathematically predicted a carrier of gravitational waves, the graviton. Another as yet unobserved concept is the geon which is an entity consisting of a pure electromagnetic field which is being held togther by its own energy and hence mass of the field. This involves the paradoxical idea of a mass without mass.

There has always been an interest in the possible relation between gravity, magnetism and the electrostatic charge. Faraday, Maxwell, Crookes and Einstein, to mention a few names, sought the relationship without much success, Einstein in a particular phase of his unified field theory devised a set of equations establishing a relationship. Experimental proof is lacking and such proof will no doubt involve a new fundamental idea of experimentation. It is hoped that our man-made satellites will provide facilities for direct experimentation and observation on gravity in order that the unified field theory can be established. With experimental proof, it may be possible to convert and modify existing fields and predict new ones. Apart from the magnetic, electric and gravity fields there is already some evidence of a nuclear force field which may even be stronger than a gravitational field.

Let us return to the relationship between gravity, magnetism and the electrostatic charge and examine the similarities and differences between them. In terms of Newton's Law we can mathematically express gravity as follows:—

$$F = \frac{G\,M\,M'}{d^2}$$

Where **F** is the force of attraction between two bodies of mass M and M′ and d the distance between them, while G is the gravitational constant.

The force of attraction between two unlike poles of a magnet is expressed as follows: —

$$F=\frac{K\,M\,M'}{d^2}$$

Where M is the pole strength of say the north pole of one magnet and M′ the pole strength of a south pole, d is the distance between them and K is a constant.

A further force, that of the attraction of two unlike electrically charged bodies has this expression: —

$$F=\frac{C\,Q\,Q'}{d^2}$$

Where Q is a positive charge and Q′ a negative charge and d as in the previous equations is the distance betwwen the charged bodies, while C is the special constant.

On inspection of the three equations it becomes immediately obvious that they are identical in form although the three phenomena are apparently unrelated. A further similarity which should be considered important is that they all obey the inverse square law.

The most important difference to be considered is that gravity differs from magnetism and electrostatics in that it is a force of attraction only while magnetism and the electrostatic charge can be forces of either attraction or repulsion (Fig. 3). The similarity of the three forces led Einstein to endeavour to relate them to a more fundamental principle. An electro-gravitic machine is an extension of this relationship for it does not require much imagination to conclude that gravity may be a force of repulsion as well and it is one step further that it may be possible to construct a machine which would be repelled by our gravity field.

Present investigations

It is little wonder that the magnet and the condensor have become the focal points in the investigation of electro-gravitics. In the October, 1961 issue of this magazine I described a method of changing the orbital motion of electrons so as to produce materials which would be repelled to the weakest part of a magnetic field.

In the United States an investigator by the name of T. Brown is reputed to be using electrostatics to tame gravity. His research is possibly along the same lines as those of Verschoyle. One can only wonder why the British Government at that time did not investigate Verschoyle's claim in 1936, for if they were founded on sound principle they may have been applied with advantage during the last war. Perhaps he received the same sort of treatment from the Air Ministry as did Frank Whittle in 1935 when he was told that his jet engine was not practical.

The Americans are going to the very core of the matter in their research and their point of attack is the atom. At the Princeton Institute of Advanced Studies, nuclear particles have been discovered which may solve the electro-gravitic problem. It is only known that these particles have been generated by such research tools as the cosmotron and the betatron and it is hinted that their use may permit gravity to be examined and worked with at will. It is not known what the Russian approach is, we only know that they have a gravity research programme which is being conducted at their Dubna atomic centre. To the best of my knowledge no research work is being done in the United Kingdom.

All projects are cloaked in secrecy and there has been no official statement or explanation issued and no scientific books published on the subject. There have been odd articles in the American newspapers and popular magazines. Occasional articles appear in aeronautical magazines, but to date we have had nothing concrete on the outcome of research in this direction. Recently the writer endeavoured to procure a verbatim report of a conference on gravity which took place in the United States and which was available for distribution. I was soon beseiged with letters from the United States Air Force, the Intelligence Department and ultimately an interrogation by a detective from the Special Branch. I may add that my Russian sounding names, Ivan Alex did not improve matters as it appeared that I might have been a communist. I was eventually cleared, but I did not receive the document. This little incident will indicate just how important the subject is and the secrecy it enjoys.

Irrespective of whether or not we succeed in making an anti-gravity machine or not there is little doubt that science will benefit by the vast amount of research that is being done in that direction.

Home made portable projection set

(Continued from page 266)

the ends flush to their finished length. If a fine tooth circular saw was used only a light rub with fine glass paper will be necessary in the slots.

The inside of the projector, the case, and the drawer, should all be painted with a matt black paint leaving only the screen inside the lid white. The outside of the projector can be treated with a gloss paint, preferably of a dark colour, which must be heat resisting. The writer used black wrinkle finish paint baked in the kitchen gas oven, owing to difficulties with a borrowed spray gun the result on this projector was a very indifferent success from an appearance point of view although the same process used on a previous occasion on another home-made projector gave very good results. The outside of the carrying case can be painted any colour with gloss paint. This of course is purely a matter of taste, and more ambitious constructors may prefer to cover it with leatherette or rexine.

Other finishing details, not shown on the drawings, which are required are a switch, a two-pin socket, and a resistance (Brimistor) to limit the current surges on the lamp filament, all mounted on the inside of the front of the case. A webbing strap should be fitted across the case to hold the projector down on its stowage blocks. Two slotted stays and wing nuts to hold the lid vertically upright in its open position should be fitted, and a carrying handle on the front of the case and a smaller one for the drawer. Two snap fasteners to hold the lid when closed and rubber pads under the case and under the front end of the drawer were also fitted. Some of the above items are visible in the photographs.

TRADE NEWS

Clansman blowlamp.

Rust

SINCE the Iron Age RUST has been man's constant problem and the engineer's most persistent enemy. For centuries the only known preventive was the messy, time-wasting process of constant greasing and degreasing before and after use.

Since the discovery of Vapour phase inhibitor (V.P.I.), however, it has been widely used throughout all industries using ferrous metals and has proved a reliable, clean and 100% effective rust inhibitor. Of recent years the man who buys his V.P.I. by the 100 yd has been fully catered for. The small user—modeller, machinist, laboratory worker, sportsman, market gardener and housewife, etc.—requiring perhaps a dozen sheets per year, has been left out in the cold.

Now at last small packs specially prepared for these small users are available at a cost of 6/- for eight sheets post paid.

V.P.I. is a white-coated paper giving off fumes which, in contact with ferrous metal, completely inhibits rust, giving a remarkable imitation of stainless steel.

The vapour given off by the white coating prevents moisture and oxygen in the air forming rust. The active life of the coating therefore depends upon the degree of enclosure or the movement of air in the vicinity of the articles under protection. In a tightly-closed toolbox one piece of V.P.I. has been known to protect the contents from rust completely for five years. On the other hand a piece draped over your lawnmower in the garage, where air is free to circulate, will protect for six to nine months.

In no case is it necessary actually to wrap the paper around the articles to be protected, but all the surfaces likely to rust must face and be not more than 18in. from the white coating. You can, of course, use the paper to wrap things like your garden shears when it is more convenient or when in store for long periods.

Neither is it necessary to wipe moisture from articles under protection, although it is always advisable. Heavy drenching of the paper—sufficient to wash off the white coating—does, however, render the paper inactive.

Generally 1 sq ft of paper will provide adequate protection of a space 12in. cube, but in very humid or exposed conditions play safe and use rather more. For example, quite a small snippet (say 1in. x 2in.) in the top of a jar of screws will prevent rust.

Workshop: Line all shelves, drawers, cupboards and racks, all toolboxes and instrument cases. Drape over the lathe and other machines when not in use.

Household: V.P.I. in the kitchen to protect mincer parts, cake tins, etc. Line pantry shelves and use in the cleaning cupboard for preventing rust on sweepers, etc. In the attic and garage for storing articles that can rust—perambulators, bicycles, etc.

Vapour phase inhibitor (V.P.I.) is obtainable from Major C. D. Elliott Owles, M.B.E., Bosula, Westerton, Chichester, Sussex.

New gas blowlamp

FALKS have just announced a new addition to their range of Butane gas appliances. This is the Clansman Blowlamp No. 76338. The lamp has been designed in the lightest possible form and is extremely easy to operate. The handle is made so that it can be hung on the belt of any fitter to leave free use of his hands. The Butane cylinder is the same as that used on Falk's Chieftain Picnic Stove and will last for approximately two and a half to three hours.

Adjustments can be made to the flame by sliding the torch up and down the arm, which is then secured by a nut provided. A spanner is supplied with the lamp to ensure that the union is tight.

Price 36/9. Replacement cylinders 3/9.

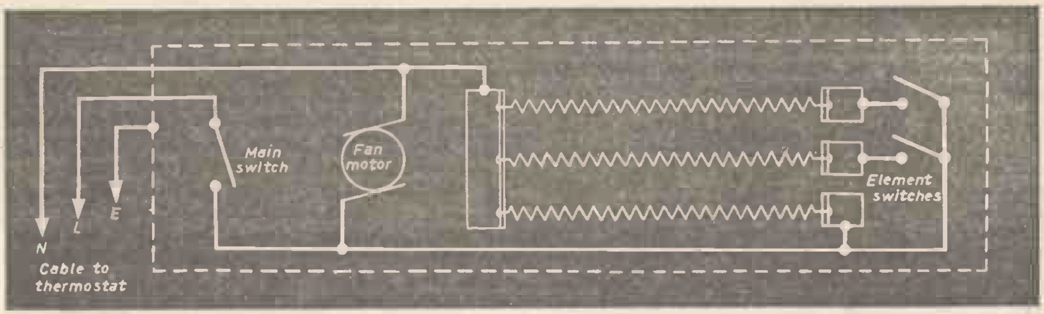
Obtainable from ironmongers' stores or from Falk, Stadelmann and Co., Ltd., 91 Farringdon Road, London EC1.

A GREENHOUSE FAN HEATER

(Continued from page 251)

the edges on the underside. These battens serve to reinforce the asbestos and to provide a space for the wiring which is all underneath the asbestos. The elements should be mounted in holders so that they are held at an angle to the base and allow the cold air blowing from the fan to come in contact with the whole length of the element. A cover of tinplate should be screwed to the battens on each of the long sides of the asbestos and should be curved to form a tunnel to channel the air over the elements. The tinplate should be strengthened with ribs of strip iron, $\frac{3}{4}$in. x $\frac{1}{8}$in., to which a carrying handle can be rivetted.

The operation of the heater is controlled by a thermostat. Throughout last winter the device was run with an electric clock connected across the heater element so that the clock only ran when the thermostat switched on the heater. This showed that the heater used about six units of electricity every 24 hours from November to March. It was usually run with the third element switched off unless the weather was very cold. The time of operation of the heater was materially reduced by insulating the glass of the house with polythene sheeting. This was stapled to the glazing bars so that there was a small gap at the top and the bottom of each piece of polythene. This allowed some slight circulation of air and reduced condensation on the glass which tended to make the transparent sheeting stick to the surface of the glass, thereby reducing the value of the insulation. Money spent on double glazing in this fashion is soon repaid by lower electricity bills.



AN INSPECTION LAMP

(Continued from page 262)

useful size but for a larger lamp 0B.A. would be preferable. For the latter use $\frac{1}{4}$in. diameter rod but for the lamp depicted here $\frac{3}{16}$in. material should be used. Thread both ends for a distance of about $\frac{3}{4}$in. and then coil one rod to the shape shown, round a scrap piece of rod. Set the scrap rod well down in the vice jaws and allow just $\frac{1}{2}$in. to project so as to form a stiff mandrel. The bending is best performed with the aid of a light hammer, gently tapping the rod to the final position. Do not overdo the hammering as naturally this soon damages the soft brass. Make sure the two " legs " are the same length. The second member should be bent to a semi-circle in the middle and this is again a simple job that anyone should be able to perform without the aid of a mandrel.

Offer up each rod in turn to the disc and mark where the holes must come. If two opposite holes are drilled first and their positions checked before proceeding further this will give an idea whether to alter the positions of the second pair.

The addition of a large " Bulldog " type of clip to the lamp is an obvious advantage as besides providing a ready-made hole for hanging up the lamp —most of these clips already have a hole punched in them—they can exert sufficient pressure to resist a comparatively hard knock so that the lamp will not fall down accidentally. So purchase the largest clip the stationer may have and fit it to the holder as depicted here. A threaded bush to screw into the lampholder and grip the clip can be obtained from most electrical suppliers. The wire used to connect up the lamp depends on the use you have in mind for it. For household applications a heavy rubber cable should be used, while for the occasional peer into a car bonnet thin gauge plastic-covered wire is usual for this type of equipment.

The lamps and holders for household and car lamps differ in size, so this must be taken into consideration when making one of these holders.

3-D CAMERA

(Concluded from page 276)

inverted images on the film surface and therefore when the developed film is viewed " right way up " it has in fact been moved round through 180°. The transposition of views on the card corrects this.

The colour film used by the author is " Ferrania-colour ", daylight reversal, size 120 roll film, and it will be appreciated that the use of other makes may or may not affect the numbering system adopted, *i.e.* commencement of warning arrow equidistant between each consecutive frame number.

If home processing of the film is undertaken then the system can be quite attractive economically, even if only two rolls are processed with one set of chemicals (and more are possible). The cost then works out at approximately 8d. per stereo pair.

MULTI-METER FOR ELECTRICAL WORK

(Continued from page 273)

$$\therefore \frac{1}{R} = \frac{1}{20} + \frac{1}{10} = \frac{1+2}{20} = \frac{3}{20}$$

$$\therefore R = \frac{20}{3} = 6{\cdot}67 \text{ ohm.}$$

Using this value:—

$$I = \frac{E}{R} = \frac{3{\cdot}2}{6{\cdot}67} \quad \left(\text{current} = \frac{\text{voltage}}{\text{resistance}}\right)$$

$$\therefore I = 0{\cdot}48 \text{ ampere.}$$

Again, use a non-inductive resistor of the lowest possible value to give at least half scale deflection on the voltmeter.

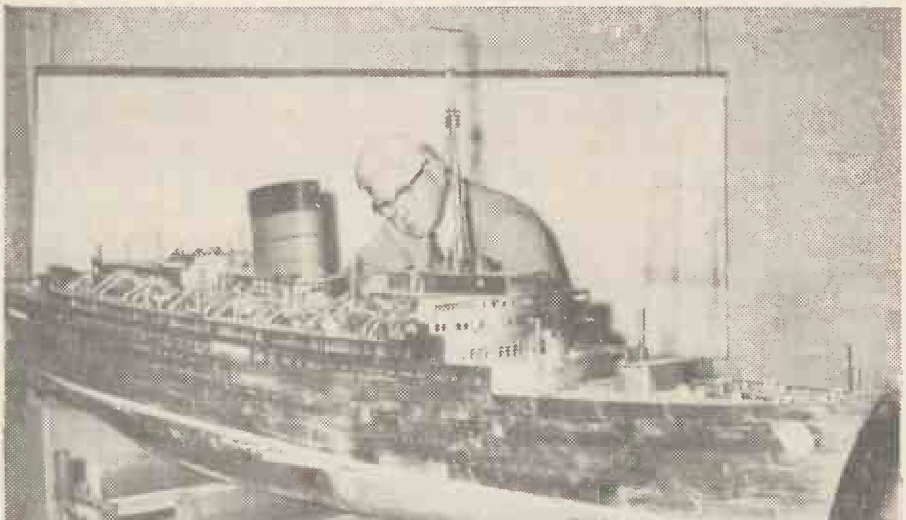
Fig. 8 illustrates the measurement of resistance or impedance. On a.c. the result would be the impedance of the coil in ohms. On d.c. it is the resistance, also in ohms. Note that both meters are in use at the same time.

$$R = \frac{E}{I} \text{ ohms for d.c.}$$

$$Z = \frac{E}{I} \text{ impedance for a.c.}$$

E=volts, I=current in amperes, R=resistance in ohms and Z=impedance, also in ohms.

The power that the coil is taking will be:— $P=IE$ watts for d.c. $VA=IE$ volt-amperes for a.c.



12ft Model of the "Coronia"

ALTHOUGH Mr. Clifford Wood, of Wimbledon, has spent five years working on this 12ft model of the "Coronia", he estimates that he has another two years' spare time work before the model is finally completed. When it is completed the model will be electrically driven and electronically controlled—it will also be fitted with internal illumination to light up the port holes. Mr. Wood works from drawings supplied to him by the Cunard Line and the "Coronia's" builders, John Brown's of Clydebank. He has supplemented these with photographs and sketches he has taken and drawn during visits to the ship.

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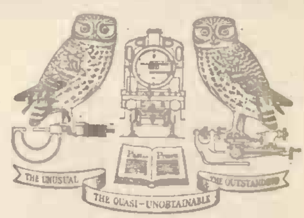

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