Practical MECHANICS

FEBRUARY 1961

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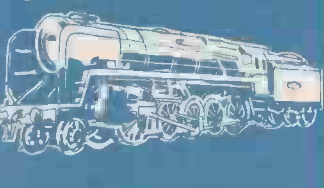
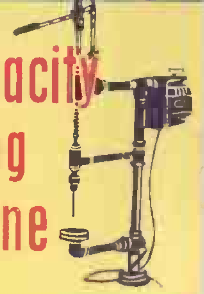
L·B·S·C's 3½" GAUGE EVENING STAR



A SATELLITE NAVIGATION SYSTEM

SUNSHINE POWER FOR SPACESHIPS

½" Capacity Drilling Machine



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CONTRIBUTIONS

The Editor will be pleased to consider articles of a practical nature suitable for publication in "Practical Mechanics." Such articles should be written on one side of the paper only, and should include the name and address of the sender. Whilst the Editor does not hold himself responsible for manuscripts, every effort will be made to return them if a stamped and addressed envelope is enclosed. All correspondence intended for the Editor should be addressed: The Editor, "Practical Mechanics," George Newnes, Ltd., Tower House, Southampton Street, Strand, London, W.C.2.

FAIR COMMENT

HOBBIES BOTH SIDES OF THE ATLANTIC

WHAT are the spare time interests of the American man? No one, so far as we know, has ever made a survey for comparison with those in this country, but conversation with visitors from across the Atlantic and reading American technical literature gives the impression that Americans are at least as interested in technical hobbies as the British.

Most Americans own their own home and like their British counterparts enjoy decorating, maintaining and improving it themselves. The immense popularity of our companion journal Practical Householder is a good indication of the British enthusiasm in this field and the number of do-it-yourself features which appear in American magazines would suggest there is the same interest across the Atlantic. Similarly most Americans run at least one car and share the liking of men all over the world for tinkering with them.

These two—the home and the car—absorb a lot of time, but when his family is installed in the car, where does an American drive to? In Britain, where everyone lives within about three hours' drive from the sea, the coast is an obvious destination. In America, however, where distances are so much vaster, he might go to the sea, a lake, a river or perhaps the mountains and forests. Then what? Well, his interests would be very much the same as ours—fishing, swimming, boating, camping, hunting, etc. For all these sports he may probably like to make his own equipment.

Many Americans in common with their British cousins go in for such hobbies as carpentry, modelmaking, wireless and television for all of which a workshop is necessary. Although the actual design of articles made may be vastly different from those made here, the actual interests would appear identical.

Reading through the foregoing gives the impression that hobbies both sides of the Atlantic are the same but is this the case? Generally speaking it is; such differences as there are are, largely of degree. America enjoys a very high standard of living and her citizens are able to spend very much more money on their hobbies than we are. Where a British worker might make a canoe, his American counterpart would probably make a hydroplane or a speedboat and similarly he can make bigger and better radios, photographic equipment and so on, according to where his interests lie. The same sort of difference applies also in the workshop. The American would probably have a much wider range of equipment and might own an arc welder, bandsaw, planing machine and lathe. His home would most likely be large enough to permit the building of a permanent indoor workshop with ample power available for all his equipment.

Having more money and facilities undoubtedly enables the American to undertake more ambitious projects than the average British handyman but we think that most of the prizes for beauty of design and craftsmanship would go to the British worker.

As leisure time increases all over the world more and more men are taking up hobbies—and it is hobbies where something is made which are most popular. The creative urge is present in all of us and there is something peculiarly satisfying in making in the workshop something which is either useful or ornamental. Many people in Britain, America and all over the world work in a non-productive capacity by day and it is among this type of worker where the pride of the amateur craftsman flourishes.

The March, 1961, issue will be published on Feb. 28th, 1961. Order it now!

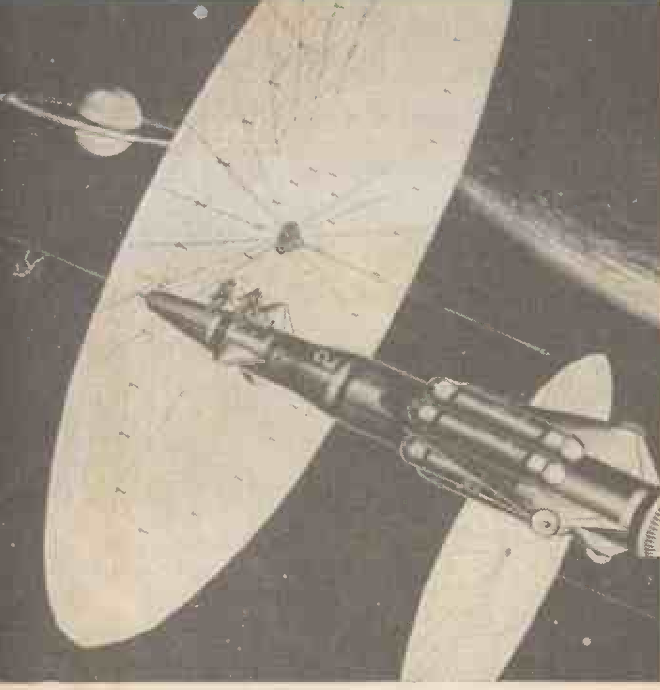


Fig. 1.—An imaginative drawing of two " solar sails," showing men aboard an atomic rocket being towed by a " sail."

SUNSHINE POWER FOR SPACE SHIPS

By R. D. F. Sears

POWER from the sun is playing an important part in man's effort to explore outer space.

Several of the American satellites now circling the earth are sending back valuable information by this kind of power. Energy from the sun, collected by solar cells, is converted into power which recharges the batteries operating the satellites' transmitters.

The idea of generating useful electrical energy directly from light or heat energy, without intermediate steps, has long stirred the scientific imagination, but practical methods of doing the job have become available only within the past few years.

Practical application of the knowledge has been speeded up by the urgent demands of space technology—by the need for lightweight, portable generators that might draw energy from the sun to supply electric power for radio equipment, guidance and control mechanisms, and instrumentation in satellites and space vehicles.

Fig. 2.—Known as a " solar sail " this disc is designed to collect sunshine and convert it directly into power for propulsion of a manned or unmanned space ship.

Sunlight Sail

While solar cells have been functioning with notable success in such satellites as Tiros 1 (the experimental weather satellite), Explorer VI (the paddlewheel satellite), and Vanguard 1 (the first satellite to convert sunlight into electricity), Figs. 4 and 6, scientists have been busy with other applications of solar energy to the space research programme.

They now believe, for example, that space ships which utilise the sun's rays to cruise indefinitely are now within the realms of possibility. They think that the free, unlimited energy given off by the sun may prove a cheap, simple and lightweight source of power for both manned and unmanned vehicles exploring distant planets and the moon (Fig. 1).

Already devices have been developed that may eventually lead to space flight in vehicles that carry no fuel. Such space ships, continuously propelled by solar power, would probably be versatile and relatively easy to manoeuvre.

One promising development is a " solar sail " that would use sunshine like a sailboat uses wind. It has been designed by scientists at Los Alamos Scientific Laboratory in New Mexico (Fig. 2).

The sail, a thin plastic disc coated with evaporated aluminium, would be folded up inside a space vehicle and placed into orbit, like present day satellites, by a rocket. Out in space, it would unfurl and begin its propulsion task.

Gradually it would propel the attached satellite into an increasingly larger orbit and finally into an area beyond the gravitational pull of the earth and other planets.

By means of radio signals to adjust gyroscopes at the centre of the sail, the space ship could be manoeuvred on trips anywhere in the solar system, including around the sun, moon or planets. Since outer space is almost a perfect vacuum, the sail would encounter no resistance and would therefore remain

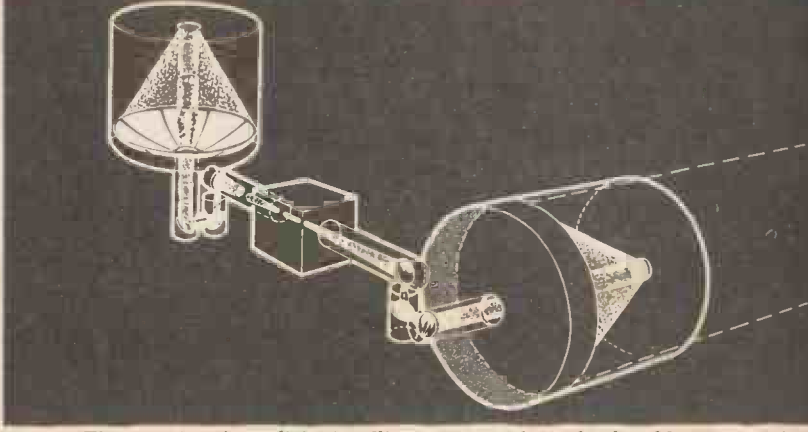


Fig. 3.—*The operation of a sunlight signalling system now being developed for space craft.*

serviceable for years. Los Alamos scientists estimate that a 1,000lb. sail a quarter of a mile wide could propel a space vehicle to Mars and back to earth in two-and-a-half-years.

Another solar conversion device that shows promise is a solar-powered, thermo-electric generator developed by Westinghouse Electic Corporation and Boeing Aircraft Company (Fig. 5).

The generator uses a reflective device—a mirror or sheet aluminium—to collect and concentrate sunlight, which is converted into a continuous flow of electricity when it is focused on two pieces of metal maintained at different temperatures.

This generator, when perfected, is expected to be light, compact and reliable and to have a long life. No maintenance will be required, so it will be of potential value during space flights of several years' duration.

Signalling System

A further development involving solar power is a new signalling system for satellites which may eventually replace some of the radios used today.

The apparatus needed for the first model in this system is now being built in California by Electro-Optical Systems Inc., of Pasadena. Fig. 3 shows how the sunlight signalling system works:

A mirror " antenna " will be attached to the outside of an orbiting satellite, arranged in such a way as to aim automatically at the sun at all times. The mirror will " collect " the sun's rays and feed them into a special coding machine.

All the information on radiation, meteorite hits, temperatures, and so on, which is collected by the satellite's instruments will enter the coder; this will transform the light into the dots and dashes of the Morse code or into a voice message.

A second mirror—a transmitting mirror—will send the dots and dashes back to earth or, in the more distant future, to manned satellites. Receiving sets at the destination will convert the dot and dash light impulses into an electrical signal that will be recorded in such a way that it can be read.

Simple and Reliable

According to Dr. Klaus Otten of the Wright Air Development Division, the greatest potential advantage of such a space heliograph would be its simplicity and reliability. The first model now being built will weigh only 30lb. but should be able to send its light beam signals over 10,000,000 miles.

It will not be possible to use the system when clouds are obscuring a receiving station on earth. But when time is not an important factor, the heliograph should be very valuable.

Another possible advantage is the privacy of the signal. Anyone trying to intercept the light beam would have to be precisely in line with it.

Fig. 4.—*The 142lb. U.S. Explorer VI satellite with four " paddle wheels."*

Fig. 5.—A scientist sights the sun through a telescope attached to a new solar-powered device known as a thermoelectric generator.

When the space pioneers of tomorrow eventually land on the moon, one of the first things they erect will probably be a solar furnace. It is likely to have a reflecting dish to collect and focus the heat of the sun on a small tube from which power will flow to provide communication with the earth.

One of the major factors that has limited the application of solar energy conversion so far, has been the lack of economical and efficient devices for storage of electrical energy. The present interest in fuel cells may rapidly change this picture.

Industrial firms in several countries are now steadily inching towards the goal of an economically practical device for spinning the wheels of our modern industrial civilisation with beams of sunlight.

Solar cells are being effectively used on earth for powering experimental salt water conversion, transistor radio sets, lighthouse beacons, forestry service radio links and clocks, and there are many more potential uses.

Recently, a sun-powered car was driven in London to demonstrate one possible use. The car is a 1912 Baker electric which has been adapted to utilise solar energy by International Rectifier Corporation of El Segundo, California, a leading producer of solar cells, rectifiers and other semiconductor devices.

More than 10,000 silicon solar cells are mounted on the roof of the car in a detachable 26ft. panel which engineers believe is the largest single photovoltaic panel for conversion of solar energy built in the world to date.

The sunlight energises electrons in the cells, which are wired together in a circuit, and puts them to work charging the car's 72-volt battery system. The car then works off the batteries. The cells are similar in function to cells used to open automatic doors and in camera light meters, except that they are made of silicon instead of selenium.

The car's solar conversion system was designed by Dr. C. A. Escoffery of the International Rectifier Corporation. Dr. Excoffery emphasises that the car is not yet a practical proposition, although he believes that it may be in the future.

The silicon solar cell is an invention of scientists at the American Bell Laboratories. As an invention it dates back only six years, though selenium cells go back to the 19th century.

In 1876, the British scientists Adams and Day built a selenium cell which converted sunlight into usable energy with less than 0·5 per cent efficiency. The silicon cell is today's successor of that early solar device.

The silicon photovoltaic solar energy converter operates by converting photons of light energy from the sun into a flow of electrons—electric current. Conversion efficiency of 10 per cent. is standard; but 14 per cent. has been reached, and 25 per cent. is theoretically attainable. Actually, " efficiency " is not all-important in solar energy devices. A 10 per cent. efficient petrol engine would waste nine-tenths of the precious and irreplaceable petrol. But a 10 per per cent. efficient solar cell wastes only sunlight.

At the demonstration of the sun-powered car, Dr Escoffery gave these facts about solar energy:

Every square meter of perpendicular sunlit earth is a potential power source of 1·4 kilowatts.

Every hour the earth's atmosphere receives 0·6Q of energy from the sun. (Q is an energy equivalent to a million BTU or to 38,000 million tons of bituminous coal.)

Every 45 hours it furnishes us with as much energy as in our total remaining useable reserves of coal, oil gas, and oil shale.

Every 40 days we receive enough solar energy to meet our estimated needs of the next hundred years.

The Cover

The Navigation Satellite shown on the cover is not mentioned in this article but is fully described on page 241. However, it is of interest to mention here that Transit IIA is fully solar powered.

Fig. 6.—Vanguard 1—the first satellite to use solar batteries. Its solar cells are housed in six rectangular " windows."

Colour transparencies in 3-D

By Norman E. Jenkinson

BRIEFLY, the taking of the 3-D photograph is accomplished by using an open box attached to the tripod. The camera takes one photograph at one end of the box and one at the other end of the box. One picture is that seen by the right eye, and the other is that seen by the left eye. When the two transparencies are viewed simultaneously through two lenses, the 3-D effect is produced.

Fig. 1 shows the box used for taking the pictures. It was made from ¼in. wood glued and nailed. The length of the box will depend on the width of the camera, and the dimension " X " in Fig. 1 should be 2½in. longer than the width of the camera. The distance between the average person's eyes is 2½in. hence this particular measurement. The height of the box should be less than the height of the camera so as not to obscure the viewfinder.

Obtain a large nut with a thread to suit the tripod and drill two holes in the nut. Secure it to the box by means of two screws. The box is now stained and given a coat of polish to enable the camera to slide freely from end to end.

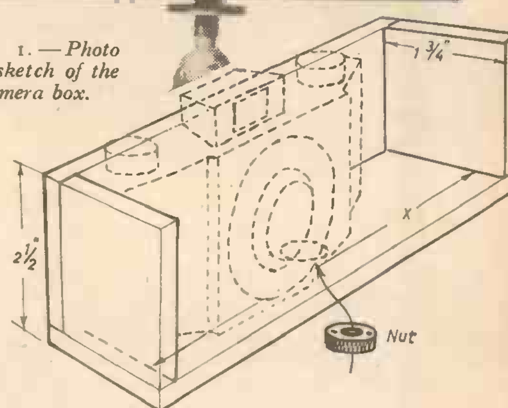


Fig. 1.—Photo and sketch of the camera box.

The Viewer

Obtain two identical double convex lenses of approximately 1in. dia. and 2½in. focal length. Ideally the focal length should be the same as the camera lens but this is not critical. Lenses of this type may be obtained easily and cheaply from any of the firms specialising in ex-WD lenses.

The viewer is made from ¼in. and ⅛in. wood, secured with glue and nails (see Fig. 3). The exact dimensions cannot be given as these will depend on the focal length of the lenses. Ascertain the distance at which the lens will view the transparency with perfect sharpness. This distance will be the dimension marked " A " in Fig. 4, and assuming that ¼in. wood is used, the dimension " B " will be " A " −¼in.

The front of the viewer consists of a piece of wood, 4¼in. × 2¼in., and two circles are cut from it, 2½in. between centres. The circles will be slightly less than the diameter of the lenses. Cut two circular eyepieces glasspaper the inside edge of one side of each eyepiece so that the lens can be accommodated and glue to the front of the viewer, holding the lenses in place.

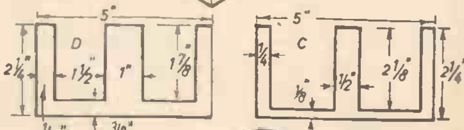


Fig. 2.—Slide-holder details.

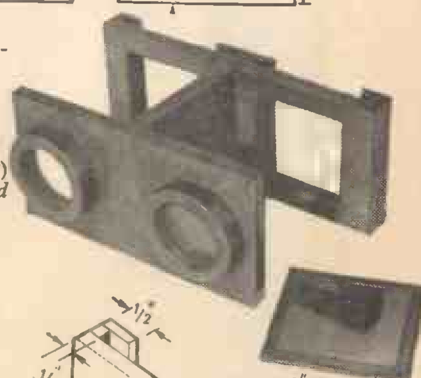


Fig. 3.—(Right) the completed viewer.

The Slideholder

The front of the slideholder is made of ¼in. wood and is 5in. × 2¼in. It has two holes, 1½in. square, 1in. apart. The centres of each square are therefore 2½in. apart and the slides will thus be viewed in the same positions as when the exposures were made. The slides are held in place by two pieces of ⅛in. wood cut as in Fig. 2 and glued to the back of the viewer. To finish the viewer stain and polish it.

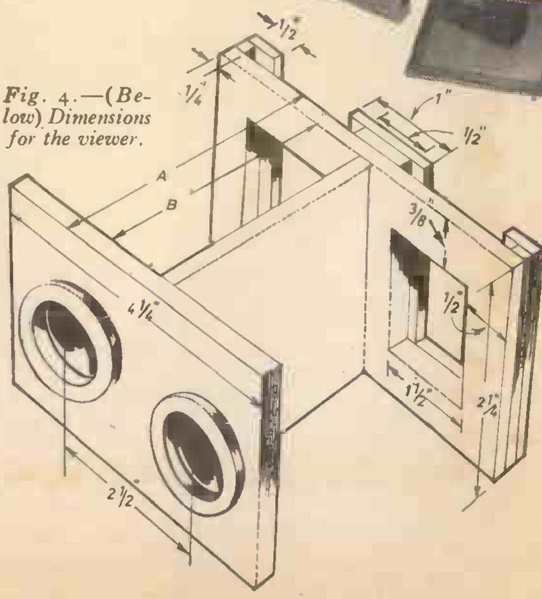


Fig. 4.—(Below) Dimensions for the viewer.

Taking The Photograph

The subject must not move at all between the two exposures. The box should be set up firmly on the tripod. Make the first exposure with the camera in one end of the box. Wind on the film and release the shutter with the camera firmly and squarely in the other end of the box. Remember the order in which the pictures have been taken, e.g., left-hand first.

Having duly masked the two transparencies, marking one left and one right, the former should be put in the left-hand slot of the viewer and the latter in the right-hand slot. Bring the viewer very close to the eyes and view in front of a fairly strong diffused light.

CASTING YOUR OWN FISHING WEIGHTS

H. J. JONES TELLS YOU HOW IT'S DONE

ONE of the items of the sea angler's equipment which has to be frequently replaced is the lead weight. Many anglers like to make their own and do so, using moulds of a simple kind which produce crude weights and do not last long. The moulds about to be described are made of mild steel and have been designed for ease of construction. The tools needed to make them are ruler square, scriber and centre-punch for marking out, hacksaw, file, drilling machine, drill-vice, 13/64in. dia. drill, ¼in. dia. drill, ¼in. British Standard Whitworth taper and plug taps, tap wrench and emery cloth. One mould is shown in Fig. 1.

The Basic Shape

The basic shape of the weight takes the form of two square pyramids placed together, as can be seen in Figs. 3, 5 and 7. Three moulds are required to make four different weights, mould No. 2 being used to make two including a small anchor type weight. The construction of mould No. 1 is shown in detail in Fig. 6. Mould No. 2 is made in a similar manner but with modified dimensions to produce a larger weight (Fig. 4). Mould No. 3 produces a better type of anchor weight and is similar to the others but for the addition of four ¼in. dia. holes at the base (Fig. 2).

Four pieces of ¾in. square mild steel 4in. long are first marked off for the size of weight required. A hacksaw can be used to cut away most of the waste material in each and then the cut-outs are filed carefully so that each piece is identical. A and C (Fig. 2) are then clamped together and a 13/64in. dia. hole is drilled through both in the position shown. The same process is carried out with pieces B and D. The holes in C and D are then tapped ¼in. Whitworth and the holes in A and B enlarged to ¼in. dia. Pieces C and D are then clamped together and a 13/64in. dia. hole is drilled in the position shown, through both. The hole in piece C is then tapped ¼in. Whitworth and in piece D enlarged to ¼in. dia. Next, pieces A and B are clamped together and a ¼in. dia. pouring hole is drilled in the position shown. Some difficulty may be experienced here as the centre line of the hole is at the junction of the two pieces. It is necessary to clamp both pieces tightly together and to make sure the position is centre punched deeply. Finally, the corners at the top end are filed off to fit the brass wire insert required to make the loop. The four pieces are then fastened together with ¼in. dia. Whitworth bolts 1¼in. long. In Fig. 1 the mould is shown fitted with three turned bolts but ordinary bolts are satisfactory. The mould may be polished with emery cloth and given a blue-black finish by coating with soluble oil or machine oil, heating and quenching in water. This affords some protection from rusting. After use, each part of the mould should be wiped over with an oily rag.

Fig. 1.—One of the moulds assembled ready for casting and also apart.

Fig. 2 (Right).—Mould No.3 assembled.

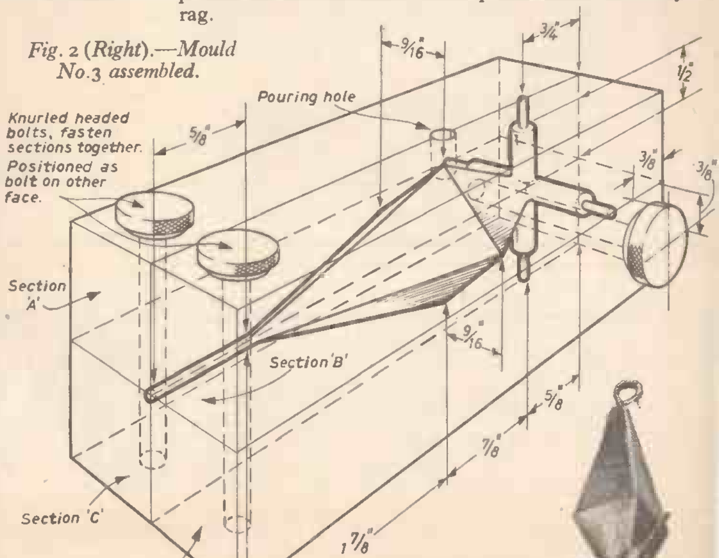


Fig. 3 (Right).—An anchor type weight cast from Mould No. 3.

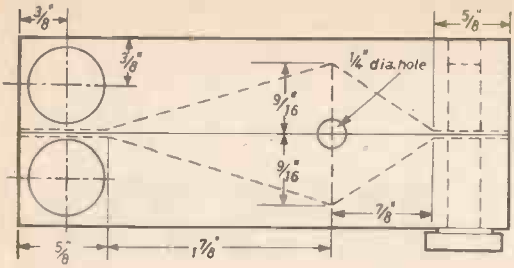


Fig. 4.—Dimensional details of mould No. 2.

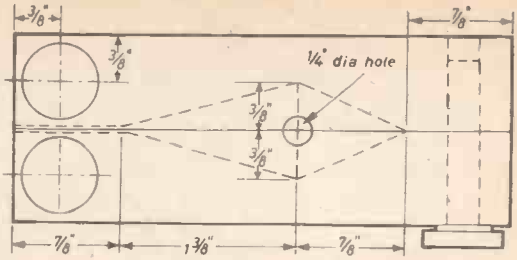


Fig. 6.—Dimensional details of mould No. 1.

If scrap lead is to be used for making the weights it should first be melted in a plumber's ladle, poured out and allowed to cool. This removes any scale and dirt.

Pouring the Lead

Fig. 5 (Below).—A plain type weight cast in mould No. 2.

In use, the four parts of the mould are fitted together, a piece of $\frac{1}{16}$in. dia. brass wire about 3½in. long and flattened at the end which fits inside the mould, is inserted and the mould is warmed. The lead is then melted and poured into the mould. When the mould is cool the bolts are unscrewed and it should come apart easily, the weight falling out. The boss left by the pourer should be removed and the weight cleaned up. The brass wire is then coiled using a pair of round-nosed pliers, any surplus being trimmed off.

Mould No. 2 is made in a similar manner to mould No. 1. This mould can also be used to produce anchor type weights by filing off the corners at the bottom, and inserting four brass wires tied together at the top with finer wire. When casting ordinary type weights with this mould it is then necessary to fit a small square metal plug in the bottom.

Mould No. 3 produces a heavier type of anchor weight. In addition to the cut-outs in previous moulds, four ¼in. dia. ½in. deep holes are drilled inside the mould. In use the usual brass wire insert is placed at the top end, and two others at right angles are placed at the bottom in $\frac{1}{16}$in. wide filed slots.

Fig. 1 shows a mould assembled ready for casting and also apart.

With this type of mould no riser is necessary as the expanding air escapes through the slight gaps in the sections of the mould. A plumber's ladle should be used for melting the lead. Lightly grease the inside of the mould with tallow before pouring the molten metal and do not forget to warm the mould.

Fig. 7 (Below).—A weight cast in mould No. 1.

AN IMPROVED 'V' CUTTING TABLE

THIS type of small cutting table, much used for fret work or for supporting thin pieces of wood or metal which it is required to cut with a scroll saw, is an improvement on many available tables in that it permits the clamp to lie below the level of the top of the table. This is a distinct advantage since the work can be manoeuvred over the entire surface of the table without hindrance from the cramp.

A convenient size is from 4 to 6 in. wide × 6 to 8in. long and about ¾in. thick. Oak was used for the table being described. The mild steel bar is 2in. wide and $\frac{3}{16}$ in. thick, and a rebate is cut in the underside of the block to receive it; fastening is by means of ⅝in. countersunk wood screws. A groove is cut to house the top of the cramp; it should be only just wide enough and deep enough to pass the cramp, and of a length to allow the bottom of the cramp to engage with the overhanging edge of the main table. The sides of the " V " are cut to 65 deg.

Fig. 1 will make construction quite clear, and Fig. 2 shows how it is attached to the kitchen or other table. Remember to put a piece of thin plywood between the screw and the underside of the table in order not to mark it unduly.

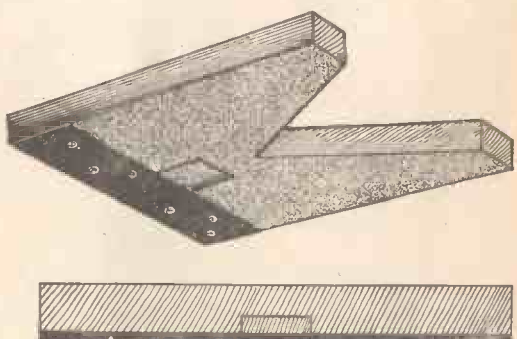
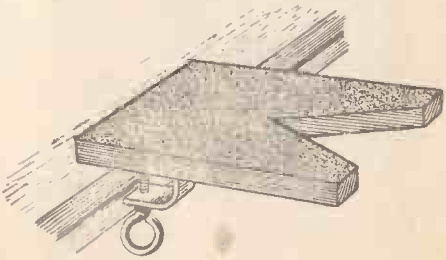


Fig. 1 (Above).—How the table is made.

Fig. 2 (Below).—Method of attachment.



D. D. Smith says . . .

TAKE THE SHAKE OUT with this—PISTOL

ONE disadvantage of using a hand-held camera is the difficulty of holding it steady whilst filming; the slightest movement produces a much exaggerated effect when the film is projected. The use of this pistol-type grip alleviates much of the trouble.

General Details

The device consists of four parts; the tray, which is the camera support; the stock; the trigger and bearing. The first part to make is the tray, which is formed from $\frac{1}{16}$in. soft aluminium. The dimensions given in Fig. 2 apply to an 8mm Kodak Brownie, but instructions are given in the final paragraph, for modifications to other cameras. It may be noticed that the width of the camera at the base is $2\frac{1}{4}$in., whilst the distance between the side pieces is $2\frac{3}{8}$in. The extra $\frac{1}{8}$in. is to accommodate a lining of velvet, felt or other similar material to protect the camera finish when in use and also to hold the camera firmly. A neat job of bending up the side pieces may be made if the method of clamping the metal between pieces of hardwood is used. The shorter side is clamped, and the longer forced over by using a third piece of wood as a lever. The holes shown may be drilled before or after bending. It has been found, however, that even small holes in aluminium tend to weaken it sufficiently to cause a wrinkle or pulling during bending.

After bending, sharp edges are removed and the corners radiused as shown. A finish very similar in appearance to the popular satin-chrome finish may be obtained quite easily; the polish on the aluminium is removed by the use of fine emery paper and a very fine matt finish afterwards imparted with an abrasive polish. A " non-abrasive " chrome cleaner was used on the prototype.

The Stock

The stock is made from hardwood $\frac{3}{4}$in. thick to the shape and dimensions shown in Fig. 3. The finger " dents " are not an absolute necessity but do add something to the comfort in use and give a professional looking finish. The dimensions marked " X " and " Y " are dependent upon the type of camera case retaining screw used. This must have the British size ($\frac{1}{4}$in. Whitworth) screw and will probably be 1in. dia. and $\frac{1}{4}$in. thick; " X " would then be $1\frac{1}{8}$in. and " Y " $\frac{9}{16}$in. It should be noted that the stock is angled forward. This gives a more comfortable holding position. After sandpapering smooth, a filler is used and finally several coats of paint, colour

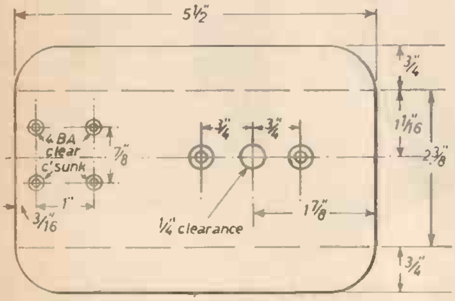
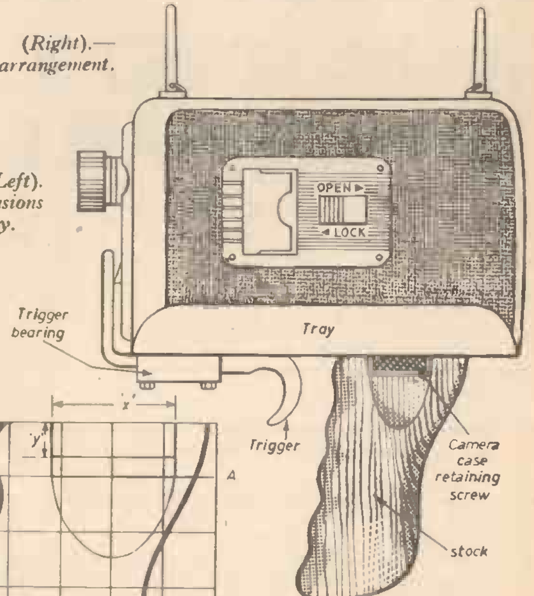


Fig. 1 (*Right*).—*General arrangement.*

Fig. 2 (*Left*).—*Dimensions of tray.*



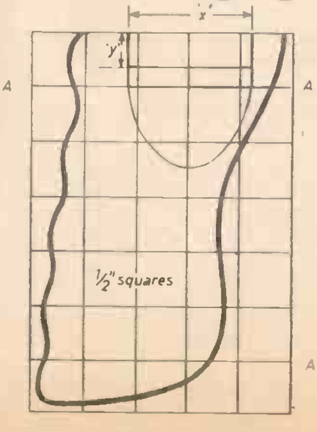
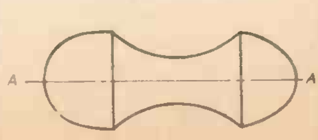


Fig. 3 (*Left*).—*Plan and section of the stock.*



OF SHOOTING GRIP

to choice, given. In the original, the oak stock was simply given three coats of clear cellulose.

Make the trigger bearing from aluminium, plastic, hardwood, or Paxolin, of ⅜in. thickness (see Fig. 5). The latter material may be obtained from most ex-government radio surplus dealers. The fixing holes are drilled 6 B.A. clearance or could be tapped B.A. if material suitable for tapping is used. A polished finish will again add much to the appearance of the finished article.

Perspex ¼in. thick is used for making the trigger shown in Fig. 4. The curve is made first by heating the material in boiling water or in a " moderate " oven and forming, whilst plastic, round a broom handle. Do not use direct heat or the Perspex will bubble. The thickness is reduced to ⅛in. where shown, by filing and the operating " finger " bent at right angles after heating again. The curve is finally filed to a shape comfortable to the index finger. Remove file marks with abrasive paper and polish with an abrasive liquid polish or one of the special polishes produced for Perspex.

Assembly may be started by screwing the stock to the tray with ¾in. × No. 4 brass screws, after first placing the camera case retaining screw in position in the recess cut in the top of the stock. Next, the trigger and trigger bearing are placed together and fastened to the tray with ½in. × 6 B.A. countersunk head screws with nuts on the underside of the bearing.

The final job is to line the tray with a material as previously suggested. This is fastened on with an impact adhesive, afterwards being trimmed with a razor blade.

Modification for Other Cameras

Although designed specifically for the Kodak camera, this holder may be adapted to suit most types of cine cameras having a tripod bush in the base. If the camera has a push-button on the front face, the trigger should be modified to suit. This would entail possible modification to the length of the sliding piece and to the operating " finger."

If the camera has the release button on the side, the simplest method of operation is by a flexible release. The operating finger should be omitted and the back of the trigger drilled partially through to take the solid end of the inner cable of the flexible release when the button has been removed. The stock is drilled in line with the hole so made and then opened out to take the shoulder on the outer cable as shown in Fig. 6. After the cable has been fitted, the space between outer cable and stock is plugged with plastic wood which holds the flexible release when the trigger is depressed. It will be found that the outer cable will twist sufficiently for it to be screwed into the socket in the camera. If so desired, the trigger may be left off, the button on the flexible release being then pressed with the forefinger (inset).

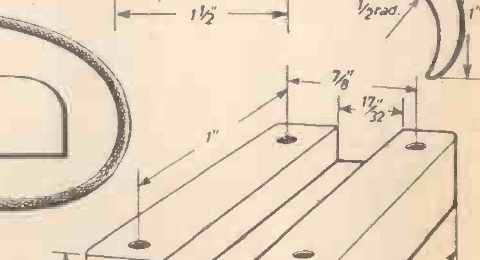
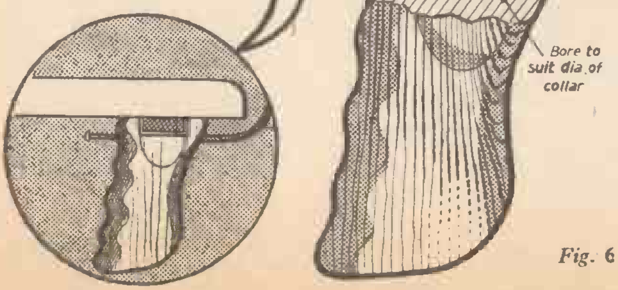


Fig. 4.—Details of the trigger.



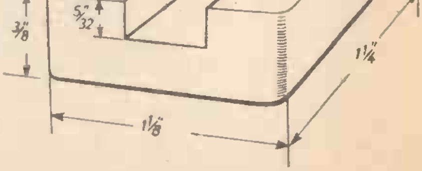


Fig. 5.—Trigger bearing dimensions.

Fig. 6 (Left).—Alternative arrangements to suit other cameras.

A Portable Punch and Judy Show

(Right) The show in progress

ERIC HAWKESWORTH

describes how to get a professional effect

THIS Punch and Judy show has several novel features. By lowering the frame height, the performing shelf is brought down to give children a better view of the show, the operator can sit comfortably while he manipulates the dolls.

Making The Frame

Planed timber of 1½in. × 1in. section is used to make the six folding frames. Fig. 1. There are two main frames measuring 2ft. 3in. × 2ft. wide and four side frames 2ft. 3in. × 1ft. 10in. wide. The frames are jointed with simple sawn halving joints which are then glued and screwed. Assemble the frames as two separate units by hinging side frames each side of a main frame. Use 2in. × ⅜in. butts and notice how an extra strip of framing is required to act as a spacer for each left-hand side frame. This allows the left-hand frame to fold flat over the right-hand one.

The upper unit of three frames is then hinged to the lower with a pair of face mounted hinges. Coach bolts with wing nuts—¼in. bolts through $\frac{5}{16}$in. drilled holes—are inserted in the positions indicated to lock the frames in the open position and a 3ft. long bar is bolted across the tops of the frames to act as a brace and also support the face screen.

Three yards of striped material 3ft. wide provides enough for the frame cover (Fig. 2). Cotton cloth is quite suitable but if it is intended to show the Punch and Judy out of doors very often, then thin canvas is advised.

Sew two 4ft. 6in. lengths of the material edge to edge and cut away the piece in the centre panel for the performing opening. Hem any raw edges and sew the tie tapes to the corners as shown. Pieces of tape, 16in. long are doubled and stitched strongly to the six points indicated. Complete cover can be added to the frame.

Combined Face Board and Performing Shelf

This may be cut from thin plywood or hardboard, using a sheet measuring 1ft. 10in. × 2ft. 6in. wide. Fig. 3 gives all the main dimensions for laying out the contours and shows how the performing shelf fits into slots and screws down on to a wood block strip.

Paint the board red then line out the scrolls with gold. An artist's brush is suitable for doing the gold lines which should be ¼in. thick. The curtain drapes are painted blue to match the velvet drape along the shelf edge. Notice how the shelf is cut back at the ends and has the front corners rounded. The shelf drape is fixed with brass-headed tacks into the $\frac{5}{16}$in. plywood.

Two bolts with wing nuts secure the face board to the frame. Correctly positioned, the upper edge of the face-board opening should be flush with the top cross member of the frame.

Puppet Rack

The puppet rack is a piece of ⅜in. plywood 4in. deep by 21in. long (Fig. 4). Six large screw hooks are fixed along its centre line at 3in. spacings and the protruding screw points hammered over at the rear. Bolt the rack inside the frame at knee height.

Complete the fit-up by hanging a back-drop over the cross bar stay. Plain lace is suitable and may be dyed green to give a good backing effect to the performing opening.

(Right and left) Two views of the finished show.

February, 1961

Making Mr. Punch and Judy

All the puppet heads are sawn out of $\frac{5}{16}$in. plywood and their shapes may be copied by marking grids of $\frac{1}{2}$in. squares and using the diagrams as reference. Mr. Punch's head is marked out on a piece of plywood 3in. × $2\frac{1}{2}$in. After shaping, the head is glued into a length of 1in. dia. tube which is slotted to receive the wood. Aluminium tube is best and each head requires a piece $1\frac{1}{2}$in. long. A 2in. dia. plywood collar is bored to fit on the tube and this glued to the tube and underside of head (Fig. 5). Paint the face pink then add all the other colours as shown.

Mr. Punch's coat and puppet body is made from red velvet and is 9in. deep. The body fits round the plywood collar on the finger tube and drapes outwards and downwards. Holes for the puppet's arms are cut in the body and 3in. long sleeves are sewn in place. Thumb and little finger operate the arms and the sleeves must be wide enough for easy operation. Glue two small plywood hands into the ends of the coat sleeves and decorate the costume with black lapels, pockets and buttons. A loop for hanging the puppet on to the rack, is sewn to the body at the rear. Mr. Punch's stick is an 8in. length of smooth, $\frac{1}{2}$in. dowel painted brown.

The puppet should fit comfortably on the right hand with first finger inside the tube and thumb and little finger inside the arms.

Judy's head is cut from a piece of 3in. × $2\frac{1}{2}$in. plywood (Fig. 6). The method of mounting with finger tube and plywood collar is the same as before but Judy's dress is cut from heavy floral brocade. It has a stand-up collar, wide sleeves, pearl buttons.

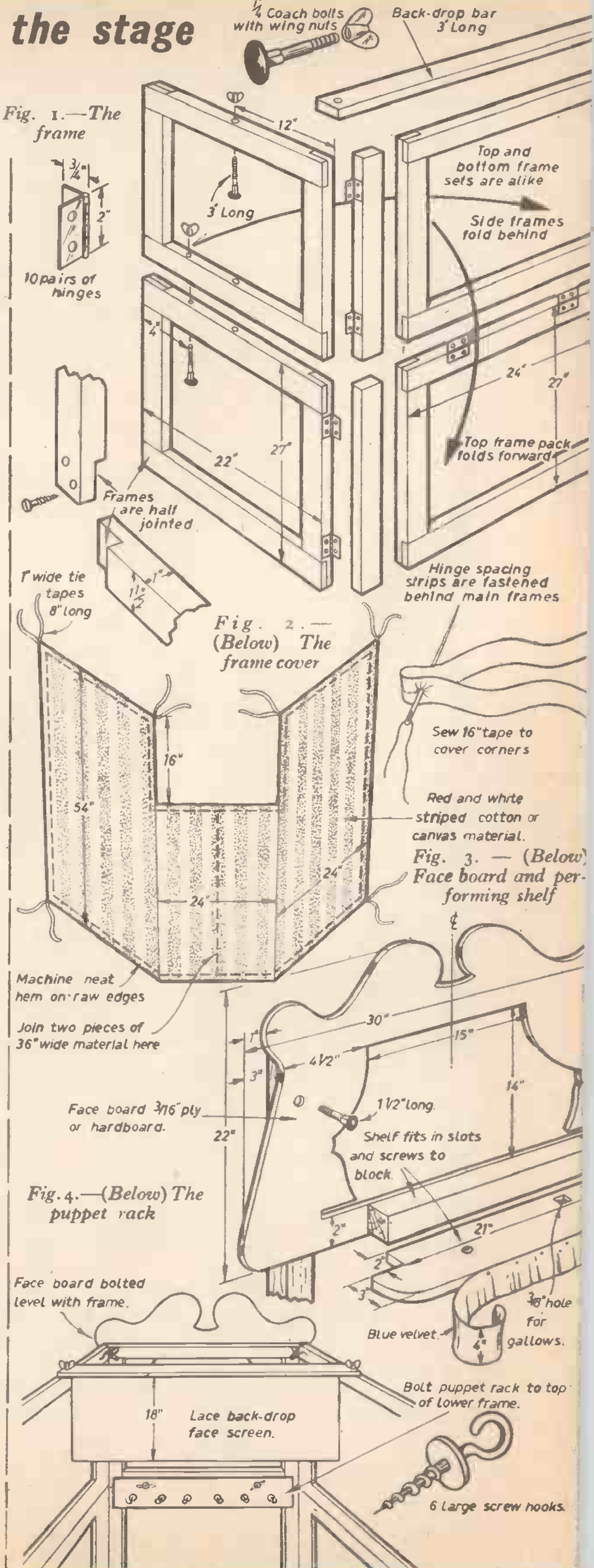


Fig. 1.—The frame

Fig. 2.—(Below) The frame cover

Fig. 3.—(Below) Face board and performing shelf

Fig. 4.—(Below) The puppet rack

Some of the puppets.

The Policeman

This puppet's head measures 2in. by 2½in. His costume is blue with silver buttons and a pair of plywood handcuffs dangle from his hand, see Fig. 7.

Frame the gallows from smooth ½in. square wood. The main post is 7in. high with the bottom 1in. narrowed down to ⅜in. square to fit snugly into a square hole in the middle of the performing shelf. Loop a length of white string through a drilled hole and screw eye as shown in Fig. 7 and tie off in a knot at both ends.

The hangman's costume is similar to the policeman's with silver buttons and belt. The head piece measures 2in. × 2in. before cutting.

The Baby and the Crocodile

Make the baby from a tube of blue velvet with plywood head and neck glued into the narrow end. Trim the figure with a strip of velvet for the bonnet and sew or glue buttons down the front (Fig. 7).

The crocodile's head and jaw is built up from 3/16in. plywood with the finished jaw fitting inside the head. Make each part as shown then pivot them together on a length of ⅜in. dia. dowel. This dowel is glued into holes each side of the head but the jaw is free to pivot on it. A second dowel is glued into the jaw as shown in Fig. 8; this is the thumb bar. Fingers of the left hand fit over the pivot bar and the thumb operates the jaw via the thumb bar.

Make the crocodile's body from brown cloth and glue it to the rear of head and jaw. As before, ensure the body of the puppet is an easy fit on the arm. When the dolls are hanging head downwards on the rack it should be easy to push a hand inside and pick them up ready for working.

Finish the crocodile by gluing a snout to the front of his head and painting the eyes, etc.

Presenting Punch and Judy

The operator sits on a chair or stool with his face level with the stage opening but concealed behind the screen. Dolls are hung across the rack from left to right: Crocodile, Judy, Baby, Policeman, Hangman with Gallows and Mr. Punch on the last hook. Mr. Punch's stick rests on the operator's lap.

A set of voices are required, one for each puppet. The policeman's voice can be gruff and the Hangman's a deep bass. Judy speaks in a high-pitched tone while Mr. Punch screeches with the aid of a Punch Call obtained from a novelty store.

Patter and Action

Operator. " Hello girls and boys! Now here comes Mr. Punch if you will all call his name! "

After Punch's name has been called three times, he is shown on the right hand and is holding his stick.

Punch. " La-de-da-de-da! Here we are again. Hello everybody! "

Punch bows to the audience and beats the stage with his stick.

Judy. (From off-stage.) " Where's Mr. Punch? That scoundrel . . . I told him to look after the baby! "

Judy is produced on the left hand and she too, shouts hello to the audience. She grabs Punch by the nose and shakes him. " I told you to look after the baby! What have you done with her! "

Punch. " I shut her in the cellar . . . down in the old coal hole! "

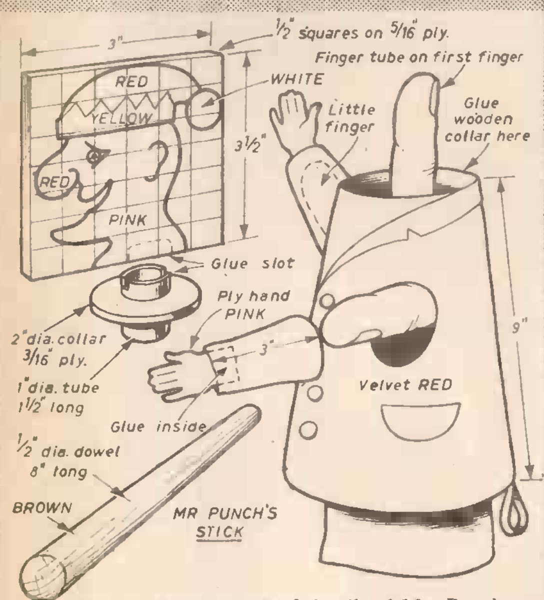


Fig. 5.—Constructional details of Mr. Punch

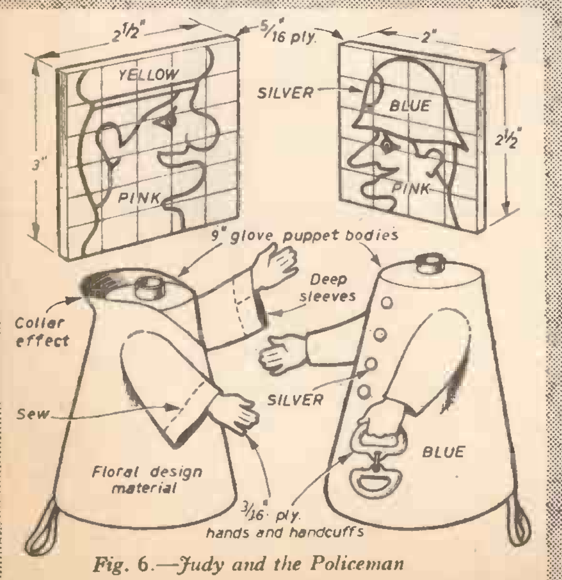


Fig. 6.—Judy and the Policeman

Judy goes below and brings back the baby which she lays on the shelf. Skirt of baby puppet is towards the inside of fit-up.

Judy. " You scoundrel Mr. Punch! Now look after the baby properly while I go shopping! "

Judy is pulled off the left hand by holding the puppet's head between the knees. Replace puppet on rack then insert two fingers into skirt of Baby puppet.

Punch. " Walkey walkey walkey! "

Punch holds up baby and lets it fall flat on its face. After several tries, the baby stands up and keeps moving across the back of the platform shelf to Mr. Punch. Punch returns baby to left side of stage each time. Finally, Mr. Punch knocks baby into audience with his stick.

Judy. (Returning to stage). " Oh Mr. Punch! What have you done with the baby! "

She asks the audience and they are usually quick to tell her what Punch has done! Punch hits Judy with the stick and lays her at the left hand side of the stage alongside the baby who has been returned by now.

Punch " That's the way to do it! One . . . two! "

He counts them with his stick. Judy is left hanging over the platform and the hand is withdrawn to bring up next—

Policeman. " Hello, Hello, Hello, what have we here? Bad Mr. Punch! I'm afraid I shall have to run you in. Come here and be handcuffed! "

The policeman tried to arrest Punch but Punch fights with his stick. The policeman keeps ducking just in time and punches Mr. Punch in the eye several times. In the end, Punch knocks the policeman to the stage.

Punch. " That's the way to do it! One . . . two . . . three! Out goes he! "

The three puppets are thrown one by one into the fit-up and then the hangman arrives with his gallows. These are set up in the slot provided.

Hangman. " Come Mr. Punch . . . it is my duty to hang you . . . to hang you high from the gallows tree . . . put your head in the noose! "

Punch acts stupid and places his head at the side of the loop. He does this several times.

Punch. " I don't know how to do it! Do I put my head here . . . or here? "

Hangman. " NO, NO, NO! Silly Mr. Punch! Put your head in the noose . . . like this! "

As the hangman puts his head through the loop, Punch promptly pulls the string tight.

Punch. " That's the way to do it! "

Punch removes gallows from platform and drops it on the operator's lap. Left hand is withdrawn from hangman puppet and inserted into crocodile which is then placed on the stage.

Punch. " Why . . . it's a pussy cat! Come here nice pussy cat! "

The children will try to tell Punch that the creature is not a cat. Indeed, they should be encouraged to participate right through the show. Usually, their sympathies will be against Mr. Punch.

Now, the crocodile comes for Mr. Punch and they fight. In the end, Mr. Punch is seized by the jaws of the crocodile and pulled below. The show concludes with Punch and Judy coming back to say Goodbye to the children.

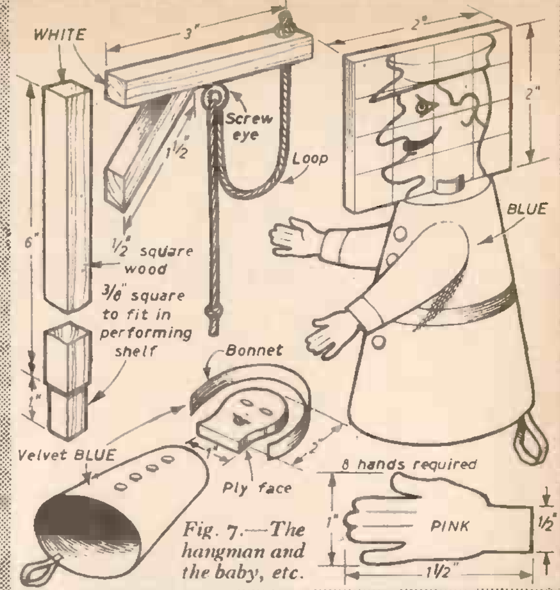


Fig. 7.—The hangman and the baby, etc.

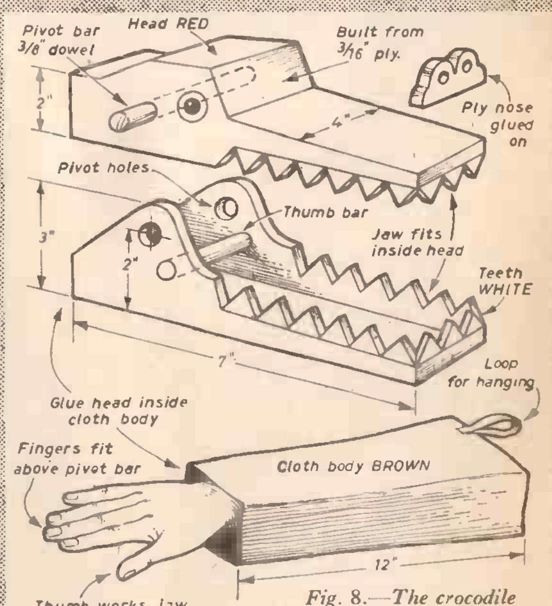


Fig. 8.—The crocodile

The crocodile eating Mr. Punch.

It feels like the real thing when you use this . . . .

MORSE PRACTICE OSCILLATOR

says J. B. Keegan

THE circuit comprises a carbon microphone and balanced armature earpiece in series with a 9-volt power supply as shown in Fig. 1.

COMPONENTS LIST

1 G.P.O. type carbon microphone insert.
1 Balanced armature insert.
1 Tumbler switch.
1 Jack socket
2 4½V. Torch batteries (flat type, No. 1289)

Connecting wire, solder, sheet metal, wooden base, wood screws.

As with all oscillators, positive feedback is employed. Random noise from the earpiece is picked up by the microphone, amplified by virtue of its inherent gain, and passed back to the earpiece, when the cycle is repeated.

As part of the oscillatory circuit is an acoustic link, it is important that the microphone and earpiece are facing each other. The distance between them will affect the tone produced, and too great a separation will prevent operation.

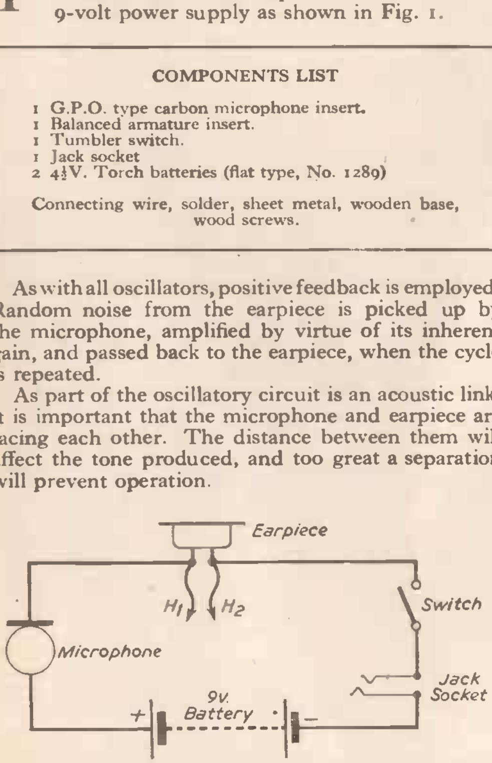


Fig. 1.—Theoretical circuit.

Construction

The optimum distance between the faces of the microphone and earpiece is about ⅜in. Providing this requirement is met, any layout may be used.

The prototype was built on a block of softwood measuring 5½in. × 4in. × ½in.

The microphone and earpiece are mounted on sheet metal clips, as was the jack socket (Fig. 3). Metal from stout tin cans may be used.

The layout used in the prototype is shown in Fig. 2. Wiring is best carried out below the baseboard. Holes are drilled beside each component, and wires are run through them. Each wire runs in a groove connecting the entry and exit holes. The wires are shown dotted in Fig. 2.

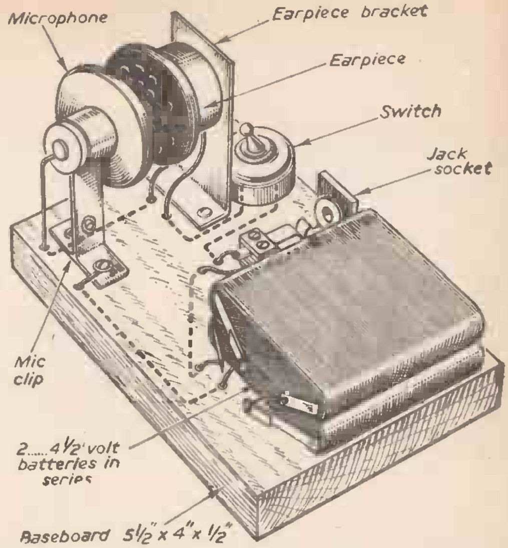


Fig. 2.—Constructional details of the complete oscillator.

One connection to the microphone is soldered to the supporting clip, the other is soldered to the socket on the rear of the unit. Connection to the earpiece is made with the flying leads already on it.

All components are secured to the baseboard by means of small wood screws. The batteries are held down by rubber bands, fastened to small hooks and eyes.

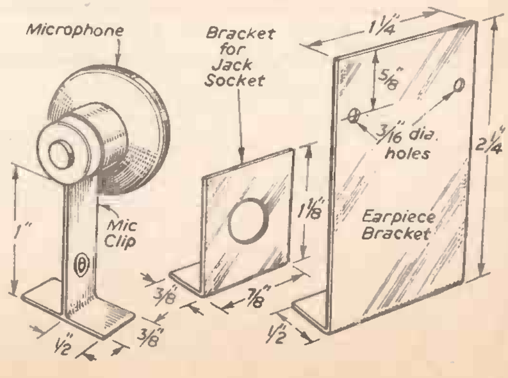
The battery is made up from two 4½V. torch batteries in series, the connecting leads being bolted on to the brass strips. These batteries will last for a considerable time, as the current drawn is in the region of only 30 m/A, and is required only when keying.

Use

The batteries are connected, a morse key is plugged into the jack socket, and the switch closed. A note should be heard when the key is pressed. If only a click is audible, the feedback is in the wrong phase. This may be remedied by simply reversing the battery connections. No sound at all indicates an open circuit somewhere in the wiring, or a bad contact between the microphone and its clip.

If desired, the note may be fed into high-impedance headphones from the points marked H_1 and H_2 in Fig. 1.

Fig. 3.—Microphone, earpiece and jack socket brackets. The base of each must be drilled for mounting screws.



Fresh Water from Sea Water

A New Venture in Guernsey

A £257,000 sea-water distillation plant was officially opened last year in Guernsey.

The plant is designed to produce 500,000 Imperial gallons of fresh water daily to supplement fresh water from the island's reservoirs and catchment areas and ensure an adequate water supply for the £7,500,000 tomato and flower growing industry during drought conditions.

The plant is the first of its kind in the temperate zone and in a country with an adequate rainfall. It is, therefore, being studied with special interest by water engineers since the problem of producing adequate fresh water supplies is becoming increasingly complex even under conditions considered favourable.

Almost everywhere population figures are rising and more people means higher water consumption. The use of water is closely related to the standard of living and this also is on the increase. In Britain water consumption has reached a national level of 60 gallons per day per head not including water used for industrial cooling. In the United States the figure is 110 gallons. Both figures are rising. In many parts of the world underground water supplies are being used up faster than they are being replenished. In some western areas of the United States water is coming out of the ground one thousand times faster than it is being replaced by rainfall.

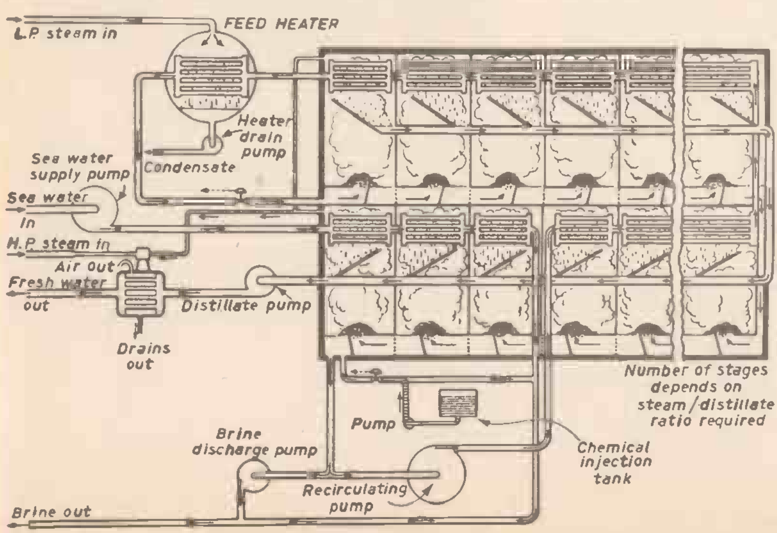
The total cost of the works at Guernsey including the necessary sea water intake and pipe lines is estimated at £257,000, or rather less than one-third of the capital cost of storage. There is an added advantage that water can be produced from the sea whatever the weather conditions, whereas with prolonged drought the storage once used would not refill.

The operating cost of the new plant is estimated to be approximately 7s. per 1,000 gallons or £14,000 for an average year's working. Taking this together with capital charges based on a 20-year life for the evaporator plant the total annual expenditure will be £33,000.

Sea water can be purified for 6-11s. per 1,000 gallons but this can be reduced to 4s. if the plant generates electric power as well as distilling and charges off part of its cost to the power generated. Recent Water Orders published by local authorities in Britain provide for charging up to 4s. per 1,000 gallons.

The Guernsey installation consists essentially of a boiler house, control room and distillation plant, together with fuel oil storage arrangements. The distillation process takes place in an evaporator 69ft. long, 19ft. wide and 18ft. high, which is internally sub-divided into a number of flash and preheater chambers.

The incoming sea water passes through heat exchangers in the plant's 40 flash chambers, after which it is further heated by exhaust steam from a steam engine. In the flash chambers the atmospheric pressure is reduced by means of an air ejector and the hot sea water in its passage through the plant flashes off salt-free vapour due to this partial vacuum. The vapour is condensed on the heat exchangers mentioned above as pure distilled water, which is collected and pumped to storage. De-aeration of the incoming sea water and chemical injection equipment ensure that corrosion and scale formation are kept to a minimum, enabling the plant to be run for long periods.



Simplified flow diagram of "Multiflash" sea water distillation plant made by G. and J. Weir Ltd. of Glasgow.

Build this ½in. Capacity DRILLING MACHINE

By S. Seager

THIS sturdy machine is readily made from pipe fittings and a few other parts, most of which are obtainable from scrap dealers and car breakers. The pipe parts can also be found at plumbers' yards. All secondhand purchases must be examined for signs of strain and distortion. The single step pulleys are from car generator drives and like the valve springs, were obtained at car breaker scrap yards.

Fig. 1.—The completed drilling machine.

Construction

Fig. 3 shows a side view of the assembled job and the parts and fittings are named. The basic frame and pillar are quickly put together, although care must be taken to see that both the horizontal spindle support arms are parallel and that the spindle axis is in line with the frame upright from both side and front views. Assemble the top horizontal arm to the frame and drill a ⅜in. hole at a distance of 5in. from the front; this is to carry the toggle lever mechanism. Fit the lower horizontal arm and leave it a loose fit so that the tee fittings are roughly in line.

Gunmetal Bushes

The preparation of these bushes requires some lathe work, and since some other parts required turning, this work should be done at once. The ideal metal for bushing is phosphor bronze, but this is not found in pipe plugs. One could, however, take cast iron plugs and insert with phosphor bronze bushes.

Take a 1½in. B.S.P. socket and mount securely in lathe chuck, the three gunmetal pipe plugs are screwed in hand tight and drilled and reamed at spindle size. The 1½in. to ¾in. reducing bush is screwed in and recessed to provide the lower housing for the spring. A further 1½in. bush is bored out a sliding fit on a ¾in. or 1in. B.S. pipe and this bush is tapped in three places with a 5/16in. B.S.W. thread; this provides for motor adjustment and locking. Screw into the socket a 1½in. plug, drill through with a ¼in. hole and then remove the plug. Bore out the socket to a clean bore free from all thread marks and take from the lathe. Drill a ¼in. hole into its vertical centre. This is for bolting the 1½in. drilled plug so that the two can be welded together. Opposite to the ¼in. hole make a saw cut along the socket, sawing right through. To each side of the cut weld a piece of ⅜in. square material, drill one at a ¼in. clearance size and tap the other a ¼in. B.S.W. This fitting shown inset in Fig. 3 is for carrying the table mount.

The gunmetal plugs are screwed into the 1½in. tee housings two at the top and one at the lower end of the bottom tee. At the top of the bottom tee, screw in the recessed bush. A piece of material of spindle size is used as a lap to ensure alignment of the two pairs of bushes. The lap carries carborundum fine grade grinding compound and the bushes must be thoroughly cleaned of all traces of paste before offering the spindle for testing. The lower horizontal arm is aligned and then welded in T-pieces.

The Spindle

This is of ⅝in. dia. carbon steel and a length of Stubbs Silver Steel, obtainable through hardware shops, is ideal for the purpose. The lower end of this rod is screwed ⅝in. × 16 T.P.I. to fit a ½in. Jacob chuck No. 34 B. The spindle is cut 2ft. 3in. long and a ⅛in. keyway is cut into it for a length of 10in.

The race assembly which retains the spindle and locates the top of the spring is in three parts (inset in Fig. 3). No. 1 is a steel disc ⅜in. × 2½in. dia. Bore out ⅝in. I.D. No. 2 is the race ⅜in. × 2in. dia. bored out ⅝in. I.D. and carrying 4 ¼in. balls on a 1 7/16in. pitch circle dia. Drill the holes and ream at ¼in. Make four centre pop marks on the edges of each hole on one face, turn it over, drop one ball into each hole and repeat with four centre pop marks. This makes the race cage. Between each hole at right angles to the axis a 3/16in. hole is drilled and tapped ¼in. B.S.W. Into these are screwed hex. head grub screws and the race can be fixed tightly on to the spindle. Phosphor bronze is best for the cage.

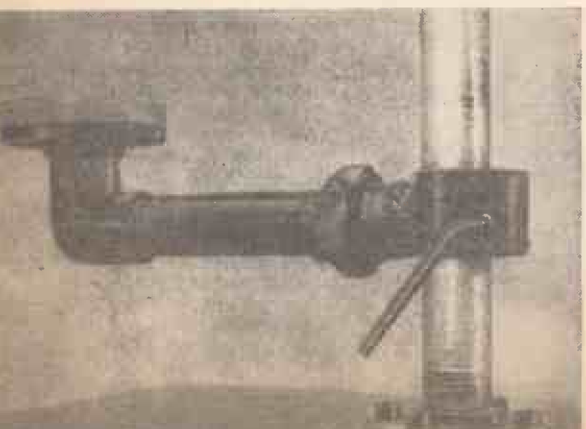


Fig. 2.—Close up of the adjustable table.

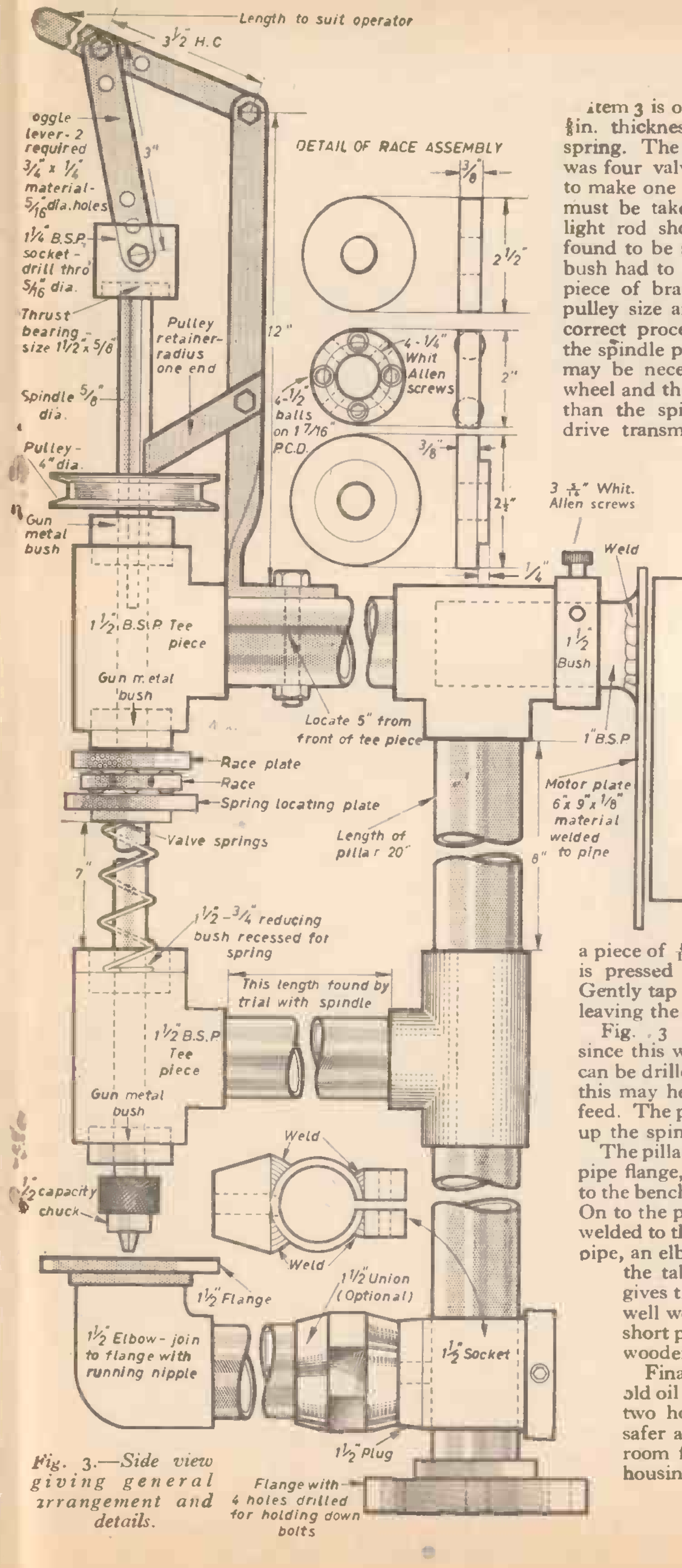
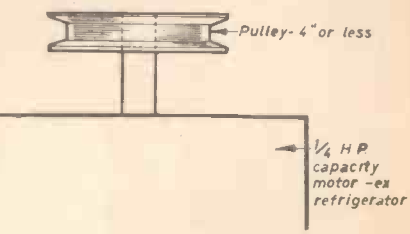


Fig. 3.—Side view giving general arrangement and details.

item 3 is of $2\frac{1}{2}$in. dia. steel drilled $\frac{5}{8}$in. I.D. It is of $\frac{5}{8}$in. thickness and has $\frac{1}{4}$in. skirt to fit inside the spring. The spring was taken from a scrap yard and was four valve springs, welded together at the ends to make one spring. If electric welding is used, care must be taken not to cut the springs; only a very light rod should be used. The drive wheels were found to be slightly oversize of $\frac{5}{8}$in. I.D. and a thin bush had to be made to overcome this slackness. A piece of brass or phosphor bronze rod turned to pulley size and then drilled and reamed $\frac{5}{8}$in. is the correct procedure. A $\frac{1}{8}$in. driving key was fitted in the spindle pulley to drive in the spindle key way. It may be necessary to do the same with the drive wheel and this should be, if possible, slightly smaller than the spindle pulley. Brammer belt is used for drive transmission and length required is 4ft. 6in.



The motor is mounted on a plate 6in. × 9in. welded to the pipe which is a free fit on the previously bored bush.

Surmounting the spindle is a $1\frac{1}{4}$in. B.S.P. socket which is used to carry the thrust bearing No. RM $1\frac{1}{2}$in. × $\frac{5}{8}$in. thrust and also to link with the toggle mechanism. Drill a $\frac{5}{16}$in. dia. hole near the top of the socket right through and cut off a piece of $\frac{5}{16}$in. dia. × $2\frac{1}{8}$in. steel rod. The bearing is pressed into the socket by means of the vice. Gently tap the bearing on to the top of the spindle, leaving the $\frac{5}{16}$in. drilled hole at the top.

Fig. 3 shows connection of the toggle and since this was found by trial and error, extra holes can be drilled on each side of the centre sizes given, this may help an operator to find a more sensitive feed. The pulley retainer is to stop the pulley riding up the spindle and should be radiused at the end.

The pillar is of 20in. length and screws into a $1\frac{1}{2}$in. pipe flange, this in turn is bolted to a good base or to the bench. Over the pillar slides table arm item 1. On to the plug is screwed a $1\frac{1}{2}$in. union which is welded to the plug. From the union a short length of pipe, an elbow, running nipple and flange complete the table arm. The union is optional, but it gives the advantage of a tilting table which is well worth having. No size can be given for the short pipe of the table arm, as it will vary, but a wooden sole can be fitted with advantage.

Finally a wrapper of material taken from an old oil drum could be made to fasten on to the two horizontal arms and give a neater and safer appearance. If a wrapper is made, leave room for the oil can at the top of each bush housing and at the race cage.

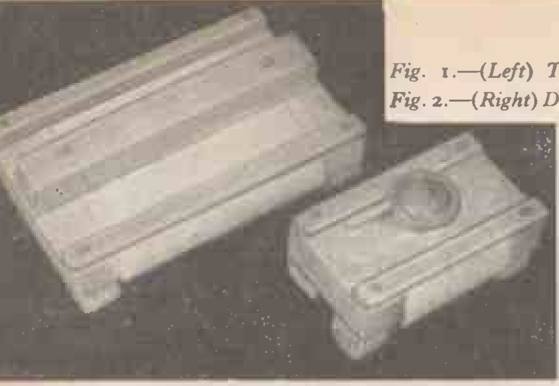
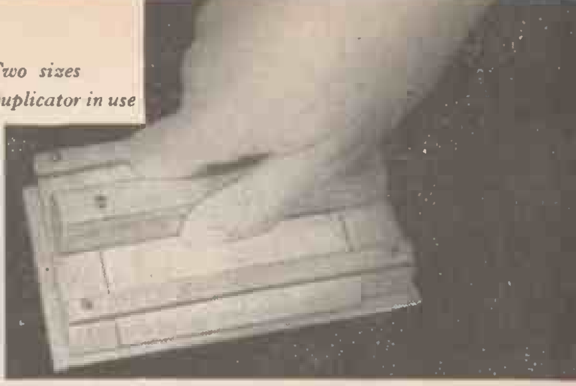


Fig. 1.—(Left) Two sizes

Fig. 2.—(Right) Duplicator in use



MAKE THIS MIDGET DUPLICATOR

By A. E. Bensusan

THE device described here was made to print labels, 2in. × 1¾in., and a larger version for printing a 3¼in. square format on postcards. Fig. 1 shows both sizes. Although used in the manner of an ordinary rubber stamp (Fig. 2), the principle approaches that of a duplicating machine.

The Base

This is made from hardwood of a suitable size. Dimensions are given for the larger size, although these could be altered to suit the nature of the work to be done. It is essential that the thickness of the base is sufficient to avoid deflection under pressure, or the impression will be uneven and indistinct. Remove all sharp corners with fine glasspaper.

Now cut out the stencil grip bars and, where required, the handle. Sand to a smooth finish, remove the corners and drill the clearance holes for the screws as indicated in the diagrams.

Return to the base and drill the starting holes for the four screws holding the grip bars, and for the screw base of the plastic knob. In the case of the larger device, the knob is replaced by the longer handle and two starting holes for the screws holding this part will be needed. To ensure that the holes line up properly, mark them through from the bars and handle. The parts may be varnished at this stage if a high degree of finish is required.

Cut the ink pad to size and staple or pin in place as shown, siting the fixings on the side of the base and not on the printing face. Assemble the handle or knob and the stencil grip bars to the base and, finally, glue small cubes of foam plastic or rubber at the extreme corners of the underside (Fig. 3). Ink the printing face of the pad with duplicator ink.

Cutting the Stencils

The stencils should be cut to the sizes shown (Fig. 4), and the matter to be printed then typed or drawn within the indicated area. Lay the stencil face down on the ink pad, so that the printing area is backed by the ink pad, and tuck the shorter blank end under one of the grip bars which has previously had its screws loosened slightly. Tighten the screws down very lightly, and repeat the process for the other end, pulling the stencil tight before securing.

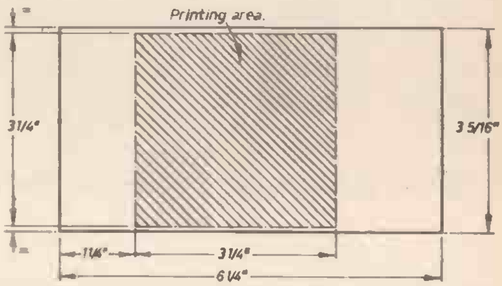


Fig. 4.—Stencil size

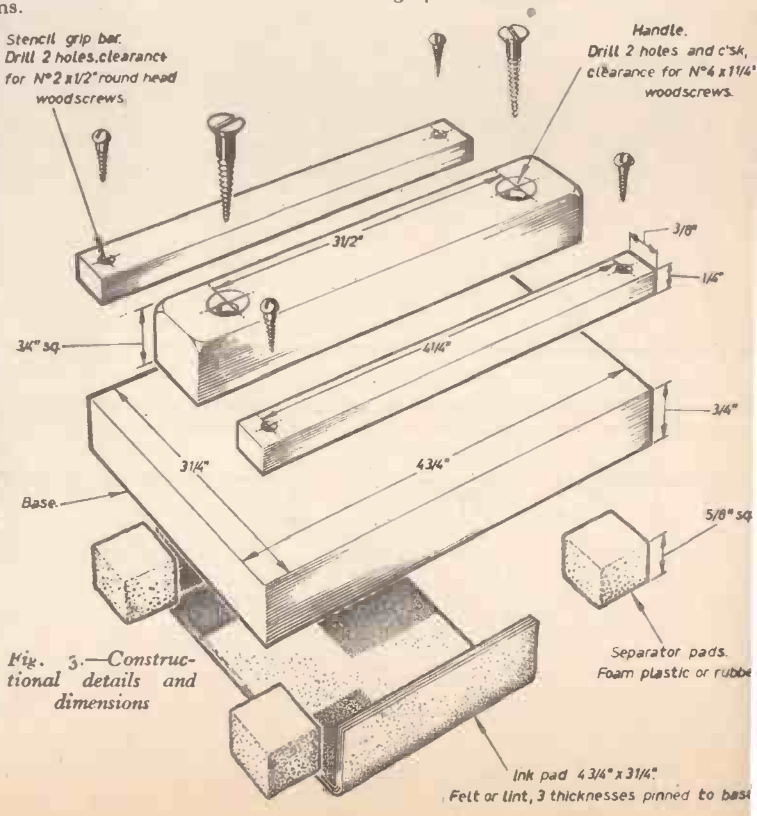
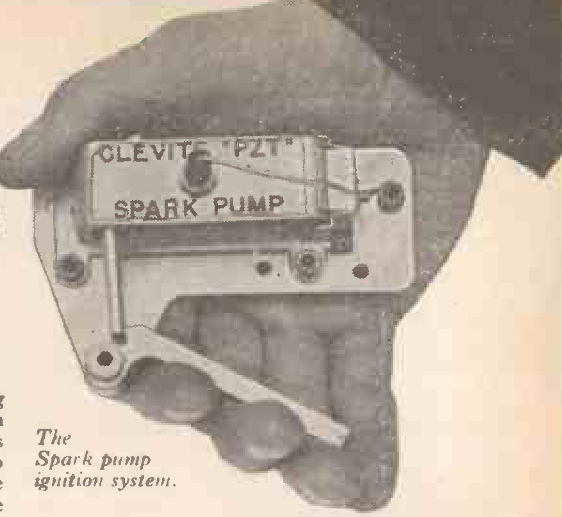


Fig. 3.—Constructional details and dimensions

SCIENCE NOTES



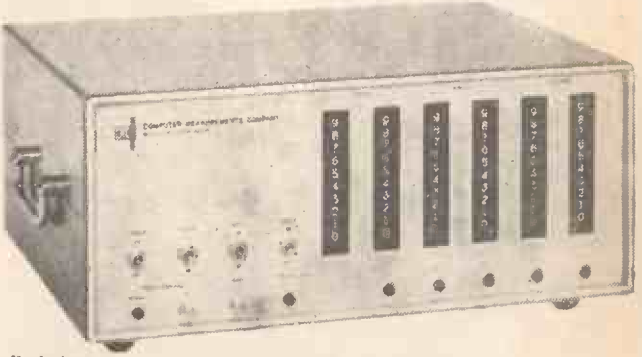
The Spark pump ignition system.

The Spark Pump

WITH a simple timing switch and a sparking plug the spark pump forms a complete ignition system for a small motor. Two tiny ceramic rods each ⅓in. dia. are placed end-to-end with a small gap between, inside a plastic container. The rods are squeezed through the plastic container by a simple mechanism driven off the crankshaft or camshaft. The timing switch to control the spark can be operated by the flywheel. The voltage produced depends on the size of the ceramic element and the pressure exerted on it; 30,000V. can be obtained. The spark is produced by " piezoelectricity " and is so hot that it is not affected by whiskered and burnt electrodes and functions even when immersed in oil. The device is being marketed by the Lambretta/Trojan Organisation, Trojan Works, Purley Way, Croydon, Surrey.

New Digital Clock

A NEW digital clock, CMC Model 224A, has been announced by an American firm, Computer Measurements Co. It provides three basic clock functions: digital time display, digital time in 1-2-2-4 coded output form, and elapsed time measurement with digital time display and coded output. Real time or time measurement is displayed in hours, minutes and seconds. The internal 1-cycle clock pulses are generated by synchronization with the 60-cycle power line (0·1% nominal accuracy) or by external sources, such as a crystal-controlled time generator. Complete details are available from Ad. Auriema Inc., 85 Broad Street, New York, 4.



The new digital clock.

Rainmakers—Modern Style

TO stimulate rain, the East African Meteorological Department has been conducting experiments with rockets fired into cumulus clouds. It has been found that well-developed cumulus clouds are induced to give up some of their moisture as rain if seeded with common salt. Many trials have been made but in all cases quick communication has been necessary with the weather forecast office in order to intercept the cumulus cloud. Marconi trans./receiver equipment fulfilled this function.

(Below) The " Rainmakers " in action.

H.M.S. OWEN, the Royal Naval surveying ship has brought up a four-foot " core " of the sea bottom from a depth of nearly five miles in the Puerto Rico Trench. This is the deepest core yet obtained by any H.M. Surveying Ship.

The record core sample taken from the half-mile wide trench floor at a depth of 4,277 fathoms is one of a number of ocean soundings being made in the Atlantic for research into the structure and shape of the sea bed. The core will, it is hoped, help scientists in their study of the earth's evolution.

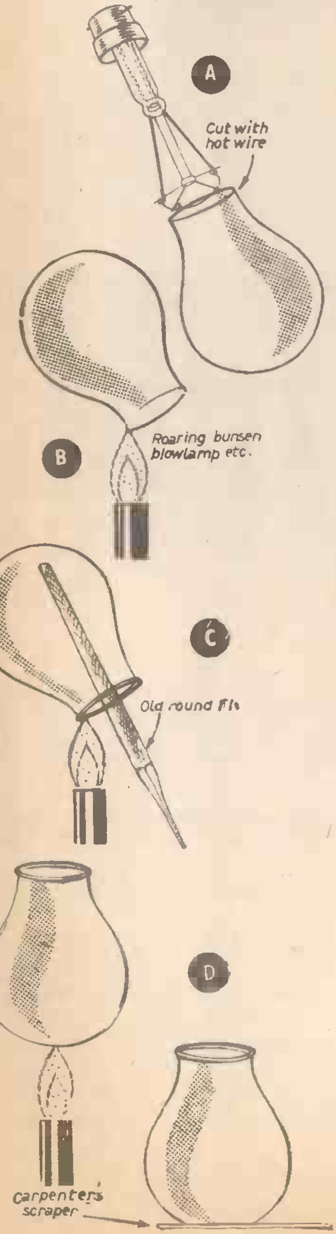
home-made

CHEMICAL LABORATORY APPARATUS

Part 6

By K. Given

Making flasks and evaporating dishes from electric light bulbs.



ALL domestic lamps seem suitable, but the large 200W. or 500W. types give a more conventional flask as the stem is narrower in relation to the radius of the bulb. Pearl or clear lamps may be used, but pearl ones probably make more useful evaporating dishes as when made into flasks one cannot see into them so easily.

Cutting

The lamp to be used has the hot wire (September 1960 issue) wrapped round the stem ⅛in. from the brass cap. The current is switched on and the glass cracks *or* with some lamps the current has to be switched off and the glass held under a cold tap. One in two will crack exactly as required, after practice nearly every lamp will crack satisfactorily, see Fig. 38A.

Separating

Do not try and lever the bulb away from the cap even when a crack has developed all round. Put the lamp down on the bench and leave it for 10 minutes. Gas pressures will have equalised through the crack and the bulb will *fall* away on its own. Remove the parts and keep the cap for future use. Any bulb stems which have faults such as small cracks beginning to travel down to the flask should be kept as they can be made into evaporating dishes as described later.

Rounding the Edge and Forming a Flange

The flask made is rather thinner than a conventional flask. Since it is round bottomed this does not matter very much as roundness gives it strength, but the stem has often to be fitted with a bung or cork. Any small crack at the top of the stem will travel down when a cork is used. Tiny cracks may be " sealed " by prewarming and holding the rim just at the top of the blue cone of a roaring bunsen flame and rotating the flask. The glass will then round itself off all round the rim (Fig. 38B). The flask may be used like this and will be perfectly satisfactory if care is used in fitting corks.

For greater strength a flange can be made by continuing to heat the rim and gently easing the hot glass outwards using an old round or half round file which should be warmed up somewhat before use. This stage is shown in Fig. 38C. Great care must be exercised to keep the neck of the flask round so that a bung is airtight.

Making a Flat Bottom

It is possible to make a flat bottomed flask by heating the bottom carefully in the roaring flame and then pressing the bottom gently on to a pre-warmed piece of flat metal such as a carpenter's scraper (see Fig. 38D). Care must be taken to get the flat part at right angles to the stem or the flask will not stand perfectly.

The Flasks in Use

These flasks are perfectly satisfactory in use providing some simple precautions are observed.

1. Use very soft rubber bungs or corks which have been *soaked in water for 24 hours.*
2. Be careful not to do up the clamp of the retort stand too tightly.
3. Use the flask wherever possible on a sand-bath.

Fig. 38.—Stages in making flasks from old electric light bulbs. A—cutting. B—rounding edges. C—making the flange. D—flattening the bottom. When rounding the edge and forming the flange (B and C) it will be found easier to work with the bulb the other way up so as to avoid excessive heat.

Fig. 39.—Examples of flasks and evaporating dishes made from a television tube and electric light bulbs.

4. Prevent excessive bumping as described.
5. When using flasks of dangerous liquids such as the caustic soda solution under consideration, *always* be ready for a breakage and arrange things so that no other damage will be done to person or apparatus.

Larger Flasks

Some old type television tubes make ideal flasks. The Brimar tube No. C12B for instance (Fig. 39) was satisfactory, but the Mullard tube No. CRM12 not so good as no way was found of removing the graphite inner coating.

The following procedure was used. The tube itself was wrapped completely in two layers of sacking with only the small makers " vacuuming " tube exposed through a hole in the sacking. This tube was then broken by squashing it with some mole grips. The sacking was then discarded.

The neck was cut off with the hot wire. Cold water treatment was necessary to start a crack. The Electron Gun was withdrawn as useless. The inside of the tube was then cleaned with a small quantity of strong nitric acid. Probably a home-made brush and plenty of water would do this job, but in case the fluorescent chemicals should prove dangerous wear rubber gloves.

The neck was not rounded off, neither was a rim flange made as the glass is very thick and the bunsen flame not really suitable for such an operation.

In use the flask may be used either with or without a wire gauze. It will stand very rough treatment; even three " full-on " burners without gauze will not crack the flask, provided water is present within.

One was used for making distilled water with a Liebigs condenser to be described later. The " vacuum " tube was sealed with rubber tube and a home-made " Mohr's " clip, and a normal cork used in the neck.

Making Evaporating Dishes

Lamp bulbs and some old fashioned radio valves can be turned into suitable vessels. Normal laboratory dishes are of porcelain, but unless expensive ones are used some will always crack in use. The same will apply to the home-made ones; when used on a sand-bath about one in thirty will fracture during use.

The red hot wire is again used in cracking off the top part of the lamp bulb or valve. Fix up the apparatus in the following manner. Fill a baking tin with fine sand, place an asbestos cloth (can be obtained from most iron-mongers as " oven-cloths ") on the sand. A dent is then made in the cloth with the lamp bulb.

A loop of resistance wire is laid as shown in Fig. 40C and fitted up as in the September 1960 issue. Take care the spare wire does not burn the table. Details were given in the earlier issue of the procedure necessary for cracking glass bottles, etc. Use the apparatus on bottles first and come to lamp bulbs later as these are appreciably harder to work with. Generally with a 12V. supply, 26g Eureka wire may be used, start with about three feet and reduce it until it glows a bright red without fusing. The foot switch is necessary.

Refer to Fig. 40 B and C. The loop of wire is held in place by a light pressure on the lamp bulb. It is important that the wire does not touch, but stays very close together, as shown in " B." Holding everything quite still the foot switch is pressed. The lamp bulb will crack round making the " dish."

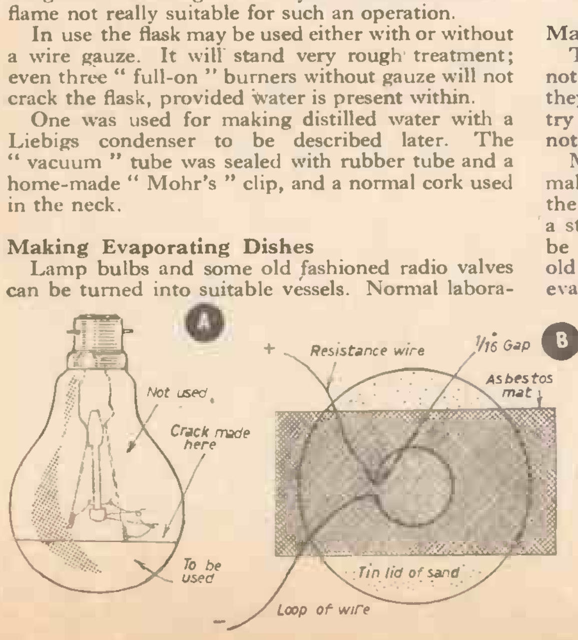
Making the Lip and Rounding the Edges

The edges are rounded very slightly if the crack is not absolutely uniform, otherwise they may be left as they are, remembering they may be sharp. Do not try to grind them with carborundum as the glass is not thick enough. A lip must be made next.

Much the same process is used as was used in making a flask and shown in Fig. 38 A to D. If the dish is heated, firstly in a yellow flame, then in a strong roaring one the glass, when red hot, can be stretched to a very neat lip using a pre-warmed, old, round or half round file. Fig. 39 shows some evaporating dishes made in this manner.

If they are required for other uses than heating it is handy to flatten the bottom as in Fig. 38D.

(*To be continued*)



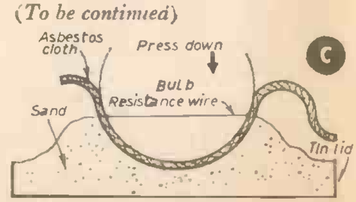


Fig. 40.—Making evaporating dishes. A—Part of bulb used. B and C—two views of the apparatus for cutting.

L.B.S.C.'s first series for Practical Mechanics

A 3½in. Gauge "EVENING STAR"

HEARTY greetings to all readers of *Practical Mechanics* who are interested in steam locomotives, and a cordial welcome to new readers who have followed my notes through the years in other journals. There is no truth in the rumour that I have retired! I've just followed the good example of L.B. & S.C.R. No. 55, *Stepney*, the " terrier " that I learned to drive before my thirteenth birthday. After many long years of service on the " Brighton," Southern, and British Railways, she took a rest, and then restarted work, fresh as a daisy, on the Bluebell line. I've had a break from writing and drawing—which I badly needed after 34½ years' weekly nonstop run—and am now once more at the service of all locomotive-builders, though working from a different " shed."

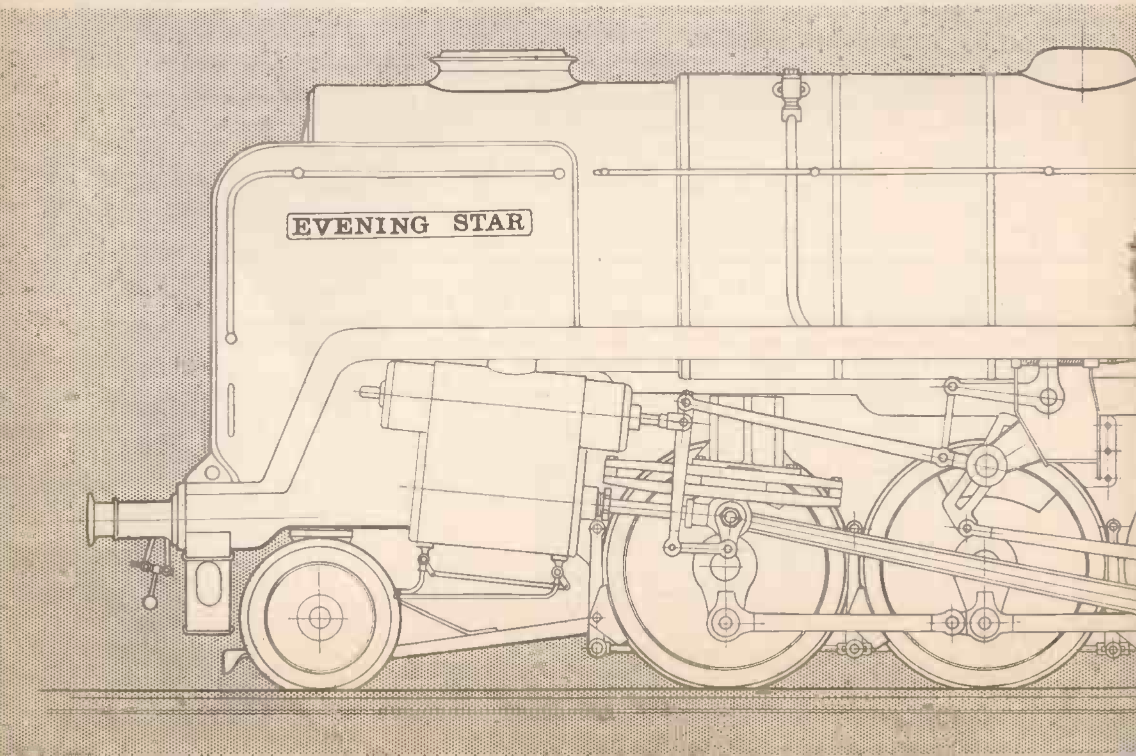
In answer to many old correspondents, I haven t been idle in the interval. It is said that a change of work is the best rest. As I love making a small success out of a full-size failure, the first thing I did was to build a 3½in. gauge edition of the Mather-Dixon ten-foot single, delivered to the G.W.R. in 1838. She was a complete washout, barely able to pull her own tender, much less a train, and never did any useful work. In my little copy, I eliminated all the faults of the full-size job; result, she has no trouble in pulling my weight (equal to a 320-ton train) well over a mile with one firing, keeping a full head of steam, and at a speed equivalent to about 85 m.p.h. Even at that speed, the huge driving-wheels turn slowly, " with measured beat and slow " like the village blacksmith in the ballad. Two beats per foot run!

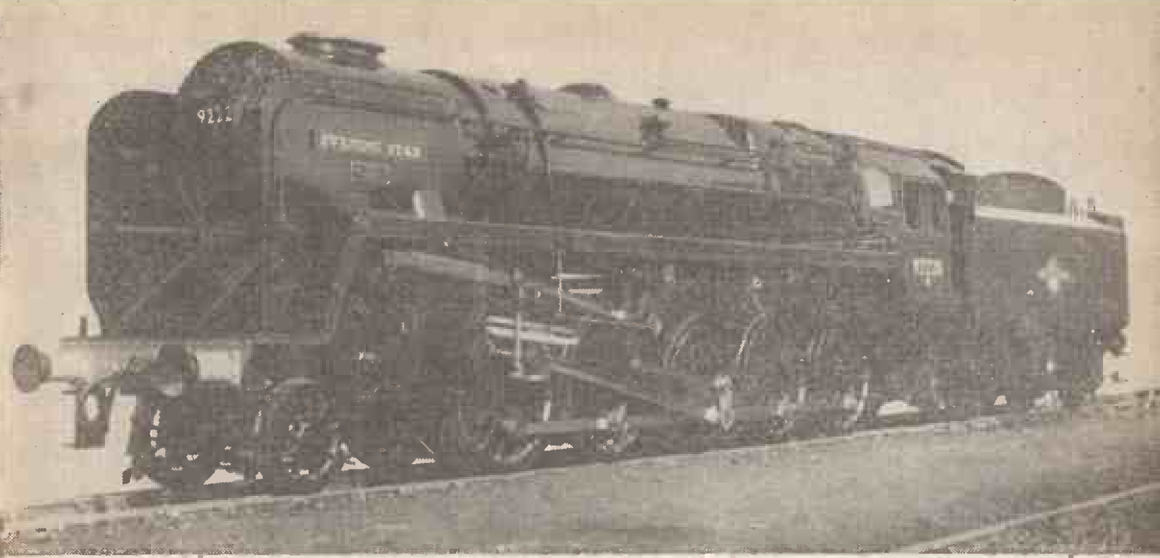
An amusing incident occurred on the first trial run, which took place on a damp misty evening. She had settled down to a steady pull, and had " got well hold of the load " as the enginemen say, when she struck a place on the line which was extra damp and slippery, and—in railway lingo—" lost her feet " and slipped. Due to flywheel effect, the big wheels spun around like a buzz-saw in full blast; and before I could reach over and shut the regulator, half the fire shot out of the chimney and joined the sputniks, and most of the remainder was in the smokebox. If the ghosts of Brunel (the old G.W.R. engineer) and the boss of Mather-Dixon's were anywhere around, they must have laughed their heads off!

After that, I got busy on a Britannia-type engine, which is now nearly ready for steam. I have made her look much prettier than those running on British Railways, and included variations such as outside Stephenson link motion, 50 per cent. more superheat, proportionately bigger cylinders with double guide-bars and alligator crossheads, and other items for maximum efficiency. What with maintenance work on my other engines—I have eighteen in the " running-shed "—also on my little railway, car, workshop, house jobs and what-have-you, I haven't had much time for sleep! Anyway, I think I can claim to be, literally, a " practical mechanic." All I write about is based on actual personal experience; so if any reader seeks information about steam locomotives, large or small, and sends his queries along to our Editor, I'll do my best to supply the answers.

" The Last of the Mohicans "

Most folk know the old saying about " the last shall be first," and with our Editor's approval, my first serial will deal with the construction of a 3½in. gauge version of the last steam locomotive to be built for





Here is " Evening Star " herself shortly after completion at Swindon. *Photo by courtesy of British Railways.*

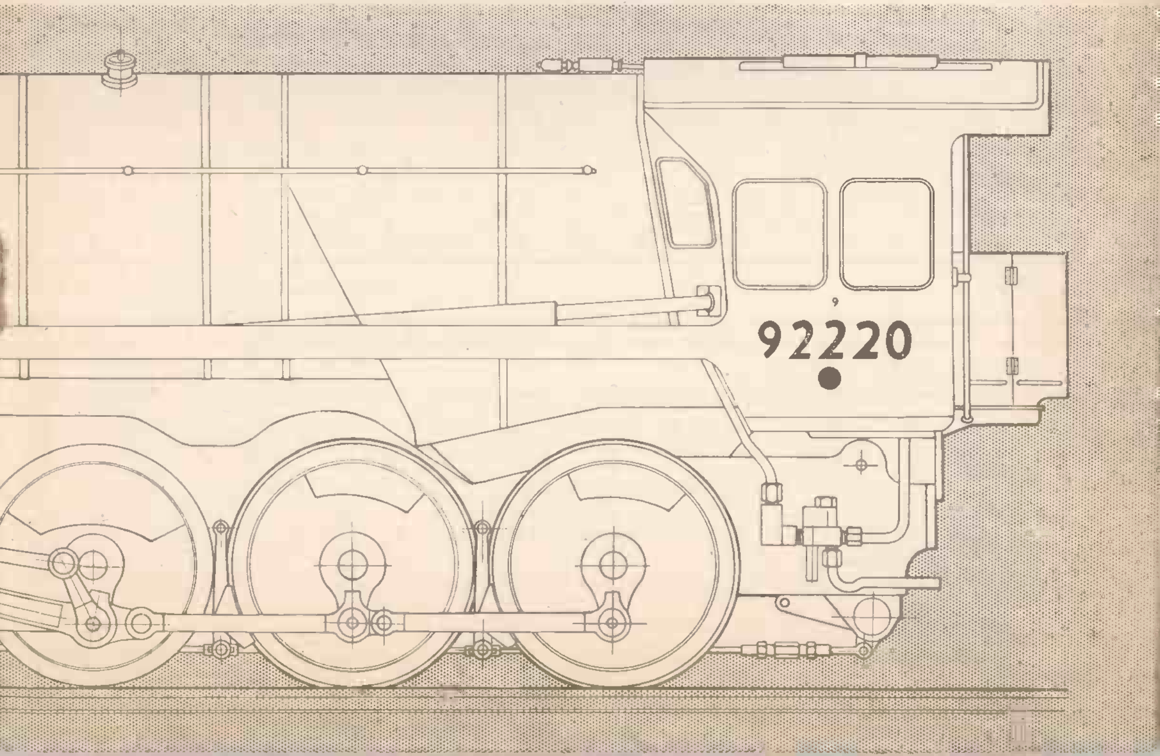
British Railways. She was turned out from Swindon Works in March last, and named *Evening Star* at a special ceremony on the 18th of that month. I received a personal invitation from Mr. R. F. Hanks, Chairman of the Western Region Area Board, to be present; but for sentimental reasons I just couldn't face it.

The engine is a class 9, originally designed for heavy goods and mineral traffic, the wheel arrangement being 2-10-0; but despite the small size of the coupled wheels, it was found that they could run at speeds up to 90 m.p.h. and were therefore quite suitable for fast passenger work as well. They were especially suited for heavy trains working over hilly routes, and on tight timings where a high rate of acceleration was called for. *Evening Star* herself is built to standard specification, but being the last of her race, was given a copper top to the chimney, a commemoration plaque, and the green livery of the Great Western passenger engines. She is stationed at Cardiff, and in addition to ordinary duties, works special trains on tours organised by railway clubs and other organisations.

No " Scale Model "

The little one to be described, will definitely NOT be what is popularly known as a " scale model." I hate the sight and sound of the word " model." It is usually applied to the clockwork and electric toys that

(Below) Side elevation of the 3½in. Gauge " Evening Star." The drawing is ⅓ full size.



are sold for children to play with, and to young ladies who display clothes in fashion salons! My engines are intended to haul living loads, and the only fundamental difference between them, and their full-size sisters is that they are made to suit the rail gauge. Nature refuses to be "scaled," and if a small locomotive is built with all its proportions reduced to $\frac{1}{16}$ of full size, to suit a rail gauge of 3½in., it would only be suitable for a glass case, and utterly useless as a working proposition. The working parts would be far too flimsy, for a start and the boiler hopeless.

The secret of the success of all the engines that I have described, is that I adopt the outline of the full-size engine, with the principal dimensions, such as overall length, width and height, wheel spacing, boiler diameter and length, and so on, and design the inside of the boiler, and all the working parts, for the job they have to do. These I found by actual experiment, not by theory. Forty years or so ago, the theorists said that it was impossible for a 2½in. gauge locomotive to burn coal and haul adult passengers, but my 2½in. gauge "Brighton" Atlantic proved that it was quite easy. Subsequently I built a Pacific that ran on rails only 1¼in. apart, and could pull a 5in. gauge flat car with a 16-stone passenger on it. She did that at a London exhibition in 1926, and again at a show in New York in 1929. She was nicknamed "the rat that could pull a pantechnicon."

Finally, a word of encouragement. If you would like to build a little *Evening Star*, and are chary of attempting it because you think you haven't the skill or knowledge, don't be put off for one minute. During the spelling lesson, the teacher asked a boy to spell "incomprehensibility." The poor kid was flabbergasted, and said he couldn't. "Is that so?" said teacher, "Well, spell 'in'". The boy did. "Now 'com'", said teacher. Again the boy did—and by splitting up the words into syllables of two and three letters, the teacher proved to the boy that he *could* spell the long word. Now my way of describing how to build a locomotive, is to take every component separately, give full instructions how to make it, and then say how it is erected, all in the simplest possible terms. By implicitly following the "words and music," the whole business becomes dead easy, even to the rawest recruit, provided that he has patience and is of average intelligence—which he *must* be, or he wouldn't be a reader of *Practical Mechanics*! I've received scores of letters from beginners who didn't know the first thing about a steam locomotive, saying that they just made the bits, put them together, got up steam, and then—to their great surprise and pleasure—*it worked*!

Tools for the Job

Mention of beginners reminds me—they don't need an elaborate outfit for a kick-off. A lathe is an essential, and it pays to get a good one, such as a Myford or similar; and in these days when most firms sell their goods on the "never-never," the cost presents little difficulty to those with shallow pockets. The lathe has often been described as a "universal tool," and it certainly is just that; because with the aid of a few simple attachments, such as a vertical slide, machine-vice, tailstock drilling pad and adapter, and so on, all the machining operations necessary in the building of *Evening Star* can be carried out quite satisfactorily. All being well, I will tell you how to do them. However, a drilling machine speeds up production.

As to hand tools, the usual assortment found in any home workshop such as hammers, pliers, files, metal snips, drills, taps and dies, hacksaw, hand brace and so on, will be found sufficient. A good stout bench is desirable, with a vice having jaws 4in. or more. For brazing the boiler, a 5-pint paraffin blowlamp, or an equivalent air-gas blowpipe will be required, and for smaller jobs a one-pint comes in handy. Small oddments such as boiler fittings can be silversoldered with a self-blowing gas blowpipe which can be home-made in about fifteen minutes; I'll tell you how. Although there is very little soldering, the "tinkers' outfit"—soldering-bit and flux—should be on hand. Naturally, the better equipped you are, the quicker the job progresses!

Brief Specification

The engine is designed in accordance with my lifetime's experience, being as simple as possible, of robust construction, and capable of hauling a dozen adult passengers without appreciable effort; yet there is nothing in its personal appearance with which Inspector Meticulous could reasonably find fault. The frames are ⅛in. steel plate, with a simpler system of staying than the full-size job. The buffer and drag beams can be made from steel angle, or castings, as desired. Cast hornblocks are used, fitted inside the frames, with solid axle-boxes. No oil pipes are needed, as the bearings and sliding surfaces can be oiled from outside, by a pet wheeze of my own.

The pony truck can be cast, or built up. No side-control springs are required, as the friction between the top bar and bearing plate prevents any "nosing" on a straight line, and yet leaves the wheels perfectly free to follow a curve at high speed without derailment. The ten coupled wheels are 3⅞in. dia., the centre pair having no flanges, as on the full-size engine. The axles are ⅝in. mild steel.

The cylinders are bronze castings, 1¼in. bore and 1⅞in. stroke, with $\frac{11}{16}$in. piston valves of rustless steel, running in pressed-in bronze liners. As some folk are scared of turning piston-valves, I will give an alternative slide-valve cylinder, as I do my best to serve all; but I strongly recommend piston-valves. They are no more difficult to turn and fit than the pistons. The valves are driven by Walschaerts gear, the only ticklish part about which are the brackets carrying the expansion links. These being conspicuous, I have made them look the same as on the full-size engine; but they couldn't be fabricated in the same way, owing to the small size. The guides for supporting the combination lever and its attachments are not required on the little engine, as the weight of the parts is infinitesimal; but they can be added by anybody who desires them for sake of appearance.

The boiler on big sister is made in sections which telescope into each other, giving a bigger diameter at the firebox than at the smokebox; but the barrel of the little one can be a single piece of seamless copper tube, brazed to the throatplate of the firebox wrapper, which simplifies construction. The inside of the boiler is of

(*Continued on page* 258)

A Satellite Navigation System

by Donald Fraser

Showing how the two satellites were joined.

A WORLD-WIDE, all weather navigation system—based on earth satellites—should be available to shipping by 1962.

A great deal of research has already been done, and two experimental satellites have been successfully launched. In a few years time, if all goes to plan, the system will be working and available to ships of all nations.

Some details of the satellite navigation programme were given in London recently by Captain Robert F. Freitag, Astronautics Officer, Bureau of United States Naval Weapons, Washington.

The programme is known as "Transit," and its operational system will involve the use of four satellites which will enable any ship to obtain a navigation "fix" under any conditions of visibility anywhere in the world.

How the System Works

This new navigational system is based upon the capacity of seven ground receiving stations and a computing centre to extract positional information from the signals of an orbiting satellite. Four of the Transit ground stations are in the United States, one in England, one in Newfoundland and one in Brazil.

The signals as measured on the ground, although originating in an ultra-stable oscillator, nevertheless change their frequency as they approach and pass over the station. This change, caused by the movement of the satellite, is called the Doppler shift, and is the key to the entire Transit system.

Measurement of this Doppler shift permits scientists to predict the future orbit of the satellite. This information, when provided to ships through another satellite system, will enable them in any weather to make their positions to a high degree of accuracy.

The system will also make it possible at last, for man to measure correctly the sizes of land masses and the distance between points on them.

Operational satellites in the Transit system will weigh from 50 to 100 lb, and have a useful life of at least 5 years. Their instruments will include a stable oscillator and a miniaturised digital memory for storing orbital information. The satellites will be completely transistorised and will use solar power.

The first vessels to be equipped with the necessary reception and computing equipment to pick up the satellite's signals will be United States Navy ships. Later, it is expected, this equipment will be available to ships of all nations.

The Transit system got under way last April with the launching of Transit 1B. This satellite has, according to official reports, met several test objectives.

Dual Launching Experiment

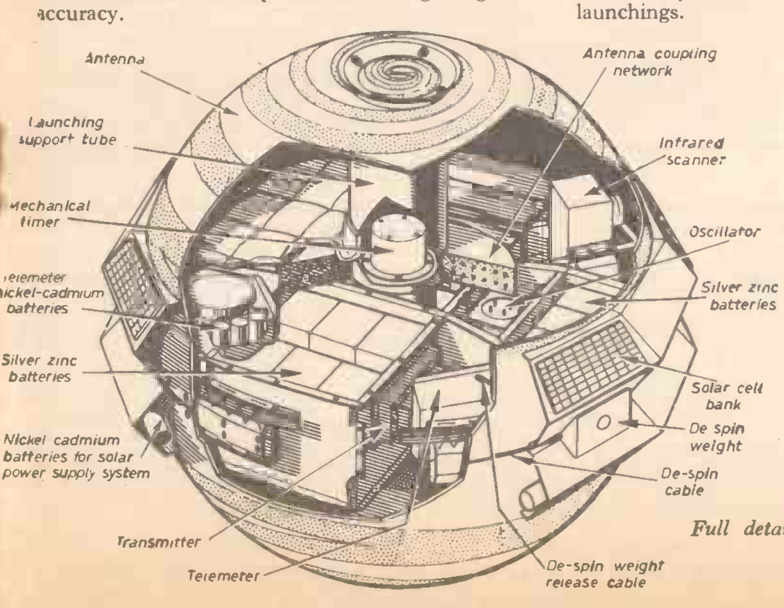
It was followed on June 22nd, 1960 by Transit 11A, which carried aloft with it, in "piggyback" style, another smaller satellite designed to send back information about radiation from the sun.

This technique of launching two satellites with one rocket may be employed again in future Transit launchings.

Transit 11A is a 223lb. sphere measuring 36in. in diameter. Like Transit 1B, it is aluminium-coated, and has a spiral band antenna painted on its surface. It also carries an electronic "digital clock" or time standard, which could lead to a new global time system and a Canadian radio designed to detect cosmic noise.

Transit 11A is completely solar powered, and has twice as many solar panels as it predecessor. It has an expected life of 50 years. Its piggyback passenger,

(*Concluded on page 256*)



Full details of the Transit satellite.

A Mains Equipment Failure Indicator

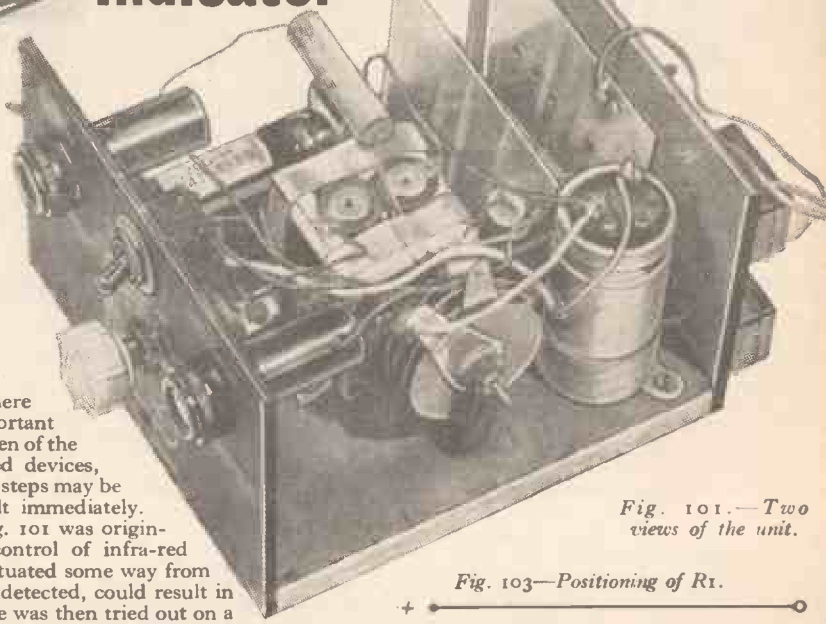


Fig. 101.—*Two views of the unit.*

Part 12 in our Automatic House Series

By E. V. King

THERE are cases where it is especially important that warning is given of the failure of mains operated devices, or the mains itself so that steps may be taken to rectify the fault immediately. The device shown in Fig. 101 was originally made up for the control of infra-red chicken house heaters, situated some way from the house. Failure, if undetected, could result in financial loss. The device was then tried out on a stage lighting set where the operator could not see all the floods from his position off stage. No doubt other uses will occur to readers, but no attempt should be made to use the unit on thermostatically controlled devices.

General Principal

The unit is placed in *series* with the neutral lead to the device drawing current. The currect drawn is taken through a low value resistor (R1) (see Figs. 102 and 103) which will drop the available voltage to the device by just under 10 volts. Normally this does not matter, but 230-volt devices could be used for 240-volt circuits, etc.

Fig. 102.—*Theoretical circuit.*

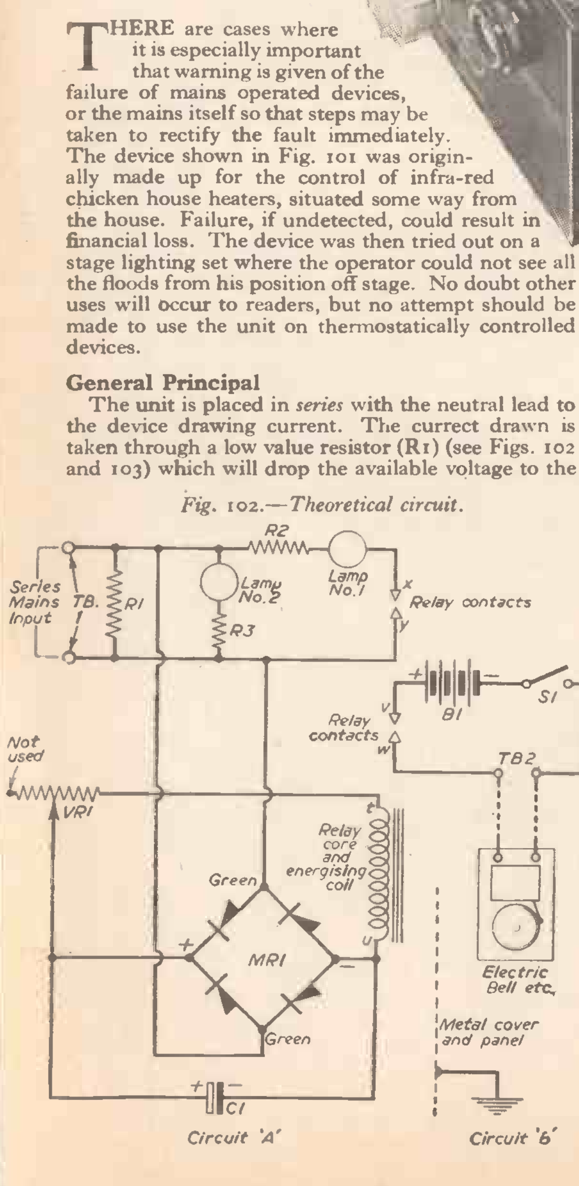
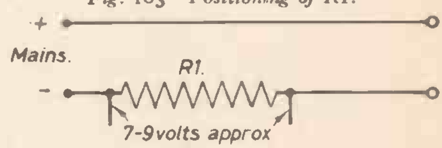


Fig. 103—*Positioning of R1.*



The ten volts drop is caused by R1, is dissipated in heat. The unit described " wastes " 45 watts when controlling 1,000 watts.

The voltage across R1 is rectified by a metal bridge rectifier MR1 and the D.C. output is smoothed by the large small-voltage electrolytic condenser C1. This D.C. potential is applied to the coil of a relay via a variable resistance.

The current through the relay coil (tu) causes the contacts x and y to remain closed and v and w to remain *open*. Should the *mains* fail or the controlled equipment fail, the current drops, the potential across the resistor drops, the flux in the relay core drops, the points v and w close and complete a battery-operated alarm system.

The Warning Lamps

Two warning lamps are fitted. Lamp No. 1 is normally off, but No. 2 is on. If the device fails No. 1 comes on and should thus have a red glass as an indication of trouble. Lamp No. 2 simply lights up as long as current is passing through the instrument and will continue to give that information even if the noise muting switch is off. Lamp No. 2 may be omitted if desired.

Lamp No. 1 goes out when the relay armature is drawn in and the variable resistance VR1 allows this to be set very accurately. VR1 is simply set so that the slightest turn one way brings the lamp on. A variation of somewhat less than 30 per cent. in the current drawn by the external device will then cause the

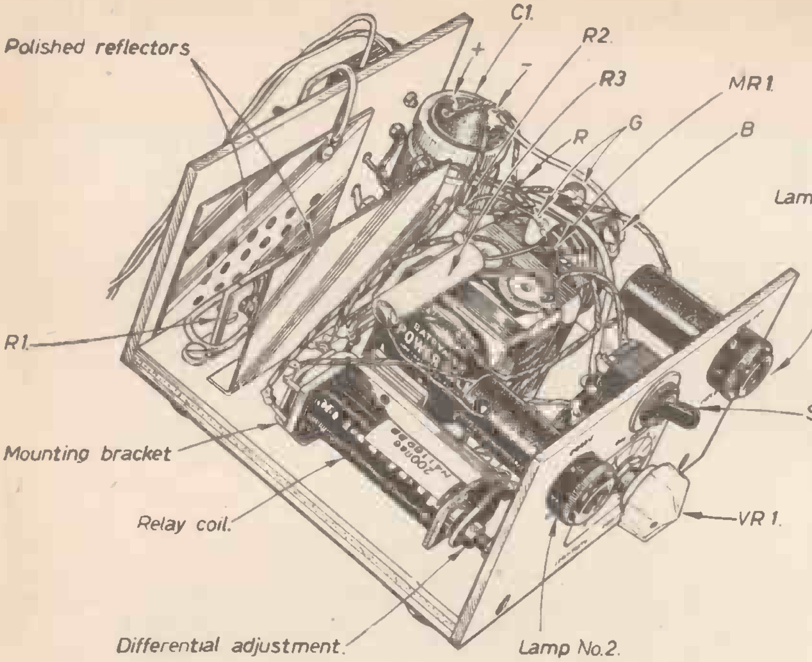


Fig. 104.—*Perspective view showing component layout and wiring.*

for the base with a 6in. × 4in. hardboard panel at each end (see Fig. 106). No metal parts are used on the front or rear panels, save an earth terminal. The holes for the components are best made before screwing the panels on to the base and a small sheet of highly polished tin plate (cocoa tin) or aluminium is placed behind the ventilation holes and is drilled to coincide and fixed, sandwich fashion, with the rear panel. Check that the air holes do coincide after fitting.

A professional finish may be given to the panels by giving them two coats of brushing cellulose and then one coat of " black crackle."

Crackle black is obtainable from Messrs. R.C.S., 337, Whitehorse Road, West Croydon, Surrey.

alarm to operate. A coarser setting, by turning VR1 back about 20 deg. from the lamp on position is normally adequate and the 6 per cent. allowable mains voltage fluctuation will have no effect.

The voltage for both lamps is taken from the drop across R1 so that the battery is not used until the bell (or other warning) actually operates.

Limitations of Unit

The unit described is for use on a system taking 1,000 watts from a 240-volt A.C. supply. Generally, the only item requiring alteration for other voltages and wattages will be R1. In the range 240 to 200 volts the adjustment on VR1 will probably be quite adequate.

The unit can only be used with devices drawing a steady current because a minimum point in a fluctuating current will cause the alarm to ring if the minimum is about 30 per cent. of the maximum.

The unit must be properly earthed, housed in dry well ventilated conditions and proper fuses incorporated in the main circuit or fitted in the No. 1 terminal block leads. The unit must not be covered up by papers or books, placed near a boiler or infra-red source, used on other wattages than that for which it was designed or painted other than black.

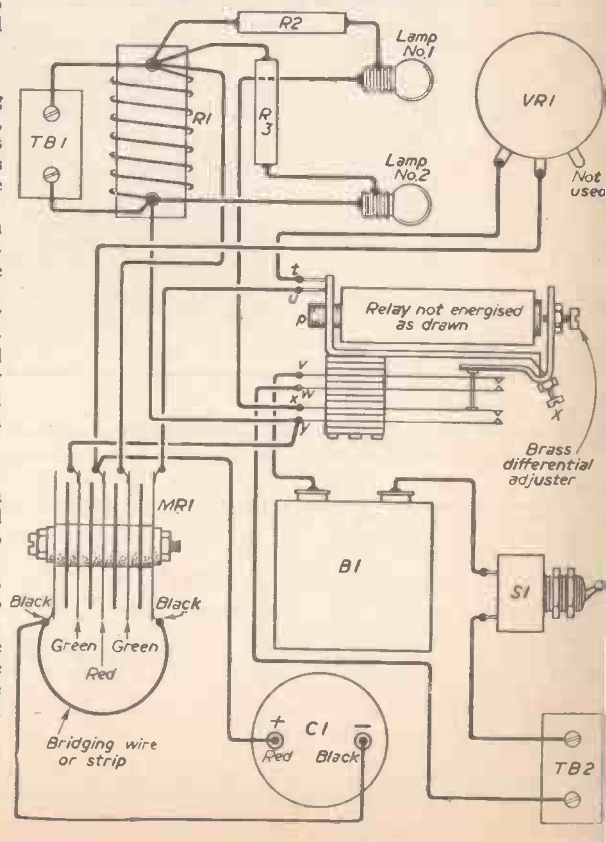
The Cabinet

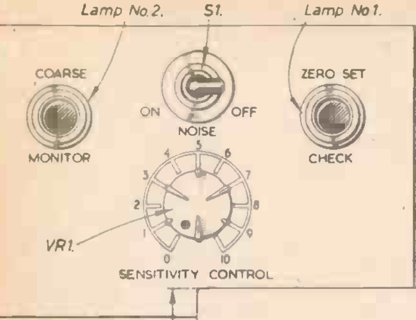
The prototype was made up in a wooden case with a thin sheet metal cover. If it is decided to use all metal construction no special care is necessary save to insulate all wires from it and to earth it properly.

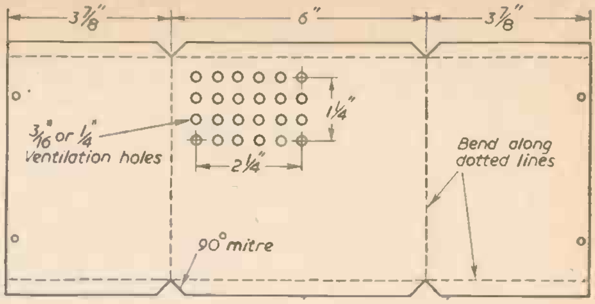
If a wooden construction is used the warning lamps switch and dial knob must all be plastic and the grub screw of the knob should be filled with sealing wax. This is in case there should be a leak somewhere which could give the operator a shock. If he were standing on a concrete or wet floor this could be dangerous. The case should be of metal to help with heat dissipation.

The prototype uses approximately ½in. softwood

Fig. 105.—*Wiring diagram.*







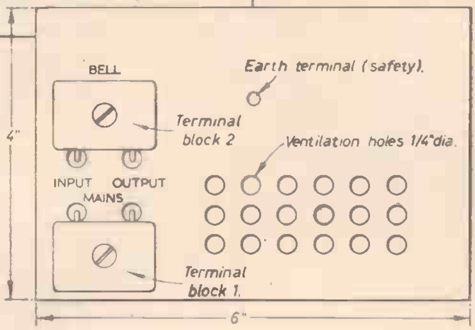


Fig. 106.—*Details of the wooden ends and metal cover.*

PARTS LIST

and sources of supply

Post Office Type 3,000 Relay. Coil Resistance 200 Ω. Available new from normal sources and also from Messrs. Annakin of 25, Ashfield Place, Otley, Yorks, as No. 2,090. Price 2/6, plus postage. Other surplus types probably suitable are 3003s and 3003t from Messrs. Whiston, Watford Bridge Road, New Mills, Stockport. Prototype used No. 2090.

B1. Any battery giving sufficient E.M.F. for working a bell will suit. Ever Ready PP7 is used in prototype.

Battery Terminal Clips. From an old battery or from Messrs. Electronics (Fleet Street) Ltd., 152, Fleet Street, London, E.C.4. Cost 1/- per dozen clips.

Metal Rectifier MR1. 12V. 1A. bridge type. It will only be used at about 1/50 capacity. Messrs. Radio Supply Co., Leeds. Cost 4/11.

Warning Lamps and Bulb Holders. Any type will do as long as the thread is M.E.S. From Messrs. H. W. English, Rayleigh Road, Hutton, Essex. Cost about 1/- each with red or green glasses. Ordinary 3.5V. .3A. flash lamp bulbs are used.

R2 and R3. 30 to 40 Ω, 5W. Any radio supplier can supply these. Also available from Messrs. Annakin as No. 316 (36 Ω) at 1/- each.

S1. Any toggle switch. If non-metal panel is used then a bakelite switch must be used. Available from Messrs. Benson, 136, Rathbone Road, Liverpool, 15, as List No. 184. Cost 6d.

VR1. 1,000 Ω wire wound potentiometer, 3W. Messrs. Wilkinson (Croydon) Ltd., 19, Landsdowne Road, Croydon. Ref. CLR4003/15S. Cost 4/-.

R1. See text. Eureka wire of all gauges available in small quantities from Messrs. Post Radio Supplies, 33, Bourne Gardens, London, E.4. 26g. costs 2/- per oz.

C1. Electrolytic Condenser. 12V. about 1,000 μF. Working temperature about 110 deg. F. Available from Messrs. Radio Traders Ltd., 23, Wardour Street, London, W.1, or most radio component specialists.

Terminal Blocks. Any type should suit. Use separate blocks for safety. Prototype uses type 5c/430 available as No. 94 from Messrs. H. Franks, 58, New Oxford Street, London, W.C.1. 5/- per dozen.

Various other parts are required, tin plate, screws, solder, insulated wire, etc.

The Relay

This is a P.O. type 3,000 and has a coil resistance of 200 ohms. It is seen in Figs 104 and 105.

When bought it will probably have upwards of eight contacts; only two pairs are required. The armature should be operated by hand and one set of contacts which make, and one which break on so doing, should be marked for retention. The others may be removed. They may be cut off carefully with tin snips or the spacers and contacts which are not necessary removed, and those required put back using shorter screws. Be sure to keep the insulated sleeves (shortened) on the screws and watch that the screws do not go through the metal and puncture the relay coil. If two complete banks of contacts are present, one may be discarded completely.

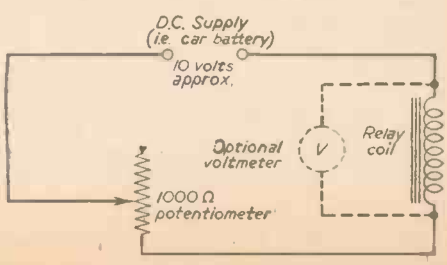
The armature retaining screw marked X in Fig. 105 is now removed and the copper rivet drilled out of the flat portion of the armature. A small B.A. brass screw is threaded into the armature (see Figs. 104 and 105). This means using a B.A. tap obtainable from an ironmonger. The screw is adjustable and is fixed by means of a brass lock nut. This adjustable screw will alter the differential of the unit, i.e. in one setting it may pull in on 10 volts and fall out on 5 volts, but on another it may pull in on 7 volts, and fall out on 5 volts. This latter will be the more sensitive setting.

Operate the armature manually and if necessary carefully bend the contacts so that two of them open (these are marked v and w) and at the *same time exactly* two close (these are x and y).

If you have a 9 to 20-volt battery available fix up the circuit of Fig. 107 and adjust the armature screw for the best differential requiring under 8 volts to pull in. If a voltmeter is not available use the setting required on the variable resistance as a guide. The unit, however, will work without this previous adjustment and it may be done when the final testing is carried out.

A convenient mounting bracket can be made to the measurements given in Fig. 111. Note that the dowel marked " P " (Fig. 105) is not used and the clearance hole in Fig. 111 is necessary. The method of using the bracket is shown in Fig. 104.

Fig. 107.—*Relay test circuit*



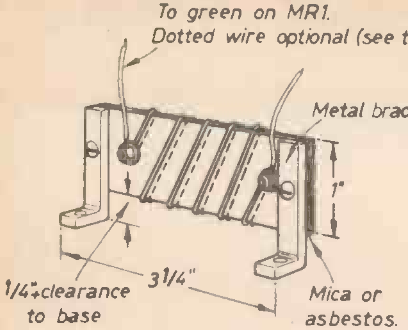


Fig. 108.—*The main series resistor, R*1.

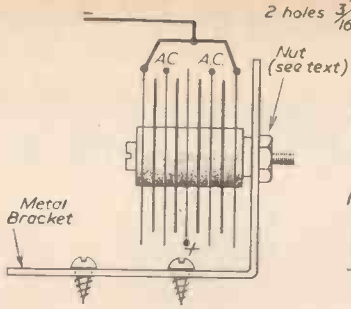


Fig. 110.—*Rectifier mounting.*

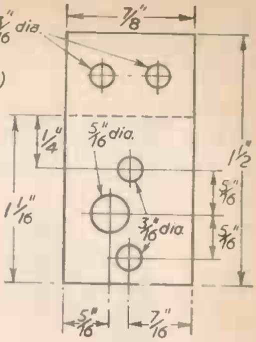


Fig. 111.—*Relay mounting bracket.*

Mounting the Components

The layout is quite unimportant, but that given in Figs. 101, 104 and 105 is satisfactory. Care must be taken to keep the heat from R1 away from the rectifier and electrolytic condenser. The unit runs at about 40 deg. Centigrade and the components will stand 70 deg., but it is worth care to see that the twc heat reflectors are bright and that the convection holes are at least as numerous and large as shown.

MR1, the metal rectifier is mounted on a bracket (Fig. 110) and must be upright for ventilation. Make sure only insulating materials project to the front panel if it is of hardboard or wood.

R2 and R3 are mounted in "air" and R1 is mounted as shown in Fig, 108. It must have clearance all round and is placed between the two polished reflectors seen in Figs. 101 and 104. Air enters the holes shown and makes an exit through holes in the top cover (Fig. 106).

Small rubber feet are fitted to pass through a few $\frac{1}{4}$in. holes drilled directly under R1.

Wiring Up

Well insulated 24g. or thicker wire should be used in wiring the unit, except for the two wires going from R1 to terminal block No. 1 which should be at least 18g.

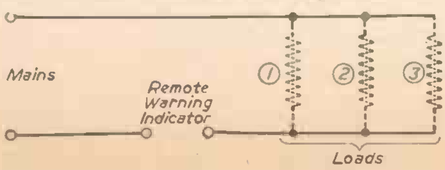
Wire as shown in Fig. 102. A wiring diagram is given in Fig. 105 for those who cannot follow the theoretical circuit. All joints must be made with solder intended for electrical use and no acid flux is allowable. Connections to R1 are not soldered but are clamped very firmly in washers between nuts.

Constructing R1

The design of the prototype is shown in Fig. 108. For controlling a larger wattage than 1,000, using Eureka wire, it will be necessary to make it somewhat larger.

The former is of asbestos or mica. About $\frac{1}{16}$in. in thickness is required and may be built up with any number of mica laminations. If asbestos is used it must be perfectly dry. Two small metal brackets are fitted as shown in Fig. 108 making sure an air space is left under the former. Two terminals are then fitted as shown, small nuts and bolts with good washers are quite suitable. Do not let the terminals touch the brackets.

Fig. 109.—*Arrangement for multi-loads.*



The resistance wire is wound on tightly from one terminal to the next, no turn must touch the adjacent one and the terminal connection must be absolutely perfect or the rectifier will burn out. Use 4ft. of 24g. Eureka wire or if using two wires two lengths 5ft. long 26g. will be required. Both are connected to one terminal and winding is then continued as if one wire were used. It is easier to lightly twist the double wire before doing the winding. Both far ends are then connected together to the other terminal. The dotted wire in Fig. 105 is the additional one referred to, it may touch the other wire, but again, adjacent turns must not touch.

R1 Values

For control of 100W. use 30g. Eureka 12ft.; 250W. 30g. 6ft.; 500W. 28g. 3ft. 9ins.; 1,000W. 24g. 4ft.; 3,000W. 16g. 12ft. Readers with a knowledge of Ohm's Law may work out the values required. The thickness of wire must be able to carry the total amperage in circuit.

Testing

A bell or lamp is attached to terminals No. 2. The mains is connected to one terminal of block No. 1, and to the equipment to be operated (see Fig. 105). Verify that this load is under 1,000W. Switch off noise switch and switch on mains.

Heat should be felt rising from R1 and lamp No. 2 should be on. If not then the lamp is faulty, R3 is wrong value or the circuit mains-load-R1 is faulty. Initially, lamp No. 1 may be either on or off.

Now rotate the sensitivity control either way. Lamp No. 1 will go out at some point where the relay draws in. A 30 per cent. fall in wattage consumed will then cause the lamp to come on again. With No. 1 lamp just set off by the sensitivity control, put the noise switch to on. A fall in wattage consumed will now cause relay to fall out and the bell to ring. Mains failure is tantamount to a fall in wattage. Blowing of a fuse, heating element, line wire, or bad connection will all cause a wattage fall and ring the alarm.

Caution

Provided the instrument is made entirely of metal, properly earthed, or of insulating material, no shock danger is present. No fire danger is present if a copy of the prototype is constructed, but readers without experience should give their unit a good test under close observation for one hour. Maximum internal temperature will be obtained in this period. All instructions should be closely followed.

(*To be continued*)

A LIGHT PRESSING TOOL

of adequate size to accommodate practically any job. By Jameson Erroll.

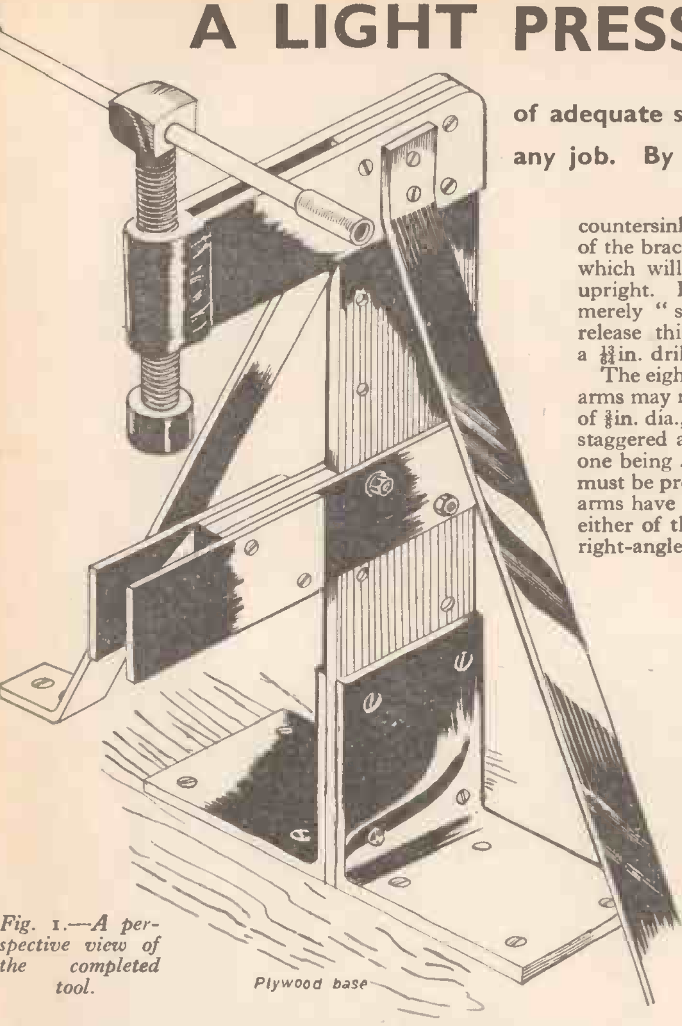


Fig. 1.—A perspective view of the completed tool.

THIS small, but for its size, powerful arbor press is an adjunct to any workshop and will accomplish many "press fit" jobs without damage to the parts involved. The employment of a vice or a heavy hammer has drawbacks, a hammer particularly often resulting in burring over a spindle or other component.

Fig. 1 is a perspective view of the completed tool. The two extensions to the lower arms provide a hollow to allow a shaft, etc., to pass through as it is pressed into, say, a ball bearing, and pressure is exerted through the medium of the lengthy threaded bolt.

Since there is a considerable amount of precision drilling and tapping to be done—much of it duplication as to positioning and size—it is best to have all the material to hand before starting on the job. A list is accordingly furnished on page 247. Most of the parts are shown in Fig. 2.

Construction

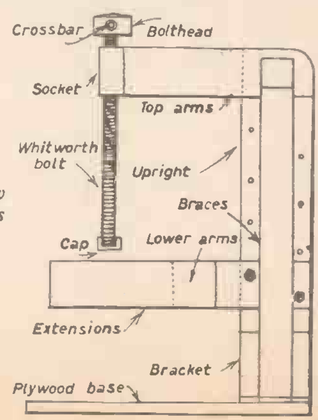
Commencing with the upright, see that the base end is perfectly square, and round the top back end to a 1in. radius. Drill both brackets—on the flats which will be attached to the base—with four $\frac{11}{64}$in. holes to accommodate the eight No. 8 wood screws; countersink them. Drill the other flange of one of the brackets with four ¼in. holes to carry the bolts which will fasten it, and the other bracket, to the upright. Fix the second bracket in position but merely "start" the holes to obtain centres, then release this bracket and complete the holes with a $\frac{13}{64}$in. drill and tap them ¼in. Whit.

The eight holes for adjusting the height of the lower arms may now be drilled in the upright; these are all of ⅜in. dia., in which the bolts are a free fit. They are staggered at 1in. intervals as shown, the lower back one being 4½in. from the base of the upright. They must be precision centred since the holes in the lower arms have to correspond to all of them and, when in either of the four possible positions, be at accurate right-angles to the upright.

The lower arms and their extensions should now be assembled *before* being attached to the upright. The filler block is placed flush with two ends of the lower arms and, to preserve alignment when the extensions are later added, should be united by means of the two 4 B.A. × ⅜in. c'sk bolts passing through the front arm and the block and threaded into the rear arm. These bolts should be staggered—one bottom left and one top right—so that they do not foul the position of the main bolts which hold the arms, filler block and extension pieces together. Now add the extensions which, it will be seen, finish 1in. short of the back edge of the filler block. They are fastened with two of the 1½in. × ¼in. c'sk bolts and tightened with nuts. Note carefully that the whole of the top surface must lie in one plane to ensure pressure being evenly distributed when the tool is operated.

Holes to carry the adjusting bolts have now to be drilled and they must be accurately positioned so that the arm lies at right-angles to the upright; they are ⅜in. dia. The edge of the filler block is pressed home tightly against the inner edge of the upright and the whole cramped after the centre of the first hole has been marked. This hole is drilled, the cramp removed, and one of the adjusting bolts fitted.

Fig. 2.—Side view identifying parts named in text.



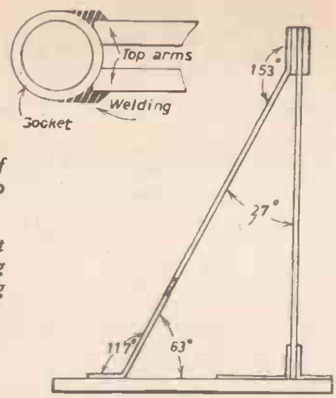


Fig. 3.—Union of socket with top arms.

Fig. 4.—Front edge view showing bending and fixing of braces.

PARTS REQUIRED

Upright ..	1	piece bright steel 15in. × 3in. × ½in.
Brackets ..	2	pieces bright steel 3in. × 3in. × ½in.
Top arms ..	2	pieces bright steel 8in. × 2in. × ¼in.
Lower arms ..	2	pieces bright steel 6in. × 2in. × ¼in.
Lower arm extensions ..	2	pieces bright steel 7in. × 2in. × ¼in.
Filler block ..	1	piece bright steel 3in. × 2in. × ¼in.
Braces ..	2	pieces bright steel 18in. × 1½in. × 3/16in.
Crossbar ..	1	length silver steel 13in. × ⅜in.
Large bolt ..	1	Whit. ¾in. × 9in. with large square head
Adjusting bolts	2	Whit. ⅜in. × 1in. with hexagon heads and nuts
Filler block fixing bolts ..	2-4	B.A. × ⅜in. long, c'sk heads
1in. bolts ..	10	Whit. ¼in. with c'sk heads
1½in. bolts ..	4	Whit. ¼in. with c'sk heads
Wood screws ..	12	No. 8 × ¾in. long with c'sk heads
Plain pipe socket	1	threaded inside ¾in. Whit. 2in. long
Gas cap ..	1	¾in. i.d. (Thread is cut away)
Crossbar ends	2	pieces tubing each 1in. long, ⅜in. i.d. and ⅝in. o.d.
Plywood base	1	piece 20 in. × 12in. × ½in. or thicker

The second hole may now be drilled, and the whole of the lower arm assembly checked for ease of contact and right-angled alignment in all four positions.

Welding

The two top arms are first temporarily fitted to the upright with the four ¼in. × 1in. Whit. bolts as shown. Exercise great care to ensure that it makes a perfect right-angle. Remove them, and substitute a ½in. thick piece of scrap steel for the upright, and bolt together again. Now round the inner front edges to make a snug fit with the outside of the socket—as shown plainly in Fig. 3—and remove unwanted paint or other preservative from the socket so that a perfectly smooth and clean surface is presented for welding. Note particularly that the edges of the arms must be accurately filed so that the large bolt, when threaded through the socket, descends at 90 deg. to the arm. Socket and arms are then held rigidly in position by means of a strong 10in. (or larger) cramp, and welding commenced. A local garage would probably undertake this work. Fig. 3 shows that an appreciable amount of extra metal must be added during the process to give additional strength to the finished connection since it takes a considerable strain when under pressure.

When the job is done, a smooth file should be used to even up any irregularities and—the scrap piece of steel having been removed—the arms be finally fitted to the upright. Then round the top back corners to match up with the upright already rounded.

The Long Bolt

As detailed in the parts list, this is a ¾in. Whit. bolt 9in. long with a large square head, threaded throughout its entire length. The head is drilled to take the 13in. length of ⅜in. silver steel to which, when it is in position, the tubular ends are added and pinned in order to prevent the bar from falling through.

The bottom of the bolt is filed smooth and flat and the gas cap, from which the thread has already been removed either in the lathe or by filing, is fitted over it. This refinement is introduced in order that the bolt will not turn on the work being pressed. It must, therefore, be a reasonably loose fit.

The machine may now be mounted on the plywood base and the braces prepared. These are first drilled at each end with ¼in. holes to take the fixing bolts and 11/64in. holes to take the No. 8 wood screws. In each case the first hole is about ⅜in. from each end and the second ⅞in. from the first. Note that on one brace all four holes are c'sk while on the other only the two holes at the end which engage the base.

One end of each brace is bent—1½in. from the end—to an angle of 27 deg. and the two remaining ends bent (also 1½ in. from the end) to an angle of 63 deg. as shown in Fig. 4. The braces should now fit snugly against the upright and the base. Bolt their top ends into position, through the top arms and the upright, with the remaining two 1½in. × ¼in. Whit. bolts, and fix their bottom ends to the base with four No. 8 c'sk wood screws.

Operating Hints

Bring up the lower arms to the highest possible position consistent with the work being undertaken.

The reason for the lower arm extensions being ⅜in. apart is to enable a shaft or the like to be pushed through a ball race or other fitting. It may well be noted at this point that the machine can be used to remove a shaft or to "un-press" work. A short length of silver steel of a slightly less diameter than the shaft is imposed between the cap and the work and, pressure being exerted, the ball bearing or other fitment will be released.

When this gap is not required and, perhaps, a larger and firmer form of support is needed, a piece of flat ½in. mild steel about 10in. × 8in. can be used as a table for holding work to be pressed.

Fig. 5.—The completed tool and close-up of the main body.

Are the Poles of the Earth Moving?

V. A. Firsoff discusses some of the current theories

THE records of past geological ages are often incompatible with the present climatic zones. One of the great headaches of palaeo-climatology is the Permo-Carboniferous Ice Age, which has left traces of glaciation, at least as severe as that of the Pleistocene in Europe and North America, in places so unlikely as South India, Central Africa and Brazil. Not the latitude alone, but the geographical distribution of these ice-sheets is highly baffling.

Continental Drift Theory

The British climatologist Brooks has constructed an hypothetical topography which would allow such an equatorial ice age and yet leave Antarctica free from an ice-cap, which it was; but the result is not very convincing. Wegener tried to account for this situation by his theory of continental drift, according to which not only have the geographical poles changed their position, but the continents, which were originally all bunched up together in a single great land-mass of Pangaea, have drifted apart across the ocean basins. Thus all the glaciated areas mentioned above would have been simultaneously in the vicinity of the South Pole.

Wegener's theory has been hotly contested and as hotly defended. It encounters many serious difficulties, one of which is the existence of great submerged mountain ranges on the ocean beds. Moreover, it is not climatologically indispensable, for, although the glaciation of India may fall within the same major geological division as that of Brazil, this need not mean that they were contemporaneous, provided that the poles shifted sufficiently fast to visit India, Africa and Brazil in turn, without overstepping the limits of that division, and 20 million years would have been ample for this purpose.

Still, there is some movement at the meeting of large continental masses and true ocean beds. This is shown by the vast island arcs of the western and northern Pacific. These arcs are based on conical fractures of the crust, which give rise to deep-seated earthquakes (foci down to 400 miles below the surface) and rows of volcanoes, indicating, together with the parallel oceanic ditches, a downwarping of the granitic (sialic) rocks of which continents are made. The uplift of the Cordilleras also seems to be due to the pressure of the Americas against the basaltic floor of the Pacific.

Rock Magnetism Studies

There exists an objective method of determining vanished geographies. It relies on rock magnetism. Rocks originate as molten magmas or loose grits, sands and muds. These contain crystals responsive to the magnetic field of the Earth and so long as the rock matrix is yielding these crystals can align themselves with this field, but once it has set and hardened the crystals cannot change their orientation and still point North and South, though North and South are no longer there. The rocks remember; they are like a magnetic recording tape.

The difficulty of the method lies in the subsequent land movements, involving generation of frictional heat and, consequently, the loss or change of the original orientation. And, of course, there may be simply no rocks to cover certain periods.

A systematic study of rock magnetism has been undertaken by Professor Blackett and his associates at the Imperial College of Science and Technology. The preliminary results show considerable changes of latitude in the geological past, as well as some continental drift. So far climatological correspondences have not been established, but the idea that the poles have always been in the same place seems doomed.

Thus it appears that Europe was south of the equator in the Mesozoic times and that the equator itself has been rotated since then by 30-40 deg. in the clockwise sense.

Other investigations made on Icelandic lava flows (Fig. 1 shows a typical landscape of this type) show an apparent reversal of the Earth's magnetism about once every million years. This does not involve any change in the position of the poles, but only an about-turn of the magnetic needle. No explanation of this curious phenomenon has been proposed.

Climate Changes

No evidence, however, has been found for large recent shifts of the geographical axis. And yet in the Tertiary luxuriant forests of deciduous trees flourished in the frozen wastes of Baffin Land, Greenland and Svalbard in the North and in parts of Antarctica in the South. Oceanic currents, distribution of high and low ground, projection of volcanic dust into the upper atmosphere during violent eruptions and fluctuations in the radiant energy of the Sun, exemplified by sunspot periods, may all affect the climate of the Earth and

Fig. 1 (Left).—Berserkjahraun lava fields, Iceland. Photo by courtesy of the Icelandic Surveying Department.

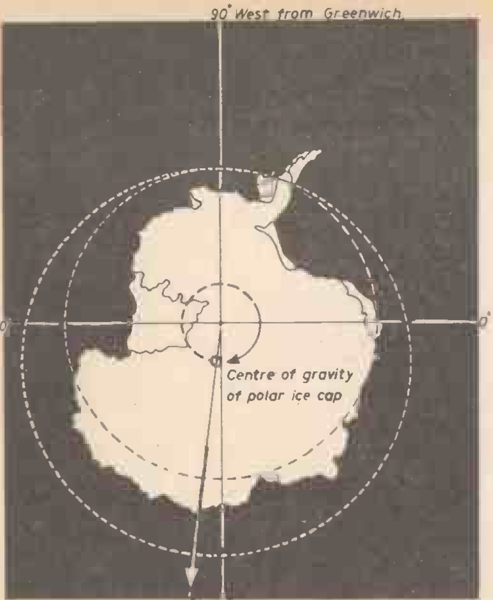


Fig. 2.—Centrifugal effect of Polar ice cap. Figs. 2 and 3 are reproduced from " The Earth's Shifting Crust " by permission of the author, C. H. Hapgood.

Fig. 3.—Some previous locations of the Pole. A—Greenland; B—Hudson's Bay; C—Alaska.

could, in combination, cause global transformations. Nevertheless, this explanation does not quite fit the facts.

During the recent Ice Age, when Britain was swathed under a thick ice-sheet as far south as the Thames Valley, the ice wheeled sharply north in the Ukraine, leaving East Russia and Siberia free. Recent geological formations can be timed by the rate of decay of the radioactive isotope of carbon. The radio-carbon datings of rock samples, marine cores and fossils in America, Antarctica and elsewhere show that the advances and retreats of the ice were not simultaneous in the different parts of the southern and northern hemispheres. Some of the most severe stages of the North American glaciation would have occurred during the warm interglacials in Europe. Also while in the latter the Ice Age ended some 10,000 years ago, it continued in America for a further 5,000 years and so into the period of the Climatic Optimum in Europe.

This is clearly quite incompatible with any world-wide fluctuations of climate and the only feasible explanation seems to be a comparatively rapid change in the position of the poles. Indeed, the radio-carbon data are quite alarming in this respect. Not only do they go against the generally accepted geological time scale, but they leave the door open to catastrophic changes almost within the span of a human life. Possibly there is some undiscovered flaw here. On the other hand, Alaska and Siberia contain vast boneyards of prehistoric animals, which seem to have been killed in their millions by some great catastrophe and buried in frozen mud. Sinews, flesh and fur have been preserved in the frozen mud of Alaska, which bears witness to great volcanic eruptions and earthquakes, perhaps comparable to and exceeding in violence those experienced last year in Chile (Fig. 4). Some of the Siberian mammoths have been so well preserved in the permafrost that their flesh is edible after thousands of years.

No mean feat of refrigeration that! It is not easy tc visualise how the frozen earth is supposed to have opened up and swallowed not just one mammoth, but large numbers of them. And how could they have been preserved intact unless there had been a sudden drop in the temperature that had endured ever since? Indeed, a climatic deterioration is obvious, as mammoths used to live in the New Siberian Islands as well.

Elevation of mountain ranges, subsidence and upheaval of land, affect the moments of inertia of the globe along the equatorial and polar axes and can cause the poles to shift position. The matter has been investigated by T. Gold and W. Munk, who estimate that the rotational axis may move through 90 deg. in the course of 10-100 million years as a result of topographical changes. No such large shift, however, is required to account for the comparatively rapid fluctuations of local climates in the Pleistocene. C. H. Hapgood finds that these can be satisfactorily explained if the North Pole first moved from the neighbourhood of Alaska to the east of Greenland and

Fig. 4 (Right).—Last year's earthquake in Chile.

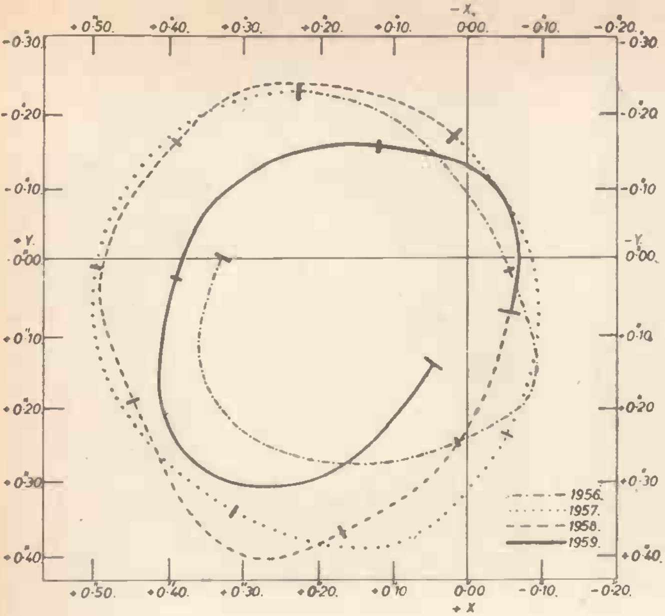


Fig. 5.—Movement of the Earth's Pole 1956-1959: 0·01″ = 1ft. on Earth's surface. The symbol ″=seconds of arc. Drawing by courtesy of Royal Observatory, Greenwich.

then swung back to Hudson Bay, whence it has drifted to its present position, thus bringing successively the European and North American ice-sheets to an end (see Fig. 3).

A curious point not remarked upon is that the Magnetic Pole is still near Hudson Bay. Would it be that it has lagged behind the movement of the geographical pole as a result of the magnetisation induced in the rocks during the preceding period? This might account to some extent for the lack of magnetic evidence for a recent polar shift.

Fluctuations of geographical co-ordinates were investigated before the late war at the Royal Observatory by Sir H. Spencer Jones, but he found no directional drift, only a small wobble of the Pole about the mean position. The recent results shown in Fig. 5 are very similar. This, however, need not be conclusive, for the periods covered were short and the stresses responsible for the shift will accumulate but slowly, as in the case of an earthquake, until the yielding point is reached and a sudden adjustment takes place, perhaps followed by elastic after-working.

Earth Crust Movement

Rapid rotation gives the Earth as a whole great gyroscopic stability, the equatorial bulge acting in the manner of a flywheel. Thus a very great force is needed to topple the earth over, but to move the poles relative to the crust, as distinct from shifting them with respect to the stars, requires only a movement of the crust over a yielding substratum. The rigid outer crust is some 20 miles thick. Underneath the rocks are fused and only prevented from liquefying by the great pressures to which they are subjected. Deep-seated earthquakes appear to show that the underlying layers respond by fracture to sudden stress, but they will flow slowly under a steadily applied pressure. Owing to this, given time, the crust could shift bodily over the yielding asthenosphere (sphere of weakness).

Here, too, the polar flattening and the equatorial bulge resist movement, for at the equator the crust is distended and at the poles compressed beyond the average corresponding to a perfect sphere. The difference between the equatorial and polar diameters is only 27 miles, but any adjustment is in depth and therefore, three-dimensional. It will be proportional to the cube of the distance from the centre of the Earth.

Before the crust can move, it must be loosened up. Steady pressure will generate frictional heat at contact with the asthenosphere, creating a kind of lubricating layer, and the overlying crust will fracture and be invaded by magma from below. The regions of increasing latitude will experience compression and elevation; those of decreasing latitude distension and subsidence. Both types of change will be accompanied by violent earthquakes and volcanic eruptions.

It has been suggested by J. H. Campbell in the U.S.A. that eccentric polar ice-caps may be the main cause of crustal shift. The asthenosphere rising beneath the crust towards the equator at a gentle slope will act as a mechanical wedge and multiply the effect of the centrifugal drag exerted by an eccentric polar cap. The matter has not been thoroughly examined in mathematical terms, but the idea is sound in principle.

Now the centre of gravity of the Antarctic ice-cap is some 350 miles away from the Pole along the meridian 96 deg. East (Fig. 2), so that it pulls the crust in this direction. Campbell contends that the pull should be sufficient to move the crust. If so, the South Pole would move into the Pacific off the coasts of Chile and the North Pole towards Siberia, where it would eventually come to rest near Lake Baikal. This would make most of Siberia and China wholly uninhabitable. The British Isles would not be greatly affected. Scandinavia, however, would become appreciably warmer, while Greenland and the North Canadian Islands would return to the mild Tertiary conditions. Large portions of the U.S.A. would founder beneath the azure main.

Earthquake Coincidence

The curious thing is that there has been a whole series of most powerful earthquakes along or close to the line of the suggested maximum displacement. Chile is very much a case in point, but there was a violent earthquake in Mexico in July 1957 and another one at San Francisco in March of the same year, farther north, all neatly aligned.

The American earthquakes were paralleled by even more devastating concussions in Asia, almost exactly along the 96th meridian. Fortunately, the regions affected are sparsely populated. Hundreds of thousands of miles were shaken by the great Assam earthquake in 1897 and the Indian Survey had to revise their maps as a result; a similar earthquake struck the same region in 1950 and the Himalayas rose by a few feet. On 4th December 1957 a tremendous earthquake occurred farther north along the line, in Mongolia. The coincidence is suggestive. Moreover the earth movements are of the right kind.

The Greenland ice-sheet is less massive than the Antarctic, but it is even more eccentric. Should this ice-sheet be caused to melt, say, by the proposed damming of the Bering Strait, the results might easily go far beyond those at present envisaged.

Analogue Computers Simply Explained

By R. N. Hadden

IN the Analogue Computer the information is fed in through rotating shafts, or some similar device, and the answer comes out on dials. This differs from a digital computer where the input and answer are in the form of figures. Fig. 1. shows the basic difference between an analogue and digital computer. The accuracy of an analogue computer depends on the precision with which the operator can read the answer on the dials. Although the accuracy of an analogue computer is usually less than that of a digital computer, it can perform certain operations and solve certain problems much more quickly and conveniently.

Analogue computers are built up of a number of simple parts, and the best way to understand the working of a whole computor is to study the operation of the parts individually.

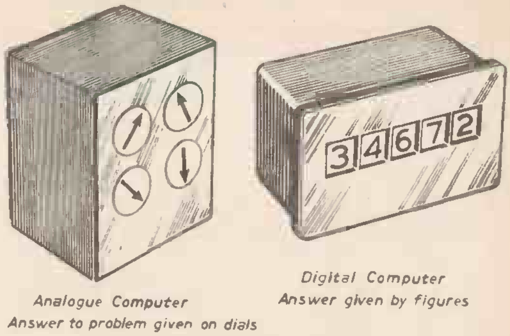


Fig. 1.—The difference between analogue and digital computers.

The Multiplier

One of the easiest things for an analogue computer is to multiply, and this can be done mechanically. Fig. 2 shows a simple device for multiplying mechanically by two. This device consists simply of a 2 : 1 ratio gear-box, if we turn the input shaft once the input shaft turns twice. Thus if we want to multiply say 24 by two we simply turn the input shaft 24 times, and we find that the output shaft turns 48 times, which as we know is the correct answer. It is of course very tedious to count the rotations of the output shaft and so we connect it up to a gear train as shown in Fig. 3. With this arrangement single revolution, tens of revolutions, hundreds of revolutions, and thousands of revolutions, are shown on separate dials. This is the same system that is used on a gas meter and is read in the same way.

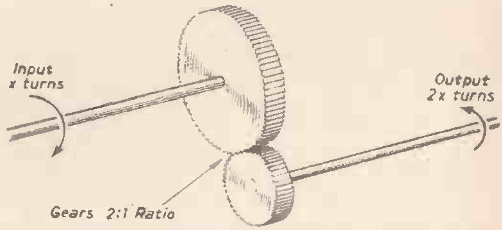


Fig. 2.—Device to multiply by two.

The mechanism we have just looked at can only multiply by two. If we wanted to multiply by some other number we would have to change the ratio of the gear-box. This, of course, would not be practical in an actual computer as it would take too long to do. To overcome this difficulty we use a whole series of gear-boxes to which the input and output can be connected. Switching from one gear-box to another is done electrically as is shown in Fig. 4. The input is connected to what is known as a transmitter, which is a device which sends out electrical signals exactly in step with the rotation of the input shaft. The transmitter can be connected by means of a rotary switch to any of ten receivers. The electrical signals from the transmitter cause the receiver to rotate at exactly the same speed as the input shaft. Thus in effect the input shaft can be connected to any gear-box simply by turning a rotary switch to the desired position. In Fig. 4 the input shaft is connected to the " multiply by three " gear-box. In the same manner the output of the gear-box can be connected up to the final output of the computer.

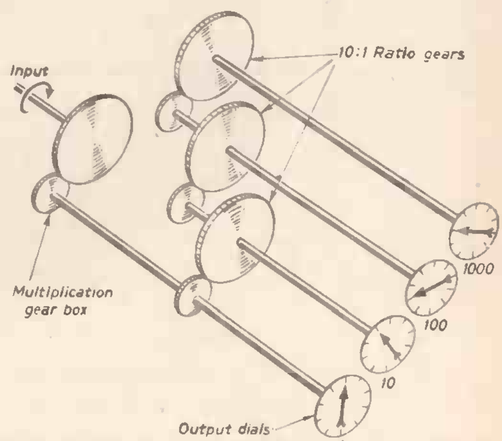
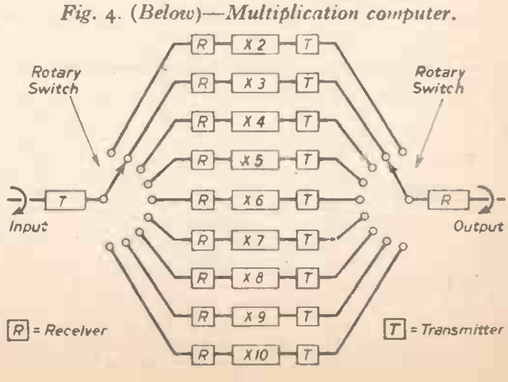


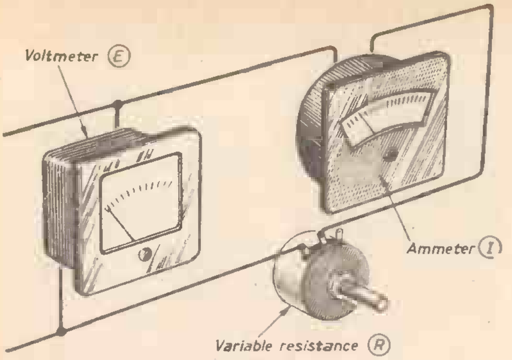
Fig. 3.—How revs. of output shaft are counted.

Fig. 4. (Below)—Multiplication computer.



Electrical Multiplier

We have now seen how a mechanical multiplier works, but as a comparison let us see how simply this could be done electrically. " Ohm's Law " states that Volts = Amps × Ohms, or $E = I \times R$. Look now at Fig. 5; this is an electrical multiplier. Suppose we have the same problem as before and want to multiply 2×24, then all we do is set the variable resistance R to 24 Ω and increase the voltage E until the ammeter I



reads 2A. then the voltmeter E will read 48V. Thus we see that the value of the voltage gives us the answer directly equal to 48.

Slide Rule

The most commonly used computer of all is the Slide Rule. It is not proposed to deal with the workings of a slide rule here as there are many excellent books on the subject, however the drawing, Fig. 6, shows how a slide rule is set up to multiply 2 × 4 to give the answer 8.

Adding

The next thing we want our computer to do is tc add. We can make quite a simple adding analogue computer as shown in Fig. 7. Suppose we wanted to add 3 + 8 we would simply slide the X lever up until the arrow was opposite 3, and the Y lever up until the arrow was opposite 8, when we would find that the pointer on the Z lever was opposite 11, which is the answer.

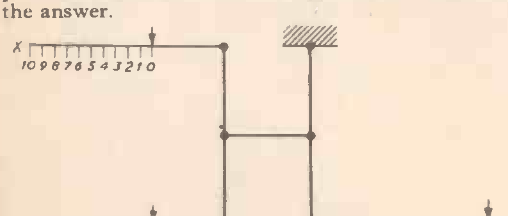
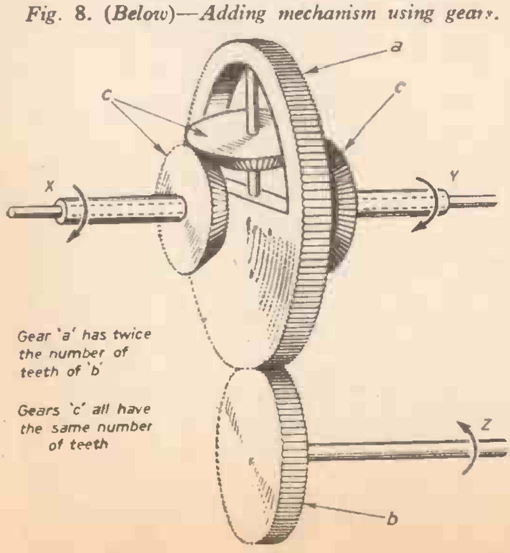
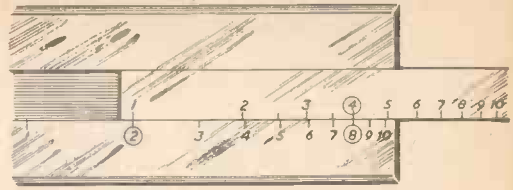


Fig. 7.—Adding computer made from links.

Fig. 8. (Below)—Adding mechanism using gears.





Multiplying 2 by 4 gives answer 8

Fig. 6.—Slide rule as a multiplier.

Fig. 5. (Left)—Electric multiplier.

This adding mechanism, suffers from the disadvantage that to add very large numbers the levers would have to be very long. To overcome this difficulty it is better to use rotating shafts as before, and represent our numbers by the number of times each shaft rotates. A geared adding mechanism is shown in Fig. 8. If input shaft X rotates once, output shaft Z will rotate once. Similarly if input shaft Y rotates once the output shaft Z will also rotate once. If, however, both input shafts X and Y rotate once, the output shaft will rotate twice. In the same way if X rotates say 9 times and Y 7 times, then Z will rotate 16 times. Thus it can be seen that this mechanism will add together the number of rotations of X and Y.

Electrical Adder

In this case too it is easy to make up an electrical adder, as is shown in Fig. 9 which is a three-number adder. In operation voltages E_1 E_2 and E_3 are made to equal the three numbers to be added. The answer is found by reading E_t which gives the total of the three voltages.

We have now seen how we can build analogue computers which can multiply and add. With the help of our electrical transmitters and receivers, which were described earlier, we can couple these units, or series of units, up in any manner which we want to solve our particular problem. However if it were not for our next piece of equipment it would hardly be worth while to build an analogue computer. This piece of equipment, which is so valuable, is known as an Integrator.

The Integrator

In this mechanism shown in Fig. 10 the inputs are the drive to the disc and the screw, while the output is taken from the wheel which runs in contact with the disc. It is obvious from examination of the mechanism that the rate at which the wheel turns is governed by the rate at which the disc turns and the location of the disc bearing along the screw. The nearer the wheel is to the edge of the disc the faster it will run, and conversely if the wheel is at the centre of the disc it will not turn at all.

Rocket Problem Example

To see how this mechanism works it is easier to take a specific example rather than to talk in general terms. Let us take the case of a rocket which is to be fired at a given target. First of all the rocket is fired straight upwards so that it gets out of the earth's heavy atmosphere as quickly as possible. When the rocket has reached a certain height it has to be tilted over to face in the direction of the target, and then a little later on the motors cut out. Once the motors have cut out it is not possible to control the rocket at all, and so the precise moments where the tilt occurs and the motors cut are most important if the rocket is to reach its target.

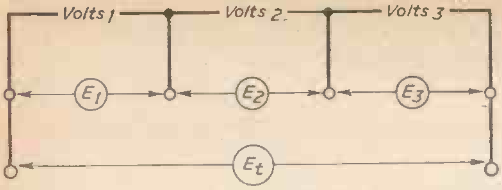


Fig. 9.—Electric adding circuit.

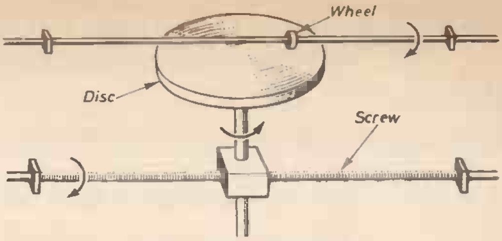


Fig. 10.—Integrator.

Suppose, for example, it has been decided that the rocket must tilt over when it has reached a height of 50 miles, the question is how do we know it is at the required height. One way is to measure the speed continuously and feed this information into our integrator when it will give us a continuous record of its height. Fig. 11 shows how we measure the speed using the Doppler effect. This effect is similar to a train whistle, as the train comes towards us the whistle is high pitched, and as it goes away it is low pitched. The faster the train goes away from us the lower is the pitch of the whistle. In the case of the rocket we use a radio transmitter of known frequency. As the rocket speeds away from us the frequency received by the ground station is something rather lower. The actual drop in frequency received is an exact measure of the speed of the rocket.

From our record of the speed of the rocket we can plot a graph as shown in Fig. 12. To find how far the rocket has travelled all we have to do is to divide the curve up into little strips of one second each and say that during each interval the rocket has travelled so many miles. For example, when the rocket is travelling at 1,000 m.p.h. it rises 0·28 miles in one second. We could carry on in this way and find how far the rocket has risen during each second, and then all we would have to do is to add all these little bits together. The only trouble with this method is that by the time we had added all the little bits together the rocket would be far beyond the place where we wanted it to turn over.

To overcome this difficuly we let our computer do all the hard work for us. We simply make our disc turn once each second and make the screw turn at a speed in proportion to the speed of the rocket, when we find that the wheel turns in proportion to the height of the rocket. If then we watch the dials connected to the wheel output shaft we have a continuous record of the height of the rocket. All we have to do then is to press the " tilt " button when the rocket is at the required height.

This is, of course, a very simple application for a computer. In practice most problems will require a combination of addition, multiplication and integration. Some computers are in fact built to deal with other quantities as well such as trigonometrical, exponential or other functions.

Simulators

On the largest scale, simulators are built to represent aircraft in flight and can be used for training air crews. In these simulators all the aircraft controls feed into an analogue computer. It is possible, for example, to feed in the effect of a cross wind and this will alter the reading of the compass, and if the pilot does not take the necessary action he will find that he is drifting off course. The course is plotted on charts which may be similar to the Decca Navigator. Another flight problem which it is possible to simulate is, say, the loss of power in one engine. This will cause the aircraft simulator to yaw, and the pilot will get the feel in his controls.

Flight simulators are made as realistic as possible. A complete mock up of the flight deck is made which is perfect in every detail. The noises of the engines are even produced, one loudspeaker being used for each engine. If it is desired to simulate, for instance, the failure of one engine, then the noise of that engine also stops. In the same way the noise of the tyres touching the runway can also be reproduced. Using a flight simulator it is possible to cut the crew training time down from about 20 hours' flying time to only about 5 hours. This saves about £4,000 for each crew trained.

One last application of analogue computers should be mentioned and that is for bomb sights and gunfire control. Here we are dealing with such factors as gravity, and air resistance, which follow well-known laws, and speed and angle of fire which vary from situation to situation. The constant factors such a gravity can be fed into the computer by means of a specially shaped cam, whereas the variable factors can be fed in by hand on a dial. The output from the computer can be shown as readings on dials, or can be directly coupled to the gun or bomb release mechanism.

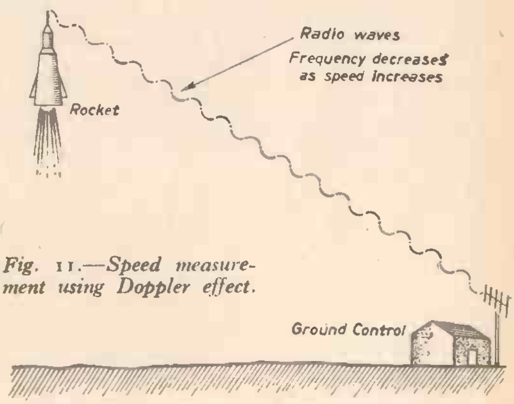
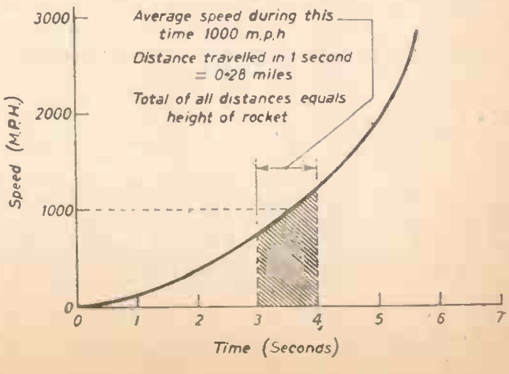


Fig. 11.—Speed measurement using Doppler effect.

Fig. 12. (Below)—How speed can be integrated to give height.



LETTERS TO *The Editor*

The Editor does not necessarily agree with the opinions expressed by correspondents

Solving the Transport Problem

SIR,—I should like to comment on the fantastic scheme outlined by the Railway Conversion League referred to in "Fair Comment" in your December, 1960 issue. The R.C.L. quotes figures when it is well known that statistics have caused some of the classic blunders of our time. Here, in my opinion, is the solution to our transport problem:

(1) Attract customers to the railways by reducing fares instead of discouraging their use.

(2) Make the fullest possible use of our Inland Waterways.

(3) Discourage the use of road transport where other forms are available by making the alternative more attractive.

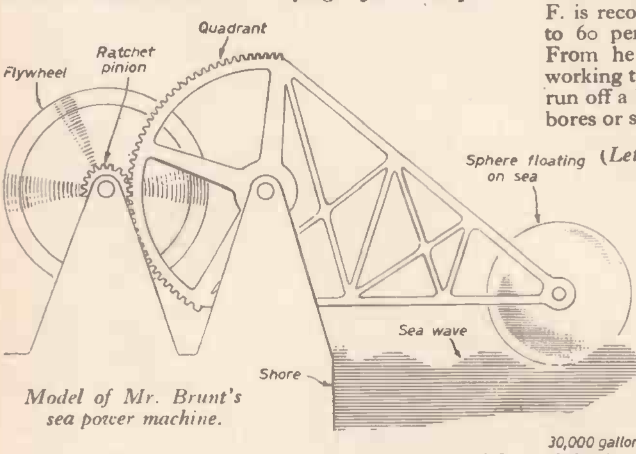
(4) Have elevated roadways, or telpher ways in the big cities as a supplement to the public transport systems and for use by emergency services, fire, police and ambulances, etc.

It would be a great mistake to scrap our railways. A private or public company could put the railways on firm business basis, which the State has failed to do.—R. N. Deane (Hants.).

Power from the Sea

SIR,—I was very interested in the article "Power From The Sea," which appeared in your August, 1960 issue. I have done a lot of research on this problem and Fig. 1 shows a model that I have made-up and tested, driving a small generator. The waves in the harbour were 2ft. and at intervals of 4 seconds. The speed of the flywheel was 200 r.p.m.

This type of machine set up off a rough point with an arm 100ft. out to sea carrying a 50ft. dia. sphere and with a wave 8 to 10ft. high could get a lift of 50 tons on the driving pinion, and by driving a heavy flywheel, the power that could be obtained would be phenomenal.

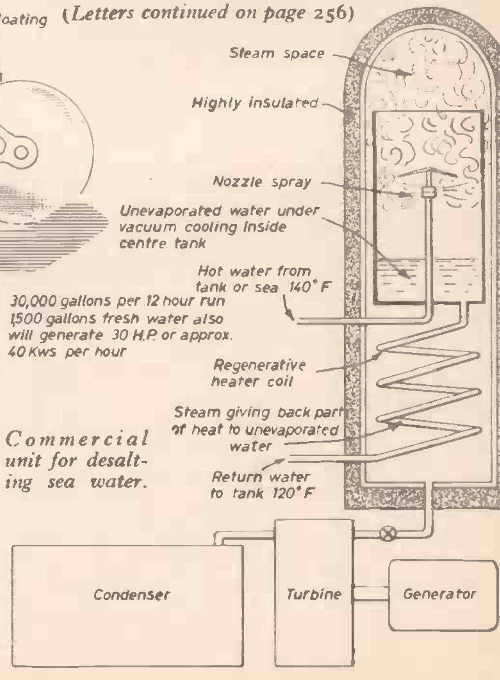


Model of Mr. Brunt's sea power machine.

The principle is to use the rise and fall of the tide as well as the rise and fall of the wave. Whenever there is any swell or movement on the surface of the sea the machine will work. It could be made to pump water to a high reservoir, from where it could run back to drive a turbine. In this method you would not require a flywheel or the quadrant and pinion, a lever would work directly on the pump.

Fig. 2. shows a machine that we have on the market in Australia for the purpose of desalting sea or bore water. After heating by solar energy, the water is pumped through a regenerative evaporator under vacuum. If you study the flow from the hot water inlet pipe you see how the hot water is sprayed into an evaporating centre chamber from where the steam separates and goes over the top of the inner chamber. In this chamber the latent heat of evaporation cools the unevaporated water to 30 deg. F. The unevaporated water is run down through the regenerative coil, where the steam from the inner chamber gives back its heat and heats the water in the coil, which is pumped back into the heating tank. In this operation over 10 deg. F. is recovered. On the average you can recover up to 60 per cent. of the latent heat of evaporation. From here the solar heaters keep the water at a working temperature. This type of evaporator can be run off a large hot lagoon, or any hot water from hot bores or springs.—R. Brunt (Sydney, Australia).

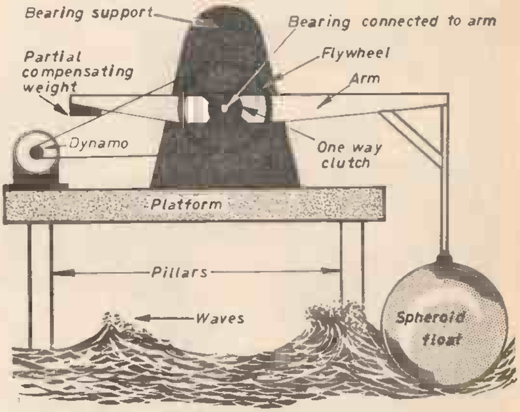
(*Letters continued on page* 256)



Commercial unit for desalting sea water.

Harnessing Sea Power

SIR,—The illustration below is my idea for a sea engine. The arm is driven up and falls again in sympathy with the waves passing underneath the platform. There is a compensating weight on the other end of the arm but it would not be too heavy, in order to allow the float to return to the trough. The bearing, connected to a one-way clutch, is independent of the flywheel. The flywheel is driven only when the arm is rising and in turn drives the dynamo. The float would be spheroid, in order to hold maximum volume and the weight on the arm would not be so heavy as to balance them. The addition of the weight means that less lifting power of the float will be used in lifting the weight of the arm. All would be enclosed and mounted on pillars near the seashore.—R. A. Peilow (Dublin).



(*Right*) *Mr. Peilow's sea engine.*

A SATELLITE NAVIGATION SYSTEM

(*Concluded from page 241*)

20in. in diameter, was bound to Transit by a metal ring, and separated by a spring after orbital speed had been reached. The dual launching was accomplished by a Thor-Able-Star rocket.

The seven Transit ground stations are the scientific ears of a laboratory at Johns Hopkins University in Baltimore, Maryland, which plots and predicts the orbits of the Transit satellites.

Predicted Orbital Paths

Frequencies are generated from two stable oscillators inside each satellite, and at each ground receiving station engineers measure the Doppler shift. This information is recorded, and special equipment reduces it to suitable data for transmission on teletape to a computing centre near Washington, D.C.

With information from the stations, the computing centre can predict orbital paths of the satellites for several days ahead. Once these future positions have been calculated, they can be used by navigators as stable reference points with which to obtain an accurate navigational fix. This is possible since the size of the Doppler shift depends on the rate of change in the position of the satellite and the position of the navigator.

Present techniques have been inadequate to give exact positions on land masses. This means that the exact distance, for instance, between the top of the Empire State Building in New York City and the top of the Eiffel Tower in Paris, is not known precisely. As a by-product of satellite navigational development, important contributions are expected to be made to the science of geodetics.

The two Transit satellites now in orbit are initiating geodetic measurement and analysis, and providing data for a better understanding of the effects of ionosphere refraction of radio waves.

Eventually in the programme, the composition of the ionosphere in terms of electron densities will be measured.

PUZZLE CORNER

As the Crow Flies!

TWO towers, one 30ft. and the other 40ft. high, are 50ft. apart. There is a milestone on the straight line between them. From the top of both towers two crows fly off simultaneously at the same speed in a straight line in the direction of the milestone and—believe it or not—reach their goal together.

How far is the milestone from each tower? Its height may be considered negligible.

Answer

It is obvious that both birds must fly the same distance (call it 'A') and, using Pythagoras's theorem, the following equation results:

$A = 30^2 + X^2 = 40^2 + (50 - X)^2$, X representing the distance of the milestone from one of the towers. Therefore the milestone is 32ft. from the 30ft. tower and 18ft. from the 40ft. tower.

BOOKS Received

The Amateur's Lathe by L. H. Sparey. 224 pages. Price 20s. net. Published by Geo. Newnes, Ltd., London.

IF you are a brand new lathe owner and are looking for a reference book or a course of instruction, this is it! The book is written by a man who is both a professional engineer and an enthusiastic amateur with his own home workshop. This duality enables him to combine his knowledge of professional methods and techniques with an awareness of the limitations of amateur equipment and the "know how" about overcoming them. The book is suitable for the amateur and also the professional with limited facilities. It would be an ideal companion for anyone contemplating building L.B.S.C.'s "Evening Star" which commences in this month's issue. The book is profusely illustrated with both drawings and photographs.

TRADE NOTES

A REVIEW OF NEW TOOLS, EQUIPMENT, ETC.

New Tyre for Kart Racing

THE new tyre known as the Firestone Micro "500" has a smooth cambered tread. Maximum adhesion and reduction of spin when starting coupled with a low wear rate are the advantages claimed by the makers after extensive track testing. The new tyre is being produced in sizes 3.00-5 and 3.50-5.

The cambered tread is provided to offset scuffing wear on typical Go-Kart race tracks which create heavy side thrusts on the offside tyres and heavy dragging loads on the near side tyres, particularly fronts. The tyres can be run with the high side of the camber on the inside edge or the outside, to suit the racing conditions. Five small holes spaced circumferentially around the near centre of the tread are incorporated to act as a tread depth gauge and the tyres should be removed from service as soon as these simple guides are no longer visible.

L.A.P. Cellulose Filler

LATEST addition to the L.A.P. range of decorators' products is their double-bonded cellulose filler. Workable for one hour after mixing it is claimed to give an extra hard and smooth finish. This new product retails at 1s. 6d. per 1lb. pack, 4s. 6d. for 3½lb. pack. The manufacturers are the Liverpool Adhesive Paste Co. Ltd., of 9 Roberts Street, Liverpool, 3.

The Magnavox Magitape Tape Recorder

THE MAGITAPE two-track tape recorder offers a choice of three speeds, giving a very wide range of reproduction. A special feature is the vented overall acoustically designed cabinet with vented base and motor panel. The control system minimises the risk of accidental erasure as there are three steps in the record control sequence. The price is 39 gns. The manufacturers are Magnavox, 129 Mount Street, London, W.1.

The Magnavox Magitape.

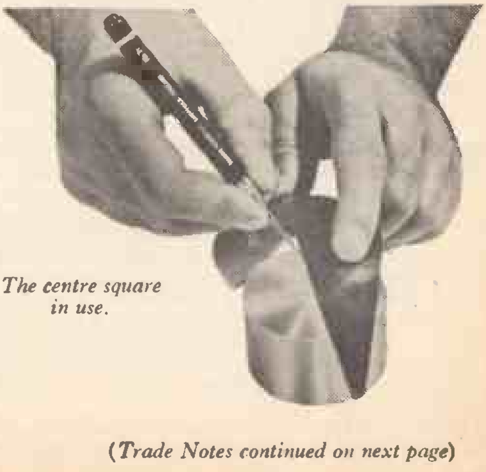
New Silent Extractor Fan

THE PRINCIPAL feature of the new Super Minex extractor fan is that it is free from buzz but has an air extraction rate of up to 20,000 cu. ft. per hour. It has a 40 watt four-pole shaded pole motor with an 8in. four-bladed impeller. This extractor is small enough to fit into a 9⅛in. hole and is ideal for the kitchen or bathroom, etc. It has an external transparent louvre. The price is £6 19s. 6d. complete and the manufacturers are Jones and Stevens Ltd., P.O. Box 35, Eastern By-pass, Littlemore, Oxford.

The Super Minex.

Centre Squares

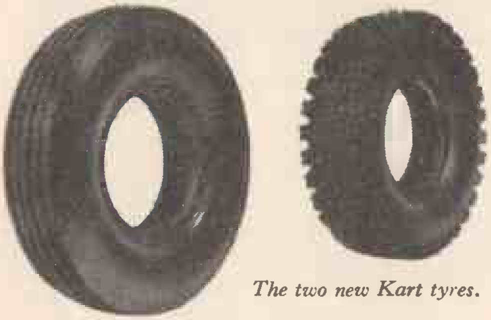
THE MOORE and Wright centre square is an inexpensive tool for rapidly and accurately finding the centre of the face of round bars or discs. The tool comes in two sizes: Cat. No. 825A for work up to 1½in. dia. and Cat. No. 825B for work up to 3in. dia. The prices are 9s. and 11s. respectively. The centre square is made of good quality tool steel, the blade being of hardened and tempered strip. The manufacturers are Moore and Wright (Sheffield) Ltd. Handsworth Road, Sheffield, 13.



The centre square in use.

(*Trade Notes continued on next page*)

Pirelli Kart Racing Tyres



The two new Kart tyres.

TWO SIZES of tyre suitable for Go-Karts are manufactured by Pirelli Ltd., of Burton-on-Trent, in 3·00-5 and 3·50-5 sizes. The 3·00-5 tyre has a ribbed tread suitable for use on front wheels, and the 3·50-5 tyre a block tread suitable for rear wheels. The 3·00-5 cover costs £1 19s. and the 3·50-5 cover £2 2s. A dual marked inner tube suitable for both tyres costs 12s. 6d.

Mark 9E Super Sports Engine

CLASS IV kart racing enthusiasts will be interested in a newly developed high-performance version of the Villiers 197 c.c. Mark 9E engine developing 15 b.h.p. at a shaft speed of 6,000 r.p.m. Known as the Mark 9E Super Sports, this engine has a high compression head, and is equipped with an Amal Monobloc Type 389 carburettor with a $1\frac{1}{8}$in. dia. choke, a swan-neck pattern competition inlet manifold and a competition-type flywheel magneto. The Villiers four-speed gearbox has internal ratios of 2·94, 1·78, 1·27 and 1·0 to one. An 18-tooth final-drive sprocket is standard. This engine retails at £60 15s. The manufacturers are the Villiers Engineering Co. Ltd., Marston Road, Wolverhampton.

Formula "E" Corrosion Killer

THIS is a non-acid and entirely non-toxic fluid made from a special blend of tannins, which combine with the oxides on already corroded metals (ferrous and non-ferrous) to form a hard insoluble tannate film. The metal is rendered inert and a hard burnished surface produced which takes paint well. A film of Formula " E " unpainted will resist weather for about ten days, providing protection until painting can be carried out. In addition lightly corroded plates can be resistance welded after treatment with the fluid, while an oxy-acetylene flame will burn away the tannate film without leaving any slag deposits. It can also be used for the prevention of underground corrosion of pipes, etc. Further details, prices, etc., are available from the makers, The Plus Gas Co. Ltd., 1-11 Hay Hill, London, W.1.

Gresham Low Voltage Transformers

THESE TRANSFORMERS reduce dangerous mains voltage to safe voltage for use with such applications as electric drills, soldering irons, illuminated displays, shop fittings, lighting, etc., and many other applications. The price of the transformers and any other information can be obtained from Gresham Transformers Ltd., Hanworth Trading Estate, Feltham, Middlesex.

"THE EVENING STAR"

(*Continued from page* 240).

the kind which I have found by experience to be the quickest and most efficient for steaming. It includes a combustion-chamber self-stayed by water-tube struts—a great help to circulation—and three large superheater flues, each containing two elements. The hotter the steam, within reason, the livelier the engine. The cast-iron grate is in three pieces, the centre one being arranged to drop, so that all residue is easily cleared after a run.

All the boiler fittings are to my usual standard, and easily made. The boiler is fed by a pump driven by an eccentric on one of the axles, and also by an injector located on the left side below the cab. Both deliver the water to the boiler through top feed clacks, as in full size. An emergency hand pump will be fitted in the tender, feeding through a clack on the backhead. Inexperienced enginemen usually find this very handy! As the driver doesn't ride on the footplate, but operates the " handles " from a seat on a flat car behind the tender, the backhead fittings will be arranged so that this can be done conveniently. If set out as on the full-size engine, some of them would be awkward to get at.

Big sister has a double chimney with a special copper top, a la Swindon practice. While this isn't the best arrangement for a little engine, as I have found by experiment, it is conspicuous, so I am specifying it, with double blast and blower nozzles to suit. The smokebox barrel can be made from brass tube, or rolled from sheet steel, the joint being brazed. Both door and ring are castings, iron or brass.

The superstructure—cab, running-boards, etc.—follows full-size practice, and forms a nice exercise in the art of sheet-metal working. The brake gear is a tighter squeeze than the Government credit squeeze, owing to the close spacing of the wheels. I have set the spacing in exact proportion to full size, in order to keep the wheelbase as short as possible, for ease in traversing sharp curves; but the wasp in the jampot is that we have to use proportionately deeper flanges ($\frac{1}{8}$in. deep on a $3\frac{1}{2}$in. gauge locomotive) and this only leaves $\frac{1}{16}$in. between the first, second, fourth and fifth pairs. The driving wheels, middle pair, have no flanges; just plain flat treads.

The tender, of which a drawing will be given in due course, is a straightforward job needing no comment here. Well, that's all for the present; in the next instalment we start business in earnest!

(*To be continued*)

SALES AND WANTS

The pre-paid charge for small advertisements is 9d. per word, with box number 1/6 extra (minimum order 9/-). Advertisements, together with remittance, should be sent to the Advertisement Director, PRACTICAL MECHANICS, Tower House, Southampton Street, London, W.C.2

FOR SALE

MIXED B.A. Screws, Nuts, Bolts, Washers, 2lb. 7s. 6d. post paid. Bifurcated rivets, 5s. ditto.—R. G. McClelland, 1 Beulah Road, Epping.

SPARES, VALVES, TUBES. 1930-1960
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"ST. JOHN'S RADIO,"
156 St. John's Hill, S.W.11. Bat. 9838.

GRINDING LAWN MOWERS PAYS, other peoples' or your own. The New Simplon 14in. grinding machine—powered by your electric drill, costs only £13 5s. carriage paid, and it's on approval. Details from—A. W. ROEBUCK, LTD., Turvey, Bedfordshire.

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Twin Cylinder 2½ cu. ft. per min. 150 lbs. pressure, base mounting complete with vee driving wheel, £2 C.F. S.A.E. for list of Motors, Gauges, Safety Valves, Air Lines, etc.
Dept. P.M.3,
WHEELHOUSE
13 BELL ROAD, HOUNSLOW
Phone: HOU. 350

AIR COMPRESSORS, single cylinder, two stage, 2½ cu. ft. min. at up to 450 p.s.i.; suitable for spraying, etc.; condition as new but slightly store soiled; cost over £10; bargain at £2 0s. 0d. each. Air Lines, 40ft., new, 30s.—Cooper, 10 Fowler Street, Nechells, Birmingham, 8.

GOVERNMENT SURPLUS AND CLEARANCE
ROTARY CONVERTERS. In 230V. D.C. Out, 230V. A.C., £7 10s.
MAINS 230V. ELEC. BELLS. Twin 6", 35s.
PAXOLIN PANELS, 12" × 6" × ⅛", 3s.
F.W. METAL RECTIFIERS, 12V., 1A., 5s.; 2A., 9s.; 3A., 12s. 6d.; 4A., 16s.; 6A., 22s. 6d.
FIELD TELEPHONES: F. Type, 90s. pair.
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FERRITE ROD AERIALS, 5s. L & M, 7s. 6d.
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S.a.e. for Latest List No. 73.
HUGGETT'S LTD.
2/4 PAWSON'S ROAD, WEST CROYDON, SURREY.

FOR SALE (*continued*)

HYPODERMIC SYRINGES, brand new 2 c.c. SIMA, excellent for oiling etc., 4/9 each. Also needles, sizes 12, 17 and 18 at 4/- per dozen.—G. Roger Smith, 16 Clyde Street, Liverpool 20.

EASIBUILD "WITCH" RUNABOUT, Fast 12ft. glass hull, ready moulded. Precision cut timber, wheel steering, screen, Attwood fittings, screws, glue, varnish, etc., all in.—Lund Finney Boats, Morda, Oswestry.

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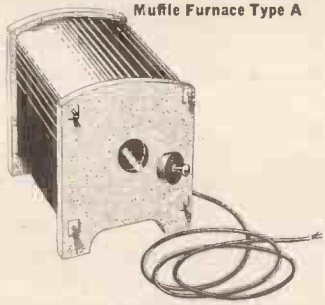
HANDYHEAT No. 10
Muffle Furnace Type A



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HAND DRILLS. Squire 0"-¼", 9-11°, Stanley 0"-¼", 15-3°. Case H.S. drills $\frac{1}{16}$"-¼", 4-3°. Full range Stanley Tools. P-P, 6d. Send requirements.—R. D. Agency, 125 Frederick Street, Rotherham.

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PHOTOGRAPHY

BELLOWS, Camera, Enlarger, Process, Industrial Collapsible Machine Guards.—Beers, 4 St. Cuthbert's Road, Derby. (Tel. 41263.)

PROJECTORS. Home Assembly Kits from £5 17s. 6d. Fan Base Kit £3 7s. 6d. Opticals: Screens. S.a.e. Marshall Smith Ltd., 64 Norwich Avenue, Bournemouth.

Continued overleaf

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SAWBENCHES.—Cast Iron. Rise and Fall. 6in., £6/19/6. 8in., £10/10/-. Carriage extra.—Drysdale, 58 Commerce Road, Wood Green, London, N.22.

SAWBENCHES.—6in. to 30in. from £8. Motorised, £16. Petrol Portable. £29. Bandsaws, £14. Logging Benches, Bundlers, Splitters. Planers, Lathes. Spindle Assemblies. Motors, Engines. Deferred Terms. Send 2s., returnable, for 40 Page Catalogue and Bargain Offers. List Free.—Beverley Products, South Thoresby 31, Alford, Lincs.

HOBBIES

CATALOGUE NO. 14 Government Surplus and Model Radio Control, over 500 illustrated items. 2s. (refunded on purchase). P/P. 6d.—Arthur Sallis Radio Control Ltd., 93(B), North Road, Brighton.

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BUILD YOUR OWN WELDER. Complete sets of plans and instructions to build your own 50 amp. (6s.); 100 amp. (12s.); 180 amp (14s.) welder, variable output.—Plans Service Co., 7 Gilpin Road, Urmston, Lancs.

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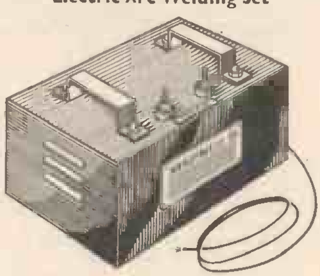

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Complete portable set which works off any 13 amp. 210/250V. mains plug. Accessories: Electrode holder, Earth clamp, Cables and Lugs, Face shield, Wire brush and Chipping hammer. All at an inclusive price of £13 16s. 9d. This includes delivery in England. The set uses standard electrodes from 20g. to 14g. enabling welds of $\frac{1}{16}$" to be laid in one pass, up to ¾" in multiple runs. Built in a strong stove enamelled case with mains lead.
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HOW TO USE EX-GOV. LENSES AND PRISMS. Nos. 1 & 2, 2/6d. each. List free for S.a.e.—H. W. English, 469 Rayleigh Road, Hutton, Brentwood, Essex.

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YOUR *Queries* ANSWERED

RULES

Our Panel of Experts will answer your Query only if you comply with the rules given below

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

Reclaiming Drawing Linen

I HAVE a number of old workshop drawings which I wish to wash in order to use the linen for polishing cloths, etc. Can you tell me the best possible method, please?—D. G. Wetton (Colchester).

WE think that the only way of removing the starch from the linen is by boiling after previously soaking the material in detergent. You will find that some drawing linens contain much more starch than others and will need more boiling and washing, but in general, this technique should be successful.

Ceramic Dyes

I HAVE some white Derbyshire alabaster which I wish to work and dye. What dye should I use and where can I obtain it?—R. H. Sparrow (Norwich).

SUITABLE ceramic dyes are available from Messrs. Wengers, Ltd., Stoke on Trent.

Light Source for Blueprint Making

I WISH to make some blueprints and have purchased some ferro-prussiate paper. The cost of carbon arc or mercury vapour lamps is prohibitive; can you suggest an alternative light source other than the sun?—A. J. Burfoot (Slough).

A GROUP of blue fluorescent tubes is used on some commercially made blueprint machines and although these do not give such fast exposure times, they have the advantage of being cheaper. Firms such as G.E.C., Kingsway, London, W.C.2., or Messrs. Hall and Harding, also of Kingsway, will be able to supply further information.

Telescope Mirror

I WISH to build a 4in. reflecting telescope and have your instructions for grinding a 6in. mirror. Can I employ the same methods of grinding and testing and what is the best focal length to use?—E. E. Hasler (Essex).

THE same procedure for grinding, polishing, figuring and silvering is applied for both 6in. and 4in. mirrors.

The focal length used is really a matter for you to decide yourself. A short focus will give you light for the observation of faint stars, star groups and nebulae and a long focus will give greater magnification which is most useful on the moon and planets. A good all-round and useful focus would be from 4ft. to 5ft. —say 54in.

Garage Doors

I AM about to construct a pair of garage doors opening directly into a sidestreet and measuring overall 10ft × 6ft. The doors will be made in two parts hinged together to save space and will comprise a 3in. × 1in. framework clad with duralumin sheet. Could you comment on this scheme, please?—R. C. F. (Manchester).

THE timber you suggest is of adequate size for the work you mention, but proper joints and strutting are needed to ensure no warping takes place. Material not less than about 16 s.w.g. will prove satisfactory and the supply and delivery question may govern the size used.

We do not think anything is needed between the sheet, nor is any elaborate finish necessary, in fact, depending somewhat on the surroundings with which no doubt you wish to harmonise your doors, we would say that no painting will be required, leaving the sheeting as purchased.

We offer the following suggestions for your consideration. Instead of wood, why not utilise angle material; either steel or aluminium? This will perhaps be slightly dearer in the latter metal, but of course rot and rust are prevented. Secondly, and in view of your desire to save space, properly constructed sliding doors on runners top and bottom are usually considerably more rigid than those you have in mind, and if angle iron is adopted this strength is greatly increased.

"Practical Mechanics" Advice Bureau. COUPON
This coupon is available until Feb. 28th, 1961, and must be attached to all letters containing queries, together with 6d. Postal Order. *A stamped addressed envelope must also be enclosed.*
Practical Mechanics. February, 1961

Sun Ray Lamp

I INTEND making a sun-ray lamp, mounting the two carbon electrodes in front of a rectangular parabolic aluminium reflector. What wattage should the series resistor be and can it be mounted behind the carbons to reflect radiant heat? Are special carbons necessary or can old dry cell carbons be used?

I have a 400 watt mercury vapour discharge lamp complete with choke; could this be used instead of carbon arc? Mains voltage is 230, 50 cycles, A.C.—A. Horobin (Middlesbrough).

WE would advise you to use a series resistor of 1,000 watts. This resistor can be mounted behind the electrodes to reflect radiated heat as you suggest. You should use tungsten or iron-cored carbons; if required you could probably obtain these from the Health Ray Co. of 50 Portland Terrace, Southampton. Infra-red rays can be emitted by any type of resistance wire, such as Brightray resistance wire as supplied by Messrs. Henry Wiggin & Co. Ltd., of Grosvenor House, Park Lane, London, W.1. The size and length of wire should be arranged so that it operates at a temperature just below luminous value.

If the inner glass envelope of the 400 watt lamp in question will pass ultra-violet rays, the lamp could be used with the outer envelope removed, in circuit with the original choke coil. However, we understand that quartz glass is not generally used in these 400 and 250 watt lamps although the 125 watt lamps frequently have quartz glass. A series resistor is not required, but you could use a radiator element on a separate circuit connected across the lamp unit for radiant heat, if required. If infra-red rays are required you could connect two similar radiator elements of about 1,000 watts each in series with each other to reduce their operating temperature.

Soil Heating

I AM making a 6ft. × 3ft. garden frame with brick built sides and intend installing soil heating. What voltage should I use and what length of heating wire will be required? Is a thermostat necessary?—J. D. Scrimgeour (Birmingham).

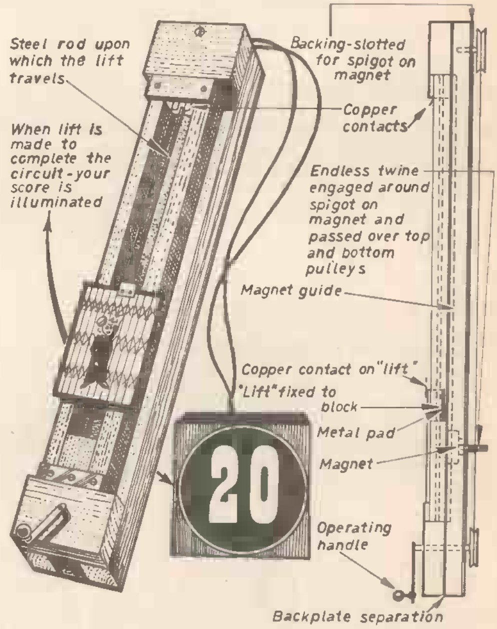
IT is most essential that a low voltage is used to supply the heating element; in fact, it is not permitted to connect any point of the public supply as would be the case if you buried a bare wire heater in the ground and connected this to the mains. We suggest you use a transformer having a secondary voltage of 6.

The rate of heat dissipation from the frame is generally such that thermostatic control is not essential. Two methods are generally employed in such frames. Firstly a heater of about 1·7 watts per square foot could be used and continuously energised. Secondly a heater of about 5 watts per square foot could be used, this being switched on by hand, or by means of a time switch, for about 8 hours in every 24. The method which is most convenient is best determined by individual conditions. For the continuous heating method you would therefore require a heater of about 30 watts and could use 73ft. of 15 s.w.g. galvanised iron wire. For intermittent heating you would need a heater rated at about 90 watts and could use 48ft. of 12 s.w.g. galvanised iron wire. If required we could supply constructional details for a suitable transformer.

Race Game

AT a seaside resort, some years ago, I remember seeing a game where each competitor turned a handle which caused a monkey to climb up a stick. If the handle was turned too fast, the monkey would slip back. A slow controlled movement was necessary to get the monkey to the top and the winner was, of course, the competitor who got his in that position first. I thought of making a similar game and wondered if you had any idea as to how it works. —P. Miller (Runcorn).

WE have never seen the game to which you refer, but the sketch below shows one way in which it might work. The monkey or, in this case, a lift is



Method of construction.

attached to a block which slides along a rod. Behind the wood or brass backplate a magnet slides up a guide corresponding to the rod in front. The magnet is connected to an endless belt which is wound round a pulley at the top and another at the bottom. On the bottom pulley shaft a handle is attached at the front. When the handle is wound the endless belt will lift the magnet. The magnet will attract the metal plate on the lift block and the lift will be carried up the rod. If the handle is turned too quickly contact between lift and pulley will be broken and the lift will fall to the bottom. To make a game a number of lift shafts will be required. The lift could be made to complete a circuit and light a lamp when it reaches the top.

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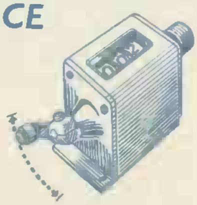

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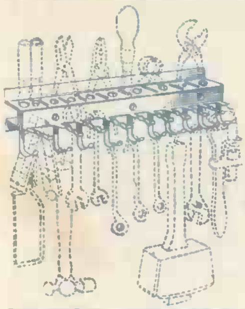

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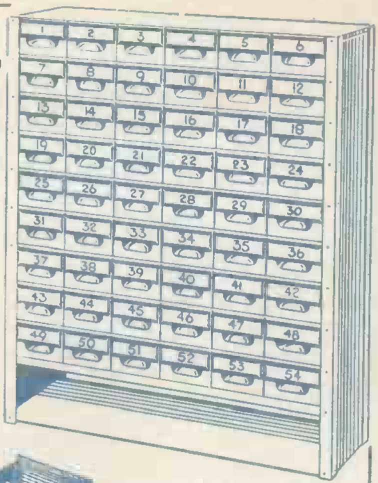

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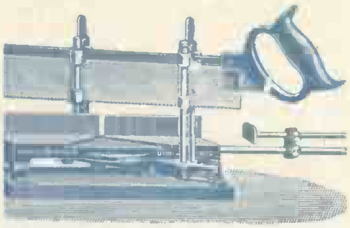

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