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Practical
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CONTENTS

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

INVADERS FROM SPACE

A HEADING like the one above sounds as if it has been lifted straight from space fiction. It characterises a theme much beloved of authors of this type of work and the "invaders" have been of many varied types from "men with beautiful faces and long hair" to "malformed midgets with television aerials sprouting from their foreheads." Now, however, like so much other space fiction which is already reality, there is a possibility that the earth could be invaded from outer space by invaders not envisaged even by space fiction writers.

A great many well-known scientists are now convinced that life does exist on other planets and it is the imminence of man's first visits to his nearest planetary neighbours which is causing an atmosphere of urgency to surround a meeting of the world's leading exo-biologists which starts as we go to press with this issue of PRACTICAL MECHANICS. The invasion feared by these scientists is one of bacteria and other tiny organisms. These, it is feared could be carried back to earth on manned or unmanned space ships returning from visits to the moon or, more likely still, from Mars.

Scientists have placed great emphasis on the sterilisation of equipment and space ships being rocketed to the moon and the planets so that these worlds should not be contaminated by germs from the earth, but until now, we have heard little of the opposite possibility of the earth being infected by extra-terrestrial microbes. Such infection could spread rapidly if the microbes were of a type not known on earth. Earthbound living things would have no resistance to them and their effect could be devastating.

What can be done to prevent this disturbing possibility? One of the first steps planned is to inspect each planet as it comes within range for signs of life., Equipment, including television cameras will be landed. These will transmit back to earth pictures of the moon's dust and other samples viewed through a microscope. The information gained will aid the scientists in evolving a sterilisation technique for returning spacecraft. The pilots, observers and scientists who travel in them would also have to be quarantined on their return to earth.

Although a growing body of scientific opinion now believes that there is some possibility of life on other planets, it is generally thought that this can only be of the most basic kind. Vegetation would most likely be a form of moss or lichen. These opinions are relatively new and ten years ago it was thought that adverse conditions on our neighbours in the solar system effectively precluded any chance of life as we know it. Opinion has been changing gradually as modern techniques uncover bit by bit new evidence to support the "life on other planets" theory. One day we shall know without any doubt and when one considers how much scientific opinion has shifted over the years, it is pretty certain that someone at least will be able to say "I told you so."

Many of the current theories and opinions will be heard at the forthcoming conference in America and among the reports to be heard are such titles as "On the Possible Existence of Intelligent Beings on other Planets," "A Manned Mission to Mars and Venus" and "Legal Aspects of Encounters with Living Forms." It is still hard to believe that such titles are being discussed by responsible scientists now and are not figments of a science fiction writer's imagination . . . .

The December 1961, issue will be published on Nov. 30th, 1961. Order it now!

MAN-CONTROLLED FREE FLIGHT

By Donald S. Fraser

"HE flies through the air with the greatest of ease," not, however, quite like the young man in the song. In this instance—and for the first time—a man has used a rocket, carried on his back, to fly over the ground.

The experimental man-rocket belt has been designed and developed for the U.S. Army Transportation Research Command by Textron's Bell Aerosystems Company. Development and tests of the Small Rocket Lift Device (SRLD) have been under way since August 1960 under Army contract. To date, the SRLD has already made more than 30 flights at Buffalo, N.Y. and at Fort Eustis, Virginia.

The chief test engineer for Bell, Mr. Harold M. Graham, has flown the SRLD over ground distances up to 360ft., and has also flown to the top of 30ft high hills, using the rocket belt. Average speed on test runs was estimated at 20 m.p.h. Mr. Graham is believed to be the first man to fly over the earth's surface supported only by portable rocket equipment.

Purpose of Prototype

This current device, in the man-rocket research programme, is strictly a feasibility model designed to prove that lightweight rocket power can lift a man and transport him over the ground in controlled flight. No attempt has been made, as yet, at shooting for maximum performance and, since the man-rocket concept is still in the proving stages, available components only have been employed, wherever possible, in the design of the SRLD.

Although the weight of the system and performance details, such as maximum thrust levels and operating duration have not been disclosed, it is understood that the rocket operator is able to carry the equipment on his back. It was reported, however, that test engineer Graham, who has made all of the free flight tests, weighs 180lb. when wearing his protective overalls, boots and helmet.

Military Uses

The current man-rocket was not designed to meet specific military requirements, although applications have been studied for Army operational units that may be developed under the SRLD research programme.

The most frequently mentioned military use of man-rockets would be to transport soldiers over surface obstacles such as streams, rivers, ravines, barbed wire and mine fields. Rocket belts may be employed during amphibious operations permitting troops to fly from ship to shore. Rocket belts also could be used to reach the top of vertical obstacles such as cliffs and steep hills. Undoubtedly, too, there must be a number of other uses for such a device in industry and other fields.

Description

Basically, the man-rocket consists of a twin-jet hydrogen peroxide propulsion system mounted on a fibreglass corset which has been moulded to fit the back and the hips of the operator. The operator slips his arms through padded lift rings attached to the corset. He then secures the unit with two quick-

The Small Rocket Lift Device (SRLD) in action. The equipment is secured to the operator's back with safety straps. One hand is used to operate a control stick to change direction; the other manipulates a motorcycle-type throttle.

thus controlling his rate of climb and descent. The device has proved so stable in flight that pitch and roll are easily controlled by movements of the operator's body.

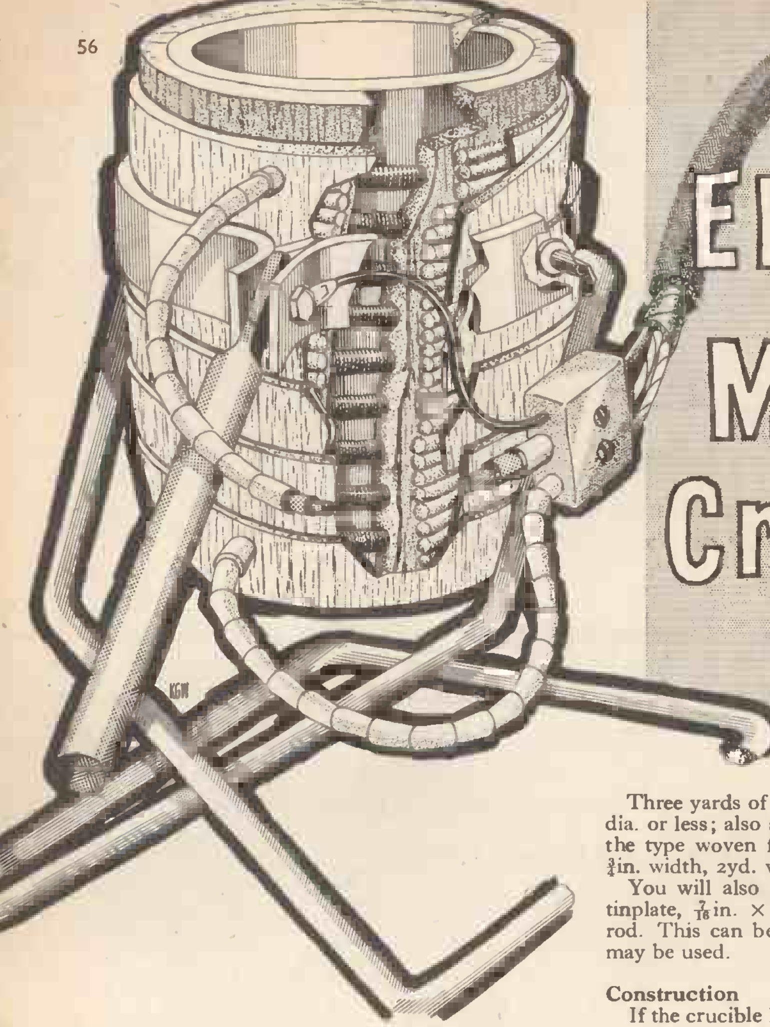
The SRLD rocket propulsion system is fully throttleable. When activated by the pilot's controls, hydrogen peroxide is forced under pressure into a gas generator where it contacts a catalyst and decomposes into steam. The steam escapes through two rocket nozzles providing thrust. Main thrust from the nozzles is directed towards the ground, while jet deflectors provide thrust for yaw control when activated by the operator. Position of the rocket nozzles and the low temperature of the steam exhaust eliminate the need for special protective garments to shield the operator.

Here the operator demonstrates the power of the SRLD by " leaping " over a large truck. The device has already flown a man to the top of 30ft. hills.

(Right) A further view of the device being tested. Pitch and roll are easily controlled by movements of the operator's body.

release safety belts passing around his abdomen.

Metal control tubes, attached to the lift rings, extend forward on each side of the operator. A control stick on one tube permits the operator to change his flight direction. A motorcycle-type hand throttle, mounted on the other tube, allows him to regulate rocket thrust levels,



Electric Muffle Crucible

by P. Wicks

THE electric furnace shown in the heading should not cost more than 10s. to make. It is small, easy to construct and economical in use. Heat is distributed evenly over the entire surface of the crucible. All non-ferrous metals, such as aluminium, white-metal, brass, copper, silver and gold, and the various alloys of these metals can be melted.

Components

The first requirement is a London Round Clay Crucible No. 1. This can be obtained from Messrs. E. Grey & Son, Grayson House, Clerkenwell Road, London, E.C.1. It is approximately 2¾in. high and has an inside dia. of 1⅝in. at the top. A crucible a size larger can also be used.

You will need a 500W. coiled wire heating element of the type used for some electric fires and boiling rings. Only the actual wire is required.

The requirements for the fire cement used are quite critical. One which has been tested and found ideal for the purpose is "Flexo 3056/SM Mixed" made and sold by Thomas & Bishop Ltd., Davis Road, Chessington, Surrey. This has good strength and the right coefficient of expansion so that the element is not weakened while it is rapidly heating or cooling.

Three yards of asbestos string will be needed, ⅛in. dia. or less; also a yard of 1in. wide asbestos tape of the type woven from asbestos string. If of ½in. or ¾in. width, 2yd. will be needed.

You will also need a strip of fairly heavy gauge tinplate, $\frac{7}{16}$in. × 8in., and 3ft. 6in. of ⅛in. dia. steel rod. This can be galvanised or a welding rod, etc., may be used.

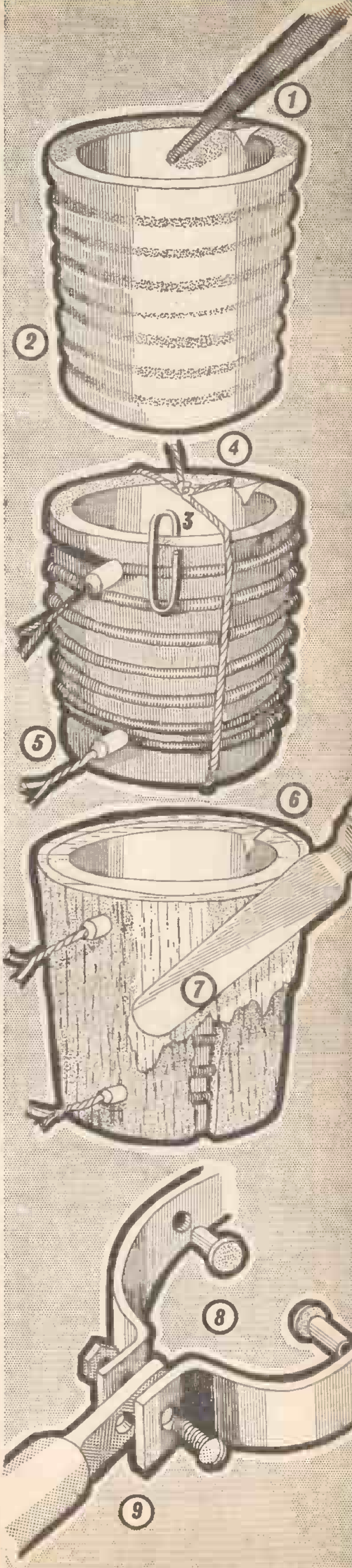
Construction

If the crucible has no lip to assist pouring, grind or file a groove just inside the upper rim to enable the molten metal to be poured out in a fairly thin stream (1). A small, thin grinding wheel is the best tool, but the job can be done with a ¼in. dia. round file.

Take the length of element and, holding it at one end, at the very top of the crucible, and with about 1in. to spare, wind it round from top to bottom in a gradual spiral, so that there is about ⅛in. space between each turn of the element. On a crucible of this size you should have about an inch or so of element to spare when you reach the bottom. If you have too much or too little left over, adjust the space between the turns so as to use up all but an inch or two of the element. With a pencil, mark the position of the turns on the surface of the crucible and remove the element.

A power-driven grinding wheel is desirable for the next step, but it can be managed with a coarse round file of small diameter. You have to cut a shallow groove—$\frac{1}{16}$in. is sufficient—to keep the element correctly located round the body of the crucible and ensure that the coils will not touch one another during the next operation (2). Grind exactly between the parallel pencil lines, being sure to run to top and bottom of the crucible.

Pull out and gently straighten about 7in. of the



Step by step constructional details.

element at each end and twist on a similar length of wire from an old element to act as a reinforcement. Starting at the top fasten the element in the beginning of the groove you have cut. A paperclip will hold it in position (3). The last ½in. of the twisted portion is to be embedded in the cement and a porcelain insulator embedded in the cement where the wire emerges. Wind the element into the groove until the bottom is reached, where you should also have ½in. of twisted wires to embed. Hold the coil in place here with a piece of string tied vertically over and under the crucible (4).

Next prepare the fire cement by mixing about half a cupful with a little water until it reaches the consistency of ordinary builder's cement. Apply it to the element with an artist's palette knife or the blade of a table knife, pressing it into all the coils of the element until that is completely covered (6). This takes a little time to do properly, but it is most important that there should be no air pockets left anywhere inside the cement. Leave the area occupied by the string for the moment, and put the job on one side until you judge that the cement has hardened sufficiently to hold the element in position. When the pressure of a finger suggests that this is so, remove the string and make good the omitted area with a fresh mix of fire cement, blending it firmly into that already coated (7). The paper clip can be removed and the cement worked to top and bottom of the crucible to make a neat finish with the existing rim and base. The cement should cover the element completely, but need be no more than ⅛in. thick outside its coils. With a knife blade dipped in water, impart a smooth, even finish to the surface of the cement until it looks like a fatter edition of the original crucible.

Drying the Crucible

The lengths of twisted wire which project at the top and bottom should emerge at right-angles to the crucible. Thread a porcelain insulator on each wire and embed it in the soft cement, leaving just the rounded top showing. Ideally the crucible should be allowed to dry naturally for 24 hours. After this drying period, place the crucible in a household oven at a gentle heat until there is no trace of moisture left in the cement.

You can now connect up for a trial run, which will also bake the coating and show up any defects which need to be repaired with fire cement. Do not worry about fine cracks appearing here and there. Stand the crucible on a sheet of asbestos and make sure it is firm. If you are careful to avoid short-circuits you may simply twist the wires of a mains lead to the wires leading from the crucible and insulate the join temporarily. Remember to touch no wires once you have plugged in. Switch on and allow a minute to warm up. Switch off again for another minute and then switch on for four or five minutes. The whole crucible should heat up to a dull red. There will be a certain amount of smoke during the first burning, but none thereafter.

After the test, leave until thoroughly cool, remove the plug and disconnect the wires.

Lagging

Bind the crucible with a layer of asbestos string. One layer closely wound is sufficient. Add a layer of asbestos tape, overlapping each turn very slightly. Finish off with a turn of tape just half way up the crucible and use a pin to hold it temporarily in position.

Take the strip of tinplate and bend it round the crucible at the centre. Cut the ends and bend them at right-angles, to leave a gap of about ¼in. between them (8). Drill a hole through the flanges at this point to accommodate the brass bolt. The handle by which the crucible is tilted for pouring is also attached by this bolt. (See 9). The handle can be a piece of light gauge tubing, $\frac{3}{16}$in. dia., slotted and flattened at one end. If this end of the handle is made to fit closely against the band encircling the crucible, any pivoting will be avoided and no other fixing will be required.

Drill two holes in the band to take two rivets. These holes come immediately opposite one-another. The rivets are pressed through the holes from the inside of the band, the band is slipped over the crucible and fitted halfway down so as to hold the end of the asbestos tape. The handle is bolted on and the flanges of the band drawn together. The bolt should not be over-tight.

The stand is simply made by bending the steel rod to the shape shown in (8). The base of this one measures about 6in. on all sides, but the (*Concluded on page* 89).

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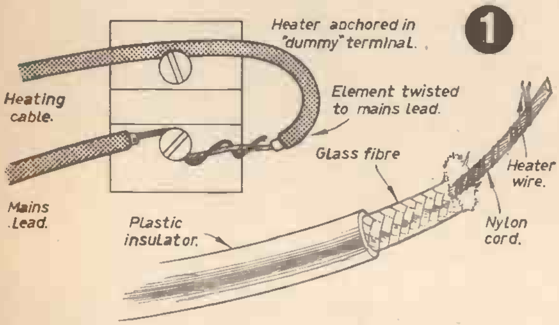


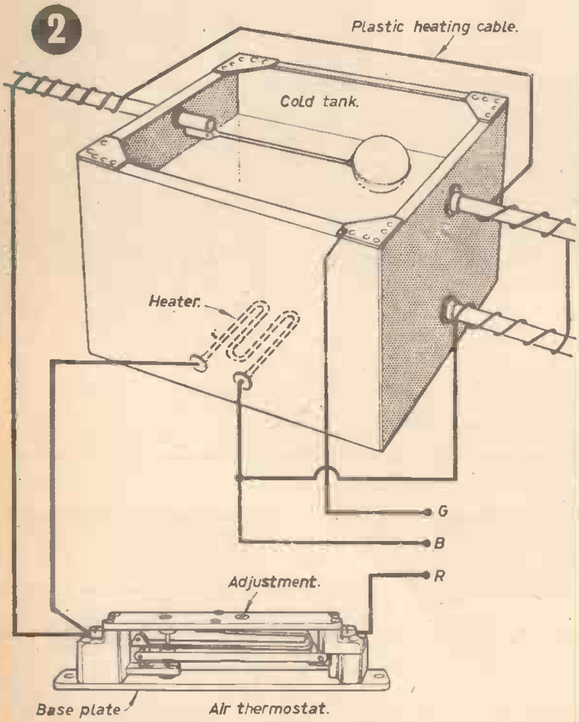


Fig. 1.—Heater wire details and method of securing.

Fig. 2.—Immersion heater with thermostat and plastic heating cable.

By E. V. King

ONE method of avoiding a frozen cold water storage tank in the winter is to fit a small immersion heater of about 250-350W., as shown in Fig. 2. It is fitted with rubber washers as low as possible inside the tank. The tank is earthed to the green wire on the mains cable and the heater may be switched on automatically by a greenhouse type thermostat set to about 40 deg. F. Technical Services' type M.L. will give years of service in this position.

With moderate lagging a 350W. heater will prevent freezing in the hardest weather. In all cases put the thermostat (air type) under or as nearly under the tank as possible. The heater illustrated is a surplus one obtained for a few shillings from Messrs. Whistons as No. 3032 B. The bare terminals must be covered with Polythene sheet for safety in the loft. A small thermostat which cuts in at about freezing point is required. Any type will suit as long as it will carry 2½A. or more. If any live parts are exposed, or if a surplus unit designed for 24V. is used, it must be housed in a wooden box provided with a little ventilation. The one shown in Fig. 2 is a surplus thermostat marked 5D 938. A suitable, cheap and reliable thermostat is marketed by Messrs. Burgess Products Ltd., of Team Valley, Gateshead. It should be ordered as "Therm/BR" and costs approximately 25s. Do not immerse the micro-switch, which is fixed to the unit, in water. It is also possible to fit an immersion thermostat in the tank, but this is not considered so effective as one operating in the air outside the tank. Lagging the tank is always useful. Do not forget the top.

Portable Hook-on Heaters.

It is also possible to use a "hanging" type of immersion heater in the cold water tank. The one illustrated (Fig. 5) is rated at 100W. and good lagging would be required to be sure of no freezing, especially in draughty locations. The clip shown is hung over the edge of the tank, ballcock support (not the lever) or a metal bar placed across the tank. It is not automatic, but can be made so by wiring to the air thermostat as illustrated in Fig. 2. In portable heaters of this type a good earth is absolutely essential. It is obtainable from Messrs Eltron (London) Ltd., Strathmore Road, Croydon, Surrey.

The Automatic Warming of Cold Water Pipes

A thermostatically controlled convector heater may of course be fitted in the loft, outhouse etc. and the thermostat set to 35 or 40 deg. F. It will only consume current when the temperature is around freezing point.

Another very useful method is to wrap heating wire round the cold water pipes and to switch the current on when frost is expected, or better still to use an automatic thermostat.

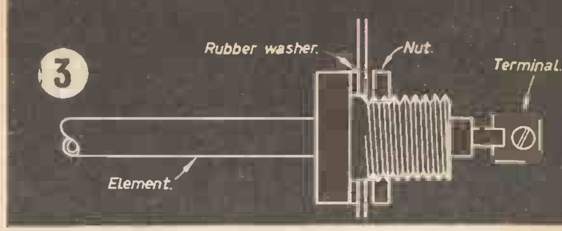


Fig. 3.—Details for fixing the immersion heater.

How the System Operates

Heater wires of exceptional insulating qualities warm the pipes, which may be slightly lagged if desired. The general arrangement is shown in Fig. 2, in combination with a low wattage heater in the tank. Another good system is shown in Fig. 4. Here the heater wire is wound round the tank, care being taken to keep it in place with wire netting and a light lagging may then be provided over the wire. The wire must not fall down so that many coils touch together; such a situation could be dangerous. Earthing is essential.

How to Fit this System

Work on the assumption that the tank will require 150W. if lightly lagged and 300 if not lagged and that each foot of piping will require about 2W. In very cold and draughty locations these ratings may be uplifted 50 per cent.

Each foot of heating cord can provide 1½W. of heating and no more. Thus 16in. of heater will do for each foot of pipe and the tank will require 100ft.

The length required is given by the formula:

$$\sqrt{\frac{2}{3}\frac{E^2}{R}}$$

Where E is the mains voltage and R is the resistance of the heater cable per foot. The number given is the *minimum* number of feet of heater which may be used in one run. If the length is increased no harm will be done electrically, but not so much heat will be generated per foot.

For those who do not wish to work out the figures the following table is ready prepared and readers should stick to the lengths required.

Mains Volts	Cable Res. per yd.	Feet Required	Watts.
240	30 ohms	65	90
200	30	50	80
240	25	75	90
200	25	60	80
240	15	90	130
200	15	75	100
240	12	100	144
200	12	85	125

Fixing the Wire Netting and Heater Cable

The tank is surrounded by small gauge wire netting which is held in position by a few wires stretching across the top of the tank. The netting MUST NOT be able to slip down (see Fig. 4).

Say we require 150W. for the tank then we can use 100ft. of 12Ω per yd. cable on 240V. or for instance, two separate lengths, wired in parallel, of 50ft. of 30Ω per yard on 200V. (giving 160W. in all).

The wire is wound round the tank, in and out of the netting, so that NO part of the heater wire comes near to another part of the heater wire, or near to any other heater wire.

The two ends are taken to terminal blocks and very securely fastened as shown in Fig. 1. This method of fixing is important if soldering is not to be done. Fig. 1 shows how the wire is manufacturered, the thin heater element may consist of more than one single wire. One inch of the element wire is stripped at the end.

The cable itself is then anchored to spare terminal (Fig. 1) and the thin heater (heaters) closely twisted with the mains lead, the two being tightly clamped in the terminal (Figs. 1 and 4).

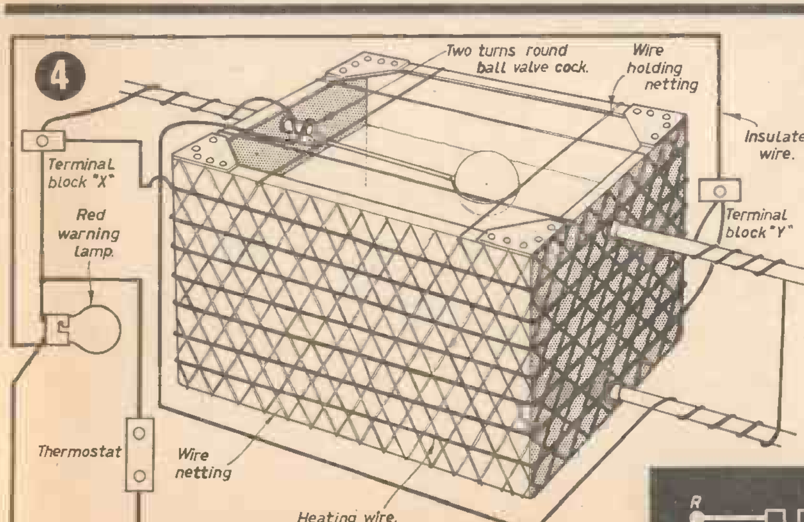
Wiring the Heater to the Mains

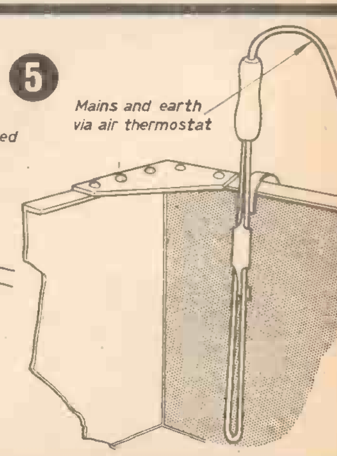
Each terminal is fixed in a safe position and the wiring is done as shown in Fig. 4. An air thermostat is fixed a few feet from the tank and a small red pigmy mains lamp is wired across the heater to give warning that the network is live. Make sure the wire is not punctured in fitting and it will be perfectly safe even if soaked in water (over 50 MΩ resistance under such conditions).

Wiring the Pipe Heaters

Choose one of the lengths in the right hand column of the chart. Wind this on the piping to be protected

(*Concluded on page* 89).





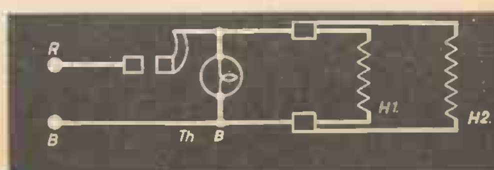
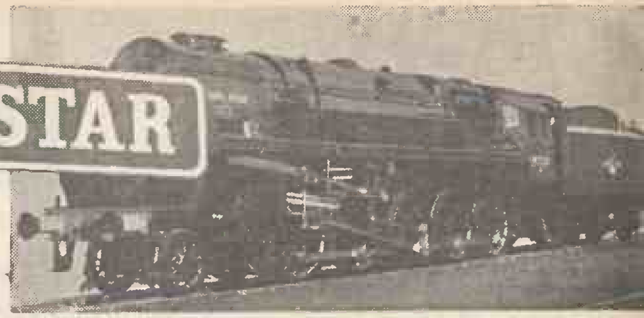


Fig. 4.—Using heater wire to warm the tank, practical and theoretical arrangements. The tank must be earthed.
Fig. 5.—Portable hook-on heater.

L.B.S.C's 3½in. Gauge EVENING STAR



Part 9. Flange plates, pistons, piston valves and slide valves.

Flange Plates

BOTH p-v and s-v cylinders are attached to the engine frames by flange plates, which are made from ⅛in. plate, either brass or steel being suitable. They are sawn and filed to dimensions given in Figs. 50 and 51 and drilled as shown. Note that a small clearance is needed in one bottom corner, to fit over the leading brake-hanger pins in the frame. The drawing of the contact side of the s-v cylinder shows the flange plate attached, 5 BA countersunk screws being used (Fig. 51). The plate for the p-v cylinder is larger, and attached by 12 6 BA screws. As this plate closes the exhaust way in the contact side of the cylinder, the joint should be steamtight; so true up both the plate and the contact side of the cylinder in the same way as described for truing the s-v portface, and smear the surfaces with either plumbers' jointing, or a liquid jointing such as used in automobile work, before screwing up " for keeps."

The pistons and piston-rods for both piston-valve and slide-valve cylinders are identical. The piston-rods should be made from 7/32in. ground rustless steel, but the drawn variety will do if the former isn't available. Two 3⅝in. lengths are required. Chuck in three-jaw, face the ends, and put ¼in. of 7/32in. × 40 thread on one end of each, using a die in the tailstock holder. Some folk are tempted to put the die in an ordinary die-stock, and apply it by hand; well, you know what usually happens to those who succumb to temptation!

Pistons

These can be turned from 1⅜in. drawn bronze rod, cast rod, or from separate castings. If cast material is used, it should be of a different grade to that of the cylinder castings. My late lamented friend Harry Sturla, who for many years ran a foundry business at Waltham Cross, and had a wonderful practical knowledge of metallurgy, always said that like metals working together resulted in uneven wear, and I found it so by experiment. Chuck a piece of rod with about 1⅛in. projecting from the chuck jaws; too much overhang on the average small lathe is likely to cause chattering. Turn 1in. length to 1/64in. over finished diameter. I find that a narrow-ended roundnose tool with about the same amount of top rake as used for turning steel, gives best results when turning hard bronze, and I always use cutting oil, despite the text-book dictum that non-ferrous metals should be turned dry. Experience teaches! Face the end, centre, and drill to 1in. depth with 3/16in. or No. 21 drill.

With a parting-tool cut a groove 3/16in. wide and same depth, at ⅛in. from the end. Part off at 7/16in. from the end, then repeat process. Parting-tool chatter which worries beginners and inexperienced workers, can be avoided by running at slow speed and using cutting oil. Chuck each blank in the three-jaw, level with the ends of the jaws, so that it runs truly. Open out the hole with a No. 3 or 7/32in. drill for 3/16in. depth, and tap the remainder 7/32in. × 40. Put one of the piston-rods in the tailstock chuck, gripping it tightly to prevent slip. Run up the tailstock until the screwed end of the piston-rod enters the hole in the piston and engages the tapped part, then pull the lathe belt by hand until the plain part of the rod immediately behind the screwed part, is drawn into

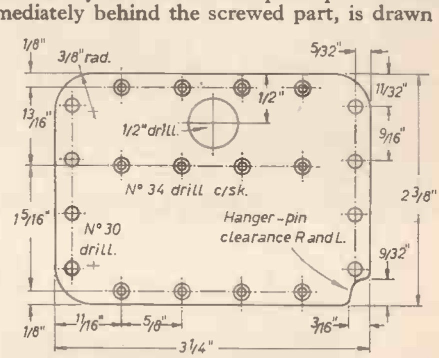


Fig. 50.—Details and dimensions of the flange plate for piston-valve cylinders.

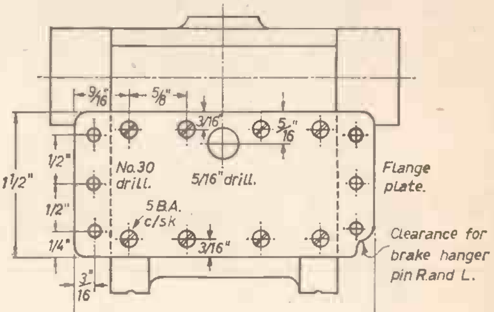


Fig. 51.—How the flange plate is fitted to slide-valve cylinder.

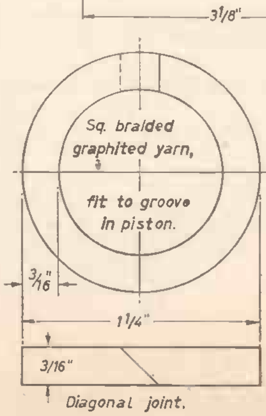


Fig. 52 (Left).—Piston packing.

the opened-out section of the hole in the piston. The screwed part of the piston-rod should just be showing through the other side of the piston. This combination of " screw-and-plain " is the surest way of getting an accurate fit. The chucks on Myford and other precision lathes are fitted thus, a fact which speaks for itself.

Finishing

The pistons are finished to size on their own rods, and to ensure absolute concentricity, the rod must be chucked truly. If your lathe has collets, this is simplicity itself; just put the rod in a $\frac{7}{32}$in. collet with the piston close up to it. If not, make a split bush to hold the rods truly in the three-jaw chuck, same as described for holding the steel when turning crankpins. Then grind up the tool used for turning the blanks, and turn the pistons until they are an exact sliding fit in the cylinder bores. Don't worry how much time is taken on this job; if you only fit one in a whole evening it is worth it. The final cuts should be mere scrapes,

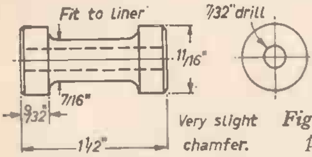


Fig. 53.—*The piston valve*

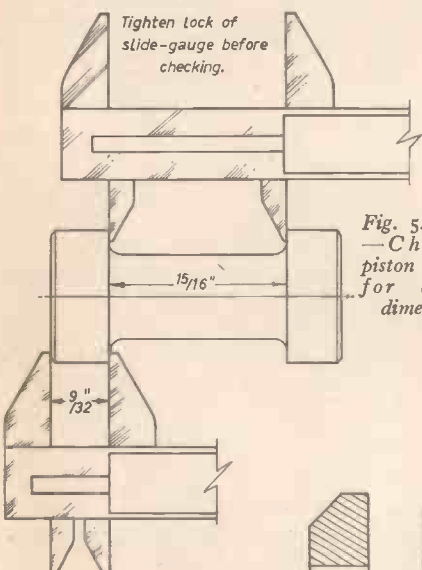


Fig. 54 (*Left*).—*Checking piston valves for correct dimensions.*

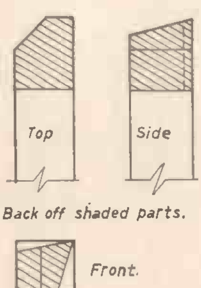


Fig. 56 (*Right*).—*Facing and chamfering tool.*

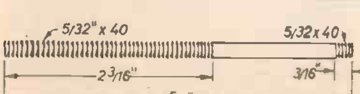


Fig. 55 (*Below*).—*Valve spindle.*

so that the piston slides into the cylinder bore without a vestige of shake. Use the self-act, if the lathe has one, with the finest available feed. If not, the top slide must be set to turn parallel, as previously described.

It has been stated, and written, that piston fits need not be as exact as all that, because the packing prevents any steam from blowing past. Don't believe it! The packing should merely act as a seal, and not relied on to withstand pressure. During my lifelong experience I have done a lot of overhauling and rebuilding jobs. In several cases when taking a slack-fitting piston out of a cylinder. I have found no packing at all in the groove. Under the combination of pressure and friction, the packing had disintegrated, and the tiny fragments had escaped between the rim of the piston and the cylinder bore, making a final exit with the exhaust steam up the blastpipe. Pistons should fit steamtight but not mechanically tight. A good test for a slide-valve cylinder is to put on the front cover, and put the piston in the back end of the cylinder, piston and bore being perfectly dry. Put your thumb over the front port, and up-end the cylinder. If the piston stays put in that position, but falls down to the end of the cylinder if you remove your thumb from the port, the fit is O.K. To apply this test to a piston-valve cylinder, it would be necessary to push a cork into the liner, to cover the port, as you can't very well put your thumb in the liner.

Face off any fragment of piston-rod projecting through the piston, and take a skim over the end of the piston to ensure a flush face. Before removing from collet or bush, try a piece of $\frac{3}{16}$in. square braided graphited yarn (Fig. 52) in the groove. This should fit nicely at the sides, and stand just a weeny bit above the rim, so that when the piston is in the cylinder, it acts like a piston-ring and presses slightly against the bore. I find that this type of packing varies in size, and if it won't fit in the groove, it is easy enough to enlarge the groove to suit, while the lot is still chucked.

Piston-valves

If the reamer used for reaming the liners is true to size, and has left a hole exactly $\frac{11}{16}$in. dia., then a piece of $\frac{11}{16}$in. ground rustless steel should be an exact sliding fit in it, and all doubts and fears of any beginner about the fit of the valve in the liner, will be dispelled at one fell swoop. All that is needed is to chuck the steel with about 1$\frac{3}{4}$in. projecting from the jaws. Face the end, centre, and drill to about 1$\frac{5}{8}$in. depth with $\frac{7}{32}$in. drill. (Fig. 53). If the drill leaves a burr around the hole, face it off, then put the centre-point in the tailstock barrel, and bring up the tailstock to support the steel whilst reducing the centre part of the valve. Using the same tool as for turning pistons, starting at $\frac{5}{16}$in. from the end, reduce the steel to $\frac{7}{16}$in. dia. for $\frac{15}{16}$in. length. The length of the gap must be no more, no less. What I do, is to set the prongs at the back of my slide-gauge (used for measuring internal diameters) to the required dimension, and turn the gap until they are a tight fit in it (Fig. 54). Part off at $\frac{5}{16}$in. from the end of the gap.

Next, chuck the valve in the three-jaw with one end projecting about $\frac{9}{32}$in. Set your slide-gauge to $\frac{9}{32}$in. and take a skim off the end of the valve, so that the slide-gauge fits tightly over the width of the bobbin (Fig. 54). Reverse in chuck and repeat operation on the other end. Both ends should be very slightly chamfered, giving the valve a small exhaust clearance, same as I always specify for the cavities in slide-valves. Don't chamfer the inner edges of the bobbins, just leave them sharp, otherwise steam will be admitted too early.

During the latter part of the Kaiser's war (1914-1918) I was in charge of a small munition shop producing aero-engine components, and my experience of reamers was that the commercial variety were more Ananias than George Washington, the holes they left being a little plus or minus their reputed size. I don't suppose the present-day variety have the reputation of Mrs. Caesar, either, so if you find that the specimen used for reaming the liners has cut over or under size, the valves must be turned to fit. There is nothing to alarm the veriest tyro in tackling this job.

A piece of rustless steel or drawn phosphor-bronze rod will be needed, ¾in. dia. and about 4in. long. Chuck with 1¾in. projecting, turn 1⅝in. length to 1/64in. over finished diameter, then proceed exactly as described above, but don't part right off. Just put the

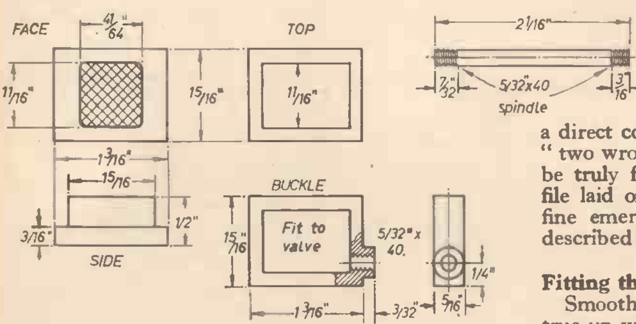


Fig. 57.—Slide valve and buckle.

parting-tool in about 1/16in. Then with the tool used for finish-turning the pistons, proceed exactly as described for turning the pistons to fit the cylinder bores. When the valve is an exact sliding fit in the liner, part it right off, repeat operation, then finish off the two valves to correct length as per previous instructions.

Valve Spindles

Two 3⅜in. lengths of 5/32in. rustless steel rod will be needed for the valve spindles. The ground variety is best, but drawn rod can be used, also drawn phosphor bronze. Chuck in three-jaw, put 3/16in. of 5/32in. × 40 thread on one end, reverse in chuck, and screw 2 3/16in. of the other end same pitch (Fig. 55). For the locknuts, chuck a piece of 5/16in. hexagon rod; rustless steel is best, but bronze, or brass, can be used at a pinch. Face, centre, drill about ¾in. deep with No. 30 drill, tap 5/32in. × 40, and part off ⅛in. slices. Repeat operation when you get to the end of the hole. Don't drill a hole deep enough for all the nuts at one go, because it is a safe bet that the drill will run out of truth at the end, and you can't tap the full depth, anyway, without risking disaster. I put these little tips in to save trouble for beginners, and beg the indulgence of experienced readers.

The nuts require chamfering, so chuck a short bit of ¼in. rod, turn ⅛in. length to 5/32in. dia., screw it 5/32in. × 40, put each nut on it, and with a square-nose tool ground off at one corner (Fig. 56) chamfer the corners of the hexagon, and skim off any burr at the sides. If the sides aren't true, the nuts won't lock properly, and if they come loose when the engine is running, it's going to be just too bad!

Slide-valves

Slide-valves are more trouble to make than piston-valves, when they have to be cut from the solid, but if our advertisers supply castings for both valves and buckles, as they probably will, much of the work is simplified. I used cast valves and buckles on my Southern 2-6-2 (the engine designed at Ashford Works, but never built, owing to British Railways taking over) and they required no machining; just cleaning up with a file. Valves and buckles are shown in Fig. 57. They are usually cast in one unit, to simplify moulding. Saw them apart, then clean up the steps around the tops of the valves with a file. Check the dimensions of the cavity; this is cast undersize, so that the edges can be clean-cut to exact width, a job easily done with a chisel. holding the valve by the step, in the bench vice. Tip: when filing the end of the valve, leave it a little over specified length. Then if any slight error is made in the valve gear, the valve can be made to suit, and everything in the garden will be lovely—a direct contradiction of the well-known saying that "two wrongs don't make a right!" The valves can be truly faced by first rubbing them on a big flat file laid on the bench, and finishing on a piece of fine emery cloth laid on something dead flat, as described for the port faces.

Fitting the Buckles

Smooth off the outsides of the buckles with a file, true up what will be the underside by rubbing on a file as mentioned above, then carefully file out the inside of the rectangle so that it is an easy fit on the valve. It mustn't be tight, or the valve will do what the enginemen call "stick up," that is, jam in the buckle, allowing steam to get underneath it and blow straight out of the exhaust. At the same time, it mustn't be slack or the steam distribution will be upset, and the engine will give syncopated beats. Aim for the happy medium; the important thing is, to avoid perceptible end-play. The hole in the boss must also be drilled and tapped dead square with the sides, so that the buckle is true with the valve spindle. If it tilts ever so slightly, it will lift the valve off the portface, and steam will blow straight to the exhaust port. Make a centrepop in the middle of the boss, and set the buckle vertically in a machine-vice on the drilling-machine table, by aid of a try-square. Drill it No. 30, then put a 5/32in. × 40 taper tap in the drill chuck, enter it into the hole, and turn the chuck by hand until the tap shows through on the inside of the buckle. Then release both chuck and machine-vice, put the buckle with the tap still in it, in the bench vice, and finish the job by hand.

An alternative way is to chuck the buckle in the four-jaw with the boss running truly; face, centre, drill No. 30 and tap with the tap in the tailstock chuck. The valve spindles (Fig. 55) can then be fitted; they are just 2⅛in. lengths of 5/32in. rustless steel or bronze, screwed for 3/16in. length at each end as shown.

SCIENCE NOTES

New U.S. Space Chamber

THE contraption pictured here, which looks like a junior gasometer with window shades is, in reality, America's newest " space chamber." It is shown being placed in position on the top of a specially constructed building in California. This space chamber has been designed to speed up America's space programme, and will simulate the conditions that exist 200 miles above the earth. It weighs 55 tons, stands 20ft. high and will be used chiefly to test Lockheed space vehicles. The protrusions in the upper half of the chamber are ducts which lead to pumps creating the near vacuum-conditions of outer space.

The new U.S. space chamber being erected on its Californian site.

Welding Tantalum

SCIENTISTS are searching for new metals, immune to corrosive acids and high temperatures, for use in the building of chemical plants. One of the most hopeful is tantalum, a bluish grey metal which resembles platinum in appearance and glass in its resistance to corrosion. Difficulties, however, have been encountered as tantalum cannot be welded in air because it becomes brittle. This is being overcome by welding it in an inert atmosphere of argon, jigs and fixtures being used so that the back of the weld can be protected with argon and warping prevented.

Simple welds can be made in the atmosphere, provided all parts of the joint near the torch are shielded with argon. Objects of intricate shape, however, are best welded in an argon-filled chamber or welding box. This technique can be seen in the photograph which is shown on the right.

The two Apelco depth sounders for small boat use.

Small Boat Depth Sounder

A TINY depth sounder with the trade name Apelco has been made by an American firm which will enable the small boat owner to " see " the bottom of the sea and determine the depth up to 60ft. Features of the unit are magnetic keying, transistorised circuitry, low current drain. Power is provided by a 12V. battery and the unit's dimensions are 3¾in. × 5½in. × 6½in.

Details of a recording depth sounder are also available from the same firm—Ad. Auriema, Inc., 85 Broad Street, New York, U.S.A.

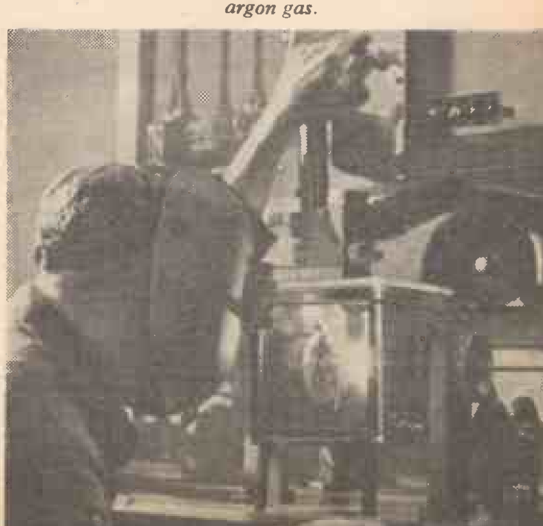
Nuclear Excavation

THE digging capacity of the world's largest digging machines may soon be put to shame by an experimental excavation project planned for Alaska. The code name " Chariot " has been given to a scheme in which five atomic bombs will be used to dig a harbour. Surprisingly, the harbour will serve no commercial purpose and the whole project is designed merely to gain information on the nuclear explosions for excavation purposes.

Oval Equator

STUDY of photographs taken by the Baker-Nunn satellite tracking cameras has convinced an American astronomer that the earth's equator is elliptical. Geophysicists have long suspected this, but so far no one has produced a theory to explain why it should be so.

(Below) Welding tantalum in an inert atmosphere of argon gas.



Major R. M. White, U.S. Air Force test pilot, stands beside the heat-scorched nose of the X-15 rocket research plane after a record 2,905-m.p.h. flight from Edwards Air Test Centre, California.

U.S Stepping stones to space

By D. S. C. Fraser

WHERE is America heading in space? Well, the answer is that the sky is the limit. U.S. space experts, and scientists, are undoubtedly looking far ahead of the present manned-Mercury capsule.

The National Aeronautics and Space Administration state that the Mercury capsule will now be considerably modified for further manned flights which are intended to orbit the earth a number of times. After that? It might be as well to look at some of the planned programmes—each a stepping stone to space, the moon, and elsewhere in the solar system.

The chief forerunners to America's man-on-the-moon, "Apollo" project—which calls for a three-man space craft to orbit the earth, and eventually the moon—are Mercury, the X-15 rocket plane, and Dynasoar programmes.

Project Mercury

With the Mercury-Redstone project to date—widely publicised as it has been—we are, more or less, conversant. Commander Alan Shepherd's successful sub-orbital flight completed a two-and-a-half year programme of extensive research, together with trial and error test flights, which has already brought about many modifications to the original design of the Mercury capsule. This was followed by another similar flight and there may be two more before an orbital flight is made, in which the first passenger will be a chimp. Redstone rockets will be used on the sub-orbital flights and the larger Atlas for the orbital.

The X-15

The follow-up, and a sort of companion piece to Mercury, has been the short, stub-winged X-15 rocket plane, which has accelerated America's experimental space programmes to a great extent. The X-15 is, what might be termed, a winged rocket, and represents the transition from aircraft to space-craft, as it encounters many of the problems posed by manned space flight.

Initially, the X-15 research plane (of which there are three) had twin rocket engines with 16,000 pounds of thrust, and it was launched from the wing of a mother plane flying at an altitude of 45,000 feet. Today, new and more powerful engines, the XLR-99, have been fitted, and will produce more than three times as much thrust.

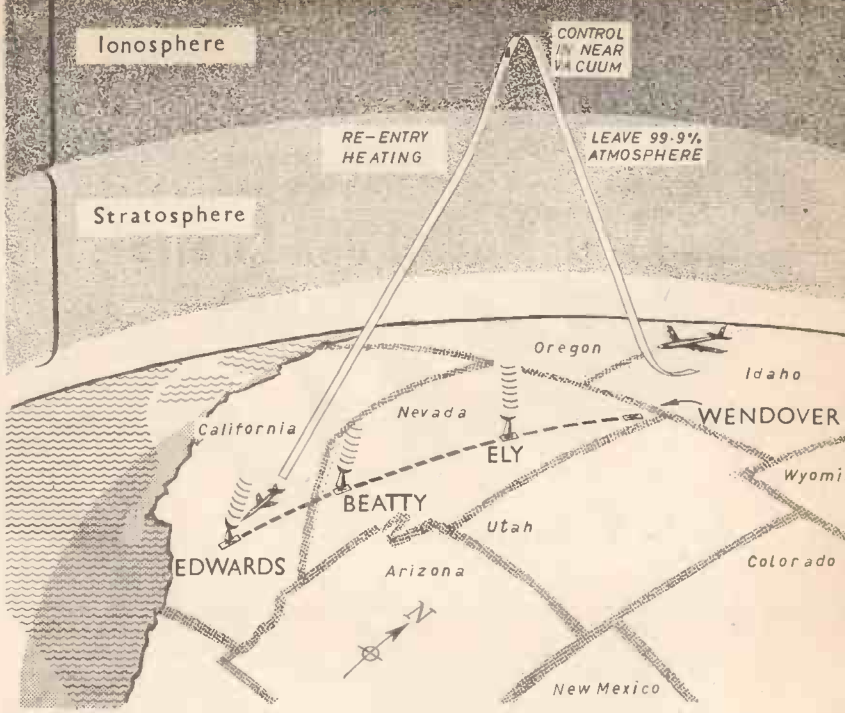
The X-15, which is a pilot-operated aircraft, has been developed to gather scientific data on the outer reaches of the earth's atmosphere, and man's operations there. This high-speed, high-altitude aircraft has been described as man's first step to the periphery of space. While not exactly a competitor to space vehicles, the X-15 has contributed much to space research work.

It is so designed, that it will take man into space briefly—under his own guidance and power—but it is not built to orbit him. The altitude goal of the X-15 is in the neighbourhood of 100 miles, and it has already flown as high as 32 miles. Its speed will eventually approximate 4,000 m.p.h., and to date it has reached 3,370 m.p.h. or, nearly a mile-a-second.

Major White, one of the X-15 test pilots, said that on one of his trips he was in a state of weightlessness for perhaps a minute. This happened at the top of the arc. He described as "fantastic," the panorama of the sky, horizon and earth, which became visible as he put his plane into a sharp climb towards the sun. He added that at about 70,000 feet there was a band of light, and farther up, much darker blue sky. "It was very deep blue," he said,

An artist's rendering of the flight of a U.S. Air Force Dynasoar. A specially adapted Titan ICBM boosts the Dynasoar glider towards space. The booster drops away leaving the glider in piloted orbital flight.

The three bands of light noted by Major White.



"but not exactly like night. The view encompasses three distinct bands, the earth, the light blue of the sky and then the very deep blue of extreme altitude."

Dynasoar

This is the next step in America's space programme. The vehicle, which will take the place of the capsule used in the Mercury-Redstone rocket, will be in the form of a moderately-powered glider. It will be manned, and rocket-launched, and capable of making a conventional landing under a pilot's control. Dyna-Soar will be put into orbit according to present plans, by a modified Titan II booster, powered by the morganic liquid fuel anhydrous hydrazine, at a speed of 18,000 m.p.h., and at an altitude ranging from 80 to 200 miles.

Apparently, if the 18,000 m.p.h. speed were increased, the glider would follow a wider elliptical course, which would take it too high for research, reconnaissance and other purposes. By the same token, if the speed were reduced, the vehicle would travel a tighter elliptical course that would prevent it from going into continuous orbit. The reason for this is that at some point in that course it would come in contact with the earth.

A vehicle, at this speed, could not be steered, although it could be rotated around its own axis. In order to get the glider out of orbit, it will have to be slowed down somehow, and a number of theories, regarding how this can be safely accomplished, are now being investigated, and tested. Strain on the vehicle, at this speed, is another problem that is receiving much attention. While this is not serious in the near vacuum of space it is, together with air friction, all important at other times. New heat resisting materials—other than stainless steel and titanium, which will be used on certain components—will definitely be used on the glider.

The Dynasoar programme is under the supervision of the U.S. Air Force. The Boeing Airplane Company is the prime contractor for the Dynasoar system and glider, and the Martin Company for the Titan booster. The booster separates from the glider in near-orbital flight. It is then taken over by the pilot who glides to a conventional landing.

(*Concluded on page* 89).

(*Above*). *A close-up of the X-15, it has a sleek speedy appearance even when standing on the ground.* (*Right*). *A dummy attired in pressurization suit is fitted into the X-15 seat for engineering test.*

Flashbulb Power and Control Unit

By A. E. Bensusan

MULTIPLE flash, that is the firing of a number of flashbulbs in synchronisation with the opening of the shutter, is virtually impossible to carry out effectively with the conventional amateur type of flashgun, without having cumbersome branch connections and shorting plugs hanging from the delicate shutter mechanism and a variety of leads actually trailing from the camera. The unit described here requires only a single synchronising lead from the shutter, and all the flashbulb leads are attached to the unit. A device for testing the electrical components, the circuit and the continuity through the flashbulb filaments is incorporated. Ample power is available to fire up to four bulbs in perfect synchronisation, over any distance likely to be necessary in amateur work. The completed unit is shown in Fig. 5.

The Housing

This is made from plywood of $\frac{3}{16}$in. minimum thickness, with $\frac{1}{2}$in. square internal corner strips. The bottom is inset, to present a neat finish, and the parts are glued and pinned, or screwed, together. All electrical outlets are through the top, and this is the only part to require extensive drilling. See Fig. 1.

Lay out the positions of the four 3mm. co-axial sockets on the lid, and drill good drive-fit holes to take them. The outside diameters of these sockets vary considerably from one manufacturer to another, so no size can be given here. Keep the holes fairly near to the front edge of the lid. Slightly back from the socket holes, and in line with them, drill four more holes to take the panel mounting instrument switches. This type of switch is mounted from the back, the flat or ball-ended tumbler protruding through the hole, and the component secured with a locking ring situated on the top. If thick wood is used, it will be necessary to counterbore the face to accept the locking ring.

Further to the rear, to the right, drill a tight drive fit hole for the 3mm. co-axial plug which will take the synchronising lead from the camera. To the other side, drill a $\frac{1}{2}$in. dia. hole to enable a test lamp to shine through and, alongside, make a $\frac{7}{16}$in. hole for the test button. Four clearance holes in the corners permit No. 4 × $\frac{3}{4}$in. countersunk screws to clamp the lid to the housing. Any painted or polished finish should be applied to the wooden parts before the electrical work is done.

Test Button

The four sockets are gently tapped into place until they just protrude from the top, the plug inserted so that it protrudes sufficiently for it to be inserted in the socket on the synchronising lead, and the four switches locked in position. A test button is made as shown in

Electrical Components List

4 — 3mm. co-axial sockets.
1 — 3mm. co-axial plug.
4 — Panel mounting miniature switches.
1 — Miniature lampholder.
1 — 6 V. 0.04 A. cycle rear lamp bulb.
1 — 2,500 Ω resistor.
1 — 100μF 25 V. working electrolytic capacitor.
2 — Small crocodile clips.
1 — 22.5 V. hearing-aid battery.
As required Wire.

Flash head and synchronising leads are additional to the above. Plugs, sockets and co-axial cable are obtainable from Mirco Ltd., 5 Friern Barnet Road, London, N.11. (Ent. 6464.)

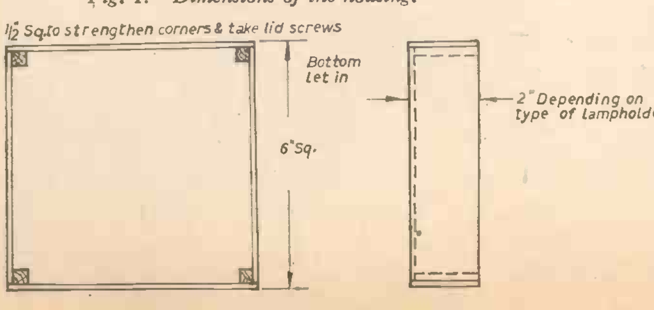


Fig. 1.—Dimensions of the housing.

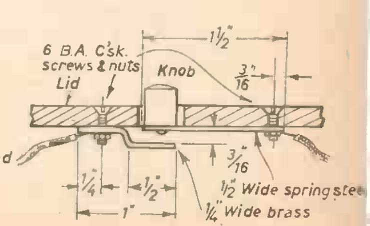


Fig. 2.—Test button details.

Fig. 2, using spring steel for the variable contact and brass for the fixed one. A wood or plastic knob, of ⅜in. dia., is screwed to the spring steel and then each half of the device is fixed to the underside of the lid with two 6 B.A. countersunk screws, placing the nuts on the underside. The knob should come through the hole provided.

A circle of clear or lightly tinted plastic is stuck on the lid so that it covers the test lamp hole, or it may be cemented into the hole. The lampholder is attached to the bottom of the housing, immediately beneath the hole, using two countersunk head screws on the underside and nuts on the lampholder side.

The Wiring

The electrical wiring is now carried out as shown in the circuit diagram (Fig. 3), but those not familiar with working from this type of drawing might prefer to use the pictorial arrangement shown in Fig. 4. Use low resistance wire, and allow sufficient to spare between the lampholder, the components not yet mounted and the lid, to enable the latter to be removed without undue strain.

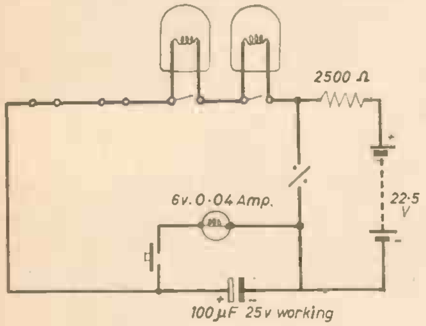


Fig. 3.—Circuit diagram.

All the joints should be soldered, taking care to ensure that the contacts are clean and well tinned. The leads going to the battery can end in small crocodile clips, so that a replacement may be made without resoldering. In any event, the battery should remain effective for more than a year of continuous use. The battery, resistor and eletrolytic capacitor may be taped to the inside of the housing, or they can be held in clips made from thin brass or spring steel. Fit the test lamp, screw down the lid and the unit is ready to use.

If the unit is stood on the floor, beneath the tripod or near to the hand-held camera, the synchronising lead should be an ordinary flash extension of about 1½ metres length. A shorter lead will suffice if the unit is clipped to the tripod. The leads to the flash heads should be of the co-axial type, as this is flexible and has a very low resistance, and the ends to be attached to the unit should terminate in 3mm. co-axial plugs.

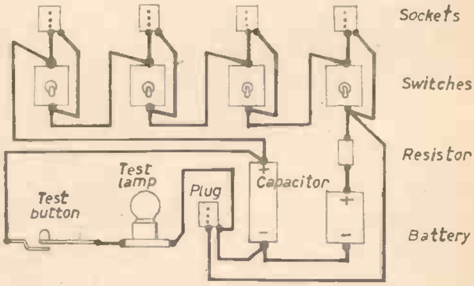


Fig. 4.—Pictorial wiring diagram.

The other ends will probably run directly into the heads without any plugs or sockets, depending on individual arrangements.

Testing

When four extension flash heads are to be used, all the switches should be set to the "in circuit" position, but where a lesser number is to be employed the vacant sockets should be shorted out by throwing the appropriate switches. This arrangement is quick, easy and renders loose shorting plugs unnecessary. To carry out a test, plug-in the required leads, including that to the camera, fit the flash bulbs and select the switches. Then press down the test button when a brief flash of the test bulb will indicate that all is in order.

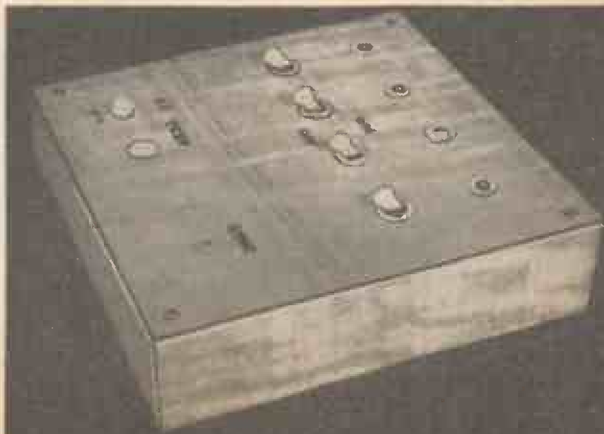


Fig. 5.—The completed unit ready for use.

AIRING CUPBOARDS

CAN BE ARRANGED

By E. V. King

ARE you one of the many people who have effectively lagged the hot-water cylinder and thus lost the heat source for the airing cupboard? Perhaps your airing cupboard is not large enough and you would like to build another. An economic and safe method is to use a low wattage heating element of the electric blanket type, which costs about 0·1d. per hour to run and provides great uniformity of heat throughout the cupboard.

To convert an existing cupboard with no tank some arrangement of battens will have to be installed. Generally ¾in. × 1½in. softwood will suit, being rested at the ends on battens plugged to the walls. The general idea, with one wall removed, is shown in Fig. 1. Drill about 12 ½in. holes 2in. from the floor in the door, back or one of the side walls, and an equal number at the top. It is wrong to have the cupboard without ventilation as extreme humidity would prevent airing of the clothes.

Test the woodwork with twice as much weight of clothing as it will be likely to have. Neglect to do this could be dangerous in some circumstances.

Heater Wires

Obtain some 15ohm per yd. electric blanket wire already polythene covered and some insulated staples. The latter may be obtained at any electrical dealer or radio shop and the cable is available from Messrs. Technical Services, Banstead, Surrey, and Messrs. Whistons, New Mills, Stockport. If 25ohm per yd. cable is used no harm will be done but not so much heat will be generated.

On 240V. mains 27yd. of cable MUST be used, no more, no less, for each run. One run only is shown in Fig. 1. On 200V. mains 23yd. exactly must be used and *pro rata* for other voltages. The cable is anchored to a terminal block at one end ("A" in Fig. 1) and is then tacked with the staples along one batten side, under the end and back down the side of the next batten and so on until the whole length of cable is used, if necessary use up some spare cable by tacking it, well spaced out, on the back wall. The other end is then connected to another block, "B."

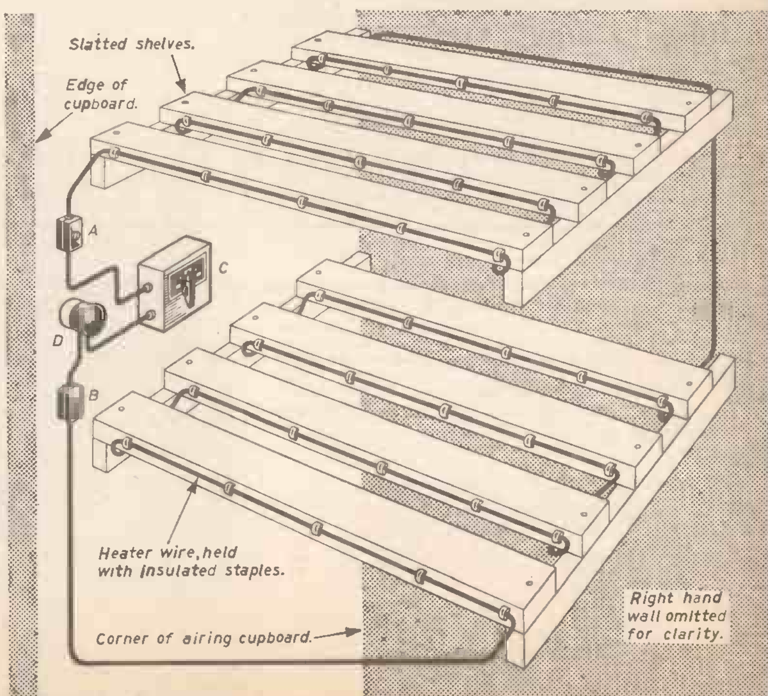
Complete Circuit

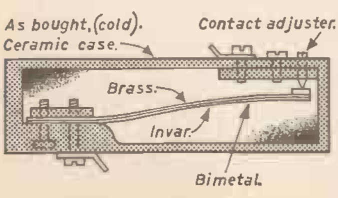
The blocks "A" and "B" are connected to the mains via a 2- or 3-pin plug in the wall nearby. The plug should be fused at 1 or 2A. In Fig. 1 will be seen a thermostat which can take the form of a CS unit or a covered and insulated "magstat," both being obtainable from Messrs Technical Services, Ltd. If the thermostat is set to about 130 deg. F. clothes should be aired well, but never spoilt. Clothes must not prevent air flow either through the shelves or to the thermostat.

Additional Runs

If the length of batten exceeds the length of heater cable one or more additional and EQUAL lengths are required. These are wired in the same way, beginning and terminating at the two blocks "A" and "B" of Fig. 1. Do not let the wires come closer than ½in. to each other as they approach the blocks. Generally no more than three complete lengths should be used in one cupboard, unless it is of exceptional proportions. If the cupboard is very high the number of strands running across on each shelf should be slightly more near the bottom than at the top as the top part of the cupboard will automatically become the warmest as the hot air rises.

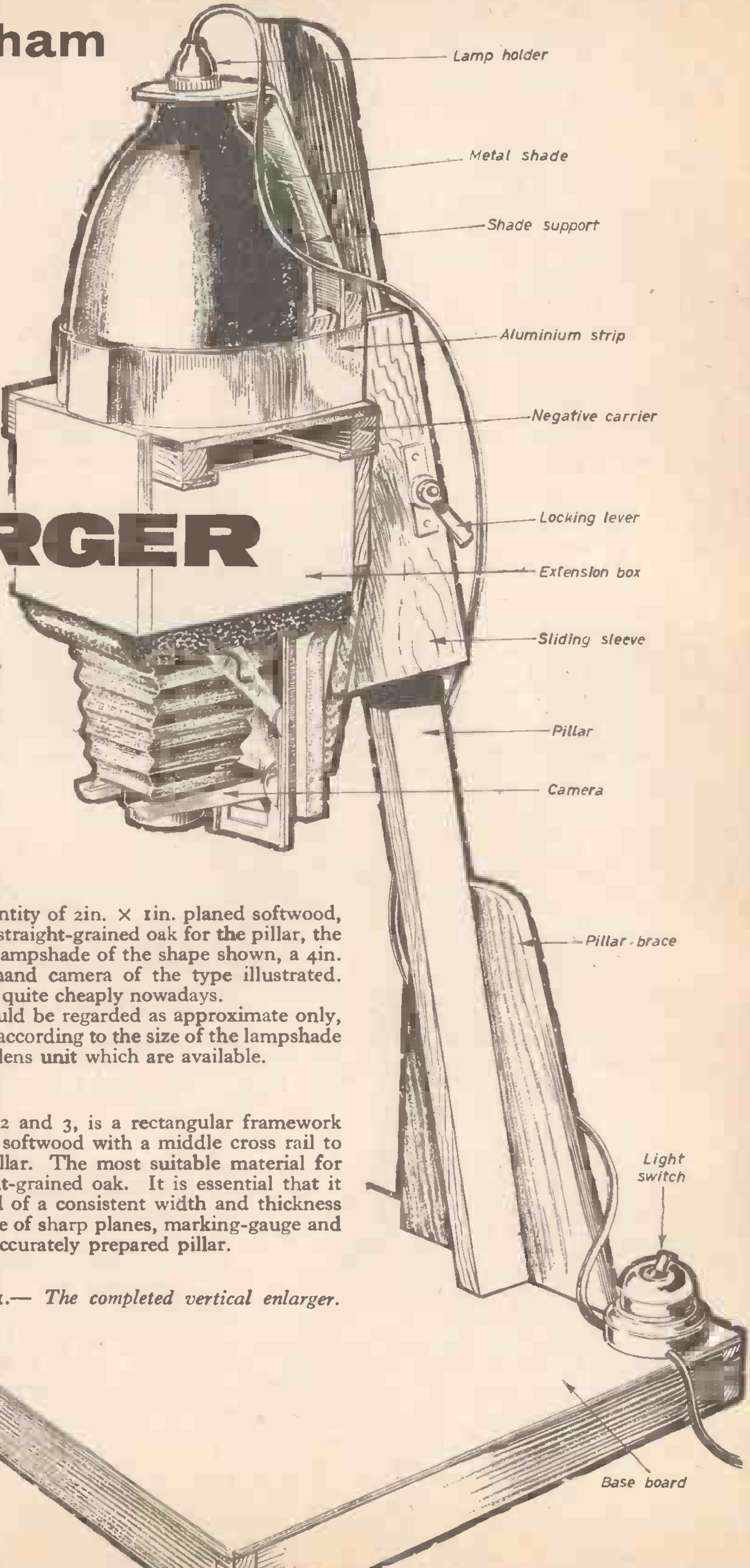
Fig. 1.—Showing the wiring and fixing of the heater cable along the battens and (below) the thermal switch.





Big pictures look better says H. E. V. Gilham

Build your own ENLARGER



THIS vertical photographic enlarger was designed for use with negatives up to 2¼in. sq. It consists basically of three parts—the base, or enlarging table, a pillar slightly inclined from the vertical, and a projection unit which slides up and down this pillar and which can be locked in any position according to the size of enlargement desired.

Materials Required

Apart from a fairly small quantity of 2in. × 1in. planed softwood, some three-ply, and a length of straight-grained oak for the pillar, the main requirements are a metal lampshade of the shape shown, a 4in. condenser, and an old secondhand camera of the type illustrated. This last item can be picked up quite cheaply nowadays.

The measurements given should be regarded as approximate only, as they will need to be modified according to the size of the lampshade and the camera or bellows and lens unit which are available.

The Base and Pillar

The base shown in Figs. 1, 2 and 3, is a rectangular framework made up of 2in. × 1in. planed softwood with a middle cross rail to which is jointed the vertical pillar. The most suitable material for this pillar is a length of straight-grained oak. It is essential that it should be perfectly straight and of a consistent width and thickness along its length. The careful use of sharp planes, marking-gauge and fine glasspaper will ensure an accurately prepared pillar.

Fig. 1.— The completed vertical enlarger.

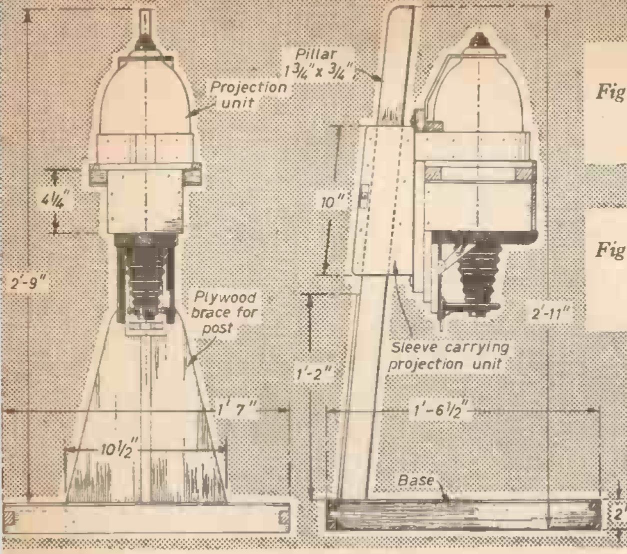


Fig. 2.— (*Left*) *Front and side views, giving dimensions.*

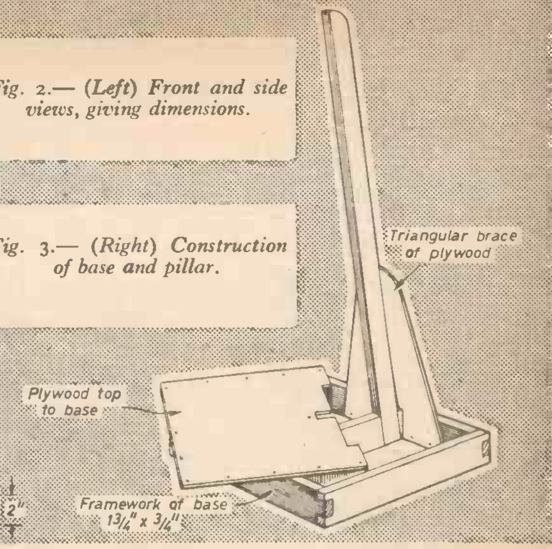


Fig. 3.— (*Right*) *Construction of base and pillar.*

The framework of the base should then be prepared from the 2in. × 1in. material. In the prototype the rails were dovetailed at the corners, but a simpler corner joint may be preferred—a good strong screwed and glued joint would be quite suitable. It will be seen from Fig. 3, that the pillar is then jointed to this base frame, stiffened in position by means of a triangular plywood brace, and the base then covered with plywood to form the enlarging table.

Since the successful construction of the enlarger depends to a great extent upon the rigidity of the vertical pillar, great care should be taken over the joint between this and the base. A detailed explanation of this joint is shown in Fig. 4. From this it will be seen that the middle cross rail of the base is jointed to the back rail by a half-lap joint, while the pillar is secured to this middle rail by means of a bridle joint. In the prototype the angle between the pillar and the base is 85 deg.—the most suitable angle can probably be found by experiment. Every effort should be made to ensure a good, close " driving fit " to these joints. If they are then put together with a good resin glue, and the triangular plywood brace screwed and glued to the back of the pillar and to the inside of the base framework (as in Fig. 3) a good rigid pillar should be the result.

When this jointing is completed, and the base cleaned up, the plywood top should be shaped round the pillar and brace (as indicated in Fig. 3), screwed down and trimmed off at the edges with a sharp smoothing plane.

The Sliding Sleeve

The construction of this can be seen in Figs. 2 and 5. It consists simply of an open-ended box fitting closely round the pillar; the sides are of plywood and the filling-in pieces—which should be a shade thicker than the pillar—are screwed and glued between them. To allow for the angle of the pillar the front filling-in piece is wedge-shaped, (Fig. 2). Before gluing together, see that this sleeve runs fairly easily, but not loosely, over the whole length of the pillar. A bolt and nut must be fitted through the back of the sleeve in order to lock it in any desired position on the pillar. Note that for about 1½in. on each side of the bolt the filling-in piece is reduced in thickness, so that when the nut of the bolt is tightened it allows the plywood sides to be pressed in and grip the sides of the pillar (see A, Fig. 5). A large wing-nut may be used on the bolt, but a little improvisation with a hexagonal nut soldered to a strip of metal will produce a more satisfactory locking lever. Short metal strips are then screwed to the top and bottom of the sleeve so that the projection unit may be attached to it.

The Projection Unit

The components of this unit are mounted and assembled as shown in Figs. 1, 2 and 7. For the lens and focusing arrangement, use was made of an obsolete type of camera (a folding quarter-plate made to take roll film only). However, it had a good lens (Goerz f/4·5) and an excellent bellows arrangement

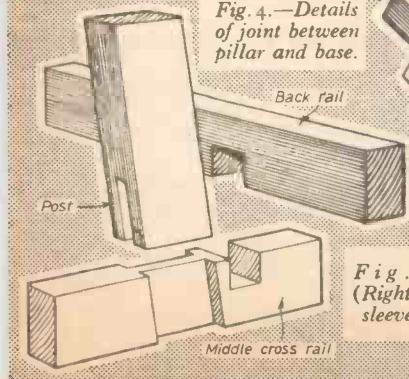


Fig. 4.—Details of joint between pillar and base.

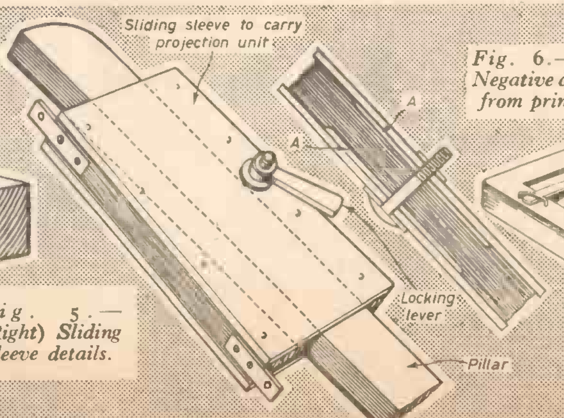


Fig. 5.— (Right) Sliding sleeve details.

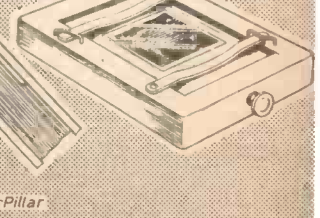


Fig. 6.— (Below) Negative carrier made from printing frame.

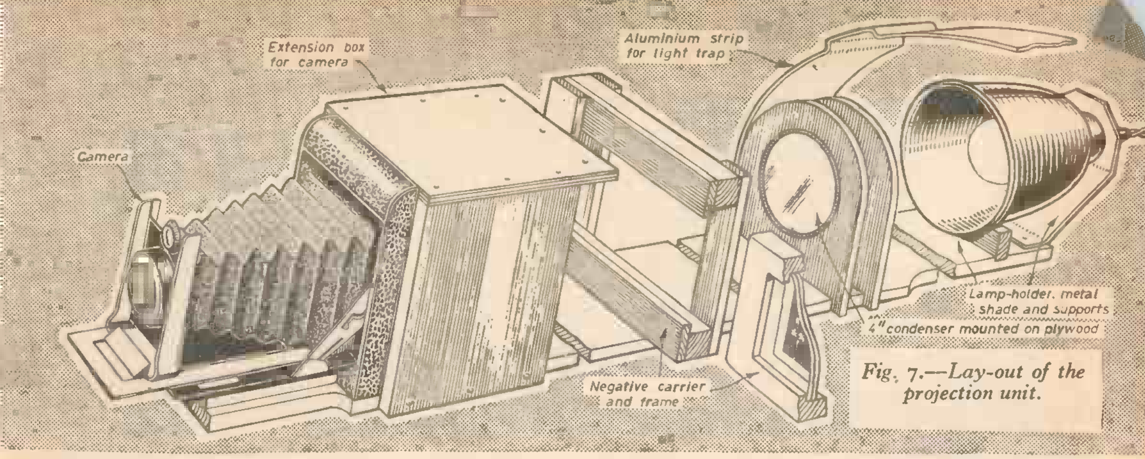


Fig. 7.—Lay-out of the projection unit.

with a fine adjustment for focusing. If such a camera is not available there are many moderately priced bellows and lens components which could be adapted to the purpose.

As the camera used had only a single extension it was necessary to make an extension box, about 4in. long. This box and the camera were fitted together and screwed down to a suitable baseboard.

The lighting consists of an ordinary 100W. opal electric lamp fitted into the metal lampshade. In this case the shade was of enamelled iron, white inside and very suitable for its purpose, but an aluminium shade would be lighter and equally effective. Fig. 1 shows how it was secured to the baseboard—the lower edge was screwed to a shaped wooden support while the lamp-holder end was held in position by a shaped and bent aluminium bracket also screwed to the base. Some thought should be given to the ventilation of this lamphouse to prevent overheating during a spell of enlarging.

The Condenser

The 4in. double condenser (taken from an old optical lantern) was mounted between two shaped pieces of stout plywood—preferably five- or six-ply. Circles were cut with a fretsaw into which the brass mount of the condenser was a close, tight fit, and the shaped plywood was then fitted over the base as shown. To connect the plywood supports and to trap any stray light, a band of aluminium was bent round and secured with small screws. Fig. 7 shows that a series of bends provides some ventilation.

Between the camera unit and the condenser must come some arrangement for carrying the negative to be enlarged. Here use was made of an old wooden contact-printing frame of postcard size. The hinged wooden back was removed and was replaced by an additional piece of fairly stout glass, so that the negative could be sandwiched between the two pieces of glass and be held in place by the springs (see Fig. 6). In order to retain the effectiveness of the springs after the removal of the wooden back, a plywood mask of suitable thickness with a rectangular aperture in it had to be made and placed below the glasses. A simple knob screwed in at the end will facilitate the insertion into the projection unit.

A simple framework into which the negative carrier can slide is easily made by means of strips of wood of a suitable thickness. See Fig. 7.

Assembling

In the fitting-up and assembly of the projection unit, care must be taken to maintain the correct alignment of all the components, i.e. to ensure that the centre points of the illuminant, the condenser, the mounted negative and the lens of the camera all lie on a common central axis. Any interior surfaces such as those of the extension box, the negative carrier and frame, and the condenser holder should be painted a dead black in order to eliminate the reflection of unwanted light.

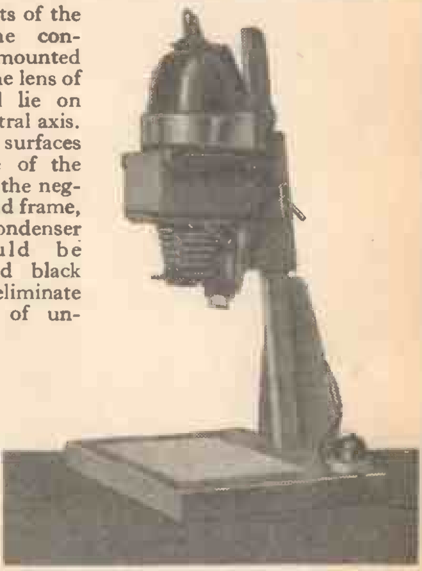


Fig. 8.—Photograph of the enlarger ready for use.

The baseboard of the projection unit is fastened to the sliding sleeve by means of screws through the metal strips fitted to the sleeve. Before the lower screw is inserted, a suitable negative should be mounted in the carrier, the light switched on, and the enlarged image projected on to a sheet of white drawing paper laid on the projection table. The projected image can then be centred on the baseboard and the projection unit finally secured to the sleeve. The flexible lead from the lamp is fitted with a plug for connection to a wall socket, while the length of exposure is controlled by an ordinary tumbler switch fitted to a corner of the baseboard as shown in Figs. 1 and 8.

The enlarger described here is capable of producing enlargements up to 12in. by 10in., but if larger pictures are desired it is simply a matter of providing a longer pillar and a slightly larger baseboard.

7 BY 7 TRANSISTOR PORTABLE

By E. V. King

YOU need not be a genius to build this set. Just follow the instructions closely and you will have a handy two wavelength portable which is capable of surprising volume. Its overall dimensions are 7in. × 7in. × 2in. and most important of all, it is comparatively cheap to build.

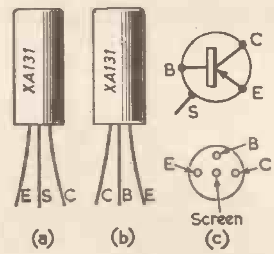
Building Sequence

The receiver itself is built and tested first of all. Then the cabinet is made up, except for the front panel, which is attached to the radio. A battery compartment is added, the cabinet is covered with Fablon and the receiver finally adjusted and inserted in the cabinet.

Building the Radio

A Formica sheet is cut to the size given in Fig. 1. Various holes, most about ⅛in. diameter are required, most of them need only be drilled approximately as shown. The holes that need accurate spacing are those concerned with fixing all the transformers and the connecting pins of the transformers and coils. These are all fully dimensioned. The pins shown in Figs. 4 and 5 have to pass through the panel from underneath and the holes required should be drilled using the actual components for marking.

Fit the volume control, the switch, the coils and transformers as shown in Figs. 8 and 9 and the photographs. Care is required to fit the T/T1 and T/T2 transformers in the correct places *and* the correct way round. Before fitting the transformers 3, 4, and 5 (I.F's) and the coil L 1/2/3 make sure there is no connection to the aluminium can from any pin. Mark



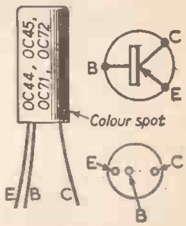


Fig. 2.—Base code for the Ediswan XA 131 transistor.

Fig. 3.—Base coding for the Mullard transistor.

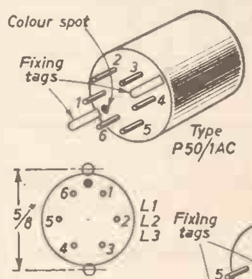


Fig. 4. (Left).—Base coding of the P50/1AC (coils L1, 2 and 3).

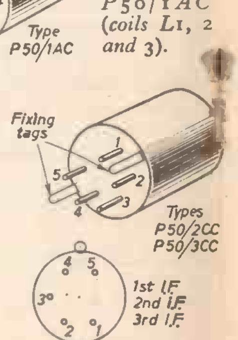


Fig. 5. (Right).—Details of the 1st, 2nd and 3rd IF's.

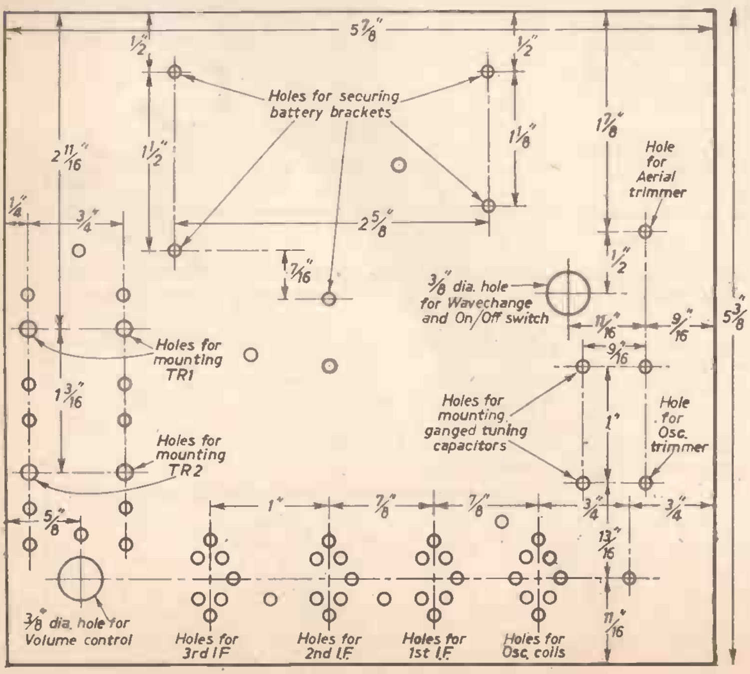


Fig. 1. (Left).—Drilling diagram for the laminated plastic chassis.

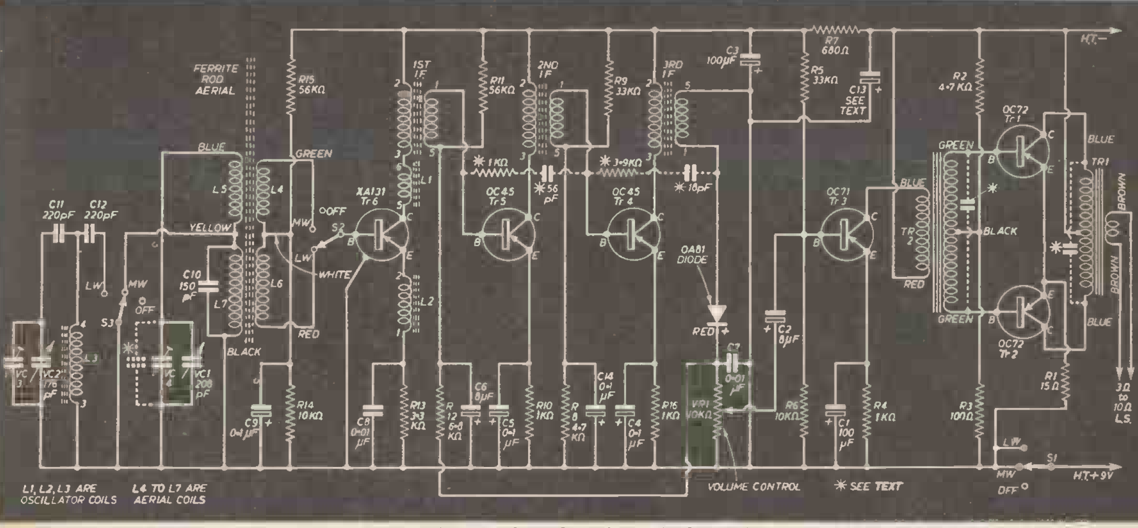


Fig. 6.—Complete theoretical circuit.

the can with a scratch at pin 1 in the case of P50/1AC. Be sure to mount it orientated as in Fig. 9, i.e. pins 1 and 6 (colour spot between them) are near the outside of the panel.

Definite spacing of the holes will be required for the fixing of the condenser for tuning and the speaker. These are made by reference to the actual components and in fact all the holes may very easily be drilled as construction proceeds.

The Audio Amplifier Section

TR1 and TR2 are fitted in the positions shown in Fig. 8. The brown wires (TR1) are anchored to 2 and 3 and then taken to the speaker terminals. All anchoring of small components and wires is done by bolting solder tags on each side of the panel with 6 BA nuts and bolts. No two tags must touch, and all nuts must be done up very tight. The blue wires of TR1 are anchored to tags 4 and 5 and the central red wire is taken to tag 10. (which is the main H.T. negative point).

The green wires of TR2 are anchored to tags 6 and and 7, R2 and R3 are linked between tag 10 and the *casing* of TR1. The central black lead of TR2 now solders to the junction of R2 and R3. The red wire goes to tag 10 and the blue one to tag 12.

The remainder of the components are soldered as shown in Fig. 8. It should be noted that the electrolytic capacitors—those with + and — markings—*must* be connected the correct way round; check carefully against the wiring and circuit diagrams. The transistors are best left off until last.

Under Chassis Wiring

This wiring can be seen in Fig. 9 and should present no serious difficulty

Check that every coil casing, transformer casing and tuning condenser case is connected to battery + with a meter or torch bulb and battery.

Fitting the Transistors

The transistors are fitted on the top side as shown in Fig. 8, sleeving should be slid over the wires and soldering should be rapid. The wires should not be shortened and the hot " bit " of the iron should not be allowed to touch the transistors. The correct identification of each lead is important and is shown in Figs. 2 and 3.

Tr1 (OC72) is fitted with its base to a green wire on TR2 (tag 7), emitter to tag 1 and collector to a blue wire of TR1 (tag 5).

Tr2, (OC72) is fitted with its base to the other green wire of TR2 (tag 6), emitter to tag 1 and collector to the other blue wire of TR1 (tag 4).

Tr3 is fitted with base to the junction of R5 and R6 at tag 9, emitter to R4 and C1 at tag 11 and the collector to the blue wire of TR2, at tag 12.

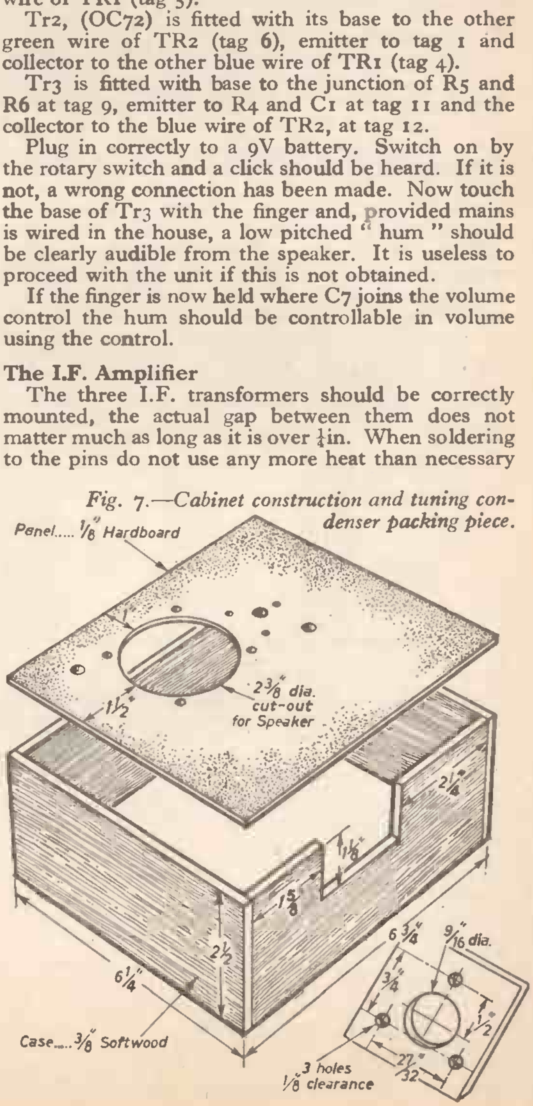
Plug in correctly to a 9V battery. Switch on by the rotary switch and a click should be heard. If it is not, a wrong connection has been made. Now touch the base of Tr3 with the finger and, provided mains is wired in the house, a low pitched " hum " should be clearly audible from the speaker. It is useless to proceed with the unit if this is not obtained.

If the finger is now held where C7 joins the volume control the hum should be controllable in volume using the control.

The I.F. Amplifier

The three I.F. transformers should be correctly mounted, the actual gap between them does not matter much as long as it is over ¼in. When soldering to the pins do not use any more heat than necessary

Fig. 7.—Cabinet construction and tuning condenser packing piece.



or damage will be done to the coils. Note the wire connecting all the transformer casings to the battery via the switch. (Fig. 9.)

The detector is added in the form of the diode. This must not be overheated in fixing and must have the red end soldered to the junction of R12, and volume control. The other end of the diode is soldered to pin 1 of TR3.

The I.F. Transistors

Two OC45's are sleeved and soldered in as follows: TR4 base to pin 1 of TR4, emitter to junction of R16 and C4 at pin 13 and collector to pin 3 of TR3. TR5 with base to pin 1 of TR5, emitter to junction of R10 and C5 at tag 14, and the collector to pin 3 of TR4.

Note that pin 4 of each transformer remains unused. Check the wiring carefully, if possible with Fig. 6, otherwise by reference to Fig. 9.

Connect up. Touch pin 3 of TR5 with a metal object and loud crackles should be heard from the speaker. If not then a wrong connection has been made. Do not touch the cores of the transformers at this stage.

The Oscillator Section

The very heart of the receiver is in this section and for this reason an Ediswan XA131 transistor is used which costs rather more than the usual Mullard OC44 which will function well in most cases. Great care is required to wire these *exactly* as described. Check especially that C8 is of the correct value and that C11 and C12 are both 1 per cent. tolerance.

If an OC44 is used connections will be as for the OC45, if the XA131 is used refer to Fig. 3 for coding details. There are four wires; the centre one is a screen connected, as in the prototype, to the casing of TR5 (Fig. 9). Sleeve the leads and solder the base to tag 15 and take a lead on to the centre (C) of S2. The emitter is connected to pin 2 of the coil, and the collector to pin 5.

Now make quite sure the oscillator coil connections are correct and perfect. Connect up and switch on. On touching base of TR6 with a metal object very loud crackles should be heard.

Aerial and Switch Wiring

The aerial is fitted with a clip (provided) as shown in Fig. 9 and the photographs. It is brittle and the two coil assemblies are free to move along the rod. There are six connections to the coils which are taken to solder tags already fitted and coded by colour. Coloured wires will help as shown in Fig. 9. The wiring shown is for a ferrite rod with ONE central connection ring, if the type obtained has a separate ring for each coil then join white to white, and yellow to yellow, of each ring with a couple of 4in. lengths of wire and then proceed as described.

Trimmers

To get best results out of the receiver two trimmers are required to be wired in with the two variable capacitors, VC1 and 2 which are ganged. These trimmers are VC3 and 4.

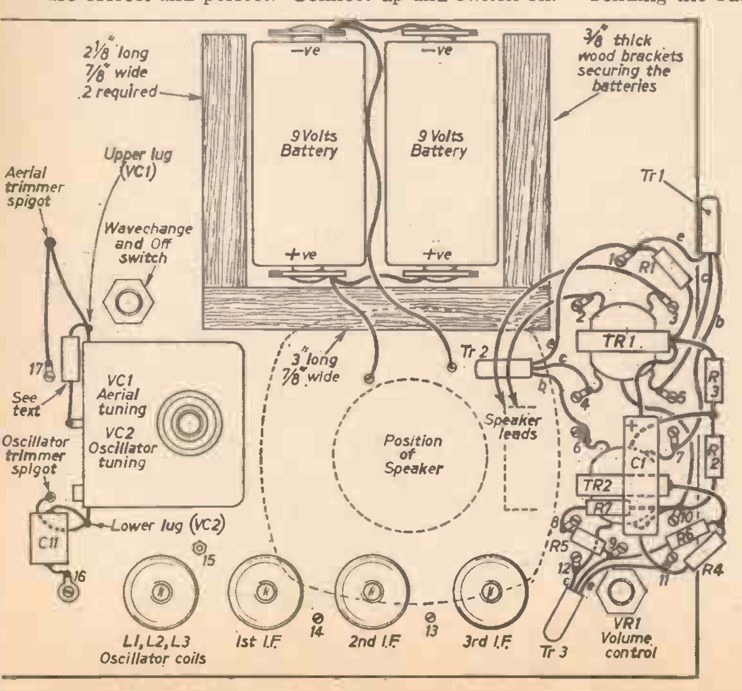
In this design Beehive trimmers, having certain advantages over other types, are used. Readers may, however, order the "OO" type condenser *with screen and trimmers.*

If the trimmers are already fitted, they take the form of small plastic screws on the side of the condenser nearest the left-hand edge in Fig. 8. They are adjusted with a flat piece of Celluloid, etc.

The Beehive trimmers are mounted as shown in Fig. 9 and the photographs, using the holes shown in Fig. 1.

In addition to the spigot connections on top of the chassis, the trimmers must have an extra "earthing" connection. This is done in the case of VC3 by taking a lead, or bending the outside tag of the trimmer and soldering it to the tag held to the casing of the variable condenser by one of the fixing bolts.

The other trimmer, VC4, is "earthed" (i.e. taken to H.T. +) by connecting with wire, or directly by bending the outer tag on the trimmer, to the casing of the switch. The switch casing is earthed to battery +, a lead from the centre tag of S3 to switch casing will do. Alternatively the trimmer may be earthed by taking a wire to the tag MW as shown in Fig. 9.



Lining-Up Procedure

Any superhet radio must be carefully lined up to get good results. The results obtained are directly proportional to the care taken. Two methods are available one using a signal generator (or getting a service man to do it with one), the other without a generator. Assuming the reader has no signal generator we shall describe the latter procedure.

Lining up without a Generator

The wiring is double checked to make sure every single lead has been correctly placed, well soldered, and is causing no unwanted shorts by loose strands, etc., being unsoldered.

Switch the receiver to "Long

Fig. 8.—Wiring diagram of the top of the chassis. All wires are as short as possible.

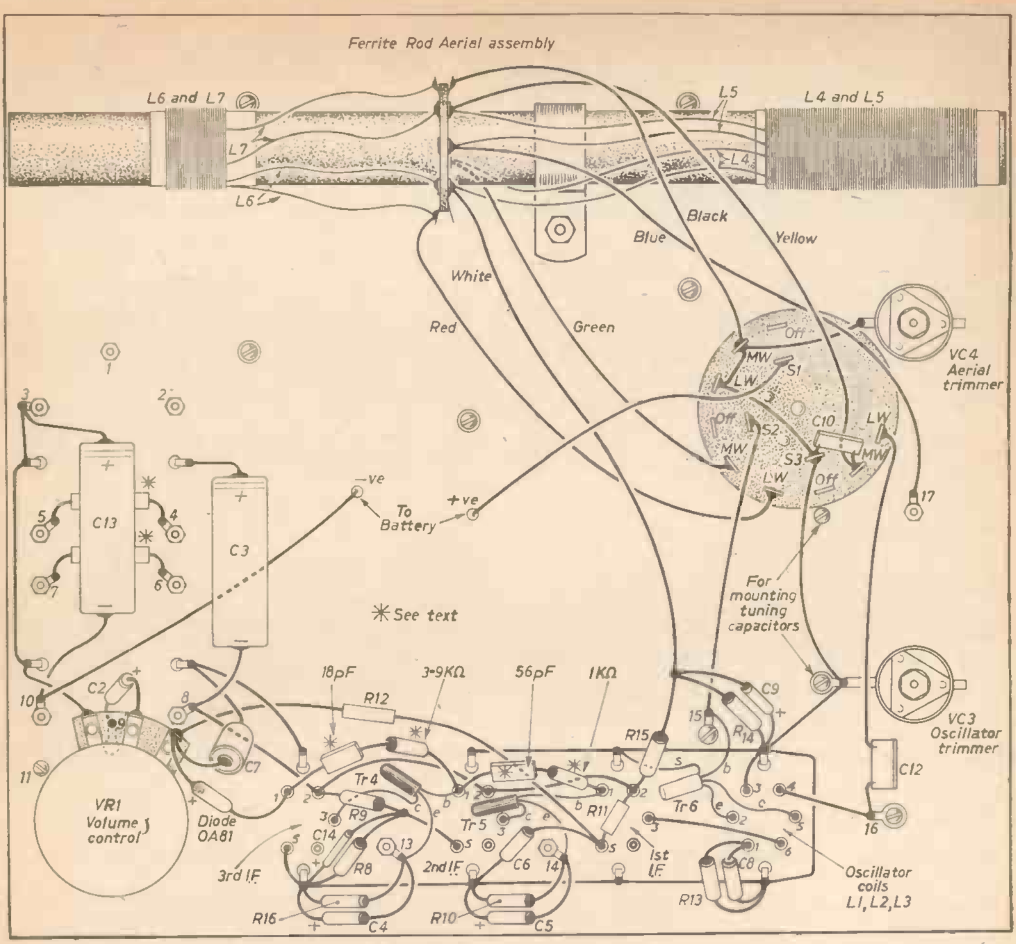


Fig. 9.—Under-chassis wiring.

Waves," i.e. turn the switch fully clockwise, put the volume control on full and the condenser vanes about 15 deg. in from the fully open position. With a tiny piece of celluloid which will fit at least ½in. inside the core of the oscillator coil screw the core in or out until you hear the Light Programme (Droitwich, 1500 metres). Once it is heard, turn the aerial (and the receiver) for best reception and peak it up carefully in the first instance by moving the condenser vanes very slightly in or out. Then peak up still more by "rocking" the vanes a degree or two either side of the position they are now in and at the same time moving the coil assembly L6/L7 (Fig. 9) backwards and forwards along the ferrite. Stick with transparent adhesive tape in the best position. The final adjustment will be made later.

Medium Waveband

Tune in a programme low on the band such as the Light Medium Wave Station or Luxembourg, the weaker the station the better. Peak up firstly by rotating the receiver (aerial) and then by use of the trimmers. If a plastic tool is made to trim with so much the better otherwise the hand must be moved after every adjustment. Finally, movement of *either trimmer either way* should take the station off peak. It may be necessary to move the variable condenser half a degree or so one way or the other to get this result.

View of under-chassis completely wired.

Another top view showing speaker and audio stages.

Another view of the completed receiver ready to fit into the cabinet.

Movement of either trimmer either way *must* take the station off peak (lower in volume). If one trimmer needs to be up tight and one loose, fit a small (say 10pF) condenser. (Fig. 8).

Then, and only then, tune in a station at the top of the band and while gently rocking the condenser vanes slide the coil assembly (using a wooden ruler) D4/L5 backwards and forwards along the ferrite. Stick with cellotape in the best position.

I.F. Transformers

Now, using a tiny piece of celluloid, as an adjuster and choosing any *very weak* station on the medium waveband, adjust each I.F. transformer core (TR 3, 4, and 5) for the loudest result. The *slightest* turn either way of any core should take the station off peak. This result *must* be attained. Check now that the station is only received in one position of the tuning condenser vanes. If it is received in two positions the I.F. transformers are not correctly aligned and volume, etc. will suffer.

Final Adjustment

The I.F.'s are not touched *ever again*. The procedure given for Long Wave alignment is then carried out again with the batteries resting in the battery compartment.

The Medium Wave adjustment is then carried out again. The receiver is now correctly aligned and will receive many Continental and British stations at full loudspeaker volume.

The Cabinet

This must be of wood or plastic and not metal. A casing can be made to the dimension of Fig. 7 using ready prepared deal and small pins. Two pieces of hardboard or plywood are cut to fit on top and bottom, the top piece being carefully drilled with a speaker cut out to coincide with that on the chassis. Fit the receiver in place to find the correct position. Holes are also made for the switch and tuning spindle. Finally three holes are made to coincide with the tapped holes in the top of the tuning condenser and four more for the speaker. Smaller holes are made around the edge of the panel for fixing.

The bottom is left quite plain. A small piece of

(*Concluded an page* 94)

PARTS REQUIRED

Resistors All ½W. 10% types.

R1	15Ω	R9	33kΩ
R2	4.7kΩ	R10	1kΩ
R3	100Ω	R11	56kΩ
R4	1k	R12	6.8kΩ
R5	33kΩ	R13	3.3kΩ
R6	10kΩ	R14	10kΩ
R7	680Ω	R15	56kΩ
R8	4.7kΩ	R16	1kΩ

Condensers

C1 100 µF. 15V. electrolytic.
C2 8 µF. 15V. „
C3 100 µF. 15V. „
C8 0.01 µF. Miniature.
C10 150 pF. mica tolerance 1%
C11 220 pF „ „ „
C12 220 pF. „ „ „
C13 100 µF. electrolytic, 15V.
C4 C5, 9 and 14 are all 0.1 µF. electrolytic (Henries Radio Ltd., 5 Harrow Rd., London, W.2.).
C6 8 µF. 15V. electrolytic.
C7 0.01 µF. miniature.

Volume Control 5 or 10kΩ potentiometer, small type, ⅛in. dia.

Switches

There are three switches all ganged together. Purchase one 3-pole, 3-way on one wafer (Messrs. Home Radio, Mitcham, Surrey). Diameter must not exceed 1½in.

Transformers

TR1 T/T2 Output transformer for 3Ω. Ratio 6.3 to 1, primary centre tapped to match two OC72's.
TR2 T/T1 Feeder transformer for two OC72's. Ratio 1 to 1, secondary centre-tapped.
TR3 Weymouth. P50/3CC (Messrs. Henries Radio or Home Radio) Final I.F. transformer.
TR4 Weymouth P50/2CC. Intermediate I.F. transformer.
TR5 Weymouth P50/2CC. First I.F. transformer

Inductances

Oscillator Coils L1, 2 and 3 are all ready made in one container; the assembly is bought as Weymouth P50/1AC.

Ferrite rod aerial is bought complete with the Long Wave coils L4 and 7, and the Medium Wave coils L5 and 6 already in place, adjustment only being required. This complete assembly is bought as RA2W and is also made by Weymouth Manufacturing Co.

Speaker

ELAC, about 10Ω or less; the prototype came from Henries Radio Ltd. Cone diameter 2½in. Tapped holes are required in the back of the magnet; a speaker without these holes is not suitable. The final performance is greatly dependent on the speaker, get a good one.

Transistors

Tr1 and Tr2 a matched pair of Mullard OC72's.
Tr3 Mullard OC71.
Tr4 and Tr5 Mullard OC45's.
Tr6 Prototype uses Ediswan XA131. A Mullard OC44 could be used, see text.

Base Board

An off-cut of laminated plastic as used for kitchen tables etc. Any type without a metal layer, or use Paxolin. A piece 7in. × 7in. will be suitable.
2 dozen 6 BA bolts and nuts and 4 dozen solder tags. Soft wood as in the text and suitable screws, pins, and enough self adhesive Fablon to cover the case. 18in. square of ordinary hardboard.

Battery

One OT4, or better still use two wired in parallel. No greater voltage than 9V. must be used.

Diode

Mullard OA81 or similar.

Variable Condensers

VC2 176 pF. max. (This is the smaller section.)
VC1 208 pF max. (The section nearest the knob.)

These are ganged and a suitable component is the Jackson 00 gang fitted with an internal screen. See text before ordering. Obtainable from Messrs. Home Radio or Henries Radio.

VC3 and 4 60 pF or similar Beehive type trimmers. (Henries Radio). See text.

NOTE. All these parts except where suppliers are mentioned by name are definitely obtainable as "radiospares" through almost any radio component dealer in the country. No surplus or non-standard components are used at all.

A SAWING stool—or sawing horse as it is frequently called—is a distinct asset even in a power workshop, and for the man who does most of his carpentry and joinery by hand it is an essential.

Fig. 2 is a perspective view of one of useful size and sturdy enough to stand up to really hard and constant use. It is bad judgment and almost a wasted effort to use lesser timbers since strength and rigidity are necessities.

Materials required are:

7ft. 6in., 2½in. × 2½in. for the legs.
3ft., 3in. × 1½in. for the stretchers.
2ft. 6in., 4in. × 2½in. for top block.
2ft., 2in. × 1in. for the brace.
Two ½in. × 7in. coach bolts with nuts and washers.

Begin construction with the legs. Fig. 1 shows the necessary measurements and how they are to be cut to receive the halved tenons on the stretchers. It also shows the notch to be cut at the top to house the top block. The angle at which the bottom of the legs should be cut in order to stand firmly on the floor is 75 deg.

Next prepare the stretchers. These are approximately 16in. long at the bottom edge, and the ends and the shoulders of the half-tenons are cut at 75 deg. Also cut the grooves (2in × ½in.) to receive the halved brace. This latter is 1ft. 10in. long and the halving 1½in. × ½in. deep. The top block needs no preparation.

When assembling, use good strong glue and, if the joints are not first-class fits, screws as well. At the top a ½in. hole is bored through the legs and the block to accommodate the bolt. Both the heads and the nuts of the bolts should be countersunk vertically so that they exert their full drawing power on the legs; the nuts will thus have to be tightened with a box spanner. It may also be necessary to cut off about ½in. from the end unless you are fortunate enough to be able to purchase bolts 6½in. long; it is not advisable to leave the ends protruding as they will catch on one's clothing and tear it.

While the stool should be nicely finished and given a rub with coarse glasspaper there is no purpose in painting it. For preservation purposes, however, it may be given a coat or two of linseed oil.

A SAW-HORSE IS A WORKMAN'S BEST FRIEND

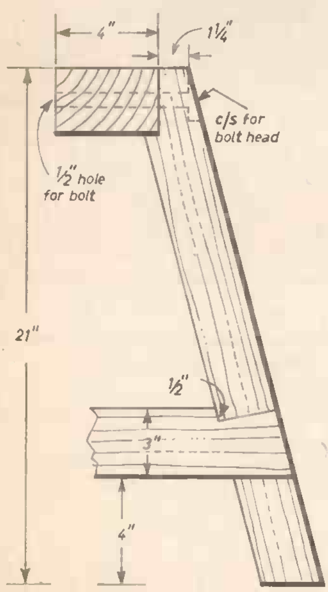


Fig. 1.—Leg measurements and details.

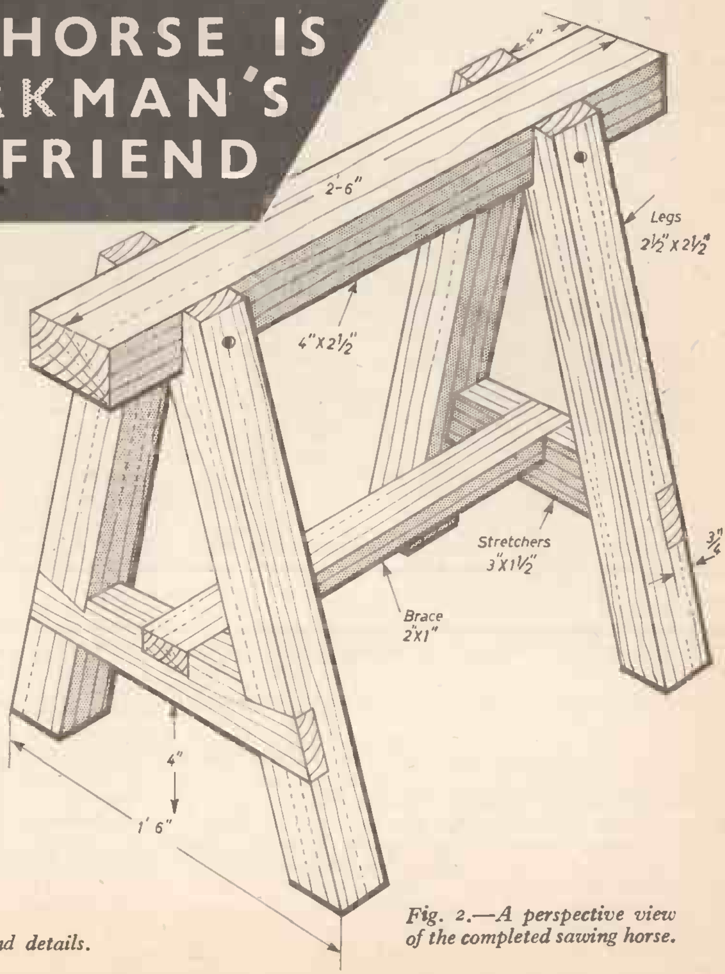


Fig. 2.—A perspective view of the completed sawing horse.

LIQUID ROCKET

to power the Titan

300,000 thrust Aerojet-General Corporation engines launch operational-type Titan I at Cape Canaveral.

IN a huge building with more than seven acres under roof, employees of Aerojet-General Corporation, Sacramento, California, work around the clock manufacturing liquid rocket engines for the Titan Intercontinental Ballistic Missile.

It is claimed, that the most powerful rocket engine of the free world to be started in space is that which powers the second stage of the 110-ton, 90ft., U.S. Air Force Titan ICBM.

The engine, which like the first stage was developed and is being produced at this plant, ignites while travelling approximately 4,500 miles per hour at an altitude of about 38 nautical miles, 35 nautical miles downrange from the launching point. The second stage engine creates 80,000 pounds of thrust, compared with 300,000 pounds by the first stage engine, and boosts the missile speed to 15,000 miles per hour and the range to more than 5,000 miles. The big first stage engine is designed to lift the 110 ton missile off the launching pad, while the space started second stage provides the thrust to accelerate the vehicle in the relatively frictionless atmosphere.

The second stage is also the most versatile single barrel liquid rocket engine yet produced, delivering power for sustained second-stage flight as well as providing control of pitch, yaw and roll, thrust for staging and vernier calibration for exact target impact.

The engines of the Titan are liquid bi-propellant rocket power plants. They consist of three major components: a thrust chamber with a hoop-skirt silhouette reminiscent of early feminine fashion; a pump-drive assembly which contains a two-stage turbine rated at over 3,900 horsepower, nearly 20 times as much as the biggest U.S. car; and the engine frame.

The Thrust Chamber

The thrust chamber is a marvel of highly advanced engineering. It is made with over 250 stainless-steel tubes welded side by side, making it lighter and stronger than its predecessors, and yet capable of handling tremendous pressures. The contributing factors to this chamber were Aerojet's development of a new process for fabricating the tubing that forms the chamber, perfection of lightweight injectors to control flow of propellants into the thrust chamber and the successful shaping of the chamber to the scientifically classical form which results in the maximum thrust.

The Pump-drive Assembly

The main task of the pump-drive assembly is to feed fuel and liquid oxygen to the thrust chamber under high pressure and in great quantities. At the same time it must be sensitive enough to control the amount and rate of flow.

The pump-drive assembly is actually two pumps, one for pumping liquid oxygen, and one for pumping fuel. To drive the pumps, a two-stage gas turbine is incorporated in the assembly. To reduce the supersonic speed of the turbine to usable pump speed, a lubricated gearbox system is provided. A gas generator provides the source of power for the turbine. The gas generator uses a small portion of fuel and liquid oxygen from the missile tanks. This pump-drive assembly is the lightest piece of rotating machinery, in relation to horsepower, known to be in existence in the United States. All the materials in the assembly were selected for strength and lightness.

Timing of propellant flow to the thrust chamber is crucial. Too much fuel, too early, could result in starting failure. When the first-stage engine is fired, a complicated sequence of events occurs: 1/10 sec. after the firing button is pushed, the turbine driven pumps reach sufficient speed to pressurise fuel and liquid oxygen.

Approximately ½ sec. later, the main thrust chamber valves begin to open. Fuel and liquid oxygen stream into the thrust chamber and are ignited. 1.2 sec. after firing, the thrust chamber valves have opened full and the missile begins to strain against the bolts holding it to the pad.

To prevent the tremendous heat developed in the

MISSILE ENGINES

Intercontinental Ballistic Missile

thrust chamber from melting the stainless-steel tubing, fuel, used as a coolant, is circulated through the tubes before passing through the injector to be burned. The engine continues a steady thrust until a predetermined command to shut down closes the thrust-chamber valves.

Engine Frame

The tremendous thrust-load of the firing engines must be transmitted to the missile body. To do this, the engine frame is engineered and constructed with as great care as the Firth of Forth Bridge. It is of tubular heat-treated steel construction, with four corner attach-points which must bear the weight, not only of the engine, but of the entire missile prior to launch.

Basic Generation

Liquid oxygen is fed to a pump which increases velocity and pressure. In great quantities, it passes through the liquid oxygen discharge line, through the thrust chamber passage to the thrust chamber liquid oxygen valve. When this opens, it rushes through the thrust chamber injector to mix with fuel in the thrust chamber.

Similarly, fuel—" RP-1 "—is fed to the fuel pump, from whence it flows under greatly increased velocity and pressure through the fuel discharge line, through the thrust chamber fuel passage to the thrust chamber valve. When the thrust chamber valves open, the fuel passes through the thrust chamber cooling tubes and thence through the injector. When the fuel and liquid oxygen unite, they are ignited and a huge fountain of flame blossoms from the thrust chamber.

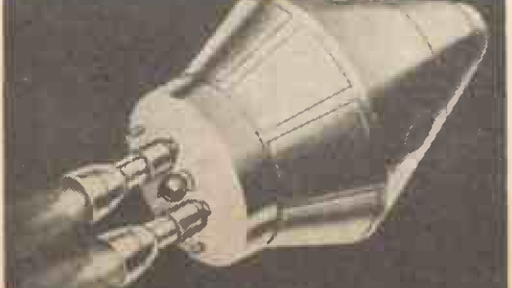
Summary

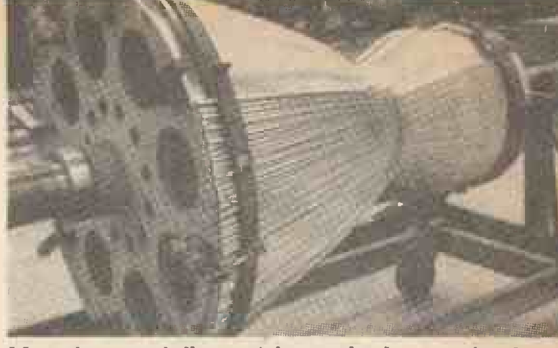
The people at Aerojet-General, who have developed and built this engine, are understandably proud of it. They say that it is the leader in the entire field of rocketry for these reasons:

1. The simple, reliable designs employed.
2. The low weight of its metal parts. This permits the Titan to carry and utilise more pounds of propellants per pound of inert parts than any other rocket propulsion system (solid or liquid) at present in use.
3. It has very favourable growth potential in respect to thrust, performance, increased reliability and decreased weight.

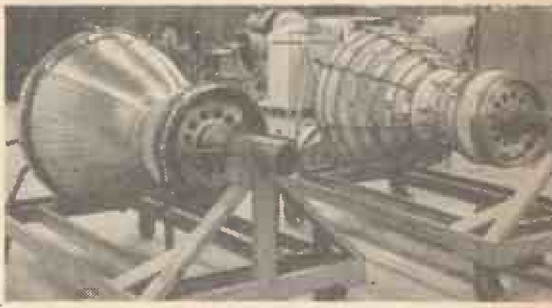
(*Continued on page* 82).

This drawing shows a possible configuration for the Apollo three-man space vehicle, with which the U.S. hopes to send a man to the moon and back within the next ten years.





More than 250 hollow stainless steel tubes are placed completely around this mandrel and then joined together to form the thrust chamber for the first stage Titan engine during engine manufacturing.



On the right can be seen a Titan first stage engine thrust chamber ready for brazing, next to a half-completed chamber.

Final touches are applied to an Aerojet second stage engine. (Below) Photograph of the Dynasoar booster engines.

STONES FROM SPACE

Fig. 1.—The Barringer Crater in Arizona, U.S.A.

INTERPLANETARY space is not empty. It is filled thinly with the proton-electron gas (plasma) of the Sun's outer corona, having in the region of the Earth's orbit an estimated density of about 1,000 particles to the cubic centimetre, and fine dust, among which larger bodies occur, both singly and in swarms scattered along closed orbits round the Sun, many of which resemble those of, and are associated with, comets. Most of these bodies are very small and are completely volatilised by friction upon entering the air at planetary velocities, as shooting stars or meteors. With a little patience a few of these can be seen any night. When, however, the Earth happens to pass through a meteor swarm, as it does several times every year and will do on November 14th and 17th, literally hundreds of shooting stars may be seen within half an hour or so.

These small meteors may differ to some extent in origin, consistency and distribution from the bigger celestial stones, or meteorites, which occasionally reach the ground, but the distinction between the tiniest meteors and the largest meteorites, referred to as fireballs or bolides, is artificial.

The roots of almost any modern trend of thought can be found in Ancient Greece and so, too, the extra-terrestrial origin of meteorites was recognised by Anaxagoras in the fifth century B.C. Yet in the eighteenth and early nineteenth century, the Age of Reason, the notion that stones fell from the sky was held to scorn as a superstition of unlettered peasantry among others by Edmund Halley. It took the careful researches of Chladni in Germany and of Biot in France to establish that for once the "unlettered" and not the "learned" had been right.

Even so, the triumph of this unpalatable truth was slow, the debate bitter. Nor was there any shortage of "rational" explanations, such as that meteorites were volcanic bombs, metal vapours from foundries condensing in the high atmosphere, or produced by that mysterious agency—the "electric fluid." In fact, in studying the contemporary records one is vividly reminded of the present controversy over the "flying saucers". This does not prove that the latter *are* spaceships, but it clearly shows that a wise sceptic should be sceptical about scepticism as well.

Origin in the Solar System

Be this as it may, today we know that stones from space fall on the Earth. It was thought at one time that they came from outer space; but modern techniques have not revealed a single meteor or meteorite moving at a speed exceeding or equalling the parabolic velocity relative to the Sun at the Earth's distance from it, so that at least the overwhelming majority of these bodies are members of the Solar System.

Bolides usually disintegrate in the air with a loud explosion as a result of thermal stresses and only their

Fig. 2.—The Chubb Crater in Canada. (R.C.A.F. Photo.)

fragments fall to earth. The explosion, however, may occur close to the ground, as in the case of the famous meteorite estimated to have weighed 40,000 metric tons whose blast laid waste to many square miles of Siberian forest on June 30, 1908. In 1947 another similar fall took place near Vladivostock, also in an uninhabited area of Siberia. This bolide shone brighter than the Sun. Large meteoritic craters, the best known of which is the $\frac{3}{4}$-mile Barringer (Coon Butte) Crater in Arizona, U.S.A., bear witness to underground explosions of huge meteorites hitting the Earth.

The Barringer (Fig. 1) is about 50,000 years old, but the hard primitive rocks of the stable Canadian Shield have preserved some ancient meteoritic scars, the age of one of which, the Brent Crater shown in Fig. 3, is estimated at 500,000,000 years. The Chubb Crater in Quebec (Fig. 2) has a diameter of two miles. Even larger crateriform structures in various parts of the world have been ascribed to meteoritic impacts, it appears, with more enthusiasm than knowledge of geology; but there is good evidence that the eight-mile depression of Deep Bay in Saskatchewan has originated in this way.

Fig. 3.—The Brent Crater, Canada. (*R.C.A.F. Photo.*)

The landing speed of meteorites varies. Some reach the ground substantially in one piece. Thus in the desert region of Hoba, West Africa, lies a 60-ton lump of meteoritic iron, whose fall was not observed. The 820lb. Arkansas meteorite of 1930 is usually listed as the largest ever seen to fall. Yet some fragments of the 1947 Siberian bolide are said to weigh over 30 tons.

Meteorite Composition

These big meteoritic blocks are always *siderites*, whose composition is exemplified by the Guffey meteorite in the American Museum of Natural History. This " iron " weighs 682lb. and consists in 88·7 per cent. of iron, 10·6 per cent. of nickel and 0·54 per cent of cobalt. The core of the Earth is assumed to be of similar chemistry, but the surface is not, which makes siderites readily distinguishable from other rocks. When polished in section (Fig. 4) they display characteristic Widmanstätten figures—another sure test when the fused and pitted "skin" (Fig. 6) has been removed by weathering.

This is why the museum specimens are usually siderites or mesosiderites (half-irons), although in actual fact stony meteorites are about twenty times as frequent as iron ones. Only that " stones " disintegrate more readily, both in flight and upon impact, and once weathered are difficult to identify.

Characteristic of some stony meteorites are *chondres*, or radial assemblies of crystals (Fig. 5) which may be from 1–1½in. long and are not known to occur in terrestrial formations; but not all stony meteorites have this structure.

The crystal grain in siderites may attain a yard, which testifies to an extremely slow rate of cooling. Occurrence of diamond and graphite indicates high pressures. Meteorites also contain large volumes of gas, occluded under high pressures: " stones "—mainly carbon dioxide and " irons "—hydrogen.

To sum up, it is clear that such rocks could have been formed only within a planetary body of appreciable size which has been shattered and scattered in some great cosmic catastrophe.

No meteorites resembling our granites are known. This is perhaps not very surprising if we consider that in the Earth's body such rocks have a thickness of 20 miles in continental areas only, occupying about two-fifths of the surface, out of a total radius of some 4,000 miles. Thus if the Earth had suffered a similar fate, the chance of coming across granitic meteorites would be small. Moreover, if any such *sialic* meteor-

Fig. 4. (Below)—Siderite in polished section, showing Widmannstätten figures. Rowton meteorite, British Museum.

Fig. 5.—Chondrite in section. Beddgelert meteorite at the British Museum.

Fig. 6.—Henbury meteorite, also in the British Museum.

STONES FROM SPACE

(*Concluded from previous page*)

ites have fallen in the past there is no certain way of distinguishing them from, say, glacial erratics.

Yet we have no right to say that meteorites do not include surface rocks, e.g. volcanics, or even sedimentary formations of biological origin.

A pumice meteorite fell at Igast, Latvia, on May 17, 1855. There have been at least eight falls of carbonaceous meteorites, exemplified by the French Orgueil meteorite of 1864, which contains organic compounds resembling lignite in general composition. Similar matter may be formed by volcanic action alone but a recent chemical investigation of this material appears to point to organic origin. Two limestone meteorites have likewise been reported.

One of these fell into a boat in open sea in 1830 and was not properly investigated. On April 11, 1925, however, a bright fireball was seen over South Sweden, followed by a fall at Bleckenstad of a stone which, according to an eyewitness's account, looked like a " crumpled newspaper " in flight and burst into small fragments. Some of these were found by Dr. Assar Hadding, professor of geology at the University of Lund, to be pure limestone of a composition that does not occur in Sweden. Moreover, the meteorite contained some seashells and the remains of a creature resembling a trilobite. This fall has been largely ignored by scientists.

Thus it appears that not only did a world come to a sudden end somewhere within our planetary system, but that it may have had seas and sustained life. Indeed, there is independent evidence for the presence of water in the parent rocks of the meteorites.

BOOKS *Received*

" Motor Cycling and Scootering for Beginners " by Dudley Noble. 155 pages. Price 6s. net. Published by The English Universities Press Ltd.

THIS book is one of the " Teach yourself " series and is ideal for the absolute beginner. It covers every aspect of riding, from using the gears to care of the machine.

" Motorcycle Engineering " by P. E. Irving, M.I.Mech.E., M.S.A.E. 326 pages. Price 25s. net. Published by Temple Press Ltd., London, E.C.1.

EVERY part of the motorcycle is dealt with in this book. All the technical, commercial and aesthetic problems are set out and the text is accompanied by a large number of line and tone illustrations. It describes modern constructional methods and compares them with practices of the past.

" Glass Fibre for Amateurs " by C. M. Lewis and R. H. Warring. 122 pages. Price 7s. 6d. Published by the Model Aeronautical Press Limited, of Watford.

ALL the information needed for producing glass plastic mouldings of any shape, form or size, is contained in this well illustrated book. The use of this most versatile material for repair work is also covered.

LIQUID ROCKET MISSILE ENGINES

(*Concluded from page 79*)

Some other important rocket and missile programmes in which Aerojet-General are participating, are as follows:

POLARIS—U.S. Navy Fleet Ballistic Missile (FBM).

MINUTEMAN—The U.S. Air Force's revolutionary solid fuel Intercontinental Ballistic Missile.

EAGLE—Navy air-to-air guided missile.

SCOUT—The National Aeronautics and Space Administration's " poor man's " solid fuel rocket for scientific and man-in-space research.

TARTAR—Navy ship-to-air missile.

HAWK—U.S. Army's swift and lethal bird of prey which seeks out, tracks and destroys attacking aircraft flying at even the lowest altitudes and at distances far enough away to protect the defended areas.

BOMARC—Air Force surface-to-air guided missile.

THOR ABLE—This is the U.S. Air Force's lunar probe and scientific satellite launching vehicle, and also the missile that travelled up to 6,000 miles in nose cone re-entry test launches from the Air Force Missile Test Centre at Cape Canaveral, Florida.

DYNASOAR—The Air Force project to send a manned rocket-powered vehicle into orbit around the earth and return.

And, work is also under way at Aerojet-General to provide pilot control of Titan ICBM rocket engines, one of the major modifications leading to use of the engines in the Air Force man-in-space Dyna Soar programme.

The Dynasoar glider is designed to orbit the earth and re-enter the atmosphere under control of a pilot for a conventional landing. It differs from the Project Mercury in that the Mercury Astronaut will be primarily a passenger while Dynasoar will be actually under control of the pilot.

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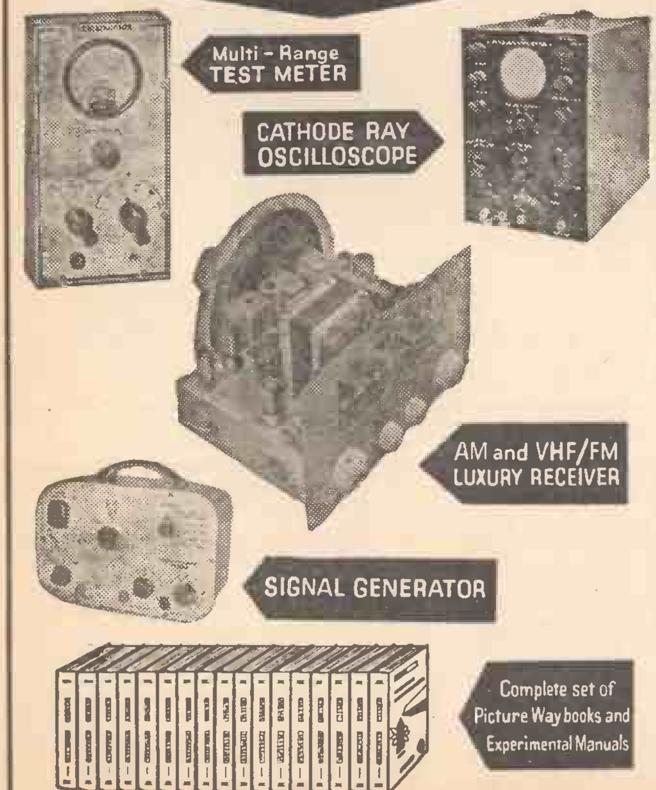

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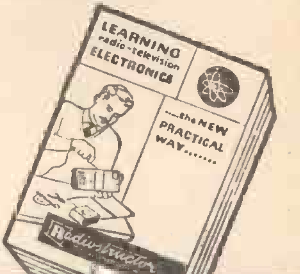

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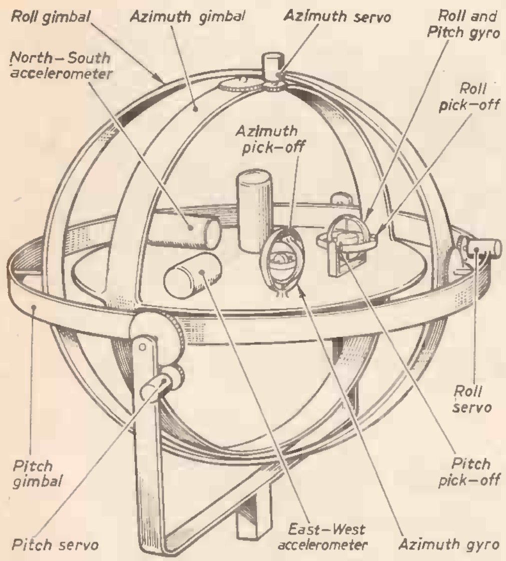


Fig. 1.—Simplified diagram of stabilised inertial platform. (Reproduced by courtesy of the Sperry Gyroscope Co. Ltd.)

THERE are strong indications that the somewhat inexact science of marine navigation will soon undergo a minor revolution. The stringent requirements of long-range missiles and high-speed aircraft have given great impetus to the development of automatic navigation techniques. Of the many recent developments the inertial system is an interesting one which could be easily adapted for shipboard use.

Present Navigation System

To fully appreciate the advantages of the inertial system let us briefly consider how ships are navigated at present before looking at the details of this system.

Before a ship leaves port the navigator marks out on a chart the course (or route) he intends to follow to reach his destination. Once the ship is well out of sight and radar range of land he can only check his position by the time-honoured method known as "getting a fix." That is, to measure with a sextant the relative angles of two or three stars (or of the sun at two separate times) and, by reference to tables and a chronometer, he can determine his approximate position on the earth's surface. Having obtained his position he will mark this on the chart. If it does not lie on his set course then he will have to calculate the new direction to steer to correct the error.

Some of the many sources of error in this method are: inaccuracies in measuring the angles of the stars due to refraction, inaccuracies in instruments such as the magnetic or gyro compass, wind action on the ship, the effect of unknown currents and inaccurate steering. The resultant error is often as high as 10 per cent.

It is obvious that if the navigator could record exactly every movement his ship has made relative to his starting point then at any instant he could calculate where he is and what course to steer to reach his destination in the shortest time. This is really what is achieved by the inertial system.

Principle of Inertial Navigation

The navigation of a ship across the oceans can be called "two-dimensional navigation" as the ship can be considered to move in one plane, and all its movements can be resolved into the fore and aft component and the athwartships component. These movements can be described in terms of time and acceleration, as shown in Fig. 2. This diagram shows graphs of velocity plotted against time, and acceleration against time for a simple voyage consisting of three stages. The first stage is a period of acceleration from rest, followed by a period of constant speed (zero acceleration) and finally a period of deceleration (negative acceleration) during which the vessel comes to rest after travelling a total distance of 8,640ft.

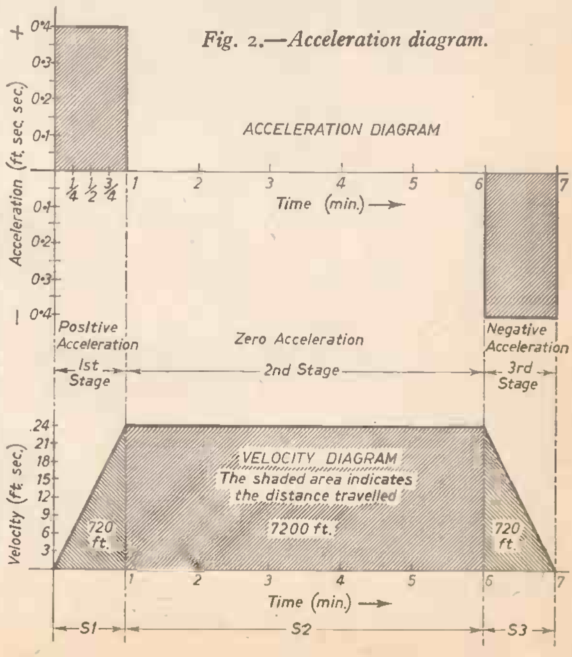
The variables time and acceleration are related by the well-known equation

$S = ut + \frac{1}{2}at^2$ where S = distance travelled
u = initial velocity
a = acceleration
t = time

Hence it follows that if we have a means of measuring the accelerations experienced by our ship and a computer which will use this information to calculate distance travelled, we can have a complete record of the ship's movements relative to its starting point. This is, in fact, the basic principle of the inertial navigation system.

We have already seen that, for marine navigation

Fig. 2.—Acceleration diagram.



INERTIAL NAVIGATION

by D. A. Watts

purposes, we are concerned only with the fore and aft and athwartships components of the ship's movements, thus two accelerometers are sufficient. These are called the North/South and East/West accelerometers. So that they sense pure North/South and East/West accelerations and are not misled by apparent accelerations due to the effects of gravity they have to be mounted on a gimballed platform stabilised directionally and in roll and pitch by gyros. The directional gyro is called the azimuth gyro, azimuth being a term used by navigators to define true bearing. A simplified diagram of a stable platform is shown in Fig. 1 showing the two gyros. Three pick-offs pass on their information through amplifiers to three corresponding servos to control the gimbals. Thus, for example, any deviation due to roll will be sensed by the roll gyro, which will send a signal from its pick-off to the roll servo such that it drives the roll gimbal to the correct position.

The Accelerometer

Let us now take a closer look at the construction of an accelerometer. Fig. 3 shows diagrammatically the principle of the accelerometers developed by the Sperry Gyroscope Co. Ltd. for their inertial systems.

A central spindle supported by three-legged suspension springs carries a small cylindrical block (known as the mass) to which is attached the moving plate of a variable capacitor. When an accelerative force acts on the mass it is thrown backwards, carrying the plate with it. This creates an electrical unbalance in the capacity bridge which is picked up by the detector unit, amplified, and passed to an integrator via a restoring coil. This restoring, or feedback, current induces a magnetic field in the coil which reacts with the permanent magnet and forces the mass back to its central position. If the acceleration increases, so also will the restoring force, and, since it is the signal from the amplifier to the integrator which operates the restoring coil, it follows that this signal will be proportional to the acceleration of the mass.

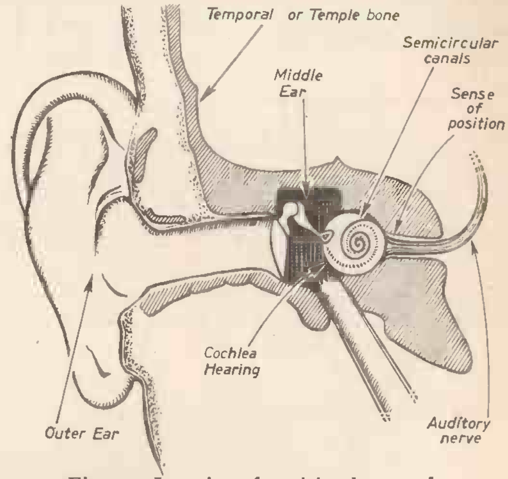


Fig. 4.—Location of semicircular canals.

It is interesting to note that this design is really an imitation of a human organ. In the human skull, inside the temporal bone, there is a duplicated system of three semicircular, interconnecting canals. They are arranged at right angles to each other and each contains a small membrane supported by fine strands of hair-like tissue. Any change in the head relative to the centre of gravity of the earth will cause the inner membrane to take up a new position relative to the outer canal. The supporting tissues, being acted upon by the mass of the membrane, send a corresponding message, or attitude signal, to the brain. Similarly accelerative forces act on these membranes in the same way. This organ is very sensitive but its range is limited as it does not have an intensive feedback arrangement such as the Sperry accelerometer has. Fig. 4 shows diagrammatically the location of this organ in the skull.

We have established that the

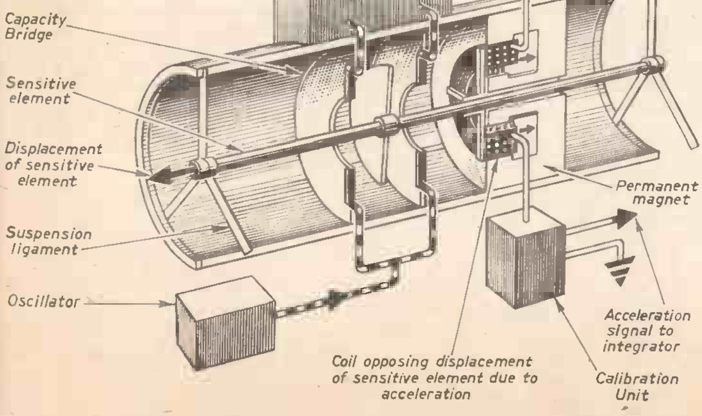


Fig. 3.—Cutaway perspective view of a calibrated precision accelerometer.

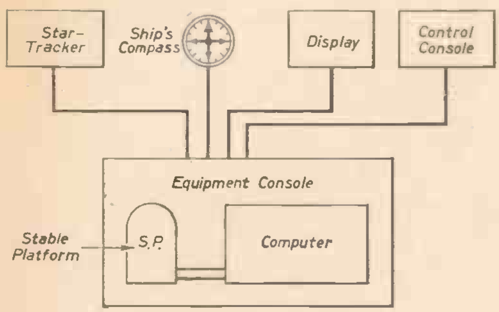


Fig. 5.—Main components of marine inertial navigation system.

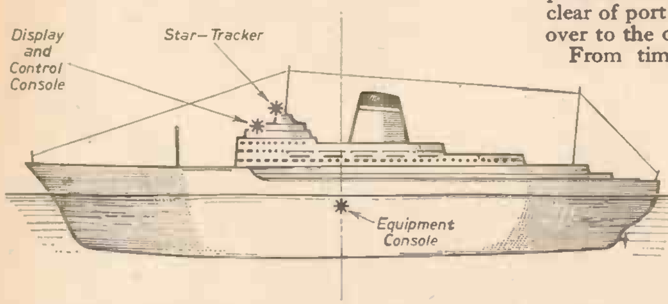


Fig. 6.—Where the main components are located on a ship.

accelerometers of our inertial system provide signals proportional to the accelerations experienced by the stabilised platform. These signals can be fed to a suitable computer, where they will be double integrated to yield corresponding velocity information. These velocity changes can be continuously recorded and compared with the desired course information previously fed into the computer. The actual course of the vessel will thus be continuously monitored and steering signals proportional to deviations can be transmitted to the steering control system for course correction.

Modern inertial systems are of two types, known as "Pure" or "Aided" systems. The system we have considered is a pure system and its accuracy depends on the accuracy of its gyros and accelerometers. Unfortunately the accuracy of the gyros falls off due to drift, and the process of integrating the outputs of the accelerometers, which themselves depend on gyro accuracy, greatly magnifies these errors. These effects are not significant over short periods such as the duration of an aircraft's flight but render it unsuitable for marine purposes.

An Aided Inertial System

This is used when operating times are of long duration. The system has the addition of a star-tracking element with telescopes which is used to track pre-selected stars and compare the observed star line with pre-computed star lines. When discrepancies exist a correcting torque is applied to the platform gyros.

Fig. 5 shows the essential components of an aided inertial system and Fig. 6 shows how they would be situated about a ship. It is important that the equipment console containing the stable platform should be placed as near as possible to the ship's centre of gravity. This is so because a ship tends to rotate about its C.G. when acted on by random accelerations due to rolling or pitching. Locating the platform at the C.G. minimises the amount of correction required as a result of these motions. Obviously the star-tracking element must be located where a clear view of the stars can be obtained. Fig. 7 shows how the output of the inertial system computer would be translated into signals to the steering controls.

Assuming we have a ship equipped with an aided inertial system, shortly before leaving port we would have to align the platform both as to azimuth and local vertical. We would feed information to the ship's heading computer concerning our present position and desired course to our destination. Once clear of port the steering controls would be switched over to the output of the ship's heading computer.

From time to time periods of automatic star-tracking will be necessary, weather permitting. Each of these periods will require 10 to 15 minutes for star acquisition and 5 to 10 minutes tracking time. Three such periods every 24 hours would be ample to maintain maximum accuracy. Should 24 hours pass without star-tracking it will degrade to a pure system but subsequent star-tracking will correct this.

The inertial navigation system has obvious advantages for warships. It is completely self-contained and has a high degree of accuracy, whereas other systems, such as radio aids, are subject to poor reception, enemy jamming or beam bending and could be seriously hampered by the need for radio silence.

With current developments in radio and radar aids to navigation it is not clear at this stage which will prove to be most attractive to the shipowner. However, the science of inertial navigation is sufficiently advanced to make its application to commercial maritime use a practical possibility.

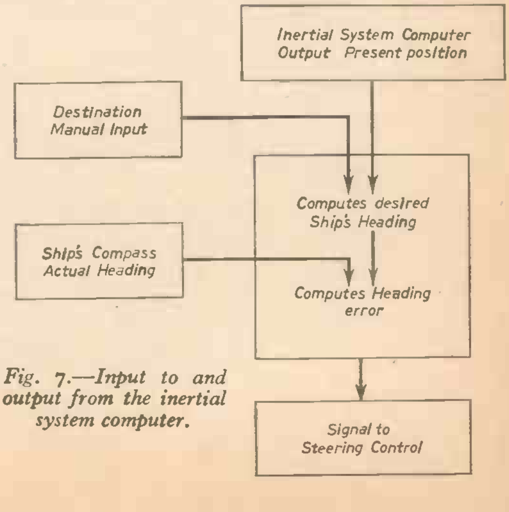
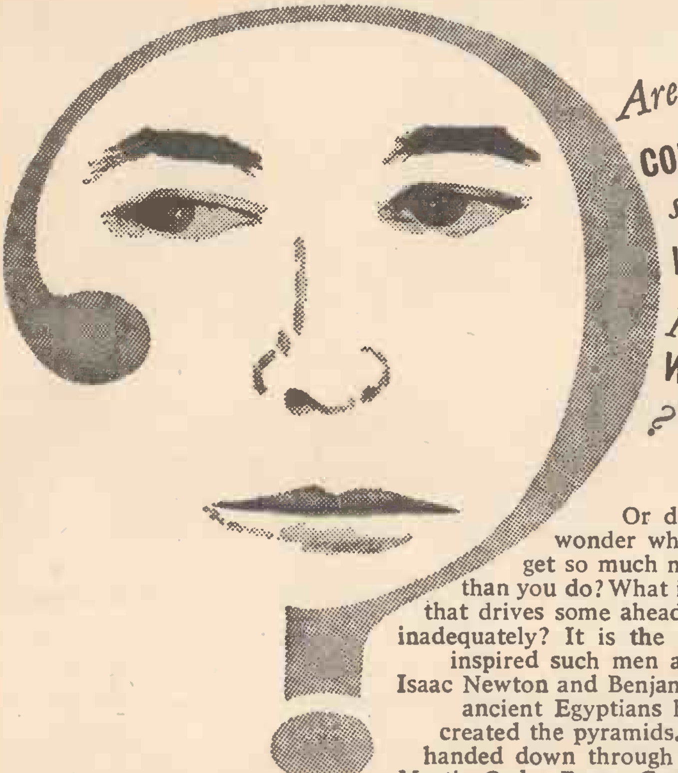


Fig. 7.—Input to and output from the inertial system computer.



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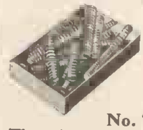

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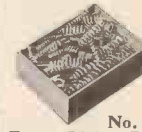

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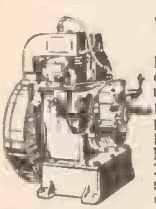

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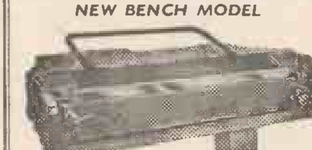

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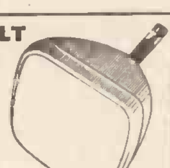

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ELECTRIC MUFFLE CRUCIBLE

(*Concluded from page* 57).

exact measurements are not important so long as you leave enough room under the crucible for whatever type of mould you are going to use.

On the stand, the rods cross over behind the crucible in order to provide a stop for the handle to rest on and keep the crucible upright and steady. The ends of the rods are finally bent inwards for about 3/16in. and adjusted until, by springing the whole framework open slightly, the ends of the frame will slip inside the hollow rivets and be retained there.

Wiring

Thread on sufficient porcelain insulators to bring the two ends of the element to the position shown in the heading and join to the mains lead, using any type of small junction block which can be attached to the frame with a back-plate. Take care to keep the porcelain insulators close together; in this way the element wires will be well enough supported to withstand the slight bending which occurs when the crucible is tipped for pouring. Make sure that there is enough slack in the coupling for the crucible to be tipped, not necessarily upside down but far enough to allow molten metal to be run out.

Using the Crucible

Sufficient scrap metal is dropped in, together with a generous amount of flux—powdered borax in the case of brass, copper, silver, gold and their alloys—and the current switched on. Do not overheat. The metal is best poured as soon as it is thoroughly molten, with the surface showing the phenomenon known as "spinning." Switch the current off or better still remove the plug from the socket, just before pouring. A further necessary safety measure is to use an earthed supply, connecting the earthed lead to the bolt attaching the handle.

The crucible's working life will be greatly prolonged if on switching on from cold, you switch off after about a minute and allow another minute to elapse before switching on again. This will help to equalise the temperatures of element wire and the inner surface of the crucible.

Should the element burn out through overheating or any other reason, it is a fairly simple matter to remove the lagging, break away the fireclay and wind on a new element.

A spot of temperature indicating lacquer on the inside of the crucible will be useful. The paint known as "Tempilaq" is obtainable from J. M. Steel & Co., Ltd., Kern House, 36/38 Kingsway, London, W.C.2. Specify the temperature to be indicated as 1,100 deg. C. This is the maximum safe temperature which can be maintained by the average electric fire or boiling ring type of element. Special elements are available which will work at slightly higher temperatures.

FROST SENTINEL FOR YOUR LOFT

(*Concluded from page* 59).

using about 16in. per foot run of pipe. Take the ends to the teminal blocks. Do NOT let heater wires run closer than ½in. except right at the terminal blocks. The return wire must not be along the pipe or under the tank lagging (if fitted).

It is a good idea to take two turns round the outlet pressure valve for the ball mechanism (see Fig. 4a).

Where to Get the Wire Heaters

Advertisements appear from time to time in this magazine. Messrs. Technical Services Ltd., Banstead, Surrey, and Messrs. Whistons, New Mills, Stockport, should be able to supply the heater cable required. Order PLASTIC covered nylon/glass/Cupro-Nickel heater and DO NOT use any asbestos type wire which can be extremely dangerous when contaminated with water.

Warning

When working with electrical gear near earthed tanks and pipes *always* have the current turned off at the main and the supply point, and work if necessary with an electric torch. Leave no bare wires, fit a warning lamp, and use the green mains lead.

U.S. STEPPING STONES TO SPACE

(*Concluded from page* 65).

Apollo Project

The three programmes mentioned all lead to the Apollo project. This calls for a three-man space craft to be built which will accomplish earth orbits and circumlunar flights, will serve as a test manned space station, and be used for an eventual moon landing.

Already the United States has taken the first step toward design and development of this craft. Three companies have been chosen by the National Aeronautics and Space Administration to conduct "feasible studies," which are being carried out immediately. The companies are: Convair Astronautics, a division of the General Dynamics Corporation; the G.E. Missile and Space Department, and the Martin Company.

"Project Apollo plans," according to N.A.S.A., "call for a versatile space craft that will greatly extend man's capability for manned reconnaissance flights to the vicinity of the moon, and as a logical step towards future goals of landing scientific teams on the moon and exploration elsewhere in the solar system."

Apollo will be carried aloft by the Saturn booster, a six-cluster rocket with a thrust of 1,500,000 lb., compared to the Atlas with 360,000 lb. of thrust and the Redstone with 78,000 lb. of thrust.

MORSE PRACTICE SET DANGER

SEVERAL of our readers have written to point out an element of danger which exists with the design we published in our September issue, page 596, for "A Morse Practice Set." If the "live" side of the mains is connected to T2 and thus to T4, it would mean that the headphones are connected directly to the mains.

By far the safest scheme is to power a morse practice buzzer with a dry battery.

TRADE NOTES

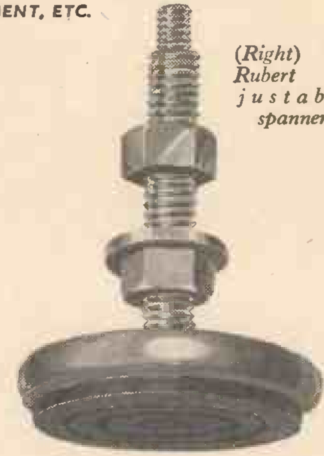
A REVIEW OF NEW TOOLS, EQUIPMENT, ETC.

New Adjustable Spanner

THIS tool has recently been introduced by Rubert & Co. Ltd., Demmings Road, Councillor Lane, Cheadle, Cheshire. The spanner works on the locking wedge principle without either screw thread or worm gear and will accept nuts or bolt heads up to ½in. Whit. The position of the moving jaw is changed by sliding an adjusting sleeve with the thumb, a spring keeping the jaw firmly in contact with the sleeve and locking it into position when the thumb is removed. The tool is 6in. long and is forged from ¼in. steel.

The spanner is finished in bright chrome and can be supplied with a real leather pocket case. Retail prices are 9s. 6d. for the spanner and 4s. 6d. for the leather case.

(Right) The Rubert adjustable spanner.



The new Vulcascot " Mini-mount."

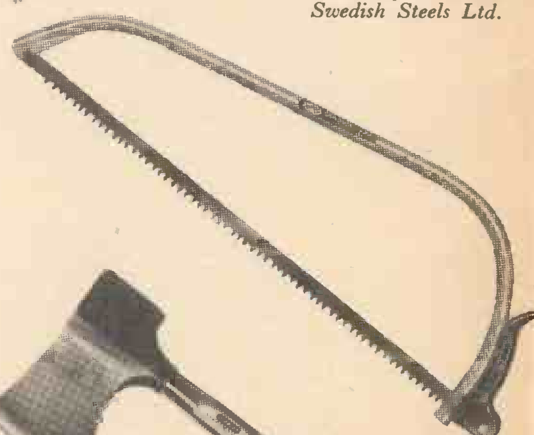
Handicrafts Catalogue

SO many handicrafts are listed in the new Northern Handicrafts Ltd. catalogue that it is impossible to mention them here but materials and tools are available for almost every hobby. Write for a copy to Northern Handicrafts Ltd., Perseverance Mill, Padiham, Lancs., enclosing stamps for return postage.

Mini-mounts

INTRODUCED by Vulcascot (Great Britain) Ltd., 87/89 Abbey Road, London, N.W.8., the Mini-mount is similar in principle to the larger level mount introduced three years ago. Designed for use with workshop machines, accountancy and other office machines, electronic equipment, etc., the mini-mount dampens vibration and ensures perfect levelling. Materials used are Neoprene and cadmium plated steel. Further information is available from the above address.

(Above and below) Two new saws introduced by Sandvik Swedish Steels Ltd.



New Saws

THE do-it-yourself enthusiast and the amateur gardener will be interested in the two new Swedish lightweight saws shown on the right. The bow saw has a tubular steel frame, 24in. blade and a plastic handle. Its weight is 1lb. The handsaw has a 22in. straight back polished blade of hardened and tempered steel. A red plastic handle is fitted and the saw weighs just over 17oz.

The price of both saws is £1 1s. and the makers are Sandvik Swedish Steels Ltd., Halesowen, Birmingham.

Stanley Axe

AN axe with a head which is permanently tight has been introduced by the makers of Stanley tools. Known as the " Steelmaster," it sells at 34s. 9d. and is designed for all-round outdoor use—in the garden, the woodshed, for camping, etc.

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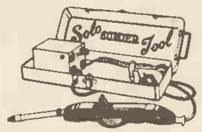

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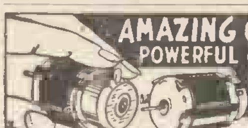

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YOUR Queries ANSWERED

Vibrating Table

I WISH to carry out some reconstruction work which will involve precast concrete and cast stone. I intend using the moulds with a vibrating table. Could you please tell me how to construct a vibrating table?—J. Dawson (Glos).

THE vibratory motion can be obtained by arranging a cam beneath the table to give it a quick up and down movement, and if this cam is driven from an electric motor and a fast rise and fall imparted to the design, then the table will operate in the way required. To give a parallel, we offer the cam shaft of a car engine which lifts the valves at each revolution, and though your cam will vary somewhat from this design, the principle is just the same.

The size and resulting shape of the cam will depend on the amount you wish to lift the table at each stroke, but we imagine about 2in. or thereabouts is sufficient. Case-harden the track and the surface against which the cam contacts and you may need a gear reduction from the electric motor to slow the rotation of the cam to more reasonable limits. Perhaps an old car gearbox may assist in this direction and the arrangement of the cam under the table—it might be preferable to lift one end rather than arrange it in the centre—is also a matter for consideration.

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.

Electronic Timer

I WISH to use an electronic timer to switch off a washing machine. Could you please tell me of a firm who supplies them.—J. Eason (Surrey).

WE feel you would be best advised to purchase the following timer, if the total current at any time is over 10A. (i.e. about 2½Kw): Interval timer MKT4. Maximum operating time 15 minutes, graduations every 15 seconds. 240V. A.C. (or to suit your mains). Manual set. If you desire to fit the unit into a panel order MKE instead of the portable unit MKT. These units are available from Messrs. Sauter Controls Ltd., 70 Dudden Hill Lane, London, N.W.10.

If your load is greater, then we suggest you consult the above firm who will probably suggest their model MKS for use on up to 15A. Alternatively the MKT unit could be used in conjunction with alternating current relay (for your voltage mains) RQ 1/30, obtainable from the same source, would appear suitable. All the apparatus listed could function from the power supply used for the washing machine.

Making an Enlarger

I WISH to make an enlarger for 2¼in. sq. 35mm negatives. I believe that a 3in. (75mm) focal length lens would be suitable. Is there any other information you can give on this subject?—J. M. Davidson (Edinburgh 10).

THE 75mm focal length lens would do. For best definition, use a 3 or 4 element enlarging type lens. The lens/negative distance must be adjustable from about 3 in. upwards, being 75mm. for infinitely large prints, and 150mm. for same size prints.

Condensers should be large enough to cover the negative area (3in. to 3½in. dia.). Place curved sides of condensers together. The flat side of the lower condenser is immediately above the negative. A focal length of about 3½in. will do, since you wish to cover both 2¼sq. and 35mm.

Use a photographic flashed opal lamp (not domestic opal) at the distance giving most even illumination on the baseboard (usually 4in. to 8in. or so). A 60W. lamp is suitable, but this may be increased with a well ventilated lamphouse. The lens can have a bellows or spiral mount, to permit focussing.

A 6in. Reflecting Telescope

I AM making a 6in. reflecting telescope and find that a tube must be used because of glare from street lamps. I have a very strong tube of ¼in. thick cardboard of sufficient length but the internal diameter is only 5½in. Could this be used or would the stopping down from 6in. to 5½in. cause any great reduction in power.—W. H. Shore (Trowbridge).

BY all means use the 5½in. internal dia. tube. If cardboard, coat inside with matt black paint. Varnish outside. On all fixings use good size washers so that bolts do not pull through tube wall. Make a 5in. mirror, you will lose no power but you will lose some aperture and light grasp in the ratio of 6^2 to 5^2 i.e. 36:25. Never the less a 5in. mirror will make a handsome telescope. If you finally decide on a 5in. mirror at f8, then focal length will be 40in.

Obtaining a Glow

I WISH to treat some metal and paper objects so that they will glow or reveal themselves in the dark. I believe there is some preparation other than ordinary luminous paint.—A. French (Birmingham).

THERE are certain substances that give luminescence chemically and one of these is lead sulphide. A substance treated with a strong solution of lead sulphide will pick up energy from exposure to sunlight and give off light again strongly when removed from the exciting influence of sunlight. But this effect wears off very rapidly—in a matter of minutes. You could coat your objects in this way (soln. of lead sulphide) expose to daylight and then cover the surface up. Upon darkness coming down the covering could be removed and your object would glow.

Rising Coloured Bubbles

I WAS shown recently a pint sized bottle containing two liquids one heavier than the other and coloured red. When heated by means of a 40W. lamp placed in contact with the base of the bottle the heavier of the two liquids slowly ascended to the top in large globules, where it presumably cooled and descended in like form. Could you please give me some information as to the nature of the liquids.—E. Fergus (Oxon).

THE rising globule lamps use water and an organic fluid immiscible with water and consisting of a mixture of a hydrocarbon which is lighter than water, such as paraffin, together with a heavy liquid such as carbon tetrachloride. The proportions are adjusted very carefully so that the mixture just sinks in cold water. Because its coefficient of thermal expansion is greater than that of water, the mixture will rise to the top when the system gets warm. Suitable dyes are used for colouring. Pink and blue paraffin are already coloured.

The mixture consists of: 2 parts blue paraffin and 1 part carbon tetrachloride by volume giving a mixture of about the same density as water at 70°F. When colder than this the mixture sinks to the bottom—when hotter it rises to the top. The mixture, plus water must be sealed in vacuo to work properly. The globules are dragged up by small bubbles by heat from the lamp.

Cleaning Chimneys

COULD you please tell me how to use Saltpeter to clear soot from chimneys.—C. B. Wigan (Bristol).

SALTPETER, in small quantities at a time, can be thrown on to a glowing fire and this is said to clear the chimney of soot. Alternatively, a soot destroyer can be made from the following ingredients:

Salt	285 parts
Zinc powder	14 ,,
Anthracite coal powder	6 ,,
Hard charcoal	3·5 ,,

7-by-7 Transistor Portable

(*Concluded from page 76*)

hardboard is cut to fit over the top of the condenser as shown at bottom right of Fig. 7, and is sanded until it is level with the speaker fixing holes.

The top and bottom are covered in Fablon which is taken over the edges for about ½in., and the holes are cut out. The back is then screwed on the cabinet. The receiver is next fixed to the panel by the three screws holding the panel to the condenser and the four screws holding the panel to the speaker.

Once the receiver is mounted on the cabinet panel, the panel is placed on the cabinet shell so that the battery compartment coincides with the slot in the casing. It is then tested and finally screwed in place with small chromium screws. The batteries are held in place by a small piece of Paxolin or Formica covered in Fablon and held on the top with two small screws. A matching plastic handle is fitted as in the heading photograph.

Final Remarks

One or two 9V. batteries may be used in the battery compartment. Renewal will not be frequent with the value of R1 stated.

If there is instability, i.e. "motor boating," especially on full volume on the Long Waves, fit a 0.01 μF condenser across the two audio transformers, i.e. in Fig. 9 fit one between tags 4 and 5 and another between 6 and 7.

If there is a tendency to undue whistling and the lining up has been correctly done then neutralisation may be required if it is decided that the interstation whistling is too much of a nuisance. Four parts only are required. A 1.2 KΩ resistor, a 56 pF 1 per cent. condenser, a 3.9 KΩ resistor and an 18 pF condenser are all joined in line. The 1.2 KΩ component is soldered to pin 1 of TR5 and the 3.9 KΩ one to pin 1 of TR3. The junction of the 56 pF and 3.9 KΩ components is then taken to pin 1 of TR4.

The receiver will work in all locations except in a completely metal building, in a car it is best placed near open glass such as a back window. No aerial or earth are required.

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.

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Ex Admiralty brand new Pocket Stopwatches by Waltham and Smiths. Fully jewelled movements, ⅕th second, 60 seconds per rec., 30 minute recorder dial, winding button start, stop and re-set, value £8, 45/-, post 2/-. Ditto, tarnished cases, but brand new 37/6, plus 2/- post.

Ex Admiralty brand new Pocket Stopwatches, Waltham, 6 seconds per rev., no recorder dial, accuracy greater than 1/10th second, jewelled movement, in original box, winding button start, stop and re-set, cost over £12. 19/6, post 2/-.

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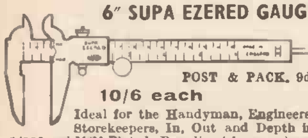

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