Practical MECHANICS

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MAY – 1962

TWO-MAN RENDEZVOUS SPACECRAFT

The G 45 GUN CAMERA

Prospecting the OCEAN FLOOR

Making a FLAT BED DUPLICATOR

Practical
MECHANICS

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CONTRIBUTIONS

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

FAIR COMMENT

Readers' Choice

THE Readers' Service Questionnaire which was included in our March issue has proved an overwhelming success. Many thousands of the forms have been returned to this office during the last six weeks from all over the U.K. and indeed from many parts of the world. These forms are now being sorted and classified in various groups and from these groups, eventually, we shall obtain an average figure showing the popularity from a readership point of view of certain types of articles. Already we have noted that certain features have a high popularity rating and would, therefore, benefit many readers if published more often. It is, in fact, our intention to cover a wider range of subjects than hitherto, although obviously it would be difficult to satisfy the varied interests of all our readers in one issue.

Many letters have been received attached to the questionnaires. Unfortunately it is not possible to answer queries raised in them individually. If by chance we should have missed some important question raised by a reader we shall be pleased to hear from them again, in which case it will be dealt with through our normal readers' enquiry service. Some extracts from these letters have been published on page 382 of this issue.

PRACTICAL MECHANICS has always had a good list of regular contributors—e.g., Donald Fraser, Jameson Erroll, E. V. King and A. E. Bensusan. These authors seem to have an inexhaustible supply of interesting articles in their own particular fields, and as we read from the questionnaires the various occupations and hobbies of our readers we feel there must be many who have some project they have undertaken at some time or other and which they feel would provide suitable material for an article in P.M. The Editor would be pleased to consider any such article.

We do prefer to have working drawings (although not necessarily of draughtsman standard) and if possible a photograph or a negative of one. To the readers who have expressed disappointment in the reduced size of the magazine we can only add that we share their views and wish we were able to control the increased production costs which brought this about. We are, however, always seeking ways of improving its quality and satisfying our readers by including their own choice of the contents. Readers who did not fill in the questionnaire and who feel they would like to do so are not too late, and we shall still be pleased to hear from them. The final checking will not be completed for several weeks.

Success Story

We often read stories today, sometimes of big industrialists and of other men who have launched into business on their own, in some cases almost by accident: some change of events in their lives has decided them to "take the plunge". If any reader has such a story, of perhaps, a small beginning in a back garden workshop into a successful business venture, we should be pleased to hear from them as we propose to publish a series of articles dealing with this subject in the near future.

The June 1962, issue will be published on May 31st, 1962. Order it now!

Pinch Plasma Space Engines

By DONALD S. FRASER

A COMPACT, electrical space engine, capable of operating indefinitely by battery and solar cell power, has been developed at the Republic Aviation Corporation's Plasma Propulsion Laboratory, in the United States.

The lightweight engine, which obtains its thrust from the magnetic "pinching" of an inert gas, such as nitrogen, has been described as the only electrical engine in existence capable of operating today just as it will in actual use on spaceships and satellites. The company expects to have a "flyable" model ready for space flight later this year.

The new engine has undergone extensive test demonstrations at the electrical and advanced propulsion branch of the Propulsion Laboratory of the Aeronautical Systems Division at Wright Field. During these tests, direct thrust measurements were taken which indicate a greater thrust-potential than that of any other electrical space propulsion system under development.

While many details of the new engine are classified, it meets practical requirements, both size and weight, for actual ship and satellite use. It can be operated continuously in near and deep space, for years, without the need of service of any kind. Experts already have predicted the feasibility, and need, for engines of this kind to propel and "steer" space ships from planet to planet with pin point accuracy, and for other missions that include control for reconnaissance, and communication satellites for military and commercial purposes.

It is understood that this space mission potential for the plasma engine is the ideal acceleration system for (1) maintaining spin rates in satellites that are spin stabilised; (2) changing a satellite's orbital path when such changes are necessary; (3) maintaining a satellite in a low-altitude position; offsetting the effects of outer atmosphere drag; (4) maintaining a satellite in a 24-hour orbit to perform such delicate functions as rendezvous or docking of smaller satellites with larger space stations; and (5) preserving the relative position of a host of satellites performing a single mission.

One of the main advantages of the plasma engine, over other forms of space propulsion, would possibly be its light weight due to its efficient use of fuel. Its specific impulse, a term used to show efficiency of fuel consumption, ranges from 1,000 to 7,000 seconds. By comparison,

the specific impulse of a rocket engine is in the order of only 100 to 350 seconds. This means the plasma unit has the ability to operate over a much longer period of time. Comparing the plasma engine with other forms of electrical propulsion, the following advantages have been cited: greater thrust, broad range of exhaust velocity (specific impulse) in the required range for most space missions, stop-start capability, variable specific impulse and thrust performance during operation, simplicity, and inherent reliability.

The pinch plasma engine uses readily available inert gases for fuel. The fuel becomes ionized after injection into the engine, and the resultant plasma is electromagnetically accelerated and exhausted out of the nozzle at extremely high velocities. It is the high velocity of the excited plasma which results in the unique, economical use of fuel. Exhaust gas velocities of over 100,000 miles per hour and ejected gas temperatures in the order of 200,000°F have been measured. Notwithstanding, according to Republic, relatively cool wall metal temperatures of 200 to 300°F are maintained, eliminating need for auxiliary cooling effects. Practically no erosion of primary engine components has ever been encountered, and there are no moving parts in the engine.

This new space engine has been described as a "significant milestone in the progression of the plasma engine principle for propulsion from the research to actual development hardware status". Work on this first continuous pulsed engine has been sponsored by Republic Aviation; the Office of U.S. Naval Research, and the Office of Scientific Research of the U.S. Air Force.

What is a Plasma?

A plasma is an electrically neutral gaseous mixture containing electrons (negatively charged) and ions (positively charged particles).

When a gas is ionized it becomes plasma. Ionization splits the molecules and atoms into "free" ions and electrons. A plasma is characterized by the fact that it has electric conductivity, meaning simply that it can be markedly influenced by outside magnetic or electrical fields. The study and application of this phenomenon is the branch of science called magnetogasdynamics, megneto-hydrodynamics—or plasma dynamics.

The physics of plasma, "the fourth state of matter", encompasses the technologies of electromagnetics, electronics, atomic physics and gas dynamics. These technologies deal with studies of electrical discharges in gases; of extremely high termperature gases (on the order of 1,000,000°F); very high speed gas velocities (Mach 100), and the break-up of atoms into more basic constituents.

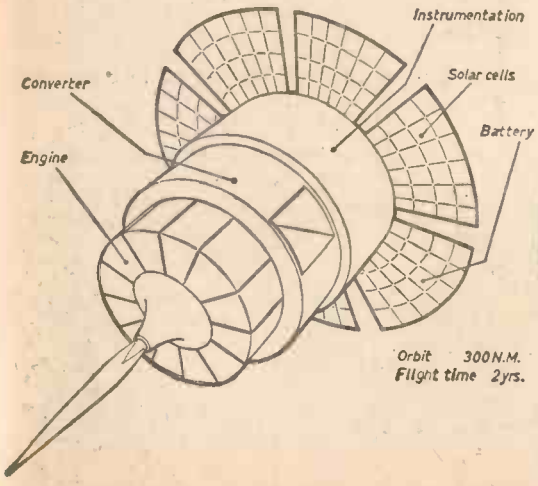
Plasma physics is one of the scientific tools required to research, develop and produce the hardware for space application. Space itself, essentially an alien environment, is much like a very low density plasma.

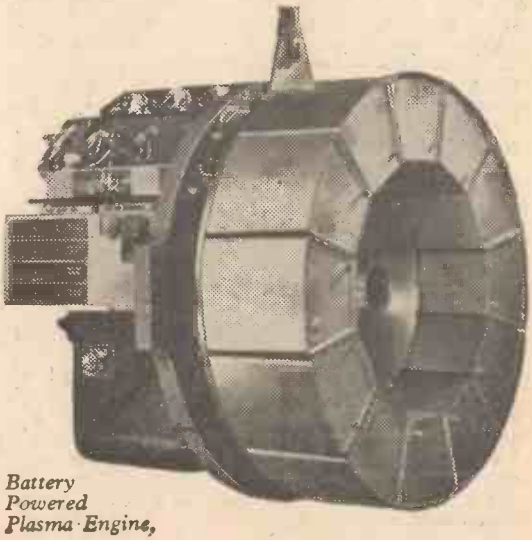
The exploration of space requires a host of devices, similar in name, at least, to the form of electro-mechanical machines commonly in use on earth.

One of the major stumbling blocks to the American Satellite programmes has been their inability to control their paths once they lose the rocket power which launches them into orbit. Even slight miscalculations in programming the initial stages of satellite launchings make them assume trajectories different from the ideal orbit. These trajectories, elliptical in shape, dip the satellite into the earth's upper atmosphere where a drag caused by friction with the atmosphere dissipates its velocity, dragging it lower and lower into denser layers of atmosphere until it either burns or crashes to earth.

The plasma engine should give an effective propulsion system which can be coupled with guidance instruments to correct errors in the satellite's orbit. As a matter of fact, satellites could be placed on such a precise orbit that their position could easily be predicted, with accuracy, years in advance, so that they could be placed over a given point at a given time at a given altitude. And, should the need arise, a satellite could be transferred from one orbit to another, thus obviating the necessity for additional launchings.

Pinch Plasma Space Engines appear to have the answer to many of today's space problems. However, only time will tell. Anything can happen—in space—and, often does, too.





Battery Powered Plasma Engine,

LATHE GADGETS

Part 5

THIN PARTING BLADE HOLDER

By L. C. Mason

IN parting off in the lathe in the normal way, using either a parting tool or a parting blade, the thickness of the tool is generally such as to produce a fair width of cutting point. The thickness is a compromise between a tool as thick as possible to give maximum strength, but also as thin as possible to give a narrow cutting edge, and therefore lighter loading on the tool.

When parting off a single turned item from stock held in the chuck, the width of cut produced by the parting tool is not generally of much consequence. However, the occasion does arise when a turned groove much narrower than the conventional parting tool is required. An even more frequent occasion when the width of the tool point begins to count for something is when a number of items are required from a length of material, what might be called "repetition parting".

This crops up most often in the turning of nuts and bolts or similar items, where possibly quite a large number are required. The average parting blade for use in the home workshop lathe would be some $\frac{3}{32}$in. thick. In producing for example, a couple of dozen special nuts, that number of partings-off represents a wastage of 2¼in. of rod turned away. In small hex. sectional steel rod this may not be of much account, but when nuts or bolts are being produced in bronze or gunmetal of fair diameter, such as for loco boiler stay bolts and nuts, then that amount of waste represents not only a measureable expense, but several more items in effect thrown away. If a parting tool or blade wider than the $\frac{3}{32}$in. mentioned is used, then the wastage is even greater.

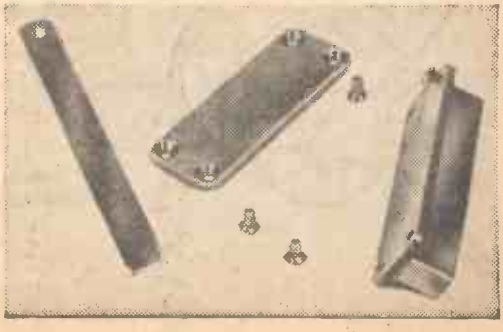
The same applies to boiler bushes and the like, from similar material. One remedy is to saw off each part when turned, rather than part it off. However, not only does that introduce the extra work of facing each sawn off item and the end of the stock, but the double facing plus the width of the saw could probably show little material saving over the parting wastage.

About the best all round answer is an extra thin parting blade, and the accessory shown provides this. It makes use of a piece of broken hacksaw blade, which when used like a parting blade provides a clean cut with a groove width barely as wide as a normal hacksaw cut.

The holder for the blade is proportioned so that it can be held like a normal turning tool, and could be so held in the back toolpost if the lathe is equipped with one. The blade is quickly removed or adjusted, and any length can be used from a complete blade (less one end hole) down to a piece only 3in. long.

The holder shown in Fig. 1 was made from two pieces of mild steel bar brazed together, but the whole thing could equally well be made from a single piece, milled to shape. The brazed construction will be found quite strong enough, however. The thick bar held in the toolpost is brazed along one edge to a thinner plate, which forms the back plate of the blade holder, a similar cover plate being attached to it by four screws to clamp the blade.

Fig. 1.—Hacksaw blade and holder components.

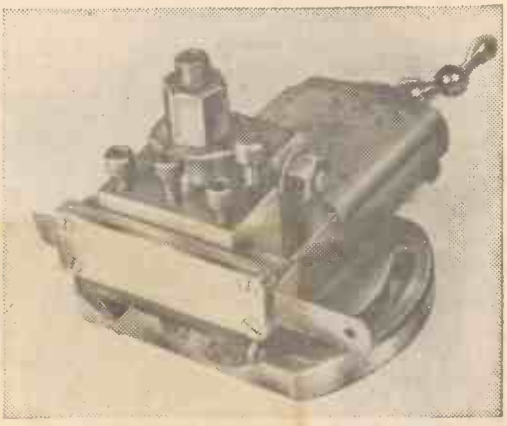


Dimensions of the topslide should be checked to make sure that there is room for the width of the clamp plates when the upper edge of the blade is set at or below lathe centre height. If there is not, the bar held in the toolpost could be made wide enough to let the clamp plates overhang the end of the topslide—or what is probably easier, the end of the blade itself can be ground to bring the cutting tip down to the appropriate height. Height adjustment is carried out as for a normal turning tool.

The drawings Fig. 2 show suitable dimensions for a holder for the ML 7, used in conjunction with the toolholder already described. Four 4B.A. screws take care of clamping the blade, countersunk into the cover plate so as to enable parting to be carried out as close as possible to the chuck jaws. It is useful to have no up and down play for the blade between the upper and lower pairs of clamp screws. If the blade should tip slightly in use the cutting point will drop. with considerable risk of a dig-in. So drill the two bottom holes first in the main plate 4B.A. tapping size (No. 34 drill), clamp the cover plate in position and spot through for the matching holes in the cover plate. Drill these 4B.A. clearing, No. 26. Lay the piece of blade in position on the back plate, with its bottom edge pressed well down against a couple of 4B.A. screws in the tapped holes, and locate the positions for the top pair of screws, allowing just enough freedom for the blade to be slid between the two rows of screws. Screw the cover plate into position by the bottom pair of screws, spot through the top holes for the other two screws in the cover plate, and drill as before. Countersink all four holes in the outside of the cover plate.

In shaping up the hacksaw blade for use in the holder, first grind a small notch as shown in the top edge to provide a little top rake, if the blade is to be used on steel. Then grind back the broken end at an angle of 5 deg or so for clearance till the ground end at the top edge just meets the start of the notch, which brings the cutting point in line with the top edge.

With the normal thicker parting blade it is possible to grind the end to a slight angle across



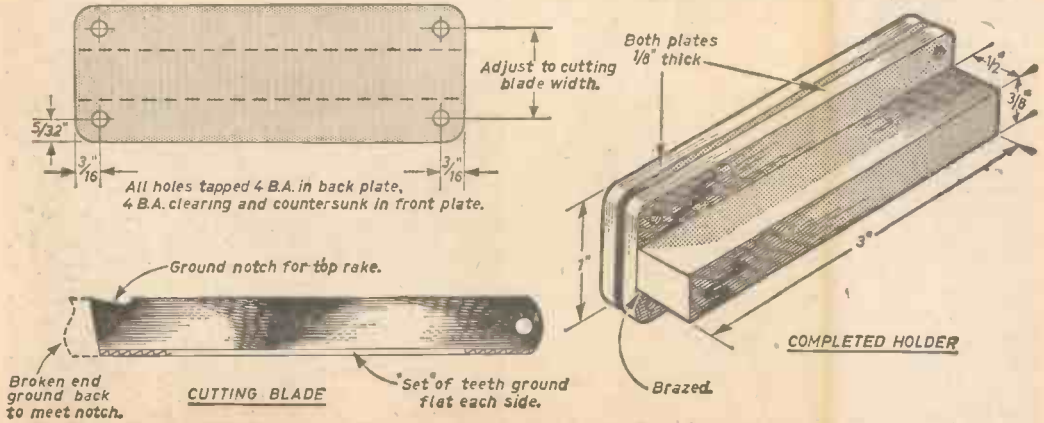
Parting blade holder ready for use.

the blade, right hand corner leading, which leaves the parting-off pip on the stock, rather than on the item parted off. This cannot be done with so thin a blade as this. In fact, care should be taken to keep the end ground exactly square across, as owing to the thinness of the blade a slight angle on the end will cause the blade tip to be deflected from a straight line into the work, with a consequent breaking of the end. Have only just enough blade projecting to penetrate the depth required.

Grind off any "set" on the blade teeth so that it lays perfectly flat and can be gripped all over by the plates, and form the cutting tip on the smooth back edge of the blade.

Again, owing to its thinness, little can be done to provide side clearance behind the tip, and a gentle stoning behind the point seems to make little difference. For this reason, deep cuts should not be attempted; for depths of $\frac{1}{4}$in. or so on jobs such as the examples quoted it is a useful tool, but deep cuts on large diameter heavy jobs should be tackled with the regular tool.

Fig. 2.—Dimensional drawings of holder.



ULTRA CLOSE-UP PHOTOGRAPHY

as described by A. E. BENSUSAN

Fig. 1.—A normal size cigarette burning.

THE ability to carry out photography at extremely short ranges opens up entirely new fields of activity to anyone with a camera. The prospect of doing so at a cost of only a few shillings and a couple of hours spent making the necessary supplementary equipment renders the proposition even more attractive. The equipment and the method described here were originally developed by the writer specially to take a short series of technical photographs, which could not be secured in any other way. The results were of such hign quality that the arrangement could be considered as proven under the most exacting circumstances, and it is now in regular use for a variety of work.

Materials

The only item which needs to be bought is a watchmaker's glass costing from two to four shillings from most tool shops and some opticians. All the other parts are easily made to suit the glass and the camera. The writer employs a miniature camera for this work, mainly because the film is cheap, obtainable in 36 exposure lengths, and the negatives are capable of considerable enlargement whenever that is necessary. However, there is no reason why other film sizes should not be employed to produce results just as pleasing.

Since it is unlikely that many readers will own precisely the same model of camera, and there is certain to be some variation between one watchmaker's glass and another, there is no point in giving the dimensions of the accessories which were made, but Fig. 3 shows the alignment of the camera with the glass together with the subject frame.

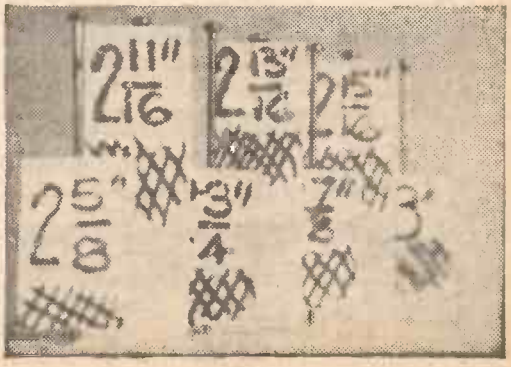
Fixing the Glass

A means must be found of fixing the glass by its small end to the camera lens mount. For preliminary experimental work or occasional use, three equally spaced strips of adhesive tape would serve. A more permanent arrangement is illustrated on the right of Fig. 4. A plastic pillbox lid of approximately the same size as the camera lens mount is a useful starting point. This cap has a hole cut in its centre slightly smaller than the end of the watchmaker's glass.

Three plastic tongues cemented around the periphery of the cap are shaped so that the glass can be pressed in and retained (see Fig. 3 again). The glass may then be freed at any time for use in examining negatives or for any similar function. Differences between the cap and the camera, or the glass and the cap, may be made up by cementing thin packing in place as necessary. The cap should just push on to the camera lens mount and consistently hold the glass in the same relative position.

The left-hand side of Fig. 4 shows the subject frame. This has a two-fold purpose: to show what

Fig. 2.—Test shot to show working distance.



will be included in the negative (the camera viewfinder is not usable for this), and to keep the camera and the attached glass at the correct distance from the subject. The material for this unit may be metal or rigid plastic of any description. Reflection from its surface must be avoided, and the material should be selected to take a black finish. The arm has a hole near one end so that it can be attached to the tripod bush of the camera with an ever-ready case retaining screw. A bracket immediately behind the hole locates against the front of the camera and prevents swivelling, while a second bracket at the end supports the actual frame.

Finding the Working Distance

The working distance, which controls the length of the arm, and the picture area covered, is best found by a simple experiment. The unloaded camera has its shutter opened to "time", the lens set at full aperture and the back opened. A piece of tracing paper is taped across the film runners and the watchmaker's glass clipped to the lens. By looking at the tracing paper screen, it will be possible to determine and note the approximate distance at which the camera must be held from a sheet of printed matter, in order to read the printing in the centre of the picture space.

To arrive at the exact working distance, labelled pins must be struck vertically into a block of wood at the distance previously found and at $\frac{1}{16}$in. intervals before and behind it. The pins must, of course, be slightly staggered to permit a part of each label to be seen from the front. The block is set up so that the labels are centrally disposed in front of the camera, which is now loaded, and with the datum label at the correct range.

The lens is stopped down about halfway between the largest and smallest apertures and a picture taken. When an enlarged print is examined (Fig. 2), the precise working distance will be obvious from the sharpest label. In the example shown it is $2\frac{13}{16}$in., and this is the distance from the end of the hood of the glass to the face of the subject. The length of the arm and the position of the brackets and screw hole can then be determined by a few simple calculations.

The area covered is found by erecting a sheet of graph paper, with the squares numbered, at the correct range and then making an exposure with the lens stopped right down, the area can be read off this negative in terms of 0·1in. squares high and wide (or whatever ruling is used on the graph paper). The ends of long negatives are bound to be rounded, but this can also be found by reference to the negative.

How to Use

In use, which may be with the camera either in the hand or mounted on a tripod, the subject is arranged on the side of the frame away from the camera and, as near as possible, in the same plane. The lens must always be stopped down to its smallest aperture, as the depth of field is extremely limited; even at small stops it is barely $\frac{3}{8}$in.

Fig. 1 reveals what can be done with this equipment, it shows a normal size cigarette burning. Compare this illustration with a similar original and you will see that there is no loss of detail. The picture was taken by artificial light on medium speed film and at an aperature of f16.

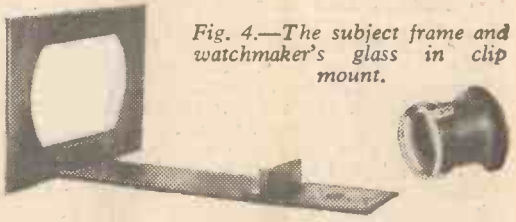
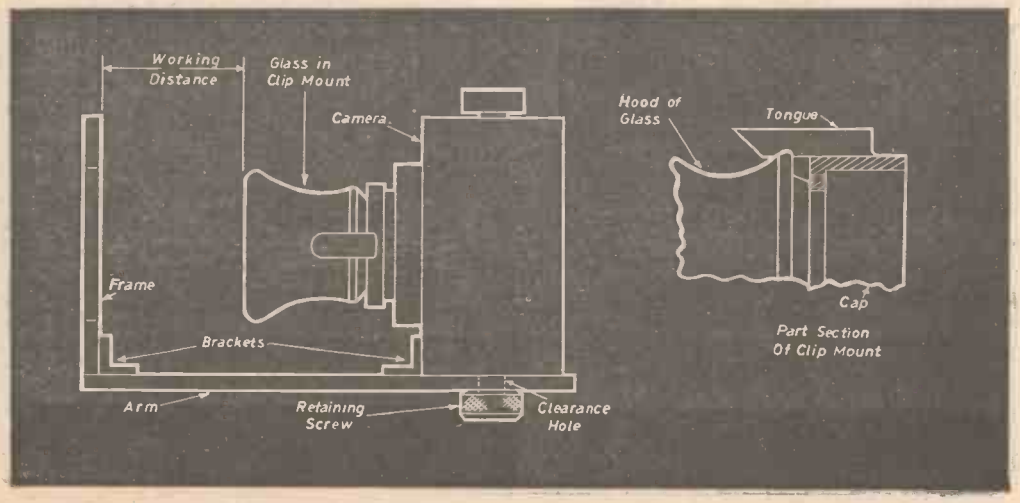


Fig. 4.—The subject frame and watchmaker's glass in clip mount.

Fig. 3.—Alignment of equipment.



PROSPECTING ON THE OCEAN FLOOR

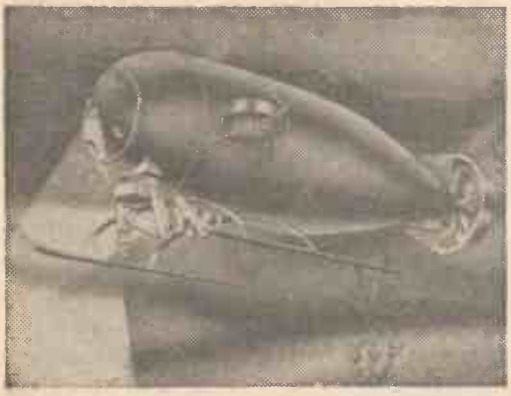
By ARTHUR NETTLETON

VAST new worlds await exploration under the surface of the oceans, and whilst many scientists nowadays have their eyes on Outer Space, others are finding that the hidden realms of Father Neptune still provide extensive opportunities for research.

Leading nations, notably the U.S.A. and Russia, have equipped themselves for more thorough oceanic surveys, and new devices are being built or are already in use for that purpose.

America's contribution to this branch of exploration includes both specially designed submarine craft and a remote-controlled vehicle which can collect information and samples while wandering about the ocean floor. Known as the RUM (Remote Underwater Manipulator), and built for the U.S. Navy, this robot is essentially a tank or tracked vehicle equipped with TV cameras and a long-jointed arm fitted with a claw.

RUM is linked up to a mobile van on shore by a five-mile coaxial cable which carries the power for operating the vehicle, running the TV cameras, and supplying current for huge mercury vapour lights. The TV cameras act as the eyes of the robot, and adapted sonar equipment is also used to guide the vehicle along the ocean bottom.



A drawing of Seapup VI, a complete underseas research system with precise manoeuvrability in vertical, horizontal and inclined planes.

The long, jointed manipulator arm and hand, similarly under remote control, not only enable RUM to collect samples and specimens but also to assemble and install scientific equipment on the sea bed.

Designed at the Hughes Aircraft Nuclear Electronics Laboratory, it can move about at depths of 20,000ft, can manoeuvre on slopes of 60°, and is able to surmount obstacles 12in. high.

Equally startling is the SOLARIS, which may be described as a mechanical crab that can prowl

When the Navy's deep-diving bathyscaph TRIESTE (pictured above) makes its next descent to the ocean floor, it will be equipped with a mechanical arm that can reach out and pick up samples of material from the mysterious and little-known depths some seven miles below the surface. A general mills mechanical arm manipulator, adapted to withstand the tremendous pressures of 8—9 tons per square inch encountered at the deepest parts of the ocean, will provide this unique capability. The TRIESTE "arm" will be modified by means of special oil-filled units designed to equalise pressures on motors and other critical parts. Oceanographers riding in the steel ball suspended beneath the TRIESTE will control the device by means of a compact control box with individual lever action switches to provide direction and continuously variable speeds for each of six motions.

the ocean floor. It is spherical, propelled by two propellers mounted on top, and moves along a few feet above the sea bed, controlled by an operator on a surface craft.

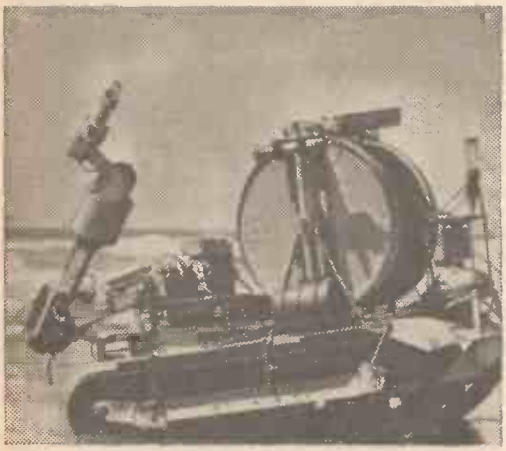
A metal claw, projecting downwards from underneath the sphere, can pick up objects weighing as much as 7,500lb, and the craft is fitted with a television camera flanked by four 500W floodlights. The TV equipment provides a continuous picture of everything within its range (normally 15-25ft) as the Solaris crawls along at depths up to 2,000ft.

Under ideal conditions the robot explorer can see a 1in. submarine cable at a distance of 50ft. But even when the water is too cloudy for satisfactory TV operation the craft is not blind. It has a sonar system which bounces signals off objects that the camera cannot see.

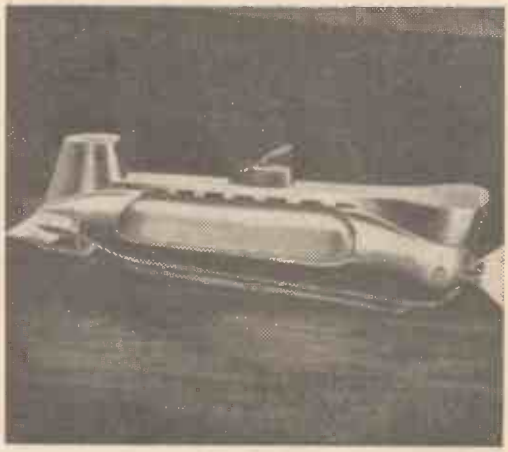
Such mobile diving craft, strong enough to withstand the enormous pressure at great depths yet light enough to surface when required, are a logical development of the bathyscaph or bathysphere. Although observations have been made at depths as deep as 36,000ft by bathysphere, the observers have had to remain in one spot.

Now the U.S. Navy has sponsored the construction of an aluminium submarine, the ALUMINAUT, for a long-term oceanographic research programme scheduled to start next year.

This vessel, 50ft long and with accommodation for a crew of two plus two observers, will be able to dive to 15,000ft and travel about 80 miles along the sea bottom. It will carry similar equipment to that of the Solaris, plus a two-way radio installation and several mechanical arms.



RUM returns from the Pacific Ocean Floor, while undergoing tests off the coast of Southern California. The new vehicle was demonstrated off the shore of La Jolla on May 16th, 1960.



Artists' conception of the first aluminium submarine built, the ALUMINAUT, which will be constructed by the Electric Boat Division of General Dynamics for Reynolds Metals Company.

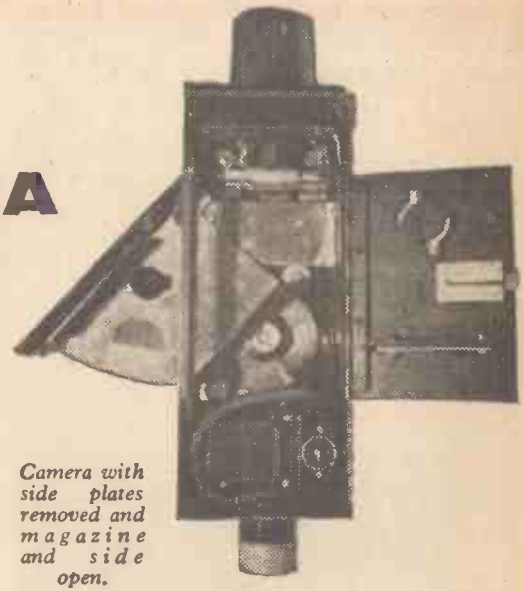
CAN YOU SOLVE THE FARMER'S DILEMA?

Toy figures to represent a farmer, a fox and a hen, together with a tiny cloth bag and a model boat will provide intriguing apparatus to manipulate when you attempt to solve 'The Farmers Dilema'. Assemble your puppets and props upon a carpet where a stretch of 'open' lino separates the objects from another carpet and then consider, the nature of the problem. The farmer wishes to cross the lino 'river' with his animals and bag of 'corn', but the old boat will only support his own weight plus the weight of the bag or one animal only. He cannot leave the fox alone with the hen, as the fox would soon make a meal of the fowl. Furthermore, he cannot leave the hen with the corn, as it is well known that hens enjoy eating grain seeds. How on earth was the farmer to cross the river with his possessions? He was in a hurry, so you must accomplish your task in as few moves as possible.

And now for the method used by the farmer to transport his precious goods across the river. He began by ferrying across the hen, then he came back alone to fetch the fox. The fox was later left upon the far bank while the farmer brought back the hen to the starting place. Next he left the hen by herself whilst he conveyed the corn to where the fox was waiting. At the end he rowed back and fetched the hen. We are not told why the farmer should apparently be so keen on keeping a fox alive but no doubt you will agree that the farmer's odd pet does help to make a pleasing plot for a puzzle.

THE G45 GUN CAMERA

F. G. Rayer supplies the know-how on this interesting ex. government purchase



Camera with side plates removed and magazine and side open.

THE G.45 gun camera is a 16mm. cine camera, with f3·5 fixed focus lens, of 2in. focal length. It uses film magazines, which may be removed and inserted complete. It is electrically operated, and intended for 24V or 12V running, as orignally supplied. The camera is die cast, and approximately 12in. x 3½in. x 2in., including lens. It is strongly constructed, being about 4½lb complete, and takes 25ft of 16mm. film, running at 16 exposures per second. This film has approximately 40 frames per ft.

Film Magazine

The magazine may be reached by opening the flap on the top of the camera, which is held by a spring catch. The magazine holder can then be raised, and is shown half open as above. To remove the magazine, it is pulled back out of its slide.

The magazine itself is light-proof, and can be opened by sliding out the side panel. The flat end of this panel is held by two small internal catches, which are freed by raising the flanged edge of the panel slightly. This panel may then be withdrawn, as in photograph below.

Fig. 1 shows the inside of the magazine, and the way in which the film is threaded. The magazine must be loaded in darkness. A clip holds the film at the take up spool end. Film passes round the

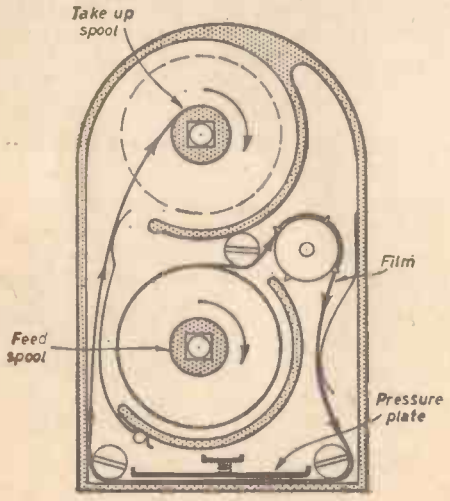


Fig. 1.—The film magazine.

Magazine with dark slide withdrawn.

(Below) Length of film inserted in magazine.

toothed wheel, under the spring, and between the pressure plate and magazine aperture. It then goes along to the take up spool. The photograph shows the magazine, with a length of film in position. After inserting the film, the magazine is closed by replacing the dark-slide panel mentioned.

Additional magazines may be obtained for the camera, and magazines may be changed in daylight.

When the magazine is replaced, and its holder is closed, the toothed wheel in the magazine completes contact to a shutter release device. These items can be left unchanged, though the magnetic shutter release will probably not be wanted.

Lens Assembly

This is shown in Fig. 2. The lens heater, intended to prevent misting under severe conditions, is not normally required, and can be withdrawn after removing the front glass. The latter is clear, and does not form part of the lens assembly itself. It should be perfectly clean.

The lens is in an adjustable mount, which enables the camera to be set for sharp focus. For normal use, it is usual to have a fixed focus lens set at the hyperfocal distance, for maximum depth of field. That is, the lens is set at some focal length shorter than infinity, from which the depth of focus extends to infinity. The near limit of the depth of focus is then from one-half the hyperfocal distance. The actual figures which may be chosen depend on the standard of definition which is considered sufficient. However, with the f3·5 2in. lens employed, a hyperfocal distance of about 50ft may be adopted. Objects between about 25ft and infinity will then be reasonably sharp. Definition will, of course, be best at the actual distance at which the lens is focused (50ft).

Fig. 2.—The lense assembly.

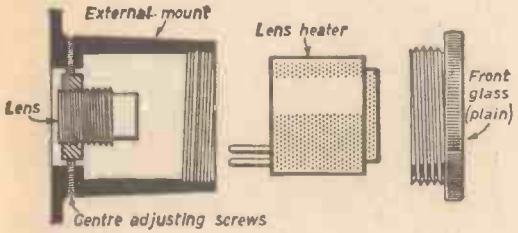
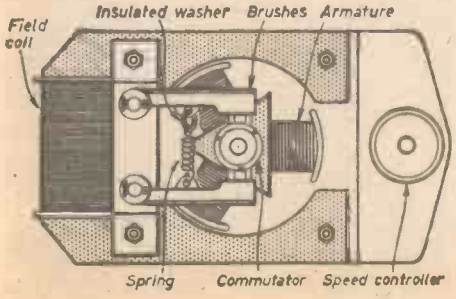


Fig. 3 (Bottom illustration).—The driving motor.



For maximum definition of closer objects, the lens has to be slightly farther from the film. Depth of focus will extend from about 10ft to 15ft, if the lens is focused at 12ft.

In view of the difficulty of developing lengths of film to check focus, a small piece of finely ground glass may be inserted in the gate aperture, with the ground side in the same plane as the film. If the shutter is rotated to bring its slots opposite the lens, the image can be observed with a powerful magnifier. Unless great care is taken, it is best to leave the lens adjustment untouched, or to remove the whole external mount, which can be seen below, and to cut cardboard washers of appropriate shape, to fit between mount and camera. This will shift the focus towards the user, and the card washers can readily be removed again. If the lens is moved in the mount, it must be replaced with its axis exactly in line with the gate aperture, or definition will suffer.

Control over exposure may be achieved by inserting filters in the external mount, over the lens. For example, a 2X filter will give the exposure equivalent of f5 (nearest usual value, f5·6), while a 5X filter will give about f8. When no tonal correction is required, a neutral filter is necessary. A yellow filter will generally improve skies.

Stopping down will reduce effective aperture, but it would be difficult to insert a stop in its correct position. In view of this, the best position for a stop is immediately behind the lens. This can be slid between mount and camera body. The hole diameter should be 9mm. for approximately f5·6 and approx. 6mm. for f8. These aperatures will give an increase in the depth of field of about 2½ and 5 respectively.

Lens mount, lens, heater and front cover glass.

The Motor

When the side panel is opened, and the rear side panel taken off by removing the securing screws, the motor will be seen in photo below. This may be for 24V or 12V. If 12V running is required, it is preferable to obtain the 12V model. This allows operation from a 12V accumulator, which may be available in a vehicle, a suitable twin flex being used for connecting up.

In most cases, current consumption will need to be kept as low as possible. The lens heater, and flat internal element secured by two screws, can be removed. The magnetic shutter catching mechanism may also be disconnected. The simplest way of making these modifications is to remove the motor, and take a new twin flex lead from the motor sockets.

The motor may be withdrawn after taking out the single holding screw on the other side of the camera case. Two projecting plugs, which engage with the motor sockets, will be seen. Existing leads are removed from these, and new leads soldered on.

The motor, with its cover removed, is shown in Fig. 3. The 24V model has armature and field coil in series, and may be changed for 12V running be re-wiring these in parallel. The 12V motor may be changed for 6V running, by similarly connecting field and armature in parallel. With parallel connections, the current consumption is considerably increased. It is for this reason that the 12V motor will be preferable to the 24V motor modified for 12V.

Thin leads pass from the brush holders and field, to the speed controller. The joint between field and one brush is disconnected, and new leads added, for parallel running. These may be seen below right. Care is necessary that the leads do not foul the armature or other moving parts.

Inside of open camera showing the motor, drive and shutter mechanism.

The speed controller is intended for the required voltage, and it is not feasible to change this item. It should be noted that new motors may be obtained separately, as plug-in units.

When replacing the motor, ensure that its gear engages correctly with the large flat gear. A transparent window is fitted, so that this can be checked.

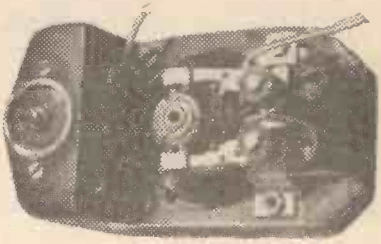
The motor will run satisfactorily from A.C. as obtained from a mains transformer. For use about the house, a 24V transformer thus offers a solution to the problem of obtaining a supply. The motor can be run from *large* dry cells. The current consumption of the 24V motor is lower than the 12V motor. The latter, an accumulator or mains transformer really becomes necessary, though it would be possible to use large dry cells in parallel. With battery running, the heater, etc., should certainly be disconnected.

Viewfinder

The lens has a telephoto effect. That is, it gives a relatively large view of distant subjects. A wire frame finder can be attached to the front of the camera, by making two hinge clips, as shown in Fig. 4. These can be cut from thin brass, and are held by two of the bolts securing the lens mount.

The frame should be of stout wire, and it is 47mm. x 35mm. It can be folded flat, or raised into position, as shown below. This will give just about the same field of view as the lens, when the camera is held in the normal position, with the eye about level with its back edge. The eye should be at the same height as the centre of the frame finder. A rear sight may be fitted for this purpose. For near objects, the sight may be a trifle higher, so that a straight line drawn from the sight, through the centre of the frame finder, crosses a line drawn from the lens axis.

Motor with its cover removed.



Front frame finder secured to lens mount screws.

Shutter Mechanism

When running free, this rotates at 8 revs. per second, and it has two slots, giving 16 exposures per second. At this speed of rotation, the exposure is approximately 1/100th sec. This is approximately an exposure rating of $10\frac{1}{2}$ as found on the exposure value scale of photoelectric meters. With any particular film, lighting conditions should be adopted which will bring the exposure reasonably within the film latitude.

The effective exposure may be reduced by using a slower film. It is not easy to increase the effective exposure, as this would involve cutting the shutter slits wider, or running the camera at reduced speed. It is preferable to use an exposure meter, and make at least one series of exposure tests. The usable limits in lighting will then be known, and the camera can be kept within these.

The shutter has a magnetically operated catching device, which will not be used for regular running. This device is situated near the gear which can be seen by the shutter below. It may be rendered inoperative by pushing it away against its tension spring, and cutting a thin metal strip to hold it in this position. This strip can be held under one of the small bolts near the end of the camera. The device was intended for electrical release of the shutter.

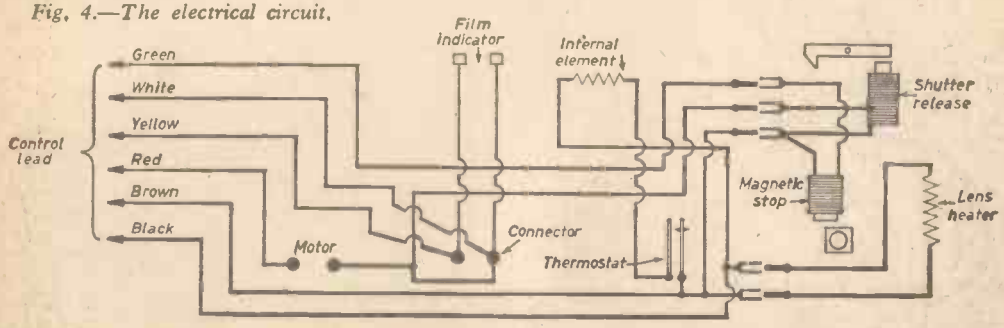
For experimental purposes, and when current is available, the device can be operated electrically.

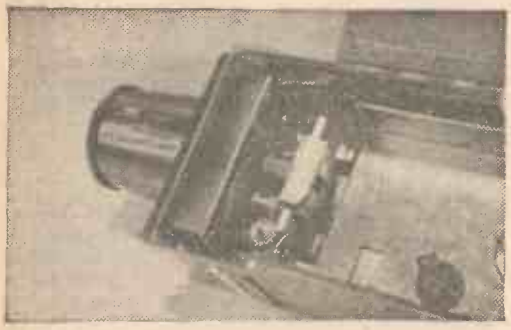
With batteries or A.C., the motor will automatically run in the correct direction. The shutter cannot operate when held by the catch device mentioned.

Manual control can easily be arranged by taking out the small inspection window of the removable panel which covers the motor, and bolting on a piece of insulating material in its place. A small push switch can be fitted to this, and wired in one battery lead.

The multiway connector on the back of the camera may be removed, if preferred, and the twin flex from the motor can then be brought out here. Individual models may be expected to vary slightly but it is not possible to give further particulars of these.

Fig. 4.—The electrical circuit.





Film gate and shutter mechanism.

Reverse side of camera with motor gear visible in window.

Workshop Tips

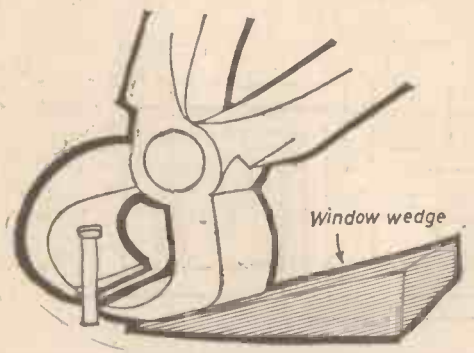
By Jameson Errol

Withdrawing Nails

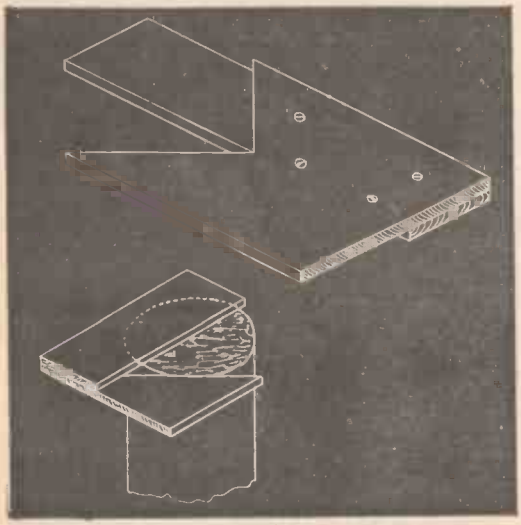
TO prevent damaging the surface of the wood when withdrawing nails with claw hammer or pincers, use a rubber window wedge as shown in the illustration. Place the wedge against the nail before applying hammer or pincers. The slope of the wedge will also furnish more leverage, an advantage when dealing with long nails.

Centring Round Work

It is almost impossible to find the correct centre on round work—dowels, tins, curtain rails, etc.—except by geometrical means, and this is rarely possible in practice. The gadget illustrated makes for accuracy, will centre any round within its limits and is very simple to make. Cut out a mitre in the wide board, and screw on the longer, narrower board with one edge dead in the join of the mitre. Place the two mitre edges against the work and make a short mark with the scriber;

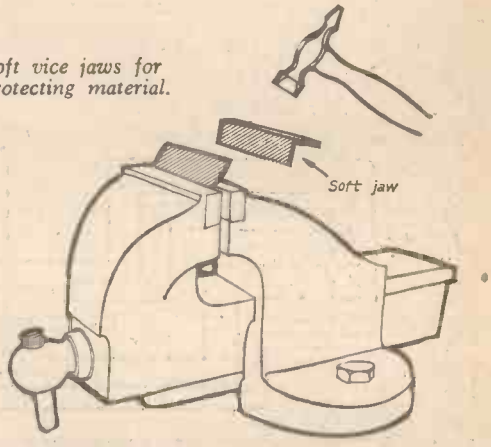


Prevent damage to paintwork by using a window wedge. (Below) Gadget used for centring round work.



re-place the gadget at approximate right-angles to the first position, and scribe another short line; where these two cross will be the centre of the circle.

Soft vice jaws for protecting material.

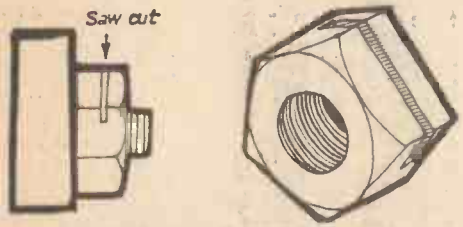


Soft Vice Jaws

If a metal vice is used for woodwork the milled surface of the grips will damage the surface, particularly with soft woods. But soft jaws can be inserted quite quickly and are easily and quickly made. They may be of brass, copper, zinc or tin; their length is regulated by that of the vice, and each lap should be about 1in. to 1½in. wide. Cut them to the required size and bend in the vice as shown.

Improvised Locking Nut

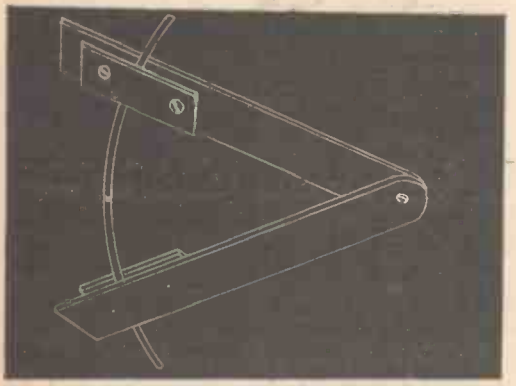
It frequently happens that there is insufficient room on the end of a spindle to thread on a second nut to act as a lock against vibration. A single full nut can, however, be made to act as a lock nut if a saw kerf is cut near the end and half way through. Thread the nut on the spindle, tighten up, and tap the top of the saw cut with a hammer or punch as shown. The metal will bend inwards and, carrying part of the thread with it, lock tightly on the thread of the spindle.



A method of fixing locking nut.

A Soldering Tip

When two ends of rather springy metal have to be soldered, it will help considerably if they can be held together by some method which will leave the hands free. The pseudo-compasses illustrated will serve many such purposes and are particularly useful in lamp shade work. The apparatus may be of mild steel or hardwood; if the latter, it is advisable to use a thumb nut as a swivel as this can be tightened to resist the outward pull of the work. Note that the clamping pieces are on opposite sides of the compass legs; this keeps the work being soldered in a true plane.



This gadget is used when soldering springy metal.

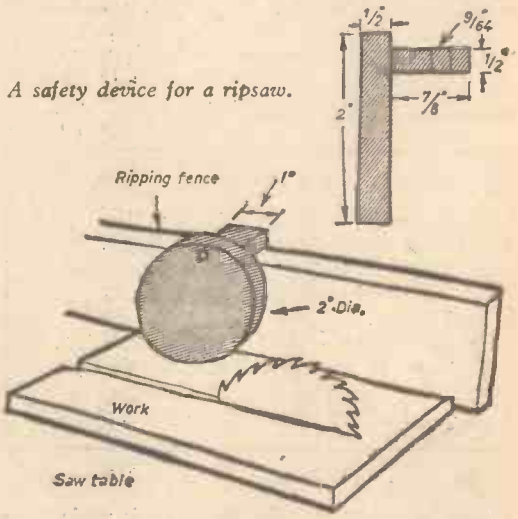
Ripsaw Hold-Down

When ripping a plank to a specified width, the work tends to ride up from the back of the saw and, in some bad cases, can be extremely dangerous. This little device shown can be quickly attached to the ripping fence and as quickly removed, and is adjustable to any thickness of wood. Its size will depend on the depth of the fence—in the author's case 2in.—and the ¼in. plywood wheel should be cut accordingly. This wheel has a hole drilled about ¼in. from the edge to accommodate a No. 6 wood round-head screw. The flat piece of wood to which it is attached measures 1in. x ⅞in. x ¼in. and has a 9/64in. hole through the centre to clear a No. 6 R/H screw for fastening it to the top of the fence. Fix it about 1in. behind the saw, and rotate the plywood wheel so that its under surface just clears the work being sawn. The work cannot possibly ride up and safety is assured.

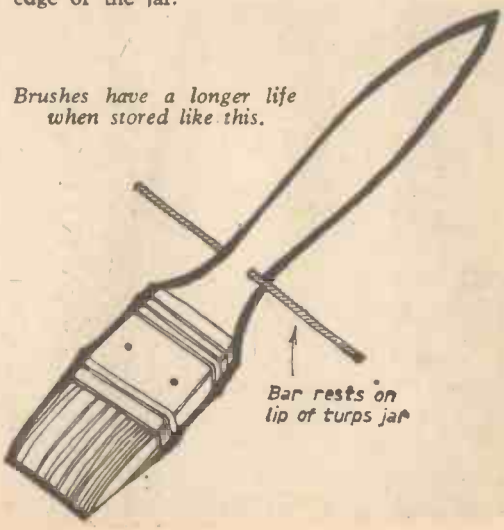
Paint Brush Holder

While paint brushes, when finished with, should be thoroughly cleaned before putting away, this is not necessarily practical if the brush is to be used again the next day. If just left in a tin in turps, resting on its bristles, these will bend with the weight of the brush and, in time, the hairs will assume an unwanted and annoying curve. The device shown supports the brush by the handle and no weight is imposed on the bristles. Any jar or metal container will do, and the hole for the piece of wire is bored at a convenient height in the handle to allow the brush to be suspended with the hairs clear of the bottom. Several brushes may be accommodated in the same container. If the brush handle is on the thin side and boring a hole in it would weaken it too much, bind some insulating tape around it and twist a piece of wire tightly over it allowing the ends to rest on the edge of the jar.

A safety device for a ripsaw.



Brushes have a longer life when stored like this.



MAKING A FLAT BED DUPLICATOR

BY A. L. MARSHALL.

THIS type of Duplicator is not only very cheap and simple to make, but easy to operate. Also it will give results equally as good as a rotary duplicator.

MATERIALS

Piece of ½in. plywood 12in. x 11in.
Piece of hardboard 10½in. x 11½in.
Piece of hardboard 12in. x 9in.
Piece of wood 1in. x ½in. x ¼in.
Pair 1in. hinges.
8in. rubber covered photographic roller.
Tube of duplicator ink.
Stencils (wax).
Piece of silk screen 12in. square.

The Method

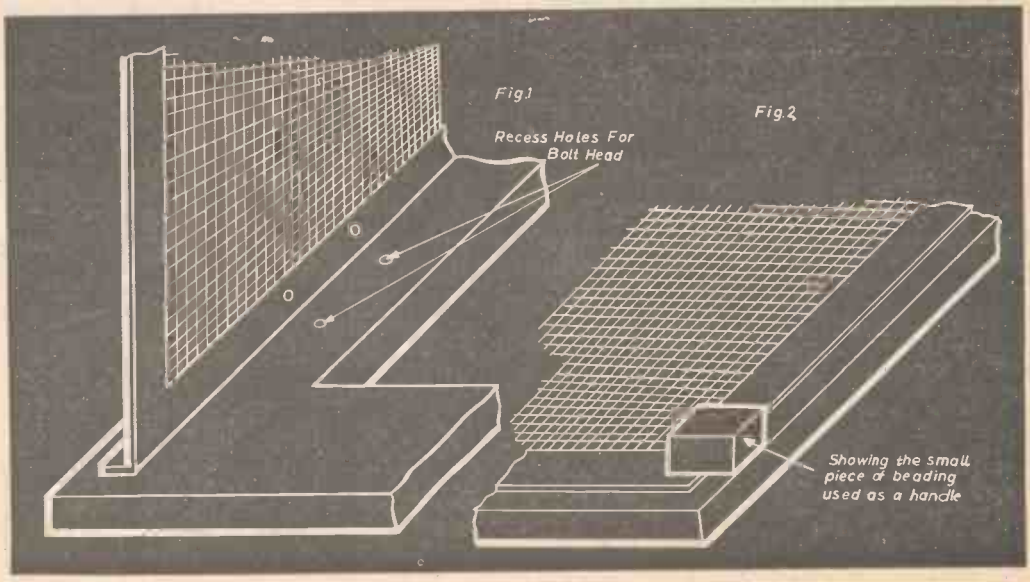
The bed or base of the duplicator is made from a piece of ½in. plywood, size 12in. x 11in.

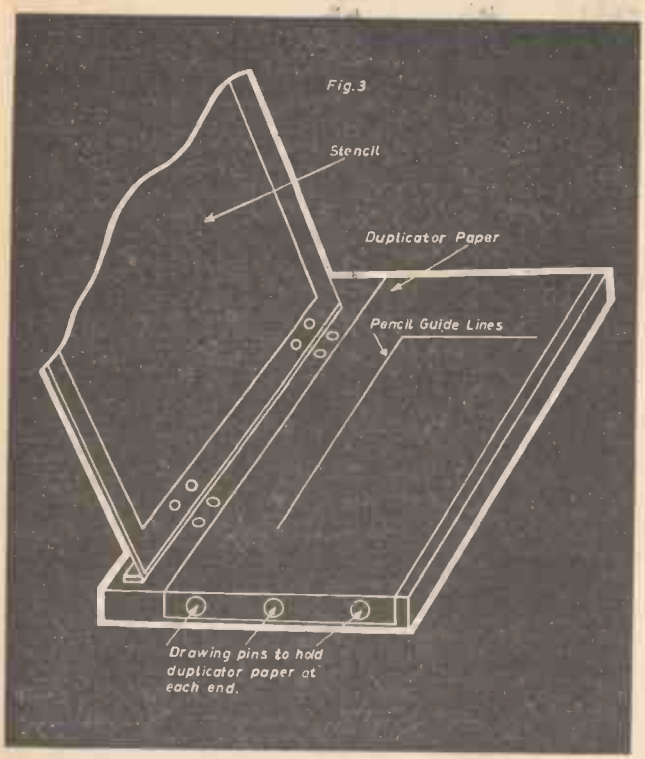
Take the piece of hardboard size 10½in. x 11½in., from this measure off a strip, 11in. x ¾in. and saw off. Attach this, with impact adhesive to the base board; ½in. in on the 12in. side. The piece of hardboard now measures 9½in. x 11½in., from the centre of this cut out a panel 10in. x 8in. This will leave a frame, each side being ¾in. wide. Using the 1in. hinges, place the frame against the ¾in. strip, and using wood screws fix the hinges to the strip, about 1in. from each end, then with 4 B.A. copper bolts fix the other half of the hingles to the frame. On the under side of the frame, holes will have to be drilled into base board, ¼in. deep and the width of the bolt heads (Fig. 1).

Fixing the Silk Screen

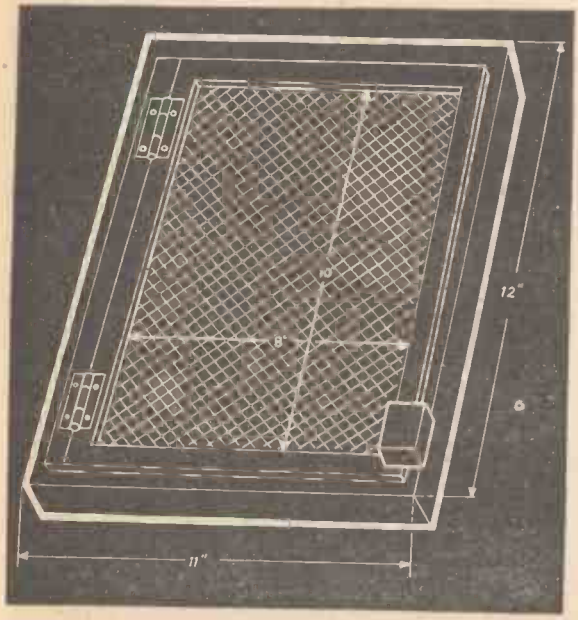
The frame will now fall flat on to the base board; taking a pencil, draw a line round the inside of the frame on to the base board. Place a piece of cartridge paper on the base board underneath the frame; but not to cover the bolt head recesses. On top of this and stretched with drawing pins at each end, place the silk screen material.

Using a good quality Seccotine, well glue the





Method of use showing how paper is placed.



Dimensional drawing of complete duplicator.

underside of the frame, close down on to the silk screen; the glue will seep through on to the cartridge paper, place under pressure and allow the glue to dry.

When this has been achieved, take a sharp knife and trim round the outside of the frame; cutting clear the silk screen and the cartridge paper, remove the drawing pins. Lift the frame and carefully tear away the cartridge paper, that has not stuck to the silk screen; leaving any that sticks to the under side of the frame.

On the front of the frame, at the R.H. bottom corner fix a small handle, with impact adhesive, using a piece of wood size 1in. x ½in. x ¼in. (Fig. 2).

Open the frame and ⅛in. inside the pencil line on the base, glue a piece of thin card. This is to pull the silk screen tight when the frame is lowered on to it.

Method of Use.

Place a piece of duplicator paper on the card and fix it at each end of the base with drawing pins; on top of this place the prepared Stencil, either hand written or typed. Close the silk screen on to the stencil, and roll out a portion of ink on the piece of hardboard, size 12in. x 9in.

When this is evenly displaced, transfer it to the silk screen with the roller, rolling until the stencil adheres to the silk. Whatever was written on the stencil will have been transferred to the sheet of duplicator paper, rule a top and side guide line in pencil (Fig. 3) then carry on duplicating as many prints as is required by placing the paper or card under the screen up to the guide lines, and running the roller once or twice over the screen.

Roulette for all

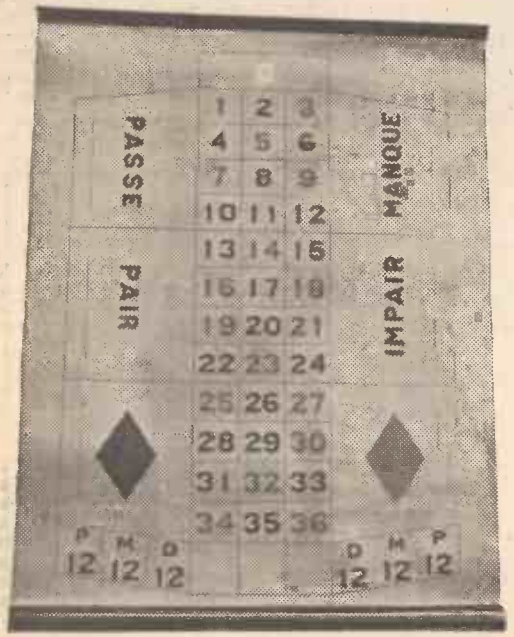
By Jameson Errol

Concluding details dealing with the table, the rake and method of play

The table (or cloth) can be of West of England cloth, green blind material, plastic, or thick cardboard. It is better, however, to make it of a pliable material since it can then be rolled. If plastic is used, it will be necessary to run over one surface with flour glasspaper to remove the shine as poster paint will not take readily on a glossy surface. Fig. 4 is from a photograph of the table and Fig. 6 a line drawing. Note, in the latter, to ignore the small letters at the moment; these refer to positions for stakes which will be referred to later but which do not actually appear on the cloth.

A convenient size is 24in × 18in., the design being 21½" × 15". When play is about to commence, the cloth lies flat and upon it the players

Fig. 4.—The green baize 'table'. There are two in professional games, the wheel being between them.



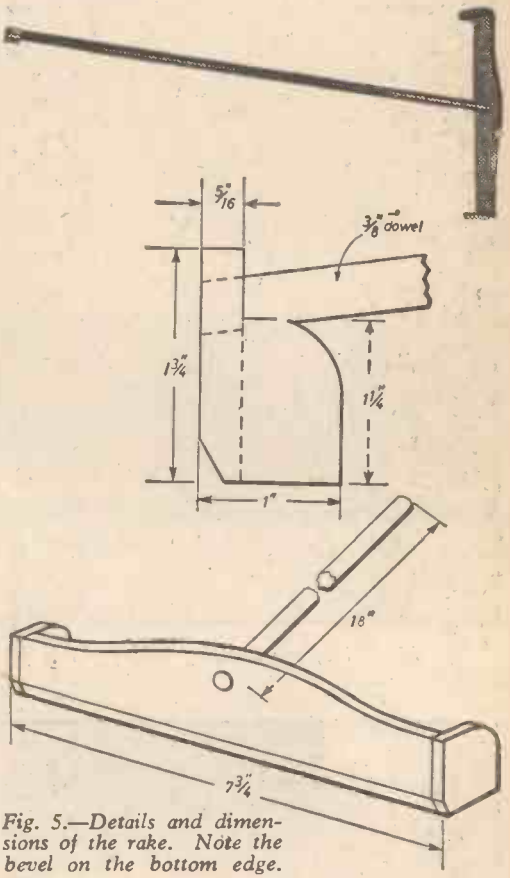


Fig. 5.—Details and dimensions of the rake. Note the bevel on the bottom edge.

place their counters according to the numbers, colours, and combinations they wish to back. The system will be explained later.

The cloth markings are first designed in pencil and then filled in in Indian ink, red waterproof ink, black and red poster paints, and process white. The whole of the top rectangular portion is reserved for Zero and is numbered 0 in process white. The remaining numbers, in numerical order in threes from left to right and down, are red or black as shown; they correspond in colour to those on the wheel, i.e. 1, 3, 5, 7, 9, 12, 14, 16, 18, 19, 21. 23, 25, 27, 30, 32, 34 and 36 are in red while 2, 4, 6, 8, 10, 11, 13, 15, 17, 20, 22, 24, 26, 28, 29, 31. 33 and 35 are black. Make the numbers as bold as possible, and the dividing lines quite thick. Note that the 12 P, M and D on the left become 12 D, M and P on the right.

When completed, mount each end of the cloth on small wooden rollers (½in. dowels) and apply a coat of thin clear varnish to preserve the lettering, etc. The cloth gets a lot of wear, and the varnish should be renewed from time to time.

THE RAKE

This is shown in Fig. 5 which also gives measurements. Its construction is simple but it is worth making in good quality wood, say, mahogany. Note the bevel along the bottom edge,

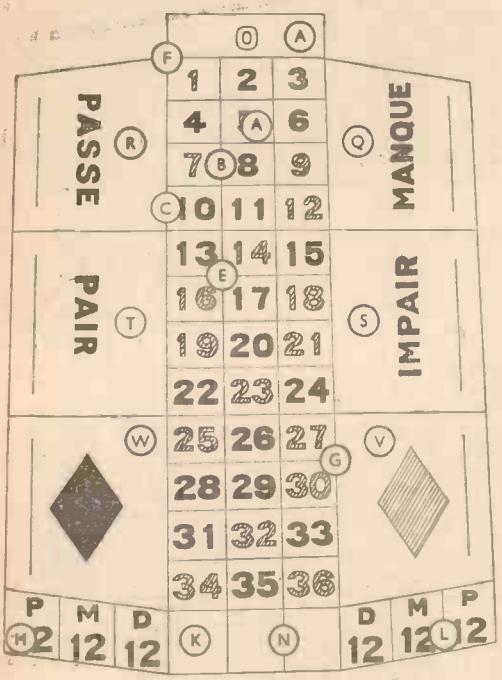


Fig. 6.—The letters shown here are the positions for stakes.

also that the handle is sloped upwards. Glue and pin with veneer pins, and stain and polish for a nice finish. The end of the handle may be tipped with a chrome ferrule which can be seen in Fig. 5.

METHOD OF PLAY

One person operates the wheel and acts as banker and invites the players to place their counters on the cloth as they fancy. He then spins the wheel and throws the ball on to it; the number of the cup in which the ball finally comes to rest determines the winnings and losses. The following table explains the varied ways in which stakes can be laid in professional games and the odds offered by the bank; the letters in the 'position for Stakes' column refer to those shown on the cloth in Fig. 6 and indicate where counters should be placed to convey the information desired, *e.g.* counters placed in position 'G' indicate that the player wishes to back the numbers 25 to 30 inclusive (odds 5 to 1), and counters in position 'T' would indicate that the player desires to back all even numbers (even odds).

Positions for Stakes at Roulette and Normal Odds paid by the Bank

Positions for stakes	French terms	English equivalents	Odds
A	En plein	Single number	35–1
B	A Cheval	Two numbers	17–1
C	En transversale pleine	Three numbers	11–1
E	En carré	Four numbers	8–1
F	Quatre premiere	Zero & 1, 2, 3	8–1
G	Transversale simple	Six numbers	5–1
H	Sur une douzaine	(First dozen (P12) / (Middle dozen M12) / (Last dozen (D12)	2–1
K	Sure une colonne (douze numeros)	The column	2–1
L	A cheval sur 2 douzaines—(vingt-quatre numeros)	Two dozens combined	1–2
N	A cheval sur 2 colonnes (vingt-quatre numeros)	Two columns adjoining	1–2
Q	Manque	First eighteen	1–1
R	Passe	Last eighteen	
S	Impair	Odd numbers	
T	Pair	Even numbers	
V	Rouge	Red numbers	
W	Noir	Black numbers	

All winning stakes are returnable.

When Zero ('0') wins, the stakes on other places are lost except when backed in a combination, or backed as a single number, and except the even chances (1-1). In professional play, these latter stakes are placed in 'prison' and returned if the next spin coincides with the original bet. If two Zeros appear consecutively, these stakes are now doubly in prison, and a double success is necessary for the stakes to be returned. In some Casinos, the system is to return half the stakes and so dispense with 'prison.' In family games, and by prior arrangement, there is no prison and the stakes are lost.

When declaring the spin, the Croupier would call, if No. 13 wins, "Thirteen, black, odd, first eighteen."

It would be too lengthy a process—and certainly outside the scope of this article—to enter into the Pros and Cons of chances and systems but, broadly speaking, the Bank may be said to have a percentage of roughly 1½ in its favour on sustained operation. Nevertheless, an examination of the table will show that the following are red numbers, viz: 1, 3, 5, 7, 9, 12, 14, 16, 18, 19, 21, 23, 25, 27, 30, 32, 34 and 36. The Impair contains ten red numbers and but eight black ones. The first column includes six, the second column four, and the third column eight red numbers. Thus a player staking on the Black and Impair has no less than twenty-eight numbers in his favour, on eight of which he wins both his stakes, and on twenty he neither wins nor loses. There are countless observations that can thus be made, but average players—and certainly the family participants—do not concern themselves too much about these chances and just back what he or she fancies.

SCIENCE NOTES

Nuclear Space Materials

EXPERIMENTS to find the right combination of materials to build nuclear-powered space vehicles are being constructed by Lockheed nuclear scientists under a contract from the National Aeronautics and Space Administration (NASA).

Scientists will attempt to find out what happens to various materials when they are assailed simultaneously by high energy nuclear radiation, and temperatures as low as 429°F below zero.

At such low temperatures. materials change their characteristics. The electrical resistance of many metals and alloys drop to zero, making them perfect conductors. The same metals also change their molecular characteristics, affecting their tension, compression, and shear qualities.

To conduct the irradiation of the experiments, NASA has built a 60 megawatt nuclear reactor, near Sandusky, Ohio.

Freezing temperatures for the project are achieved by means of a special refrigerator. The 1150 watt refrigeration system, operates with helium gas as the refrigerant to produce temperatures of 429°F below zero. The system allows specimen testing under the same conditions as those encountered in nuclear flight.

Specimens are selected from the families of aluminium, nickel, titanium and stainless steel alloys. Detailed pedigrees of the metals composition are required from the manufacturers. After acceptance, they are again subjected to industrial X-ray, dye penetrant tests, stress and tension studies and ultrasonic tests, before fabrication into test specimens.

Coal by Hosepipe

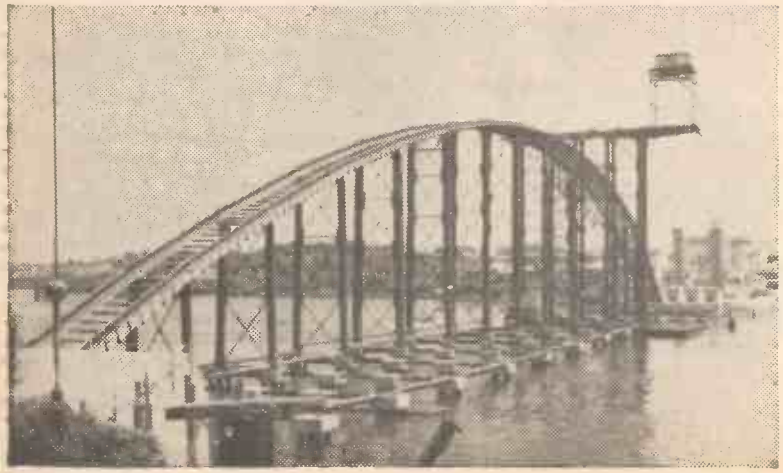
TRANSPORT of petroleum, milk, beer, acids and other liquids by road and rail tanker is commonplace.

Now the principle has been applied to delivery of small coal at the National Coal Board's Coal Research Establishment at Stoke Orchard, near Cheltenham. There has been developed a "coal tanker" which discharges coal into storage hoppers pneumatically with the same ease that, for years, grain has been discharged from ship's hold to dockside silo.

The Stoke Orchard tanker holds five tons, but its capacity could easily be doubled. A compressor on the tanker runs from the vehicle's engine through a separate gear box and shaft and the discharging operation can be carried out by the driver alone. He presses a separate accelerator to control the speed of discharge.

The coal is blown through a 5in. diameter flexible hose at the rate of a ton in three minutes. Dust is trapped in a bag filter.

Delivery by this method has proved fast, convenient and cheap, only 1cu ft of compressed air being needed for every 5lb of fuel transported. It will be particularly suited to delivering to boiler plants in large office blocks, hospitals and factories where coals of $\frac{1}{8}$in. or less are used.



Photograph shows:— Work in progress on the Gladesville bridge across the Parremetta River, Sydney, Australia. When completed this will be the largest pre-stressed concrete span in the world. The steel framework in this picture will support the concrete bridge which is being built at a height that will ensure the free passage of colliers proceeding to and from the Mortlake Gas Works.

Brighter than Light

BOTTLED sunlight? The expression has been used in describing cod liver oil, but, have you ever heard of reproduced sunlight? Well . . . it's here!

The electric light bulb, shown in the illustration, is not quite so innocent as it appears. Scientists, at both Westinghouse and General Electric, for many years have been endeavouring to produce a light equal to the sun's brilliance. Now, they have succeeded. This General Electric, 5,000-watt xenon arc lamp produces a light which is nearly three times as bright as the sun. Its light output totals 275,000 lumens, equal to the units of light emitted by 327 60-watt household light bulbs. Because of the brilliance of the arc, a welder's helmet must be worn through which to view its light source.

In the Westinghouse system, the simulated sunlight will be provided by approximately 150 high-pressure, mercury xenon lamps. The light from each lamp will be projected by a 16in. parabolic reflector. The intensity of this light can be varied from that which might be found while exploring Venus to that which would be encountered around Mars. In this short-arc lamp, the arc has been compressed down to a fraction of an inch. Because of this, the source becomes so brilliant and so compact, that it becomes a high intensity ball of light approaching the brightness of the sun itself.

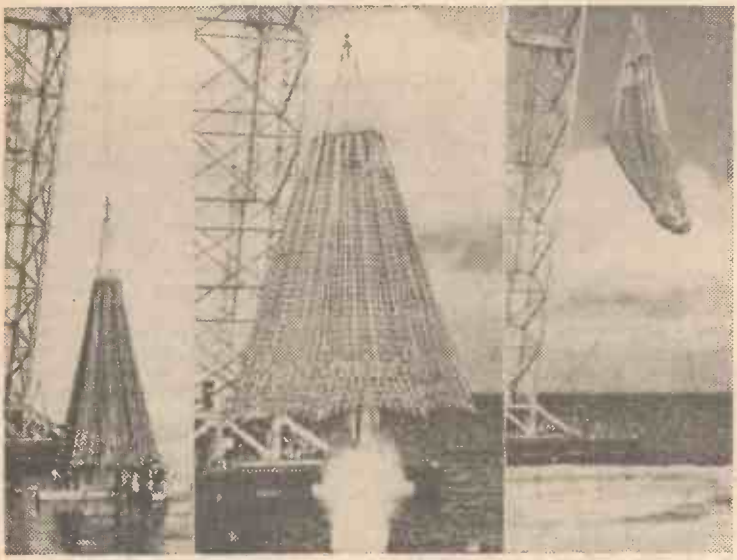
Both of these lamps will be used extensively in space research as solar simulators. In the visible spectrum, the lights closely resemble sunlight, and its total spectrum, including ultra-violet and infra red, approximating solar radiation.

Environmental space chambers, in which model spacecraft are tested, have walls that won't emit heat or reflect energy radiated by spacecraft under test, and an almost perfect vaccum exists. These chambers duplicate conditions which exist in outer space orbits. It is in these chambers that the two new light sources will be installed.

5000 Watt Xenon Arc Lamp.

RECOVERING TEST MISSILES

RECOVERING test missiles is not always easy or, "in the bag" as it were. A whole new bag of tricks is being used to test advanced versions of the U.S. Navy's submarine-launched Polaris missile. The illustrations show a huge "grab-bag" catching a 15-ton test vehicle as it breaks the surface after being launched from a tube on the ocean's floor. Huge draw-strings snap the bag shut as the Polaris enters. This enables engineers and technicians, from the Lockheed Missiles and Space Company, to study the highly instrumented missile's underwater performance, and prevents damage, permitting repeated use of the test vehicle. The first generation Polaris A-1 is now operational; the 1,500-mile A-2 is in production, and the A-3, 2,500-mile Polaris is well into the development stage. Test missiles are costly. No wonder that special floating docks, and equipment, are being used for their recovery.



Photograph shows the three stages of recovering a test missile, the bag suspended in readiness—the missile breaks the surface from the ocean floor—draw-strings enclosed the missile in the bag and it is hoisted aboard the recovery ship.

Project Mercury.

Comparison of manned spacecraft.

Project Gemini.

TWO-MAN

DEPENDING, of course, on a great number of variables, it is possible for the United States to have a two-man, rendezvous spacecraft in orbit within the next year or so.

This development—to be known as Project Gemini—is closely allied to Project Mercury. The two-man spacecraft, which will be the same shape as Mercury, will have 50 per cent greater volume, and weigh two to three times as much as the one-man, one-ton Mercury. Gemini, it has been announced, will be boosted into orbit by Titan 11, and will be ready to undergo flight tests in 1963-64.

Gimini is to be built by McDonnel Aircraft Corporation, prime contractor of the Mercury spacecraft, and will be used to develop space rendezvous techniques, and for extended earth orbit missions lasting a week or more. Gemini is named for the twin stars, Castor and Pollux.

Rendezvous in orbit is one way of carrying out the later Project Apollo manned lunar landing missions. Another possibility is the direct-flight approach using a multi-million pound thrust Nova booster. Both methods will be explored in order to meet a national goal of a manned lunar landing by 1970.

The National Aeronautics and Space Administrations have announced that the Gemini, which will be capable of docking with another vehicle in Earth orbit, will have as its rendezvous target vehicle an Agena stage, produced by Lockheed Aircraft Corporation, and similar to the vehicles used in Ranger and Discoverer projects. In carrying out rendezvous operations, the Agena stage will be launched into orbit by an Atlas booster. Ground tracking stations will determine the optimum launch time for the Titan-boosted spacecraft. Then, with both vehicles in orbit, propulsion in both the Agena and the two-man spacecraft can be used to perform rendezvous and docking manoeuvers.

Preliminary cost estimates for the programme —including about a dozen spacecraft, Atlas-Agena and Titan 11 vehicles—run to about 500 million dollars.

Two-man flights would begin in the 1963-4 period, starting with several unmanned ballistic flights from Cape Canaveral, Fla., to test overall booster-spacecraft compatibility and system

Artist's conception of the Project Gemini rendezvous in orbit.

RENDEZVOUS SPACECRAFT

engineering. Several manned orbital flights would follow. Rendezvous fly-bys and actual docking missions will be attempted in final flights.

The programme provides the earliest means of experimenting with manned rendezvous techniques. At the same time, the two-man craft will be capable of Earth orbital flights of a week or more, and thereby provide pilot training for future long-duration circumlunar and lunar landing flights. NASA's current seven astronauts will serve as pilots in this programme. Additional crew members may be phased in during the later stages of the flight programme.

Expanding the 74-inch base of the current Mercury capsule by about one foot and lengthening the capsule proportionately will provide 50 per cent more cabin space needed to carry out the new craft's missions. Use of many proven Mercury spacecraft systems will hasten development of the two-man vehicle.

It is, perhaps, worthwhile at this point, to describe the latest procedure consistent with launching the Mercury vehicles. While the mission profile for the Gemini will, undoubtedly, be more advanced, it should still be similar, in many respects.

POWERED FLIGHT. The manned Mercury spacecraft will be launched by an Atlas from Cape Canaveral following a two-day split countdown. Technical conditions or weather could, of course, delay the launch by minutes or days.

According to the flight plan, the spacecraft will be launched on a path along the Project Mercury World-wide Tracking Range on a launch heading of about 72 degrees—just north-east of Cape Canaveral.

An internal programmer in the Atlas will guide the vehicle from lift-off until staging occurs. All the Atlas liquid-propellant engines are ignited before lift-off.

At the staging, about two minutes after lift-off, the two booster engines will drop off and the sustainer and vernier engines will continue to accelerate the vehicle. Staging occurs at an altitude of about 40 miles and a range of about 45 miles from the launch pad.

During the first 2½ minutes of flight, an electronic brain, called the Abort Sensing and Implementation System (ASIS) is capable of sensing impending trouble in the rocket and triggering the escape rocket. The astronaut can also trigger the Mercury escape rocket to pull the spacecraft away from the Atlas.

About 20 seconds after staging, and assuming the flight is proceeding as planned, the 16-foot escape tower and rocket will be jettisoned. Landing systems will be armed. The Mercury-Atlas

vehicle will continue to accelerate toward the orbit insertion point guided by ground command guidance.

Until orbit insertion, the abort sensing system will continue to look for trouble. If significant deviation should occur, the system will actuate circuits to release the spacecraft-to-Atlas clamp ring and fire the posigrade rockets on the base of the spacecraft.

About five minutes after lift-off, guidance ground command will shut down the sustainer and vernier engines. As the engines shut down, the spacecraft-to-booster clamp ring is released automatically and posigrade rockets are fired to separate the craft from the Atlas.

ORBITAL INSERTION. After a few seconds of automatic damping—getting rid of any unusual motion—the spacecraft will swing 180 degrees so that the blunt face of the craft is turned forward and upward 34 degrees above the horizontal. From that point on, during orbital flight, the spacecraft can be controlled in proper attitude automatically or manually by the pilot.

If all goes well, the Mercury spacecraft will be put into orbit in the vicinity of Bermuda. By that time the vehicle will be at an altitude of approximately 100 miles and travelling at a speed of about 17,500 miles per hour. At engine cut-off, the craft will have been subjected to more than 7½ "G." Re-entry "G" will also reach 7½.

A three-orbit flight will last approximately 4¼ hours; a two-orbit flight, 3¼ hours; one orbit, 1¾ hours. The Mercury craft will reach a peak altitude (apogee) of about 150 statute miles off the West Coast of Australia, and a low point (perigee) of 100 miles, at the insertion point near Bermuda.

RE-ENTRY. After the desired number of orbits, as the space craft approaches the West Coast of North America, retro and braking rockets will be fired to initiate re-entry.

Shortly after the retrorockets are fixed, the exhausted rocket package will be jettisoned and the spacecraft automatically will assume re-entry attitude. The vehicle should begin to encounter the denser atmosphere of the earth approximately over the east coast at an altitude of about 55 miles. At this point, temperatures will start mounting on the spacecraft's ablation heat shield.

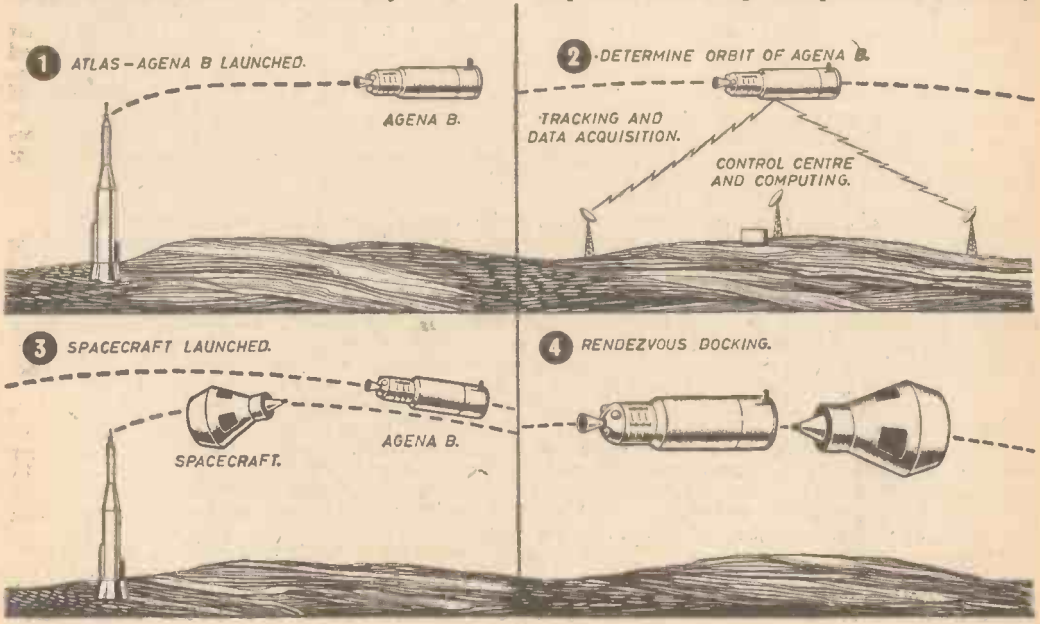
On a nominal mission, peak re-entry temperature of about 3,000 degrees F. will occur at 25 miles altitude while the spacecraft is moving at nearly 1,500 miles per hour. All told, the craft will sustain temperatures in this neighbourhood for about two minutes.

Almost coincident with the heat pulse is a dramatic reduction in capsule speed. Between 55 miles and 12 miles altitudes—covering a distance of 760 miles—spacecraft velocity should drop from 17,500 miles per hour down to 270 miles per hour in a little over five minutes.

At about 21,000 feet, a six-foot diameter drogue parachute will be opened to stabilise the craft. At about 10,000 feet, a 63-foot main landing parachute will unfurl from the neck of the craft. On touchdown, the main chute will be jettisoned. On-board electrical equipment will be shut-down, and location aides will be activated.

RECOVERY. Several new recovery techniques are at present being tried operationally. If all's well, the astronaut, on leaving the craft via the neck or the side hatch, should be greeted by two frogmen who, by that time, will have cinched a new flotation belt around the base of the craft, to add to the craft's seaworthiness.

Plans call for the frogmen to leap into the water with the quick-inflating belt from one of the recovery helicopters staged off aircraft carriers in the three principal recovery zones. As soon as they have secured the three-foot high belt, the astronaut will immerge, grab a "horse collar" loop from a hovering helicopter and be lifted up.



A TRANSISTORISED EXPOSURE TIMER

By D. Watkins

THE timer described in this article gives, in two ranges, a continuously variable range of enlarging exposure times from ¼ second to approximately 2½ minutes.

Circuit Description

The circuit comprises an emitter-follower buffer stage feeding a flip-flop circuit which switches a relay firmly on or off (see Fig. 1).

When the timer is switched on, i.e. switch S3 is closed, the base of V3 will be at −6V due to the potentiometer effect of R7 and R8 (i.e. both R7 and R8 are 10,000Ω in value, and the total voltage across them is −12V, therefore, the base of V3 will be at half of the total voltage). Similarly, the base of V1 will be at some voltage less (more positive) than −6V. This causes the emitter of V1 and the base and emitter of V2 to be at some voltage less than −6V. As the emitters of V2 and V3 are joined together, the emitter of V3 is also at this same voltage.

Now, if the emitter of a transistor is at a lower potential than its base, the transistor will conduct, therefore V3 will conduct and relay A will operate, and its contact, A1, will switch the enlarger lamp off.

If switch S1 is now set to position "reset", capacitor C1 or C2 charges up to −12V through resistor R1. Switch S1 is now set to position "start". The −12V to which the capacitor is charged is now applied to the base of V1. The emitter of V1 together with the base and emitter of V2 are thus taken up to −12V with the emitter of V3, while the base of V3 is held at a constant −6V by R7 and R8. When the emitter of a transistor is set at a higher potential than the base, the transistor is cut-off, and relay A releases. In releasing, relay A closes contact A1 and switches the enlarger lamp on.

The −12V to which the capacitor is charged, falls steadily at a rate determined by the value to which potentiometer R4 is set, until it reaches a point just below −6V. When it reaches this point, the state of the circuit is exactly the same as when the timer was initially switched on, therefore, V3 again conducts, re-operating relay A which switches the enlarger lamp off again.

As there is no warming up time for transistors, the timer is switched off for focusing, thus eliminating the need for a special focusing switch.

The emitter-follower stage, V1, is included to act as a buffer between the time-constant circuit formed by R3 and R4 in series and C1 or C2, and the flip-flop circuit. It is included to minimise the effect of the low input resistance of V2 on the time-constant circuit. The emitter-follower, having a comparatively high input resistance, does not shunt the time-constant circuit to such a great extent.

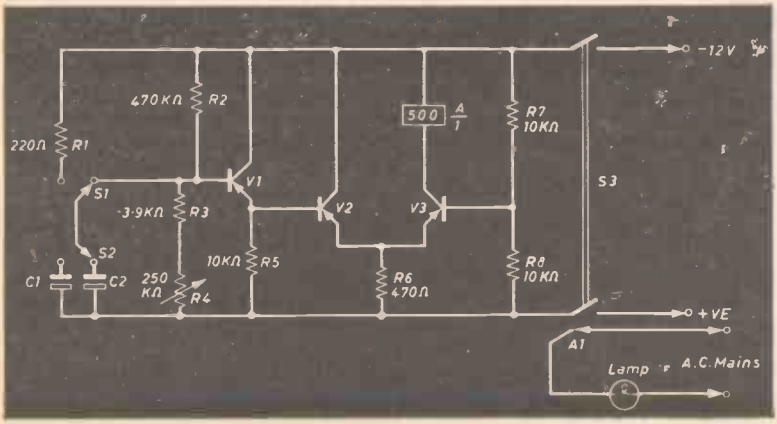


Fig. 1. — Circuit diagram of timer.

Construction

It is as well for those inexperienced in electronics to obtain all the parts required and to follow these step-by-step instructions in the order given.

The only tools required for the wiring are a soldering iron, preferably electric, a pair of wiring pliers, wire cutters, and solder.

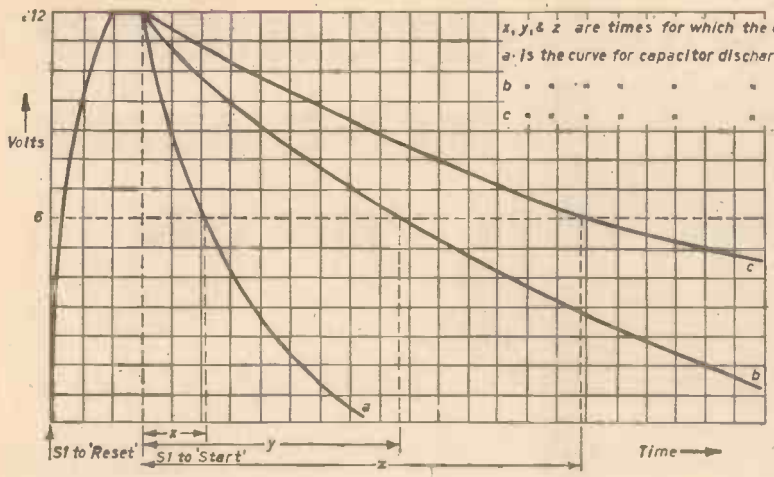


Fig. 2. — Explanatory diagram of timer operation.

The first step is to carry out all inter-connexions on the tag-board (Fig. 3). The tags have been numbered in all diagrams to simplify construction.

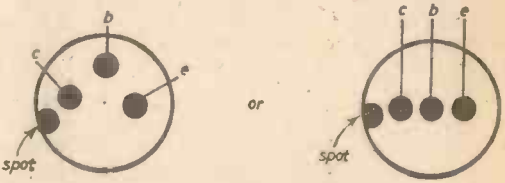
Using red wire, connect together tags 11, 15, 18 and 19. Using black wire, connect together tags 2, 3, 7 and 20. With blue wire, connect tags 6, 13 and 14.

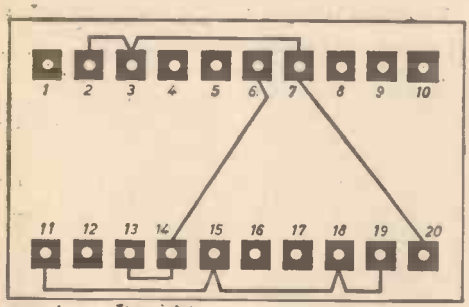
A few words on soldering will probably be found useful here. Always use resin-cored solder. A small carton containing ample solder for constructing the timer can be purchased at any hardware store for sixpence. If possible use an electric soldering iron with a small bit. Do not use too much solder for each joint, or there is a possibility that the solder may run down to the base of the tag which could cause a short-circuit between adjacent tags. On the other hand, if too little solder is used, a dry joint may result, i.e. the wire and the tag appear to be correctly soldered, but there is no metallic contact between them. This can be tested for by gently twisting the wire back and worth a few times. If a dry joint has occurred, the wire will come away from the tag.

The components must now be connected on to the tag-board together with wiring from the tag-board to components on the front panel (Fig. 4).

Connect capacitor C1 between tags 1 and 11 with the positive end (marked + or coloured red) on tag 11. Connect the following resistors as stated: R1 between tags 2 and 12. R2 between tags 3 and 13. R3 between tags 4 and 14. R5 between tags 5 and 15. R6 between tags 8 and 18. R7 between tags 9 and 19. R8 between tags 9 and 20. Cover the transistor leads with the following coloured sleeving: Collector White, Base Green, Emitter Red.

Some transistors are manufactured with short lengths of sleeving in these colours already on the leads, while others have the collector, base, and emitter arranged as follows:





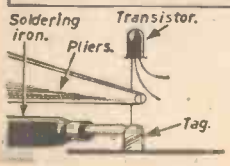
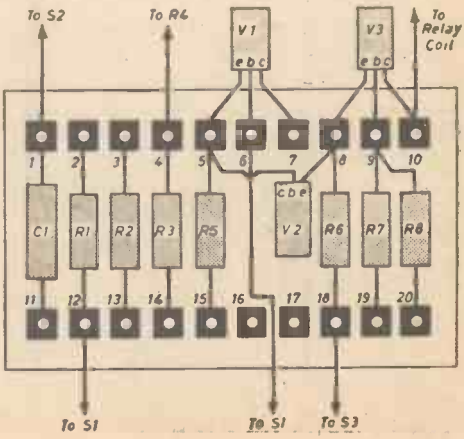


Fig. 3 (Above). — Tag-board inter-connections.
Fig. 4 (Right). — Components on tag-board.
Fig. 5 (Left). — Using pliers as a heat shunt.



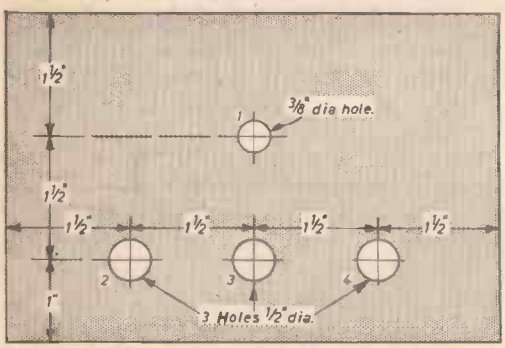


Fig. 6.—Front panel drilling.

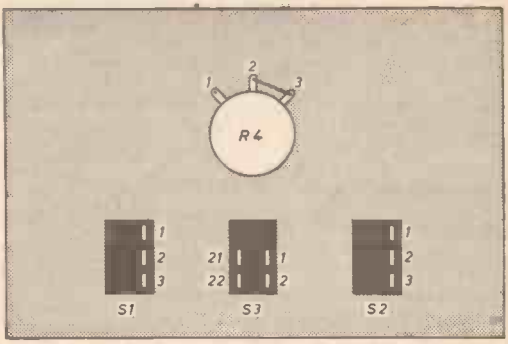


Fig. 7.—Components on front panel.

Connect transistor V1 as follows: Collector to tag 7, base to tag 6, emitter to tag 5. Connect transistor V2 as follows: Collector to tag 7, base to tag 5, and emitter to tag 8. Connect transistor V3 as follows: Collector to tag 10, base to tag 9, and emitter to tag. 8.

Next connect a length of red wire to tag 18, a length of black wire to tag 20, a length of brown wire to tag 12, orange wire to tag 1, grey wire to tag 4 and connect a length of yellow wire to tag 6. These wires should be left about 8in. long and should be coiled up for the time being.

When soldering transistors in circuit, it is essential to provide a heat shunt to dissipate the excess heat from the soldering iron. This can be done by gripping the transistor lead-outs in a pair of pliers as shown in Fig. 5.

Mounting Controls

The next step is to mount the controls on the front panel, which is made from a piece of aluminium size 6in. by 4in. drilled as shown in Fig. 6. Into hole 1 fit a 250kΩ potentiometer, R4; into holes 2 and 4 fit change-over toggle switches, and into hole 3 fit a single-throw, on/off toggle switch. The wiring to these components is now carried out by connecting tags 2 and 3 of the potentiometer together, and connecting tag 2 of the switch S2 to tag 2 of switch S3.

The case should now be made, as the tag-board, the relay, and capacitor C2 are mounted on this. The case is made from wood or aluminium and has outside dimensions of 6in. by 4in. by 4in. with the front open to receive the front panel. The 1,000mfd. capacitor, C2, is fitted into the rear left-hand corner by means of a Terry clip of appropriate size.

The wired tag board is fitted adjacent to the capacitor, and the relay is fixed 1in. in front of these two items, see Fig. 9. If the case is made from metal, the tag-board must be spaced away from the wall of the case by means of two nuts to prevent the tags from short-circuiting on to the case.

The remaining wiring can now be carried out. Connect the black wire on tag 20 of the tag-board to tag 21 of the switch S3; the red wire on tag 18 of the tag-board to tag 1 on switch S3; the brown wire on tag 12 of the tag-board to tag 1 of switch S1, the orange wire on tag 1 of the tag-board to tag 1 of switch S2; the grey wire on tag 4 of the tag-board to tag 1 of potentiometer R4. Next connect the yellow wire on tag 6 of the tag-board to tag 3 of switch S2, then connect a length of black wire from tag 10 on the tag-board to one of the relay coil tags. Black wire from tag 20 on the tag-board should be connected to the other relay coil tag and blue wire from tag 3 of the switch S2 to the negative (black) tag of capacitor C2. Connect a length of red wire from the positive (red) tag of capacitor C2 to tag 11 on the tag-board. Fit ¼in. rubber grommets into the two holes in the side of the case. Insert a length of 3-core rubber-covered cable about 2ft long through the rear hole and connect as follows: the green wire to tag 11 on the tag-board, the black wire to tag 17 on the tag-board, and the red wire to the lower of the two relay contacts.

Insert the cable from the enlarger lamp through the front hole and connect as follows: the green

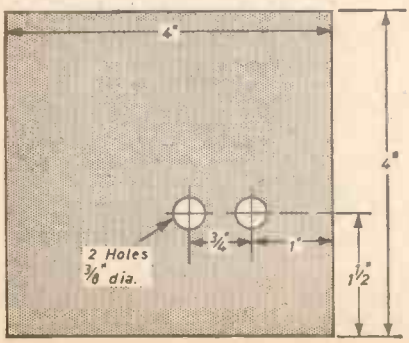
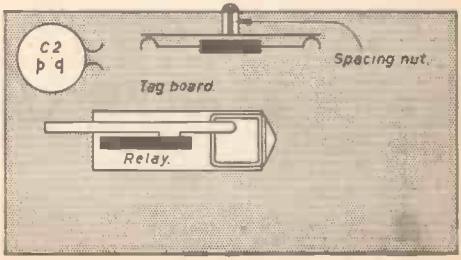


Fig. 8.—Side of case.

Fig. 9.—Layout of components in case.



wire (if there is one) to tag 11 on the tag board, the black wire to tag 17 on the tag-board, and connect the red wire to the upper of the two relay contacts.

All that now remains of the wiring is to connect the power supply to the timer. The circuit described in this article was designed for use with a 12V battery, but a simple mains operated power unit can be constructed if desired, but this supply must be reasonably stable.

Connect up the battery, the negative pole being connected to the black wire on switch S3, and the positive to the red wire on switch S3.

A 3-pin 5 amp plug is connected to the length of cable which emerges from the rear hole in the side of the case.

Calibration

A stop-watch will be required to calibrate the timer or, failing this, the sweep second hand on an ordinary watch may be used.

Check all wiring thoroughly and do not plug the timer into the mains until you are completely satisfied that the wiring is correct. When you plug the timer into the mains, the enlarger lamp should light.

Switch on the timer at S3 when the enlarger lamp should extinguish.

Set S1 (Range Switch) to Range 1 (Up). Set S2 (Control Switch) to Reset (Up) and set R4 fully anti-clockwise. Start the timer by setting S2 to Start (Down). The enlarger lamp will light, stay on for a length of time, and then extinguish. Check this length of time and mark it against the setting of R4.

Repeat this procedure at least ten times around the full travel of R4, and again with the Range Switch set to Range 2 (Down).

When this calibration is complete, the positions on the scale can be divided visually into smaller subdivisions and the appropriate times inserted.

With average use the batteries should last up to about six months without the need to be changed.

LIST OF COMPONENTS

Resistors

R1 220 ohms 5% ½ Watt
R2 470K ohms 5% ½ Watt
R3 3.9K ohms 5% ½ Watt
R4 250K ohms potentiometer (Linear)
R5 10K ohms 5% ½ Watt
R6 470 ohms 5% ½ Watt
R7 and R8 10K ohms 5% ½ Watt

Capacitors

C1 50μF 12 Volt electrolytic
C2 1,000 μF 12 Volt electrolytic

Switches

S1 and S2 Single throw change-over switches
S3 Single pole single throw

Relay

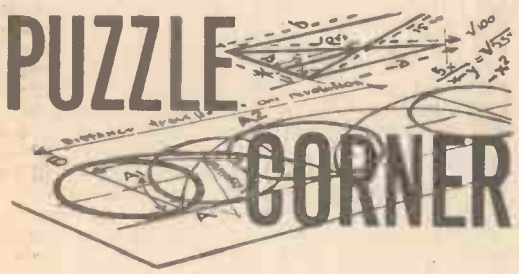
P.O. 3,000 type 500 ohm coil. Heavy duty break contact.

Transistors

Any general purpose transistors will do such as G.E.C. type GET 4, or Mullard type OC70

Sundries

10 way tag-board, wire, sleeving, metal for case (or wood), screws, nuts, etc.



1.—

THREE clocks register, respectively, 7.50, 7.53 and 8.06 o'clock. They are incorrect by 4, 7 and 9 minutes but not in that order. What is the correct time?

2.—

A MESSAGE which has to be taken across 180 miles of desert is entrusted to two men. Each can march 20 miles per day carrying 12 day's rations. On the outward journey they can bury food to eat on the return. Can the message be delivered and both men return to the starting point without missing a day's food?

3.—

IF a pint bottle had all its dimensions doubled, what would it then hold?

4.—

AT a church bazaar the public were invited to guess the number of ball bearings shown in a glass jam jar. The four nearest guesses were: A—467, B—478, C—484 and D—491. One of these numbers was 3 out, another 20 out, another 9 out, and another 4 out.

From this information you are asked to name the winner.

Answers

1.—The time is 3 minutes to 8 o'clock. If each in turn is taken to be 4 minutes out (either fast or slow) and again 7 minutes out and yet again 9 minutes out, it will be found that only one time is found in all three calculations, i.e. 7.37 o'clock.

2.—Yes. One man returns after 120 miles and buries 6 day's rations for the second man who delivers the message and picks up the food on his return.

3.—It would have its volume increased eight-fold (the cube of two) and would hold one gallon.

4.—The correct number of ball bearings was obviously 487 and Mr. C the winner.

L.B.S.C's 3½in. Gauge EVENING STAR

PART 15
EXHAUST DETAILS, VALVE SETTING, AND MECHANICAL LUBRICATOR

Exhaust Cross Pipe

The cross pipe, of the "breeches" pattern, is made up from two pieces of $\frac{5}{16}$in. x 20-gauge copper tube. Bending tip for beginners: to avoid kinking, never use pliers to hold pipes when bending them. My 3½in. gauge 4-6-2 has a similar cross pipe, and the way I made it was first, to soften the end of a length of tube by heating to red and plunging into clean cold water. A piece of lead wire was then pushed into the tube; a short length of hard tube $\frac{5}{16}$in. bore was put over the softened end, and by holding this in one hand, and the unsoftened end of the $\frac{5}{16}$in. tube in the other, a perfect bend was produced by hand pressure only, without the least sign of kinking. The lead wire was melted out, the bend cut off to the required length, the process repeated, and there were my bends—"poifect" as they say in Vitachapel.

I use lead wire to prevent the tube from kinking, as I have a small stock of various diameters purchased umpteen years ago, but it isn't essential. If one end of the tube is plugged, melted lead can be very carefully poured into it and allowed to cool to solidity before bending, or the tube may be filled with fine sand, and plugged at both ends. Beginners will be agreeably surprised to find how easily the tube can be bent, when it is first softened as mentioned above.

After cutting the bends to length, file away half the diameter of each short end, so that when the filed parts are put together, they look like Fig. 94. For the flanges, chuck a piece of $\frac{7}{16}$in. round brass rod, face, centre, and drill with letter N or $\frac{29}{64}$in. drill, to a depth of about $\frac{1}{8}$in. Part off a $\frac{1}{4}$in., slice, reface the end, and part off another slice. Ream the holes so that they fit tightly on the ends of the halves of the cross pipe, and squeeze them on with the faced sides outwards. Hold the halves together, and try the assembly in place between the frames, which the flanges should just touch. If O.K. put the assembly in the brazing pan—a bit of thin iron binding-wire will prevent the joint coming apart—and silversolder the joint and the two flanges at one heating. I decribed how to do small silversoldering jobs in the pump instalment last August. Pickle, wash off, and clean up, then screw the top of the joint $\frac{5}{16}$in. x 40 for $\frac{1}{4}$in. down, as shown in Fig. 94. The same cross pipe does for either a single or double blastpipe.

Put the assembly between the frames, and line up the flanges with the exhaust holes, keeping the screwed top of the pipe vertical. Put a small cramp over frame and flange at each side, to hold it in place; run a No. 41 drill through the three countersunk holes in the frame, making countersinks on the flanges. Follow through with No. 48 drill and tap $\frac{3}{32}$in. or 7B.A. As there is only exhaust pressure to withstand, jointing gaskets between frame and flange are not needed. Just remove the cross pipe, and scrape off any burring left by the drilling and tapping, so that both flanges and frames are quite

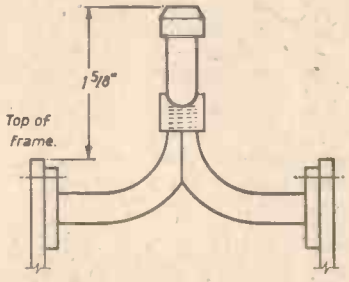


Fig. 94.—End view of Exhaust Pipe assembly.

smooth. Replace the pipe and fix it with countersunk screws through frame and flanges as shown in Fig. 96. As the pipe is soft, the screws will pull the flanges steamtight against the frames. I usually smear a little liquid jointing, as used in motorcar work, over the contact faces, as an extra precaution.

Double Blastpipe

On the full-size engine, the double blastpipe is a casting with separate nozzles bolted on, and these nozzles have a cored passage into which the blower jets are screwed. It would be very difficult to reproduce this in 3½in. gauge size, so I have devised a much simpler arrangement which is easily made. It is just a piece of tube bent into a U-shape, with turned brass nozzles silversoldered on, and a tapped boss at the bottom for screwing on to the cross pipe. With this arrangement, only a small hole is needed in the bottom of the smokebox, as the blastpipe can be screwed in place after the smokebox is erected. The whole arrangement is shown in Fig. 95. A separate ring blower will be fitted over each nozzle.

The blastpipe is made from a piece of $\frac{5}{16}$in. x 20-gauge copper tube, same as the cross pipe, and is bent to shape by the same method. The "horns" should be 1in. apart. To make the nozzles, chuck a piece of $\frac{7}{16}$in. round brass rod, face, centre, and drill to about $\frac{1}{4}$in. depth with No. 20 drill. Bevel off the end to $\frac{3}{8}$in. dia for $\frac{1}{8}$in. length, and part off at $\frac{5}{16}$in. from the end. Bevel and part off another similar bit, then chuck each with the larger end outward, and open up the holes with letter N or $\frac{5}{16}$in. drill for $\frac{1}{8}$in. depth. The nozzles should fit tightly on the horns of the blastpipe.

To make the boss, chuck the $\frac{7}{16}$in. rod again, face, centre, and drill to about $\frac{1}{4}$in. depth with $\frac{9}{32}$in. drill. Part off at $\frac{1}{8}$in. from the end, rechuck, and run a $\frac{5}{16}$in. x 40 tap through. File a half-round groove across one end of the boss, so that it fits closely to the bottom of the blastpipe. Put a bit of binding-wire around it and the blastpipe to keep it in place, then silversolder it and the nozzles at one heat. Pickle, wash off, and clean up, then run the

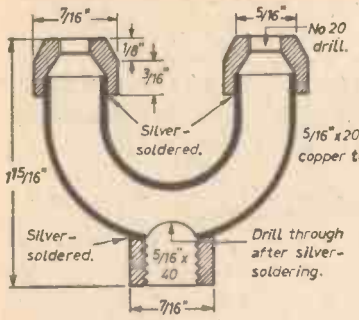


Fig. 95.— Section through Blastpipe.

$\frac{5}{32}$in. drill through the boss into the blastpipe. Don't leave any chips inside!

Single Blastpipe

Chuck a piece of ½in. hexagon brass rod with about 1½in. projecting from the chuck jaws. Face the end, centre, and drill to about 1½in. depth with No. 3 or $\frac{1}{32}$in. drill. Open out to a depth of 1¼in. with $\frac{5}{32}$in. drill, and tap $\frac{5}{16}$in. x 40 for ½in. depth. Turn $\frac{1}{16}$in. of the outside to $\frac{7}{16}$in. dia. and part off at 1$\frac{5}{16}$in. from the end. Reverse in chuck, gripping by the turned part, and bevel off the end of the hexagon to ½in. dia. and $\frac{5}{16}$in. depth. The ring blower will fit over this coned top, when the smoke-box is erected and the blastpipe permanently fitted.

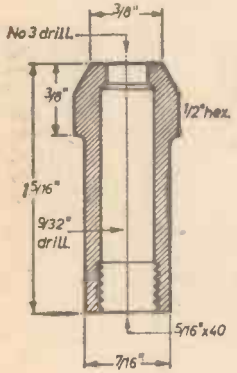


Fig. 97. — Alternative Blastpipe for single chimney.

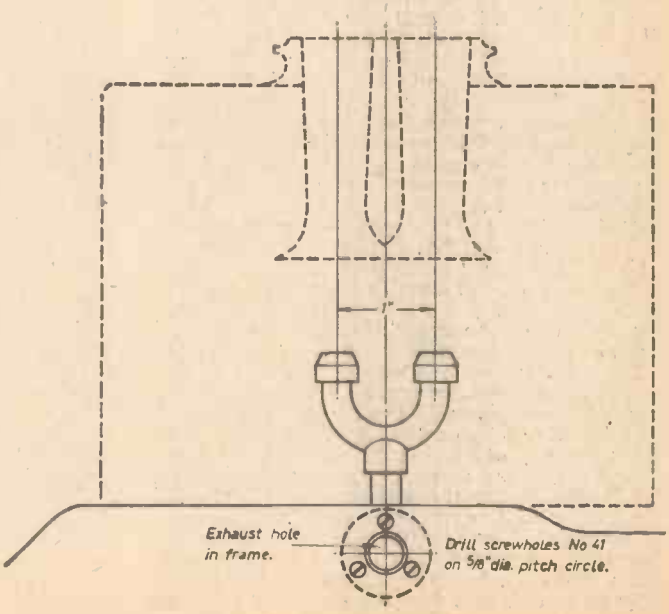
Fig. 96.—Arrangement of Blast-pipes for double chimney.

How to Set the Valves

After fitting the exhaust cross pipe, the cylinders can be erected "for keeps". See that the contact side of each cylinder is quite clean and smooth, also the frame plate to which it is attached. It is advisable to smear a thin coating of the liquid jointing previously mentioned, over both the contact faces, leaving it to become tacky before putting the cylinder in place. All the fixing bolts can then be put in and tightened up, the guide bars and brackets replaced, and the radius rods reconnected to the combination levers.

A lot of tommy-rot has been written and spoken about valve setting, but there is really nothing difficult about it. Anybody with average intelligence and patience can do the job as well as the college-trained individual with a string of letters after his name, so there is no fear of any reader of this journal running into trouble! I always set piston-valves by air pressure. In the top of the steam-chest there is a $\frac{1}{8}$in. hole for admission of steam. Put a ¼in. x 40 tap into it just far enough to cut about three threads. An inch of copper tube with one end screwed to match, is screwed into this, and connected by a rubber tube to a motor tyre pump. That is all the apparatus needed.

To be able to develop maximum power, there should be full steam pressure on the piston at the instant the crank passes dead centre; and as everything in this benighted world takes time, the valve must of necessity open the steam port a shade, admitting steam before the crank reaches dead centre. For beginners' information, the amount of opening is called "lead" With Walschaerts gear, the lead is constant; that is, the valve "cracks" the port, as the enginemen say, exactly the same amount at each end of the stroke whatever the position of the die-block in the expansion link, and it is the action of the combination lever which attends to that part of the business. Therefore, all



we have to do, is to set the die-blocks in the middle of the expansion links, so that the radius rods don't move when the wheels are turned by hand, and adjust the piston-valve on its spindle until it cracks the port an equal amount at each end of the stroke when the crank is on dead centre.

Turn the wheels slowly by hand in the forward direction. They should be raised clear of the bench by putting wood blocks, or anything else handy, under buffer and drag beams. As the crank approaches front dead centre, press on the pump handle, forcing a little air into the cylinder. If the valve is correctly adjusted, there will be a "siss" from the front drain-cock hole as the crank reaches dead centre. However, the chances are, that it will siss either before or after. If before, the port is opening too early, and the valve wants moving back a little on the spindle. If after, the valve is opening too late, the valve needs moving forward. Adjustment is easily made by taking out the pins at the top of the combination lever and pushing the rods clear, removing the back steam-chest cover, and pulling out the valve and spindle. Slack off the locknuts, make the adjustment, then be very careful to tighten the locknuts so that the valve cannot move endwise, but can be twisted easily on the spindle between finger and thumb.

When the front end is O.K. turn the wheels until the crank reaches back dead centre. If the valve is correct to length, the siss will be heard as the centre is reached, and the job is done. All that remains is to give the other cylinder a dose of the same medicine.

Setting Slide-valves

The slide-valves can be set by the same process, the only difference being, that as steam is admitted at the outer edges of the valve, it will require moving forward if the port opens too early, and back if the opening is late. Adjustment is made by screwing the valve-spindle in or out of the boss of the valve crosshead. The valves can also be set by sight, in which case the steam-chest covers must be removed. With the die-blocks in the middle of the links as before, turn the wheels slowly by hand, and watch the edge of the valve closely. When the crank reaches dead centre, the port should just appear as a thin black line at the edge of the valve. If it appears before or after dead centre, adjust by screwing the spindle into or out of the crosshead as before mentioned. Check back dead centre likewise, and when each port cracks on the dead centre, the setting is O.K. Drill a No. 52 hole through crosshead boss and spindle, and squeeze in a bit of $\frac{1}{16}$in. silver-steel, which will prevent the adjustment being upset.

Tips on Valve Adjustment

None of us being perfect, it sometimes happens that slight error is made in the dimensions of a valve, or the size of a port, which passes unnoticed. When an attempt is made to set the valves, they just *won't* come right. Maybe one port cracks on dead centre, but the other doesn't, and no amount of adjustment will make both ends behave themselves. However they can soon be taught good manners. Suppose with a piston-valve, you get the siss from the drain-cock hole on front D.C. but no amount of adjustment will produce a siss from the back hole until the crank has passed back D.C. Well, the trouble is that the distance between the valve bobbins is less than it should be. The remedy is, to take out the valve, and turn a tiny shade off the inner edge of *both* bobbins. It is useless to reduce one only, as both bobbins must be exactly the same length, if the valve vents are to be correct. After reducing, reset the valve on the spindle and try again.

It is a rather more serious matter if the siss is heard correctly on front D.C. and then *before* the crank reaches back D.C. This indicates that either the inner edges of the steam ports are too close together, or the valve bobbins are a wee bit too far apart. Obviously nothing can be done about the ports, and as the bobbins are solid with the middle part of the valve, they can't be closed in. The quickest way out of the trouble is to make a fresh valve with the bobbins a little closer together, say a full $\frac{1}{8}$in. between, and make a fresh start with the setting. A bit can always be taken off, in places where it can't be put on.

With slide-valves, the opposite obtains. If the front port cracks on D.C. and the back one doesn't crack until the crank has passed D.C. then the valve is too long, and a shade should be filed off *both* ends, so that the cavity is kept exactly in the middle. If the back port cracks before D.C. then the valve is too short, but unless you happen to be a close relation of Inspector Meticulous, there is no need to make a new valve. Just silversolder a strip of brass $\frac{3}{16}$in. wide and about $\frac{1}{32}$in. thick, to each end of the valve, letting it project just below the valve face. Trim the ends, and reface the valve. It will then probably be a little too long, but is very easily reduced to correct length by treating as mentioned above.

Finally, never lose any sleep about any variation in the *amount* of port opening. The only valve gear in the wide world which gives equal port openings at both ends of the cylinder in both directions, is the simple loose eccentric. All full-size engines vary in the port openings, some to a considerable extent, especially in back gear. The vital factor is that each port shall crack on dead centre in either direction of motion; and if they do that, then the engine will do the job in the approved fashion.

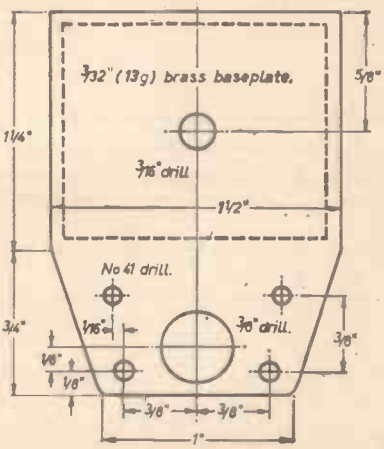


Fig. 99.—Baseplate.

Cylinder Lubricator

It is essential that any locomotive using superheated steam in bronze or gunmetal cylinders, must have an adequate and continuous supply of oil, the viscosity of which must enable it to stand the heat without excessive thinning or vaporising. This is provided by a mechanical lubricator, consisting of a tiny pump working inside the oil tank, and driven by a ratchet gear. Many years ago, I carried out a long series of experiments with small mechanical lubricators, and found that the type to be described here, proved to be the best of the whole bunch. It is amusing to note that one pattern I tried, and discarded because any steam leaking past the check valve could blow straight into the tank, condense, and "throw all the oil overboard", was recently resurrected by another designer as something new! If the lubricator shown in the drawings is properly made, it is impossible for this to happen, as the movement of the pump cylinder positively closes the inlet port when the pump barrel is full of oil; in fact, the pump will function quite well without any check valve at all, provided that the port in the cylinder doesn't bridge those in the stand.

The oil tank is made with an extended baseplate which is bolted to the top of the pony bolster, in a position accessible for easy filling. The drive to the ratchet lever is taken direct from an eccentric on the first coupled axle (described in May 1961 issue) shown in the plan and elevation of the lubricator erected (Fig. 98). Oil is delivered via a check valve with two outlets, which will be connected to the steam pipes leading to the cylinders. The rush of steam picks up the oil and carries it in a fine spray to the valves and pistons, giving perfect lubrication.

Oil Tank

Cut a piece of 18-gauge sheet brass a full 5¼in. long and 1¼in. wide, and bend it into a rectangle measuring 1½in. x 1¼in. with the joint at one corner. Cut out the baseplate from 13-gauge ($\frac{3}{32}$in.) brass to the shape and size shown, but leave the part which forms the tank bottom, a little wider, which makes the silversoldering job easier. Put the base in the brazing pan and stand the tank body on it, smear some wet flux all around the bottom and in the corner joint, heat the lot to medium red, and apply a strip of best-grade silversolder, or Easyflo wire, to the joints. This will run like water if the heat is right, leaving a neat fillet. Pickle, wash, and clean up.

Tips for beginners: bend up the tank over a jig block in the bench vice, as shown in July 1961 instalment. The simple gas blowpipe which I described in the August instalment, is just the gadget for the silversoldering, as it gives the required heat without risk of melting the thin brass sheet. I use a 2lb jam jar as pickle bath for these small jobs, and it stands on a shelf at the back of my brazing forge, nice and handy. Keep it about half full, and when not in use, keep a lid on the jar to prevent evaporation.

After cleaning up, file the sides and back of the baseplate flush with the tank, then drill all the holes. The $\frac{3}{16}$in. hole should be right in the middle of the tank bottom, as it locates the pump stand.

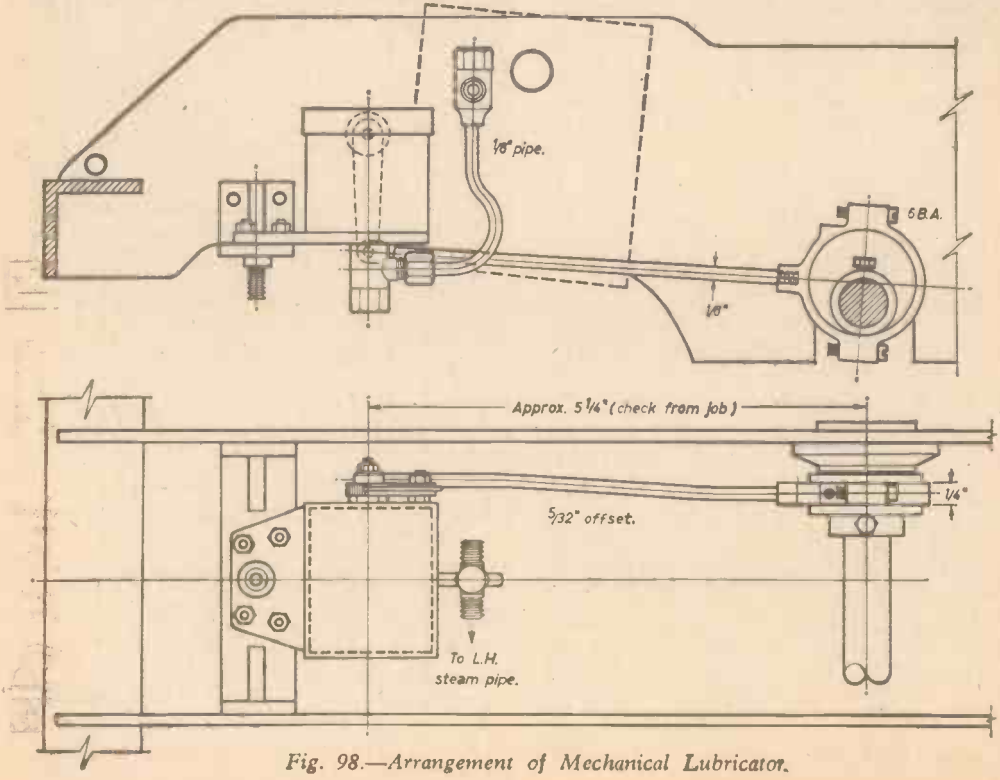


Fig. 98.—Arrangement of Mechanical Lubricator.

Shock proof!

ELECTRICAL SAFETY IN THE AMATEUR WORKSHOP

By G. W. McDONALD

BROWSING around in various amateur workshops has led the writer to conclude that all is not as it should be as far as the safety from electric shock is concerned. Electricity is taken very much for granted, but it should always be remembered that it can turn on you savagely if mis-handled, and can when conditions are suitable cause a fatal shock. The number of people who receive fatal shocks are relatively few, but the fact remains that electricity is a potential danger to life. Any electric shock, however mild, should be taken seriously and some effort made to find the reason for it. This article is an attempt to show how electricity can be safely used, also to give some practical hints to readers who are not too familiar with electrical circuits. Always switch off before handling apparatus is a wise precaution.

The distribution of electricity in the house is by a two-wire or three-wire system. The Supply Authority mains come into the house on two wires, these are named the live and the neutral. After passing through the Supply Authority's fuse and meter the current passes to the house distribution circuits. The Supply Authority's fuse is sealed, and should it blow, can only be replaced by calling on the services of the Authority's service department.

The household distribution unit, known as the consumers unit takes care of the distribution within the house to the various appliances, cooker, lights, and heating. The distribution unit contains the various circuit fuses, these fuses are in the live wire only; it is not permitted to have fuses in the neutral.

Current for the lighting circuits is carried by two wires, one live and one neutral. The live wire is usually fused at the distribution unit, the fuse being rated at five amps.

The power distribution is by a three-wire system, designated live, neutral and earth. All outlets are terminated in a three pin socket. Fuses are situated as for the lighting circuits but the rating may be as high as 30 amps. This additional wire, the earth wire, is connected to a good earth such as the main water pipe, never the gas pipe. This wire, if properly connected to an appliance serves to provide a safety device should the appliance develop an insulation fault between the live wire and the metal frame of the appliance. Such a fault will cause the fuse to blow, thereby cutting off the supply and protecting the person who may be handling the particular piece of equipment from receiving an electric shock.

FIG.1

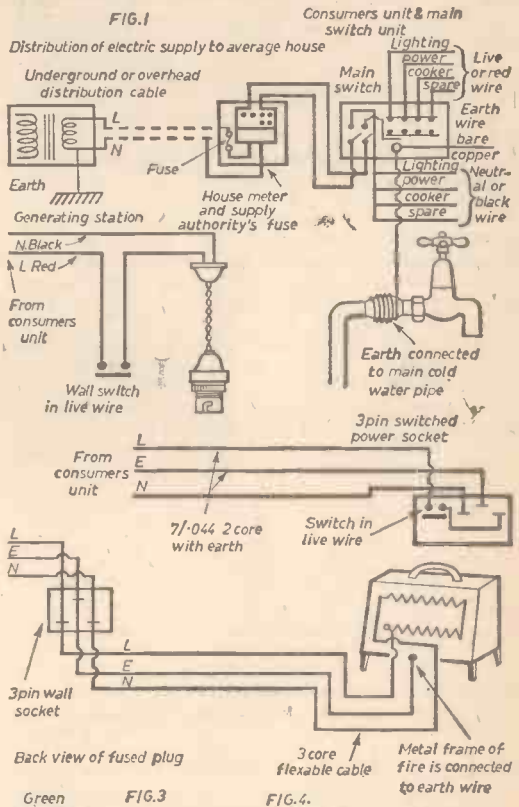


FIG.3

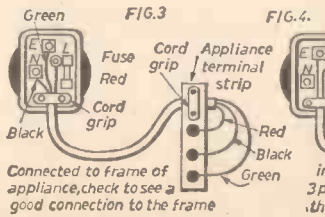
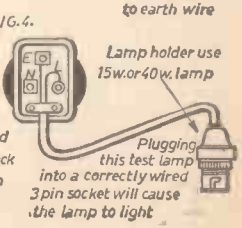
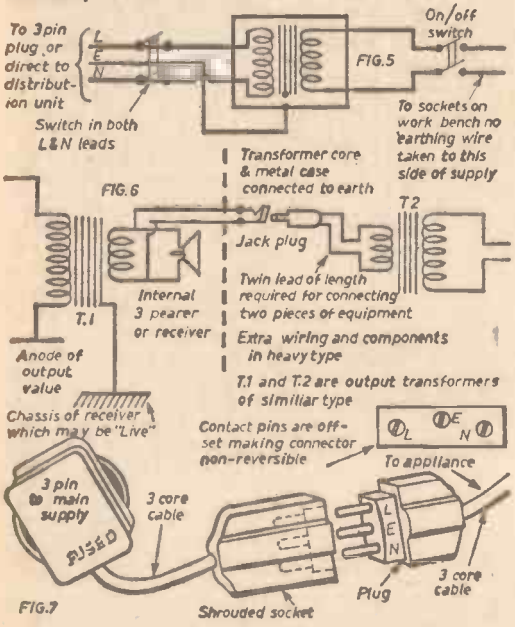


FIG.4.



How the supply mains can be isolated from earth in order to work with safety on "Live chassis" radio sets.



From this it can be seen that all electrical equipment capable of being handled should be connected to the mains by a three-wire system properly wired to a three-pin plug. This system protects the user at the expense of a blown fuse from what could be a fatal accident. It cannot be too strongly emphasised that operating portable appliances from a light socket is definitely dangerous. It should, however, be mentioned that in recent years some manufacturers have gone to some trouble to make portable tools with certain safety measures incorporated so that they can be safely operated from a two-wire supply.

Plugs and Sockets

Certain domestic apparatus, notably vacuum cleaners, radio and television sets are connected to the mains by two-wire flexible leads. Using such equipment from a lighting socket is normal practice and is not dangerous so long as the radio equipment is in its insulated wood or plastic cabinet. The vacuum cleaner has its motor insulated from the outer case and is therefore safe to handle. It is important to note that any appliance fitted with a three-wire lead be connected to a three-pin plug. The three-pin plug has its terminals marked live, neutral, and earth, the letter L.N.E. are more usual. Fig. 3 shows the correct method of wiring such a plug and if the safety facility of the earth wire is to be achieved a socket to which the plug is to be fitted must also be wired correctly. The standard British colour code for three-core flexible cable is as follows: Red indicates the live wire, black the neutral, and green the earth. The colour coding on certain foreign makes of appliance differs from this and should the three-core flex have different colours to those mentioned, do not connect it to a plug until expert advice has been obtained on the connections within the appliance. In a case such as this the local electrician is the person to connect the plug.

In order that the properly wired plug be considered safe, it must be connected to a properly wired wall socket. The house wiring to a socket can easily be tested by making up the lamp circuit shown in Fig. 4. To test the sockets for correct earthing, fit a small 240 Volt lamp to the socket and plug the test unit into each three-pin socket in turn. If the wiring is correct the lamp will light. No light will indicate that the earthing circuit is faulty, or the live and the neutral lead have been reversed. A dim light indicates a poor earth. All these situations are likely to lead to dangerous conditions arising when appliances are connected. Should any of the above faults be discovered during the tests have them attended to by a person skilled in the art of house wiring.

Portable Tools and Extension Leads

It is in this field that most fatal electrical accidents occur. The conditions under which electrical tools have to be used are the cause of this. They are nearly always held in the hand and the operator is invariably standing on a damp floor or within touching distance of well earthed objects such as water pipes, metal sinks etc. Such conditions make it essential that the earthing of the frame of the apparatus in use is most important to the safety of the operator. Three-pin connectors are an essential factor in the safety for the operator using portable tools. A properly connected plug and socket will ensure safety.

Extension leads are always necessary in the home workshop. These should be of a permanent make-up, not a temporary lash-up using twisted leads and insulating tape. The job must be done properly using non-reversible plugs and sockets for any joins. Fig. 7 shows how this can be done.

All modern plugs are fitted with a cord grip, which should be used to prevent the cord pulling out of the plug. Should the lead pull out, the earth may become disconnected thereby making the earthing of the tool ineffective. Under worst conditions the live lead may touch the earth wire thus making the metal frame of the tool live, the operator will then receive a severe shock, the severity depending on the ground on which he is standing.

Radio and the Mains Supply

This heading will interest many readers who like to do odd jobs on the domestic radio and television receivers, which involves working on them out of the cabinet.

It is safe to say that almost all radio and television sets use the "live Chassis" method of connection to the mains supply. This means that the metal chassis is connected to one side of the supply mains. Whether the chassis is live or not depends upon which way round the mains plug is connected. It is essential to prove that the chassis is connected to the neutral lead before work on it starts. The best way to check this is to use one of the many screwdrivers with a neon lamp in the handle which are sold for this purpose. If such a screwdriver, held by the insulated handle, is touched to a radio chassis it will show a light if the chassis is connected to the live side

(Continued on page 377)

ALLOY BRACKETS

S. U. Belsey suggests a method of making robust shelving brackets by utilising odd lengths of alloy angle.

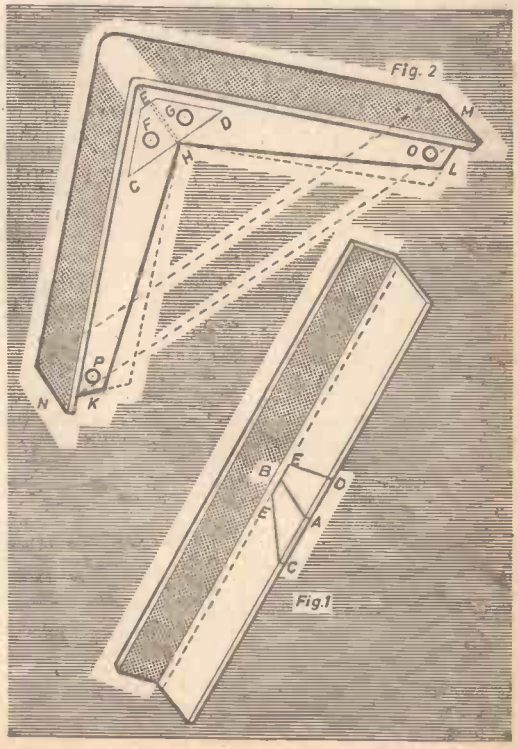
THE usual amateur engineer's workshop comprises a machine shop, drawing-office, erecting shop stores, not to mention a retreat for a contemplative cup of tea, all in one room. To keep sufficient floor space for all these activities, the store department is normally a set of shelves and this is where the device about to be described can help.

Shelves require supporting brackets, which are always expensive and normally pieces of mangled sheet-iron. The alloy brackets I have made are simple, cheap and of good appearance. The basic requirement for each bracket is a length of 1¼in. x 1¼in. x ⅛in., alloy angle 13in. long. A line is scribed across both outside faces of the piece of angle 6in. from one end, A.B. Fig. 1. Two lines are also scribed from the point where this line meets the apex of the angle at 45° to it making an included of 90°, BD and BC.

Sawcuts are made along BD and BC, without breaking into the other web of the alloy angle, allowing the triangular piece DE and EC to be broken away. This piece will be needed later. The short gap EE helps in the next operation, which is to bend the bracket to its conventional L-shape with a smooth curve along EE instead of a sharp bend.

Now the small piece of metal DE EC comes into use. It is clamped into position on the inside of the angle as shown in (Fig. 2), with the two sides enclosing the right-angle parallel to the limbs of the bracket. Holes F and G are drilled $\frac{7}{64}$in. right through and opened out to ⅛in. The holes are countersunk from the outside and the bracing piece is riveted in place with ⅛in. countersunk rivets.

To make the job look elegant, surplus metal is sawn away along HL and HK leaving about ½in. at LM and KN. For greater load-carrying capacity a strip of ½in. x ⅛in. alloy can be riveted between O and P and for those who wish to store anvils and model steam-rollers two opposite-handed brackets can be bolted back to back; hence the specified countersunk rivets.



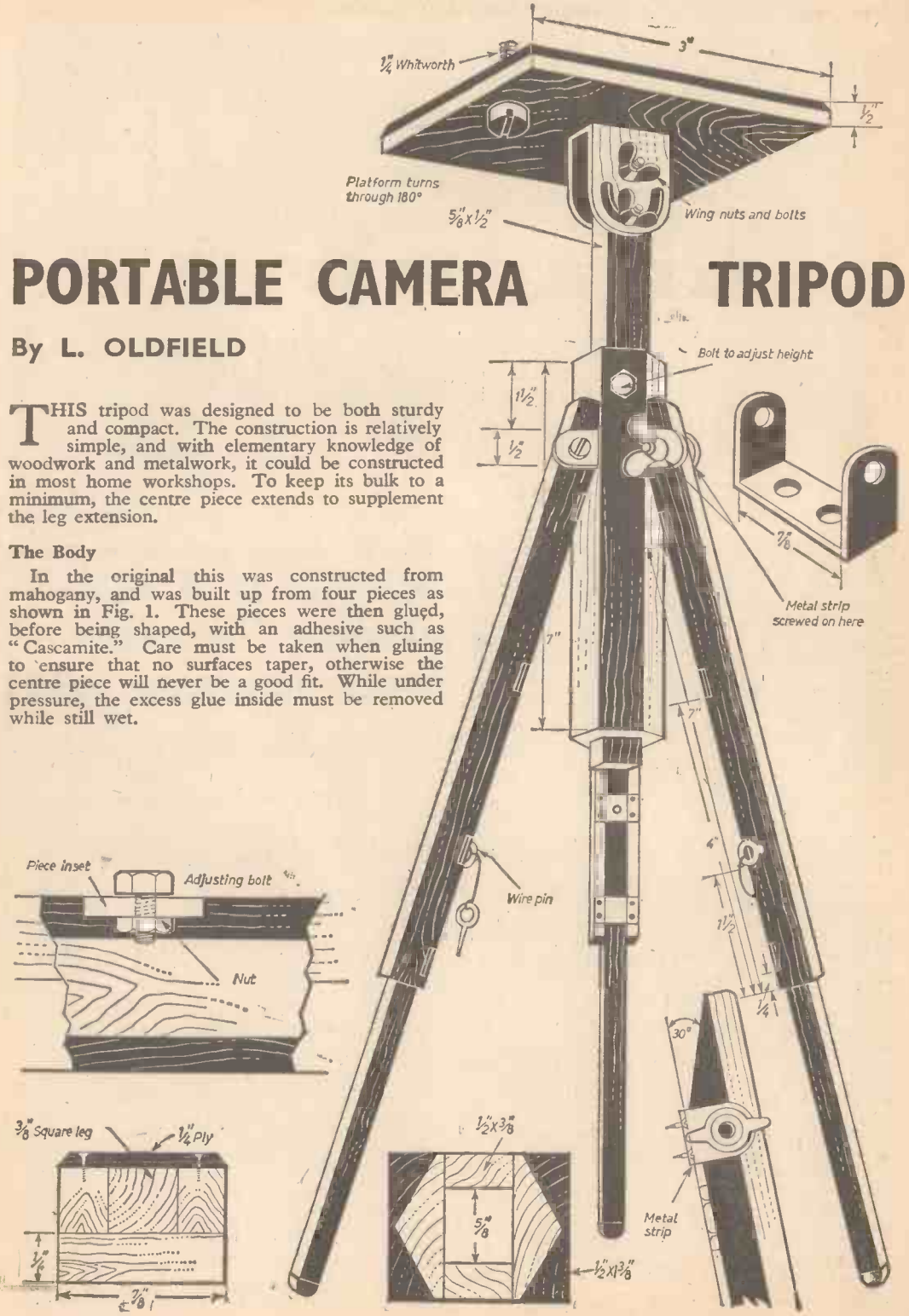
PORTABLE CAMERA TRIPOD

By L. OLDFIELD

THIS tripod was designed to be both sturdy and compact. The construction is relatively simple, and with elementary knowledge of woodwork and metalwork, it could be constructed in most home workshops. To keep its bulk to a minimum, the centre piece extends to supplement the leg extension.

The Body

In the original this was constructed from mahogany, and was built up from four pieces as shown in Fig. 1. These pieces were then glued, before being shaped, with an adhesive such as "Cascamite." Care must be taken when gluing to ensure that no surfaces taper, otherwise the centre piece will never be a good fit. While under pressure, the excess glue inside must be removed while still wet.



When dry, the ends are squared off and two paper templates cut to the shape shown in Fig. 1. These are lightly adhered to the ends, and the assembly planed to hexagonal cross-section with the templates as a guide. To enhance the appearance the ends are lightly chamfered.

In order to accommodate the adjusting screw, a hole ($\frac{3}{16}$in. dia.) must be drilled in the front (Fig. 2) and a groove cut to about half the thickness. (Fig. 3). A nut is then sunk flush with the bottom of the groove and a piece inset to fill up. The inset piece, which is suitably drilled before fixing, should be a tight fit and well glued. Excess glue should be removed from the hole, and the insertion trimmed when dry. The bolt should then pass through the hole to bear on a metal strip fixed along the length of the centre piece.

Platform

This is prepared according to the type of camera to be used (3in. x 5in. in the original). A hole is drilled in the appropriate position to accommodate a $\frac{1}{4}$in. Whitworth bolt to hold the camera in position. The platform is fixed to the centre piece by means of metal plates and wing nuts and bolts as shown in Fig. 2. Alternatively a ball and socket head can be purchased, but this offers no real advantage over the platform.

Legs

These are made in two parts so as to obtain maximum extension. The centre pieces, which can be of any desired length, are cut from $\frac{1}{4}$in. square ramin. Pieces of rubber appropriately shaped are fixed to the ends to act as feet.

The main parts of the legs, in which the centre pieces slide, are built up from $\frac{1}{4}$in. ramin. The back is prepared first, and the sides glued to it, using the centre piece as a guide to ensure that they are at the correct distance apart. One end is closed with a $\frac{1}{4}$in. cube, so as to ensure that the sides are at right-angles to the back, and to make it strong enough to withstand the pressure of the bolt at the top (Fig. 4).

When the glue is dry, the structures are planed smooth and small pieces of $\frac{1}{16}$in. plywood attached across with $\frac{1}{4}$in. nails or screws. (Figs. 4 and 5). One of these pieces has a hole in the centre. This is matched up with the holes in the centre pieces by means of wire pins bent as shown in Fig. 5, so that any leg extension can be obtained.

Fitting the Legs to the Body

Three pieces of metal are bent to the shape shown in Fig. 6 ("Meccano" was used on the original). These fit in small recesses cut in the body. Fig. 2. They are screwed in position, ensuring that the screws do not foul the centre piece of the body.

The legs are shaped at the top, and placed flat against the body as they will be when the tripod is folded (Fig. 4). The holes in the legs can then be marked, so that they will be drilled in the correct places. Bolts and wing nuts with washers can then hold the legs firmly in place at the required angle.

The whole assembly can then be polished with white polish, and a piece of felt adhered to the platform to help keep the camera located in the required position.

The Completed Tripod made by the Author.

TRADE NOTES

A REVIEW OF NEW TOOLS, EQUIPMENT, ETC.

For the Scooter Enthusiast

NEW BRITISH AUTOMATIC SCOOTER —AT LESS THAN £100

THE world's first fully automatic scooter to sell at less than £100 is announced by Triumph Engineering of Coventry.

Known as the Tina—"the scooter that thinks for itself"—it will sell in the U.K. at £93 9s., of which £17 5s. 8d. is purchase tax.

This lightweight scooter has several important safety features, not least of which is the completely automatic transmission. This enables the rider to concentrate entirely on traffic conditions without the distraction of clutch and gear operations.

Controls have been reduced to just throttle and brakes. The Tinamatic transmission gives "infinitely variable" ratios from 5:1 to 15:1.

Riding the Tina is absolute simplicity. After starting the 100cc two-stroke engine the scooter moves off as soon as the throttle is opened. As the engine revs rise the drive takes up and the machine smoothly gathers speed. The transmission unit then automatically adjusts itself to all road conditions.

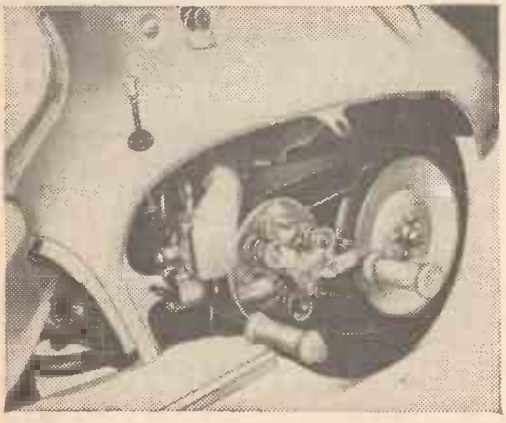
Carrying two adults the Tina will reach a maximum speed of over 40 mph and it will start on a 1 in 4 hill without difficulty. Fuel consumption of the petrol mixture is about 100 mpg under normal conditions.

Completely British in design and manufacture, the Tina is being produced in a specially built extension to the Triumph factory.

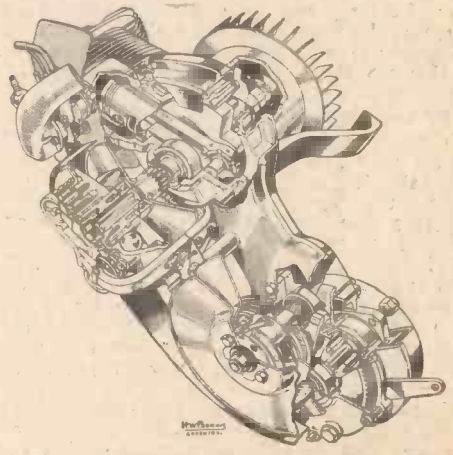
"Tina" with all accessories.

Details of the Automatic Transmission

The automatic transmission unit of the new Triumph lightweight scooter is simple, robust, and ingenious.



Access to the engine and transmission is gained by removing a panel on the left side.



Cut-away view of engine and transmission unit.

The drive from the engine is completely disengaged at tickover speeds. When engine revolutions rise, centrifugal force thrusts three steel balls contained in a cylindrical casting outwards in their conical channels. This movement engages the drive.

Primary drive is by endless V-belt of special design which runs on two pulleys. The effective diameter of these is varied automatically according to engine load and road speed. There is a final reduction by helical gears in the rear hub.

An electrical cut-out prevents the drive being engaged accidentally while starting.

The new Avon cling tyre as fitted to the Triumph "Tina."

AVON CLING TYRES

TYRES made of new high hysteresis cling rubber are fitted as original equipment to the Triumph "Tina" Scooter. Made by Avon these tyres give an exceptional improvement in wet road adhesion and breaking. The tyres combine the cling rubber with a new multi-studded pattern which with its many edges is designed to give greater grip on extra-slippery surfaces. The pattern is extended well down the sidewalls to give continued stability when cornering.

High hysteresis rubber is lazy rubber. When it is deformed by an irregularity in the road, much of the work done is dissipated as heat. The rubber remains longer in contact with the deforming irregularity and thus there is much improved "cling" to the irregularity and the road, particularly in wet conditions.

ACCESSORIES

A FULL range of accessories for this new all-British automatic scooter is already available. They are made by Motoplas Co. Limited—a member of the BSA Group, of which Triumph is also a part.

The accessories can be bought separately but a special "all-in" pack containing the whole set is available for £10 10s., plus 16s. 4d. purchase tax.

The accessories in this kit include a fairing, mirror, licence holder, legshield bag, and pannier bags.

All of these can be fitted by the average handyman, but in case of difficulty Triumph dealers can undertake the work.

Sold separately the items are priced as follows:—

fairing	£4	4s.	0d.
mirror		11s.	6d.
legshield bag	£2	9s.	0d. (inc. purchase tax)
pannier bags (pair)	£3	4s.	10d. (inc. purchase tax)
pannier carrier		9s.	3d.
inflator		5s	3d.
licence holder		2s.	6d.

Shock Proof!

ELECTRICAL SAFETY IN THE HOME WORKSHOP

(concluded from page 372)

of the mains. Should this be the case it will be necessary to reverse the connections to the mains plug.

For those readers who make a hobby of repairing radio receivers the writer recommends that the receiver be fed with power through an isolating transformer. Fig 5 shows the wiring of such a transformer.

The live chassis technique can lead to many complications when it is found necessary to interconnect two pieces of radio equipment, such as connecting the radio set to a tape recorder. It would appear that the manufacturers consider a tape recorder to be a portable apparatus. They are nearly always wired to a three-pin plug with the chassis earthed. It will be seen therefore that if it is connected to a "live chassis" radio set where the chassis is actually connected to the live lead and not the neutral, the live side of the mains will be earthed. This will cause a blown fuse at least. This could cause a severe shock to the operator if he has the earthed side of the interconnecting lead in one hand and comes into contact with the "live" receiver chassis with the other. This takes rather a lot of words to describe but the shock will come quickly and will hurt. A safe way of inter-connecting radio equipment, a tape recorder to a radio set, is shown in Fig. 6. This sort of work requires great care and knowledge of the circuits and should not be attempted by readers unfamiliar with the electrical circuits.

In conclusion, the writer passes on a tip given many years ago by an electrician. "If you think it may be live, don't grab it in both hands." Flick one hand gently across it and if it is live you will feel a mild kick on your arm. That is good advice, because once you have got a good hold of a live piece of equipment it will hold you there until someone switches off the power, and by that time it may be too late.

A RECORDING METER FOR A TAPE DECK

By J. H. B. Gould

IN the tape deck, the construction of which was described in the September 1961 issue of PRACTICAL MECHANICS, no mention was made of a recording level indicator. While not indispensable, some form of recording indicator is a very useful accessory and greatly reduces the chances of making a faulty recording.

The circuit described here is not the simplest that can be devised, but it has the advantage of giving a very wide latitude in the components of of which it is constructed. The use of a meter, rather than an indicator, makes the device very accurate and convenient to use.

The Circuit

This comprises a voltage-amplifier stage (the triode), rectifier stage (the double diode) and a network with a very large time-constant; the function of this latter is to "smooth" the peaks and troughs of the input signal to a certain extent, so preventing the meter needle from swinging about violently.

Fig. 2 illustrates the response curve of the circuit. The point of interest here is that the meter scale is expanded over the range which is of greatest importance: the region about full recording level. The frequency characteristic is something of a compromise, but the absence of a perfectly "flat response" will not be noticed in practice.

The bias-erase oscillator gives rise to strong high-frequency fields and the record-level circuit should be mounted as far from the oscillator as practicable in order to avoid interference which would swamp the readings. Unfortunately, the small difference between the highest recording frequencies and the erase frequency makes it difficult to filter out this interference by electrical means, so that it is better that it should not be allowed to arise. The input to the circuit is obtained from the "R" socket (or the upper pin of the "R" socket in Fig 7c September 1961 issue), and this lead should run screened over the shortest path. Some interference will, in fact, result, but provided it is small this is no disadvantage. It may even be useful, as an indication of the bias level.

The transformer and choke are not critical and odd components can be used. "Tr" could be an intervalve transformer, which "Ch" could be a small 10 henry choke or the high-resistance winding of any small transformer which happens to be available. In the same way, although valves 6J5 (6C5, L63) and 6H6 (D63) are specified, any small triode or diode could be tried in their respective roles, remembering that the pin connections may not then be as given in Fig. 1.

A number of 1½ or 2in. scale, 5mA moving coil meters are available, notably as ex-service stock, which are eminently suitable for this circuit. The long time-constant of the meter network opens up another possibility to those with a certain manual dexterity. In many areas, small radio-frequency meters with scale readings of 0·5-5A are available very cheaply. These are thermo-couple instruments usually based on a 5mA *moving-coil movement.* If the meter is opened, the thermo-couple heater can be removed from between the terminals, the leads from the movement cut away from the thermo-couple and then soldered to the terminals. It will immediately be obvious that the movement is undamped, but the "damping network" of Fig. 1 makes this immaterial.

The circuit can be calibrated by means of variable resistor "VR" which should be of the preset (screwdriver-slotted) type, mounted conveniently within the recorder.

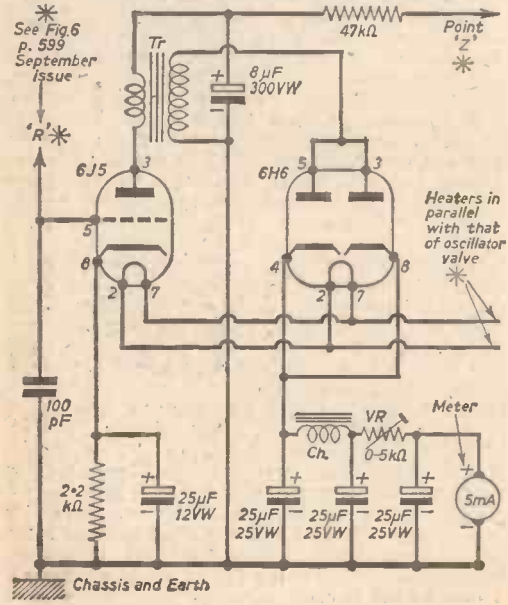


Fig. 1.—Schematic diagram.

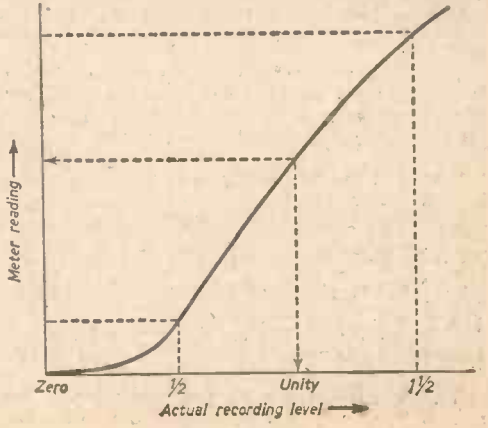


Fig. 2 (Below).—Response of the recording-level meter to a recording voltage of fixed frequency.

YOUR *Queries* ANSWERED

RULES

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

A stamped addressed envelope, a sixpenny crossed postal order, and the query coupon from the current issue which appears at the foot of page 381, 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.

Staining Wooden Floors

I AM living in a new bungalow with soft wood flooring and we wish to stain the floors with a wood dye, can you advise as to the preparation of the floors.—R. Stanley (Essex).

WASH the floor well with clean water and scrape off any plaster or other stains left by the builder. Allow to dry, then sand along the length of the boards to cut down the raised grain of the timber. Stain with a wood dye such as "Colron." When applying the dye deal with only one board at a time and keep the edge of the stain "alive" by working quickly. This will ensure an even texture.

Making a Step

I WISH to build a step outside my front door by using concrete first and facing this with 6in. red quarry tiles. The size will be approximately 48in. x 18in. x 6in. Would it be in order to use Marley Concrete Mix?—D. Yew (Yorks.).

TO form a step covered in 6in. x 6in. x ¼in. quarry tiles to the specified size, the mould or shuttering must be made smaller to allow for the thickness of the tile and mortar bed. The internal size of the mould must therefore be 3ft 10in. x 17in. x 5in. Marley Mix concrete would be quite suitable and should be given about 24 hours to initially harden before the quarry tiles are bedded. We would suggest that you use a one part cement, four parts mortar for bedding the tiles, which should be well soaked for at least four hours and drained for about 15 minutes before placing. The side and front tiles must be cut to 5in., but the should be in ½in. of mortar, set the sides then top tiles need not be cut. Bedding of the tiles front and top in that order. A ½in. bed plus a ½in. tile will then give the step the required size.

New-type Boat

HAVE you any information on a boat which is driven by a large aeroplane-shaped propeller which is mounted behind the seat of the operator, consequently it can be propelled in very shallow water.—A. T. Jay (Salop).

THERE is a motor available developed by C. W. F. Hamilton and Co. Ltd., of Christchurch, New Zealand, known as the Hamilton Marine Jet. This motor needs only 3in. to 4in. of water in which to operate. A car engine is used to drive the jet unit which is fixed to the transom. The unit sucks in water through a flush grille in the bottom of the boat and thrust is obtained when the pump expels the water behind the boat. Steering is effected by deflecting the jet to one side or the other.

Patent Query

WHILST working on the railways in Canada I came across a gadget used on the locomotives which as far as I know is not in use in this country. Assuming the gadget has a Canadian patent is it possible for me to take out a patent to use in this country?—J. Pettit (Dorset).

YES it is possible to take out a patent for a device already in use and even patented in another country, for a patent is given in respect of "a manufacturer new within the realm"; the first introducer becomes the patentee. It is most likely however, that the gadget you refer to has been patented in Canada where it is used and in other countries where it is not in use. Before you spend money upon the quest for a patent, therefore, you should make further enquiries about it.

Removing Stains from Prints

CAN you please tell me how to remove large brown damp stains from old black and white prints?—L. Taylor (Devon).

PLACE the print in a large shallow tray filled with water and stir in about three or four dessertspoonfuls of chloride of lime. Allow the print to soak for half an hour in this solution. Next, pour off the solution and, without rinsing the print, pour on to it a solution consisting of 12 parts water and 2 parts acetic acid. Soak for 5 minutes, then pour off the solution. Finally, allow fresh tap water to flow through the tray containing the print for two or three hours in order to wash away every possible trace of the solutions used. This final washing is absolutely essential. After this bleaching treatment the print will need re-sizing. This is done by soaking it in a hot 3 per cent. solution of gelatine for five or ten minutes, passing it through a roller-machine to squeeze out all superfluous gelatine and then by allowing it to dry slowly. Finally the print can be ironed on the wrong side.

Dealing With a Steamy Bathroom

I should be grateful to know the best paint to use in a very steamy bathroom. At the moment the emulsion paint is unsatisfactory, also the walls and ceiling have become covered with a brown fungus which is difficult to wash off in spite of using strong disinfectant.—J. Allan (Walthamstow).

A MOULD growth will develop quite readily in a damp or humid atmosphere and can exist beneath the paint film. We recommend that you clean the walls down removing the existing emulsion paint, then sterilize the surface using Santobrite or Shirlan N.A. The base plaster should be allowed to dry then given a coat of plaster primer. As a finishing we suggest that an air finish such as Siscomatt could be used since it is specially formulated for steamy conditions.

Cleaning Un-polished Oak

COULD you advise me of the best method of cleaning a bedroom suite. It is of light un-polished oak and rather badly discoloured in places. After staining would you recommend varnishing?—A Stephens (Dorset).

WE would suggest that you use a cleaning agent which you can make up by mixing equal parts of linseed oil and turps. Apply with a cloth, rubbing well in, and clean off with a second cloth. Next give a quick wash down with a wash leather and tepid water to which should be added a small quantity of vinegar. I would not advise varnishing.

Camouflaging Scratches

CAN you please tell me how to successfully camouflage scratches, etc., on black or ebonised legs of various items of furniture?—E. Slade (Lincs.).

THIS is by no means easy, but you can try the following: Lightly paper the scratches to smooth them off. Obtain a black brushing cellulose paint and apply this, using only one brush stroke per application. If you brush over the cellulose several times you will only drag it up again, so do not use the brush as you would with ordinary paint. Allow to dry for one hour, then apply another coat. However, before doing so smooth off the previous coat with the finest sandpaper available. Continue in this manner until the scratch is built up level with the surrounding polish. Smooth down again, then restore the gloss with a liquid car polish. Brushing cellulose is obtainable from most garages in tinlets, and is used for touching up scratches on cars.

Restoring Old Brass

I AM trying to restore some antique brass ornaments which have become badly tarnished. I find this very difficult to do using normal methods owing to their shape and intricate designs which are carved on them. Do you know of any solution I could use which would make this work easier?—E. Hutchins (Lincs.).

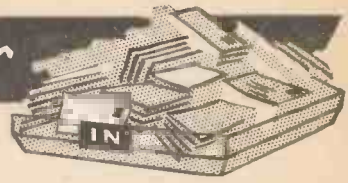
WE think you will find this work easier by treating the ornaments with a form of acid solution. We would suggest a rust-removing liquid which is sold under the name of Jenolite. This solution contains a high proportion of hydrochloric acid. You should apply it using an old toothbrush and allow some time for it to take effect, then wash off with warm, soapy water.

Ebony Finish

I AM at present making a small coffee table which has contemporary style turned wooden legs and I wish to know the best way to obtain the black ebony appearance which is seen so often with modern style furniture. — K. Shepheard (Lancs.).

THERE are several ways this finish can be obtained, one is by dyeing the wood with black shoe dye. This may require two applications. Subsequently the legs should then be painted with a clear varnish. When this is thoroughly dry, lightly polish the way of the grain with fine, dry steel wool. This will remove the high gloss and any blemishes which have adhered to the surface.

LETTERS TO *The Editor*



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

Some extracts from letters returned with questionnaires:

SIR,—It was through reading a copy of PRACTICAL MECHANICS many years ago that I first became interested in all things mechanical and it is true to say that in the years between and up to the present time P.M. has been to me a film guide and companion in the pursuit of my own particular hobbies and in countless other ways also.—D. Nolon (Eire).

SIR,—It is very nice to think that at least one Editor is interested in the opinions of its readers. I await with interest PRACTICAL MECHANICS every month, I should however, like to see more pages given to space and science.—J. Marshal (S. Wales).

SIR,—I have been a reader since the first issue and various contempory papers which preceded it and often wonder if any of your readers recall the journals of fifty years ago. The magazines I have in mind were entitled "Work" and "The Mechanical World". Perhaps some of your readers may recall making such things as flying models of the Wright biplane and the Bleriot monoplane given in one of these journals in 1908-1910. I made them at the time and they did fly. I would like to correspond with someone of that era.—G. J. Rushton (Berks.).

SIR,—Preferences I have shown in the questionnaire do not really give a true picture; for example, I have struck out models, though I have done a certain amount of model steam engine building, strictly non-lathe variety. Like other readers I know, I always read with great interest almost any "how to make" article, and I am more or less ready to try anything of interest from designographs to convector heaters. I have learned a great deal from the articles you publish from time to time on astronomy and space matters. — J. W. Barker (Yorks.).

SIR,—I was very pleased to be able to fill in your questionnaire and give my choice of articles that interest me the most. I have been taking PRACTICAL MECHANICS for approximately 18 years and am a tool maker by trade. Being the owner of a fairly well equipped workshop, naturally my main interests are in workshop projects such as lathe gadgets, etc. I have incidentally designed and built several of my own machines.

My interests do not remain entirely in my workshop, I am a keen do-it-yourself enthusiast and am interested in any home projects. For the odd moments when one is content just to sit and read, I find the features on space projects and Science Notes most interesting and I feel it keeps the average man up to date with these events.—F. Farnham (Northants).

SIR,—I find very little to criticise about the general arrangement or types of articles in PRACTICAL MECHANICS in fact it suits me quite well as it is. However, I would like to see more items included in your Trade Notes page and also an article describing the latest types of power tools on the market.—P. B. Gray (Lincs.).

Club News

Ramsgate and District Model Club.—Headquarters: Effingham Street, Ramsgate, Kent. Hon. secretary: Mr. E. Church, 103 Pegwell Road, Ramsgate, Kent. Meetings: Every Wednesday and Friday evenings, 7.30 p.m. to 9.30 p.m.

1962 Agenda

May 13th. Welcome return visit to Mr. Leigh Pemberton's 9in. gauge railway at Doddington near Sittingbourne. Party leaves 1.30 p.m. prompt. Meet at Club.

June 3rd. Annual Summer Outing to Dover Harbour witnessing the entire functioning of the famous Train Ferry coupled with a very interesting tour. Depart from Club 1.0 p.m. prompt.

July 21st. Live Steam Section supporting Flower Show and Fete at Preston, near Canterbury, Kent, operating a complete layout. Meet at Club at noon.

August 11th. Entire Club's support including the operation of layouts in T.T.-Steam-etc., for the St. Lawrence Fete and Gala Day to be held in Ramsgate. Meet at Club at noon.

September 21st. Annual General Meeting to be held at the Club's premises, Effingham Street, Ramsgate, 7.0 p.m.

At any of the above events all members, relatives, friends and any members of the public will be more than welcome. (F. M. Munster, P.R.O.)

A Surf Board

SIR,—The manufacturers of the Hy du lignum board as mentioned in my article on a surf board in the March issue are: Hydulignum-Jabroc (Tools) Ltd., Haddenham, Buckinghamshire.—John A. Waller (Author).

Calling Young Rocketry Enthusiasts

SIR,—I have had experience in both amateur and model rocketry and would like to correspond with someone of my own age (16-17 years), with a view to forming a rocket club. All letters will be answered and any information on this subject will be appreciated.—I. Sneap, Estate House, Shottle, Belper, Derbys.

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.

PERSONAL

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PROJECTORS. Home Assembly Kits, all types and sizes and Stereo from £6/2/6. Fan Base Kit, £3/7/6. Opticals, Screens. S.A.E. MARSHALL SMITH LTD., 64 Norwich Avenue, Bournemouth.

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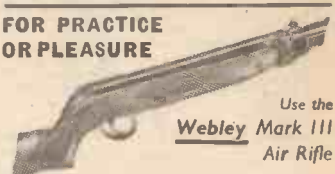

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