Practical MECHANICS

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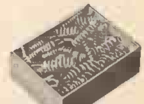

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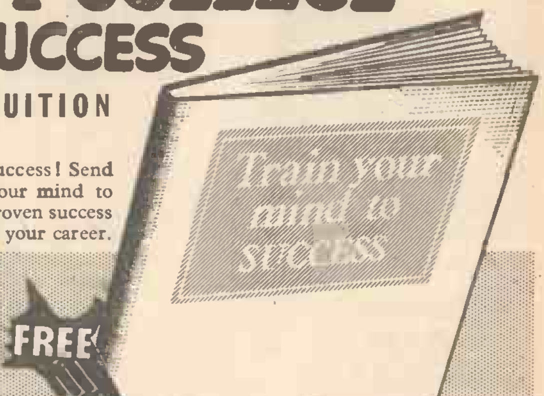

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Practical

MECHANICS

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CONTENTS

CONTRIBUTIONS

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

FAIR COMMENT

TO THE MOON

THAT the first man to visit the moon will be a Russian seems almost inevitable, but the American plans for a Moon rocket are steadily forging ahead. The rocket has been named Nova and it will be some 275ft. tall. Fifty times more powerful than the Atlas Booster scheduled to orbit an American astronaut sometime this year, Nova will use a cluster of engines, each developing a thrust of 1½ million pounds. It will be a three-stage rocket surmounted by an Apollo space capsule, which although still in the early design stage, is envisaged as being very much more complex than the Mercury capsule used by Commander Alan Shepard. It will incude a "command centre module" from which the crew of three will control their flight and where they will position themselves for take-off and re-entry.

There will be a propulsion unit which will be used for taking off from the moon on the return trip. This unit will also be used in earlier flights which are planned to circle the moon, when its job will be to power any manoeuvres required during the journey. It can also return the capsule to earth from any point along the flight path.

There will be a further propulsion unit which will be used to slow the capsule down and allow it to land gently on the moon and also a laboratory for use in earth-orbiting flights. Of all these units, however, only the command centre can return to earth.

ELECTRO-GRAVITICS

All the information so far released relating to future plans for interplanetary travel envisages the use of solid or liquid fuelled rockets but there is another possibility. This is the science of Electro-gravitics. Research into the use of this type of propulsion is being carried on in all the major countries of the world, including Canada, Russia and the U.S.A. PRACTICAL MECHANICS first described the possibilities of electro-gravitic lift in February 1942 in a well-informed article by the late W. D. Verschoyle who as early as 1936 gave a practical demonstration of the principle, using a model which "flew" to his laboratory ceiling. Basically, electro-gravitic lift does not seek to overcome the force of gravity as do other sources of power, but instead turns this very force ito its own advantage. Fantastic? Well turn to page 30 and read more about this dream of the future.

LIFE ON OTHER PLANETS?

Whatever type of propulsion is used, there seems little doubt now that man will travel at least as far as the moon and probably to the other planets of our own solar system. Many of man's speculations as to their history, composition and surrounding atmosphere will either be verified or discounted. Most interesting of all, he may discover finally whether the planet Earth and life as we know it is unique in the Universe. This is a long way in the future, however, and in the meantime some important work is being carried out on meteorite fragments which have hit the earth, to find out whether they have brought any evidence of life with them. Some scientists in America say that the answer to this question is a definite affirmative. They claim to have discovered microbes in the centre of meteor fragments and also to have isolated complex hydrocarbons that, on earth, are only made by living plants and animals.

This provides one more link in the chain of discovery for man to ponder over, but the day when his doubts will be ended is approaching. It may even be during our lifetime.

The November 1961, issue will be published on Oct. 31st, 1961. Order it now!

POWER from the waves

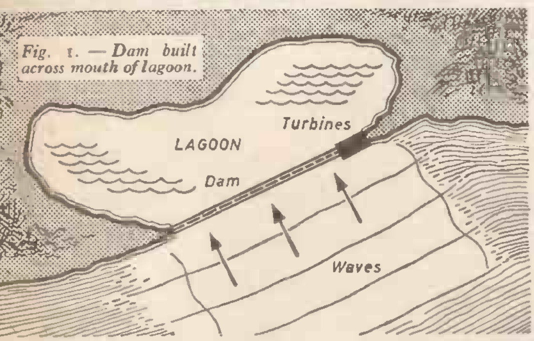


Fig. 1. — Dam built across mouth of lagoon.

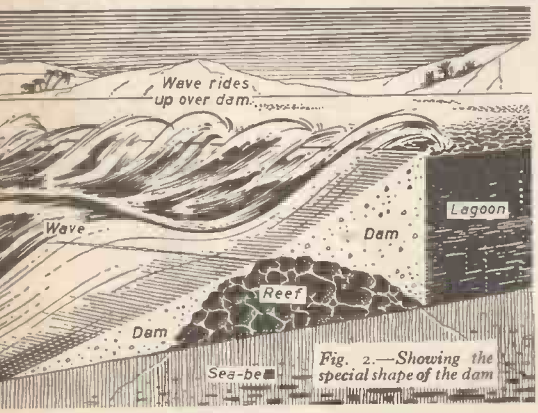


Fig. 2.—Showing the special shape of the dam

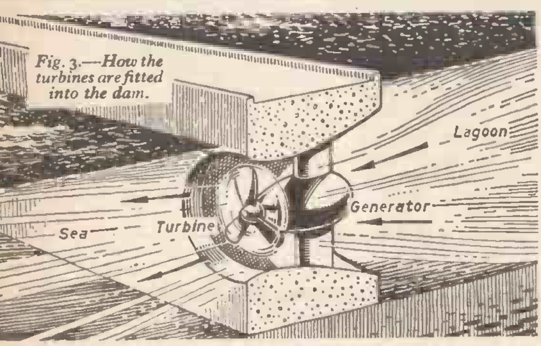


Fig. 3.—How the turbines are fitted into the dam.

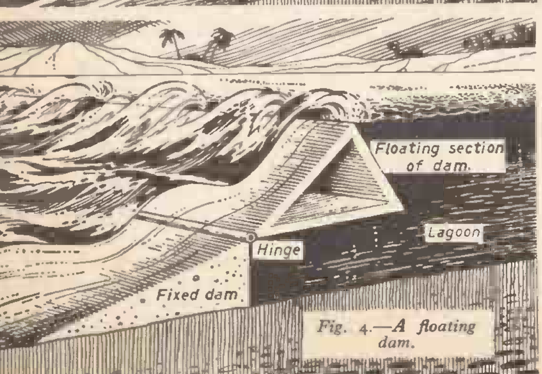


Fig. 4.—A floating dam.

A NEW and ingenious way of producing power from waves has recently been proposed, and it is hoped that the first power station to work on this principle will be built on the island of Mauritius. This island is situated in the Indian Ocean where many of the natural features make it very suitable for a " Wave Power Station." Two of the most important features are that throughout the year continuous waves pound the shore, the height of the waves varying from 4 to 12ft., and also there is very little tidal variation.

The Dam

The wave power station will be built to make use of a natural lagoon as shown in Fig. 1. A dam will be built across the mouth of the lagoon where a natural reef will help to reduce the amount of work to be done. The dam itself will be of a very special shape, as shown in Fig. 2. In fact this special shape is essential for the correct operation of the power station. The side of the dam facing the sea slopes gently at first from the sea bed, but nearer the top it slopes more steeply. The top of the dam is unique in that it is quite sharp, most other dams having a flat top.

In operation the waves coming in from the ocean reach the dam and instead of dashing themselves to pieces, as would happen if the dam were straight faced, they simply rush up and over it, and into the lagoon. The special face of the dam is so designed that very little of the energy of the waves is wasted, and nearly all the water flows into the lagoon, which consequently fills up to a high level. The average height of the water in the lagoon is perhaps 10 to 15ft. higher than sea level.

The Turbines

Power is generated by allowing the high level water in the lagoon to flow back to the sea through turbines. The turbines themselves would be of the bulb type as shown in Fig. 3. In this type of turbine the generator is enclosed in the same casing, so that there is no need to have a separate power station. The generator part is pressurised with air which prevents water leaking in. The rate of flow back through the turbines is regulated so that a constant level is maintained in the lagoon. The only limit to the amount of power which can be developed with this system, is the length of dam which can be constructed. In the first power station it is hoped to build a power station of 9,000kW. initially, but sufficient room is available to expand it to 44,000kW. at a later stage.

Mauritius is in a fortunate position in that there is very little rise and fall of the tide, as it is obvious that if this were not the case it would be impossible to use a fixed height dam. If a fixed height dam were used where there was a tidal variation then it would be too low at high tide, as there would be insufficient difference of level between the lagoon and the sea to work the turbines. At low tide the waves would not be able to flow over the top of the dam. However, if this first wave power station proves to be successful there will be an incentive to build others elsewhere. If there were tidal variations at these other locations, then it would be necessary to use variable height dams. Such a dam is shown in Fig. 4, where it can be seen that it in fact floats on the water of the lagoon. This means that it is self-adjusting in height, and no mechanical power is required to operate it.

By R. N. Hadden.

A Talking Light

By D. S. Fraser

TWO new devices, recently demonstrated in the United States, hold vast promise in the communications and other fields.

The Bell Telephone Company has perfected a continuously operating gaseous optical maser—a new tube that generates a coherent light beam. According to the company, this "talking light" device has a potential capacity for carrying information millions of times greater than that of the radio waves used in voice and communications. Its usefulness lies in its ability to produce extremely pure frequencies of light and to operate on less power than a common light bulb.

The "Laser"

The Hughes Aircraft Company has announced a super light source known as a "laser," which, it is claimed, is the first true amplification of light. Such a device could generate an intense, extremely narrow beam of light capable of vaporising materials or illuminating small areas of the moon, nearly 240,000 miles from the earth. According to officials of the company, development of practical models of the laser could lead to instruments for more precise studies of the structure of matter, for high-fidelity communications, and for amplifying faint star light not now visible to the most modern telescopes.

It is claimed that on the Bell device, when used for communications, that its infra-red beam could carry up to a million simultaneous telephone conversations. In space it could send information for millions of miles without serious loss of strength as the distance increases. For scientists and industry it could supply a convenient source of controllable heat that could be focused to almost infinite fineness. The device has already been successfully tested in voice transmissions experiments.

Continuous Operation

The new Bell maser uses a mixture of helium and neon gas to achieve continuous operation. Previous optical masers—built around crystals—required thousands of watts of power to transmit large bursts of visible light of very short duration.

Light waves vibrate millions of times faster than radio waves. Because these "optical" frequencies are so high, light beams should be capable of handling enormous amounts of information—telephone calls, TV programmes etc. by the million. But the light must be coherent. It is the coherence of radio waves, for example, that enables them to carry voice, music, TV and other forms of intelligence efficiently. Radio waves move like disciplined soldiers and can be controlled. Ordinary light waves—the kind thrown off by light bulbs—are highly incoherent and move like an unruly mob.

Bell scientists visualise the possibility of using the gas maser for communications through outer space, between air and space craft and—on the ground—through long pipes or conduits.

Applying the gas maser to communications is actually an important by-product of an achievement that provides scientists with a remarkably precise tool for investigating atomic structure. Since the gas maser generates a light beam several hundred thousand times narrower in frequency than heretofore available, scientists will be able to study the atom in much greater detail.

In simplified terms, the Bell gas maser achieves its effect through interactions between helium and neon atoms enclosed in a glass tube about 40in. long. The helium atoms are excited to a highly energetic state by a continuous electrical discharge at radio frequencies. The excited helium atoms transfer their energy to the neon atoms by colliding with them. The neon atoms, now "stimulated," radiate their energy—on demand—as a highly coherent stream of infra-red light.

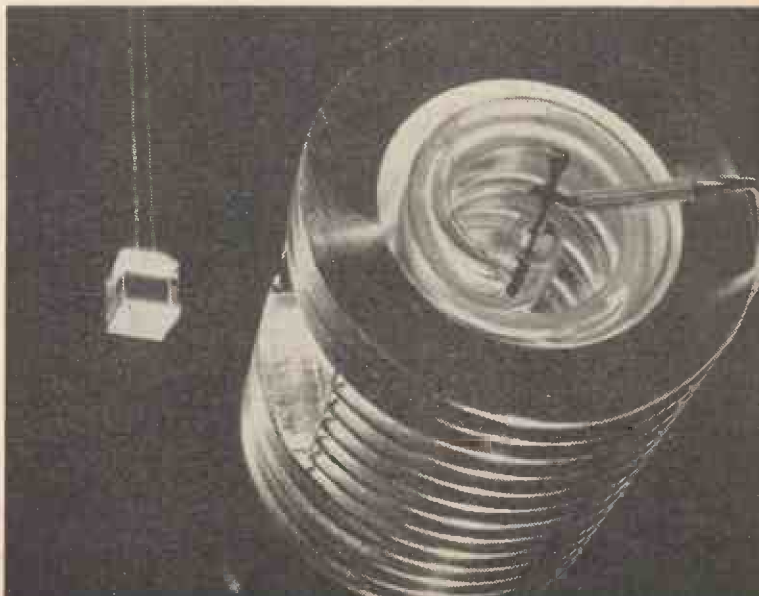
The Hughes Laser

The Hughes Aircraft laser is similar, in many respects, to the Bell Telephone maser. Its beam of light would be brighter than that emitted by the centre of the sun. It would also be exceptionally pure.

In the case of the laser, it is a light that interacts with electrons (negatively charged particles) in the crystal-line structure of a synthetic ruby. This is how it works:

The ruby is exposed to green light which pumps energy into the electron in its crystal structure. The

(*Concluded on page 39*).



Glowing with absorbed light is a synthetic ruby crystal (left). A light source (right) pours "random" waves of light into the ruby.

Fig. 1.—*The completed Heater.*

Forced air blast CONVECTOR HEATER

Home-made — Efficient — Safe

THE heater is housed in a square-type biscuit tin obtainable from any grocers and Fig. 1 shows the complete assembly in use forcing hot air out into a room. Figs. 2 and 3 show the principle of operation. A nickel-chromium element is drawn out and arranged to cover the outlet hole in the former lid of the tin and air is blown from a similar hole in the former bottom of the tin by means of a small home-made electric fan. The fan may be used on its own for ventilation, etc., in the summertime. The unit may be controlled by an air thermostat situated behind the unit.

Construction

The exact centres of the top and bottom of the tin are found by drawing diagonals and then a 2½in. radius hole is cut in each. A small piece of expanded metal, as used for loudspeaker grilles and available from Lasky's Radio, 370 Harrow Road, London, W.2, is then fixed with small nuts and bolts to the inside of the lid. A similar piece of metal is prepared for the other hole, but is not fitted yet.

Parts Required

Switch Arcolectric CS200. This switch must take at least 5A. of current; small toggle types are not suitable.

Warning Lamp Arcolectric neon SL160. Arcolectric (Switches) Ltd., Central Avenue, West Molesey, Surrey.

Element 1,000 spiral. Messrs. Technical Services Ltd., Banstead, Surrey.

Ceramic Insulating Beads 2 gross. Technical Services.

Motor A small tape recorder motor (induction type) is used in the prototype shown; further details are given in the text. Some electric gram. motors will suit and, with alterations to the circuit, surplus 24V. types will do.

Interlocking Ceramic Washers 1½ doz.

Whit. Nuts and Bolts 2 doz. 1in. × ⅛in. with washers. 1 doz. 1½in. × ¼in. with washers.

Mild Steel Strip ⅛in. × ½in., 5 ft.

Various parts such as wire, grommets, solder.

Mounting the Motor

The motor is arranged to be fixed centrally in the biscuit tin so that the motor is as far to the back (the old bottom) as possible (Figs. 2 and 4) and the shaft is facing forward towards the former lid. The motor mounting should be rigid but, if possible, rubber blocks should be used to cut down noise. Tape recorder motors are ideal and one is illustrated in Fig. 8 with a suitable mounting. The mounting bolts holding the support beams are seen in Fig. 4.

Another method of motor mounting tried out, for use with any round-type motor, is illustrated in Fig. 8. Rubber tubing may be slid over the clamping pieces to buffer vibrations, but unless tape or gram-deck motors are used there is bound to be some vibratory noise from the unit. The motor illustrated is a "Hoover" type 24V. motor available cheaply from Messrs. H. English, Rayleigh Road, Hutton, Brentwood. Special wiring is necessary as detailed later.

The Fan

The fan is now cut out of steel or aluminium sheet.

Fig. 2.—*How it works.*

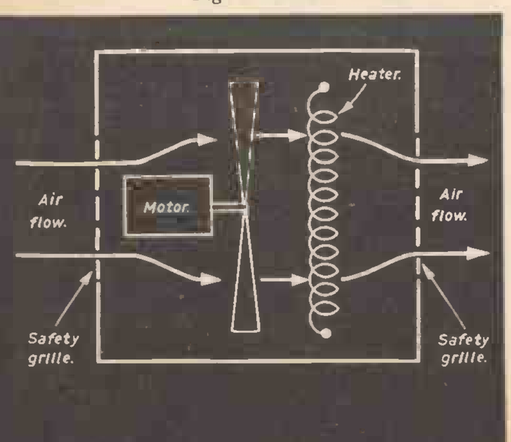
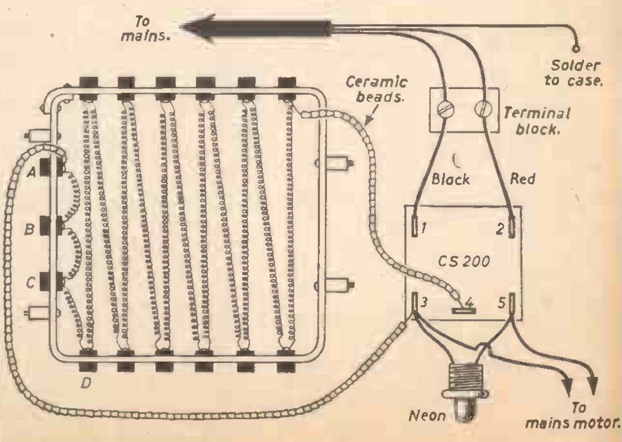


Fig. 3.—*Wiring mains induction motor and heater element.*



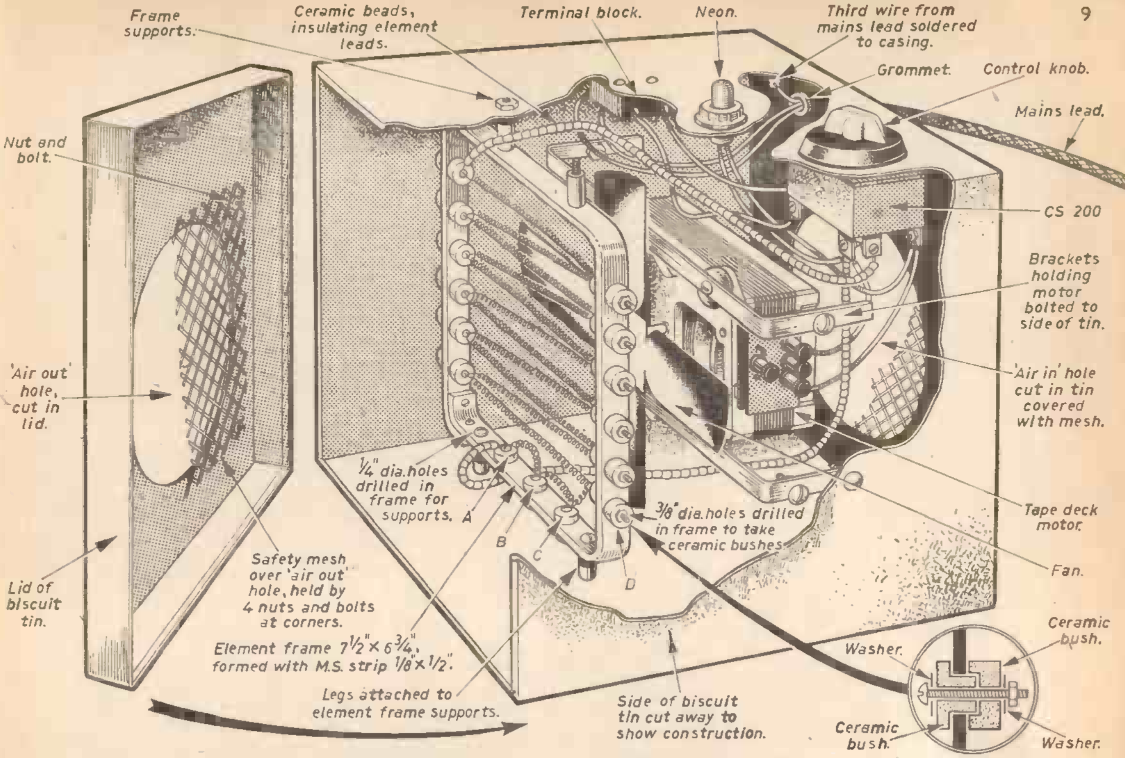


Fig. 4.—Cutaway perspective view of the complete heater.

It need not be thicker than $\frac{1}{16}$in. and is cut as shown in Fig. 6. It must be cut accurately so as to balance or the finished convector will vibrate.

The method of fan mounting found satisfactory is shown in Figs. 4 and 8. A small piece of brass with three holes is soldered to the shaft of the motor. The fan is then bolted to this with bolts, spring washers and nuts, making sure it is balanced.

The fan is then tested with the motor running to make sure there is no undue vibration. If all is well the blades are all given a slight twist. The angle is not critical and care must be taken not to bend the motor shaft.

The fan blades, when twisted, must receive the correct deflection for blowing the air AWAY from the motor, otherwise the unit would be rapidly overheated and dangerous.

The motor, complete with fan, is mounted in the unit in the position shown in Figs. 2 and 4. It is tested for balance. The prototype is hardly audible a yard or so away.

Making the Heater Element

The framework, shown in Fig. 4, should be made fairly accurately to size and care is required to file off rough edges of all the $\frac{3}{8}$in. holes (15 of them). The ceramic split washers shown in Figs. 3 and 4 will break unless they are clamped to a flat surface. The bolt heads are inside the square and are fitted with washers. Nuts and washers are fitted loosely on the outside (temporarily).

The element is now prepared for use. The number of complete turns on the spiral is counted and divided by 12. The element is then pulled straight for $\frac{1}{2}$in. or so after each group of turns; 44 turns proved correct in the prototype. The straightened heater

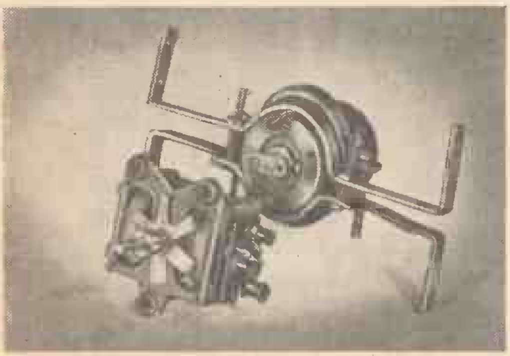


Fig. 5.—Two suitable types of motor fitted with mounting clamps.

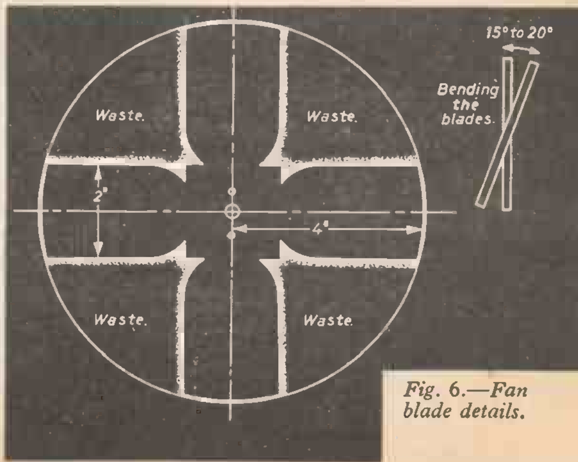
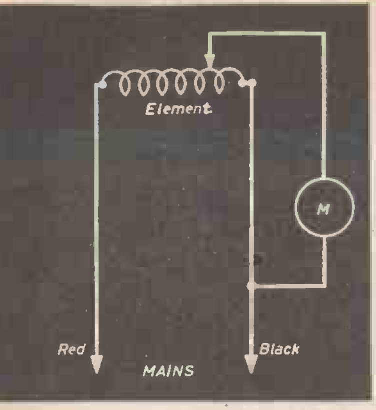


Fig. 6.—Fan blade details.



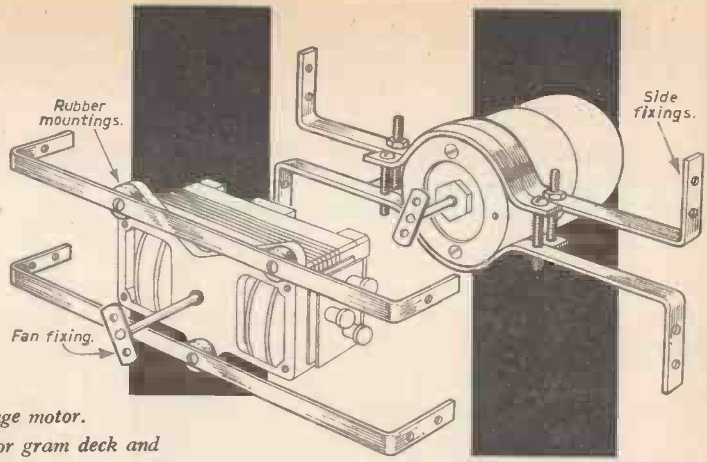


Fig. 7.—Circuit for low-voltage motor.

Fig. 8. (Right).—Mounting clamps for gram deck and round motors.

wire is then wound twice round each bolt head, under the washer. Two washers can be fitted for safety against breaking the ceramic insulators, as shown inset in Fig. 4. The end spiral piece is "split" up again and fixed to the bushes A, B, and C. This is to give tappings for working low-voltage Government surplus motors. Readers may omit B and C but should fit them if the element is likely to touch the spiral connected to D. Connect each end of the element to the mains and note that the element glows a bright red. Tighten up all nuts and cut off the bolts if they protrude more than ⅛in.

Four holes are drilled in the top and bottom of the tin in the position shown in Fig. 4, and four ¼in. Whit. nuts and bolts are used for mounting. These are shown in Figs. 3 and 4. Four small lengths of piping are slit over them to keep the side of the tin from being drawn in to touch the " live " bolts. The two underneath can be left extra long to form legs to raise the front of the unit about 1in. off the floor. Rubber bottle stoppers (from any chemist) can be fitted on these bolts to prevent them scratching furniture. Make sure that no live bolts (i.e. those passing through the ceramic split washers) pass near the metal casing; at least ¼in. clearance should be given. Check that the fan is at least 1in. away from the element at its nearest position.

The Controls

A small neon suited to the mains voltage is fitted in any convenient position towards the back of the unit; it can be seen on top in Figs. 1 and 4. Do not bend the stiff connecting wire near the neon because it contains a concealed resistor. In any convenient position fix the special heavy-duty switch Arcolectric C.S.200. The markings on the knob will not suit and will have to be altered either by using white and black paint, sticking on paper marked with indian ink or rubbing down with emery paper and using a hard lead pencil followed with varnish.

OFF is left as OFF (this is the *correct* off position)
Low is marked HOT
Med. is marked COLD
Hot is marked OFF

Wiring

The circuit employed is shown in Fig. 6. If a surplus motor is used then the circuit will be as in Fig. 7. The practical layout with the mains-type motor is shown in Fig. 3. Copper wires of 24g., completely filled with ceramic beads, are used between the switch 3 and 4 terminals and the two ends of the heater element. The wires are tightly clamped at both ends and the beads checked for interlocking. The wires must be led along from front to back of the unit in such a way that the fan will not foul them. Tin clips can be soldered on the inside of the case to hold the wires in place. The motor is now connected between terminals 3 and 5, as is also the neon. Terminals 1 and 2 are connected to a terminal block in order to anchor the mains leads securely and the green mains lead MUST be securely soldered to the metal casing of the unit. The earth pin of the plug must be connected and the plug should be fused at 5A.

Using Surplus 24V. Motors

Surplus motors having a field winding can often be used by tapping off the necessary voltage from the element at points A, B, C, and D in Fig. 3. The circuit is shown diagrammatically in Fig. 7.

The motor cannot be worked on its own without a heater, and the end of the heater, marked A in Fig. 3, MUST be connected to the neutral side of the mains, and to one motor terminal. The other motor terminal is then connected by trial and error to either B, C, or D, whichever is most suitable.

Generally position C will suit. Experienced readers may like to take B, C, and D to a switch (single pole, 3-way type) to give a variable-speed air blast. A 110V. motor may be connected half-way along the element in a similar manner.

Testing the Unit

The leads are connected and plugged in. The neon should not light until the switch is turned to either COLD or HOT. In either position (except where using 24V. surplus motors) the motor should work and in the HOT position the element should be black, possibly with one or two very small patches of red. The prototype construction described will give perfect black heat. The consumption will be slightly over 1,000W. When tested, fix the lid with self-tapping screws and fix a grille in a similar way to the back hole.

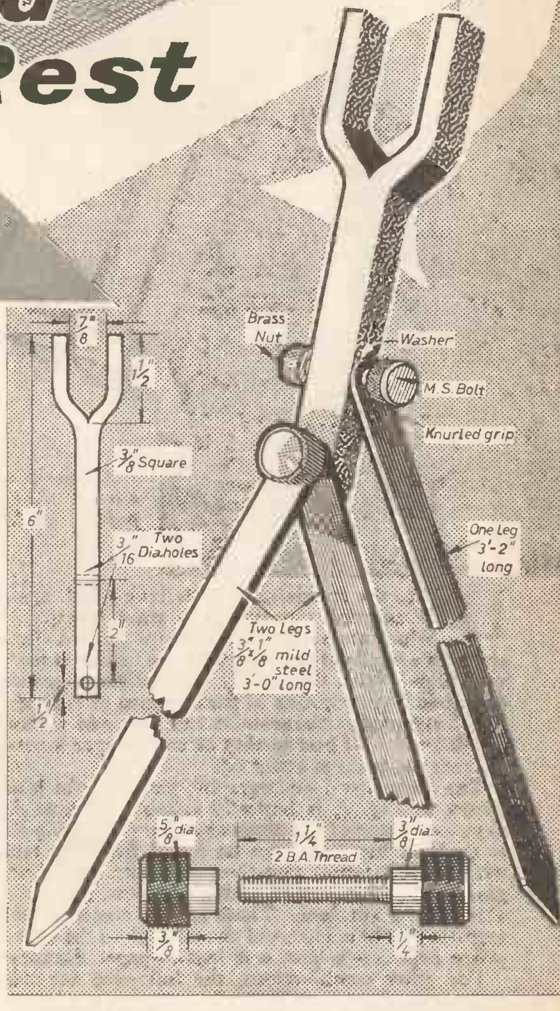
Safety Precautions

This model is as safe as any commercial model, but remember an earth is necessary, and that the front and back ventilating holes MUST be CLEAR and there must be no chance of anything falling on either to interrupt the air flow. If one of the heater leads is broken and soldered again without twisting it you will have an automatic safety device should the air flow be interrupted; with this arrangement *the plug must be fused and an earth used.*

The rod rest in use on a beach.

Fishing Rod Rest

BY H. J. JONES



Measurements and constructional details of the rest.

WHEN fishing from the beach or river bank most anglers use a fishing rod rest. The one about to be described has proved satisfactory in use and is of the tripod type but has been designed so that no complicated joint is required.

Materials Required

1 3ft. 2in. length ⅜in. × ⅛in. mild steel strip.
2 3ft. 0in. lengths ⅜in. × ⅛in. mild steel strip.
1 6in. length ⅜in. square mild steel bar.
1 6in. length ⅝in. dia. round mild steel bar (2 bolts).
1 3in. length ⅝in. dia. brass bar (nuts and washer).

Construction

The fork may be made first. After cutting to length, the ends are filed square and a saw-cut 1½in. long made at one end. In order to keep the saw-cut straight the bar is turned round in the vice after about a ¼in. cut is made and another ¼in. cut made from the other side, after which it is turned around again. The sawing operations are repeated from opposite sides until the required saw-cut depth is reached. The end of the bar is now heated to a dull red and the fork prised open by levering with the blade of a cold chisel. The sawn edges are filed smooth and sharp corners rounded off. The fork is then forged to the shape shown by heating and hammering around a ¾in. dia. bar. Two 3/16in. dia. holes are then drilled in the positions shown.

The Legs

One end of each is rounded and a 3/16in. dia. hole drilled 3/16in. from the end, the other end being pointed.

Turned nuts and bolts are shown in the assembly drawing and should be made if a lathe is available. The bolts are turned from ⅝in. dia. bright mild steel bar. Knurling is the first operation, then the end is turned down to 0·185in. dia. for a length of 1¼in. The ⅜in. dia. part is turned next. The 2 B.A. thread may be made in the lathe by using a tail-stock die holder and turning the chuck around by hand, after which the bolt is parted off.

The nuts are made of brass and again the knurling is done first of all. Using a No. 26 drill, a hole is drilled about 1in. deep in the end, after starting it with a combination centre drill in the tail-stock chuck. This hole is then tapped 2 B.A. and the nut finally parted off after turning the shoulder.

If no lathe is available a 1¾in. length of 2 B.A. studding can be used with two wing-nuts to replace each turned bolt and nut. A brass washer ⅜in. outside dia., 3/16in. inside dia. and ⅛in. thick is required to complete the assembly.

The fork and legs are painted with an enamel or lacquer paint of any desired colour and allowed to harden thoroughly before assembling. The bolts may be given a blue-black finish, which affords some protection from rusting, by coating with soluble oil, heating and quenching in water.

Make This

Fixed focus enlarging is

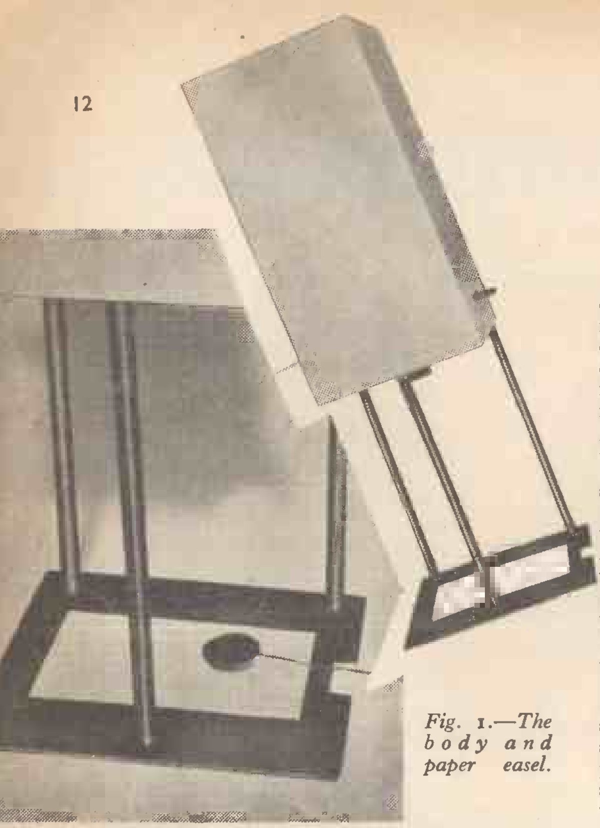


Fig. 1.—The body and paper easel.

DUE to the standardised technique which has to be adopted commercially to produce enprints, which are fixed ratio enlargements made from almost the whole of the negatives, the quality is never very high. With the simply constructed enprinter described here, enprints of the standard of individually, hand-made enlargements can be made without any difficulty. If best quality bromide paper is used, the cost per print is about 2d.

The design, two photographic views of which are shown in Fig. 1, is basically suitable for any size negative. Some of the dimensions vary from one size to another, but these can be found from the table which covers 35mm. negatives with both 45mm. and 2in. lenses, 2¼in. square with a 3in. lens, and 3¼ × 2¼in. with a 4in. lens. These are the standard lens/negative combinations, and the table gives the appropriate negative-to-lens, and lens-to-paper distances.

For other combinations, the following formulae may be used:

$$\text{Magnification} = \frac{\text{projected image size,}}{\text{masked negative size}}$$

$$\text{Negative to lens distance} = \text{focal length of lens } \left(1 + \frac{1}{\text{magnification}}\right),$$

$$\text{Lens to paper distance} = \text{focal length of lens } (1 + \text{magnification}).$$

Slight adjustment of the figures found will be required owing to minute variations from the stated focal length of the lenses. This adjustment can be gained by adding or removing thin packing attached to the underside of the negative carrier and at the point where the legs meet the easel. It is preferable to leave the lens in a fixed position.

There is no reason why this type of enprinter should not be used for printing from sub-miniature negatives, particularly since practically no suitable commercial apparatus is available for the very small negatives. Frame enlargements from 16mm. negative cine film can be made with ease. With a lens of the correct focal length, perhaps borrowed temporarily from the camera, the two leading dimensions are found from the previously mentioned formulae.

Body Construction

The body of the enlarger is bent up from aluminium alloy or even heavy tinplate, the gauge being completely unimportant provided that it is heavy enough to give a rigid structure. A 6in. square section is the smallest practicable for this component, otherwise it will become overheated. A number of ventilation holes, drilled or punched in each side, permit cold air to enter the lamphouse part of the body and cool the bulb. One slot in each side wall allows the negative carrier to pass through, and support it (Fig. 2).

Two plates, of gross size 6in. square and 18 or 16 S.W.G., are profiled to fit inside the body, one to act as the lens panel, the other as the top. Strips of ½in. angle are bolted inside the body to retain the lens panel. All screws should be countersunk on the outside, and secured with hexagon nuts inside. Fitting the angle closely around the inside of the body provides an effective light-trap on the underside. The use of screws, instead of rivets, makes maintenance easy.

The Legs

The three legs are of ⅜in. dia. brass or aluminium rod, threaded ¼ Whit. or B.S.F. for ½in. at one end, later inserted in clearance holes in the lens panel and locked with nuts. The other end of the legs is also similarly threaded, but only for a distance of ¼in. The lens is attached to its panel by a threaded flange obtainable for a few shillings from most large photographic dealers.

As shown in Fig. 2, a sheet of flashed opal glass is positioned in the body to act as a diffusing screen. As a substitute, one or two thicknesses of tracing

Negative size	35mm.		2¼in. sq.	3¼ × 2¼in.
Focal length of lens	45mm.	2in.	3in.	4in.
Negative to lens	2–15/64 in.	2–35/64 in.	5–5/32 in.	6–33/64 in.
Lens to paper	8–5/32 in.	9–5/16 in.	7–11/64 in.	10–23/32 in.
Magnification	3·65 ×	3·65 ×	1·39 ×	1·59 ×
Carrier aperture	1·4 × ·9in.	1·4 × ·9in.	2–7/32 × 2–7/32 in.	3–7/32 × 2–7/32 in.
Paper size	5½in. × 3½in.	5½in. × 3½in.	3½in. × 3½in.	5½in. × 3½in.
Projected image size	5⅛in. × 3–9/32in.	5⅛in. × 3–9/32in.	3⅛in. × 3⅛in.	5⅛in. × 3–5/32in.
Print image size	5–1/16in. × 3–1/16in.	5–1/16in. × 3–1/16in.	3–1/16in. × 3–1/16in.	5–1/16in. × 3–1/16in.

All fractional dimensions are given to the nearest 1/64in.

Enprinter

deal for holiday pictures,

paper may be sealed between a pair of plain glasses. The diffuser rests on other pieces of angle screwed to the walls.

Immediately above the diffuser, a light-trap of bent-up strip masks the ventilation holes, but allows air to flow across the screen. The top rests on another set of angles, and has ventilation holes to aid the expulsion of air heated by the bulb. A dished light-trap, fitted between the batten type lampholder and the top prevents light escaping. The lampholder is secured with screws and nuts, a central hole in the top providing the cable entry. A rubber grommet, pressed into the hole, guards against cable wear.

The Easel

Details of the easel are given in Fig. 2. Use of 16 s.w.g. or thicker sheet for the three parts of this, ensures that there is adequate material for the three ¼in. threaded holes which take the lower ends of the legs. The paper should slide in quite freely, and can be withdrawn by finger movement through the right-hand end cut-out. The dimensions given are suitable for enprints on postcard paper. For 3½in. square paper, the printing aperture should be as wide as it is long, and centralised in the easel. Again, only a slight amount of the picture is lost through masking.

The negative carrier is made from two identically shaped strips of 16 s.w.g. brass or aluminium alloy (see Fig. 2). The apertures needed for various sized negatives are given in the table, and it can be seen that the minimum amount is taken for masking. A thin packing strip attached to the underside of the lower part of the carrier with small rivets, corrects any minor differences in back focus of the lens. For negatives larger than 35mm., the carrier should be made from two strips of flaw-free glass, with metal foil packing strips cemented to the lower one. The packing should have a suitably sized aperture below the negative.

Assembly

This is simple. The legs are screwed into the paper easel, using thin washers as spacers, and their other ends secured to the lens panel as described above. The body is fitted over the lens panel and screwed in place, using the angles. The diffuser is lowered on to the central set of angles, and the light-trap immediately above is fitted. A 60 or 75 watt enlarging bulb is fitted into the lampholder, which already carries its light-trap and is bolted to the top. The top just rests on the upper set of angles, so permitting easy access to the interior. Vary the packing on the negative carrier and at the easel until a perfectly sharp picture is projected.

All the lower parts of the enprinter, that is the lens barrel, easel, legs and lens panel, should be painted matt black to avoid reflections falling on the paper and degrading the tones. The interior of the lamphouse may be painted matt white to obtain maximum light conservation without the risk of internal reflections

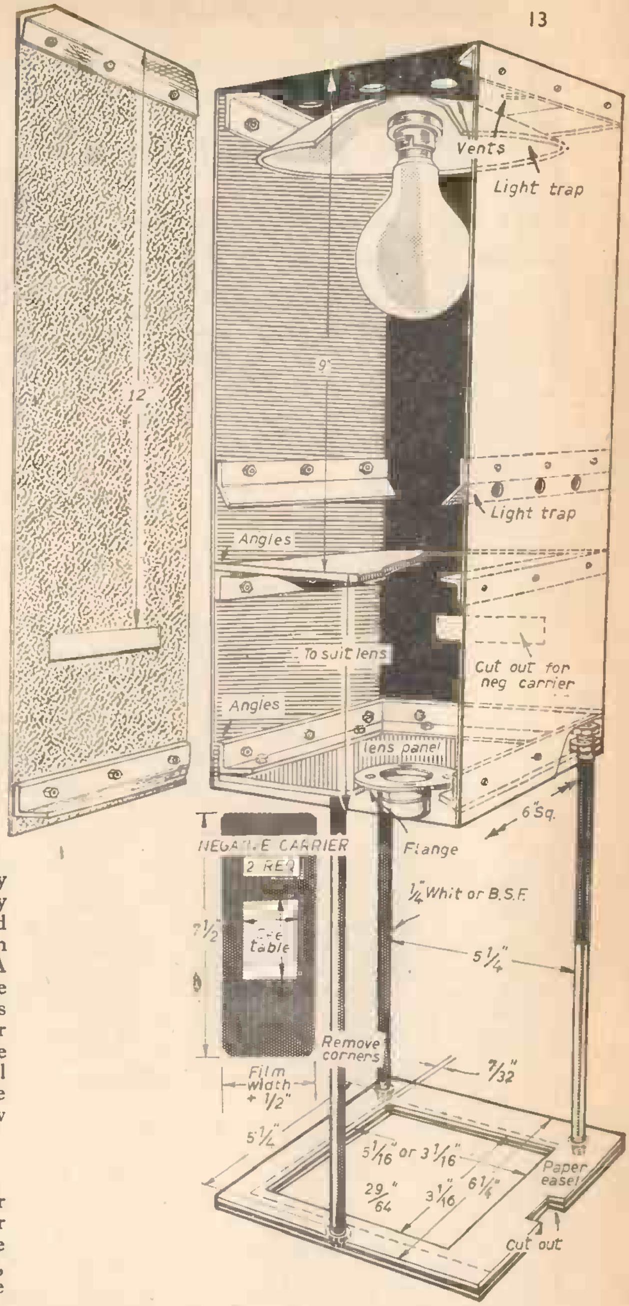


Fig. 2.—General arrangement and details of the enprinter together with dimensions.

which a polished surface would give. The outside of the body can be finished in any desired shade although, again, a matt finish is preferable.

With the negative carrier loaded and slid into its slot, and the lens screwed into the flange, the enprinter is ready for use. As may be seen from Fig. 2, the unconventional open plan of the lower part permits full control of printing by shading with the fingers or a " dodger," and by " burning in " dense parts of the picture.

L.B.S.C's 3½in. Gauge

EVENING STAR

Part 8. Alternative Slide-valve Cylinders.

IF I now give a few hints on machining the castings for the alternative slide-valve cylinders (Fig. 42), we can take the valves, pistons, covers and glands for both types together, and save time and space. The method of mounting and boring the castings is pretty much the same. Bolt an angleplate to the lathe faceplate, and set the casting on it, contact face down, securing with a bar across its back as previously described. Adjust so that the corehole runs truly, and is parallel to the centre-line of the lathe. Tighten the bolts, then go right ahead as before, facing off the end, and boring to diameter shown. Mount on a mandrel as previously described, for facing the other end.

There are two flat faces to machine off on the slide-valve cylinder castings, against the one face on the piston-valve type, and these must be exactly at right angles. Fig. 43 shows how to set up for this job. First of all, up-end the cylinder on the angle-plate as described for the piston-valve type, and tool off the contact face until it is $\frac{1}{4}$in. from the edge of the bore Then slew the casting around for a quarter-turn, so that the portface is now at right angles to the lathe centre-line. To get it exact, apply a try-square as shown, stock to faceplate, and blade to the machined contact face. Tighten the clamp nut, and tool off the portface until it is $\frac{3}{8}$in. from the edge of the bore.

Coat the portface with marking-out fluid, scribe a line on it at $1\frac{3}{8}$in. from the edge opposite to the contact face, and on this line, set out the ports as in Fig. 44. I have arranged the dimensions of them to suit the valve gear specified for the piston-valve cylinders, so that the locomotive will be just as powerful and speedy. To cut the ports, bolt an angleplate to the vertical slide, and fix the cylinder on it, end-up with a bolt through the bore, setting the portface at right angles to the lathe centre-line. This is done in a jiffy by putting on the lathe faceplate, and running the casting up to it until the portface touches the faceplate all over; then tighten the clamp bolt. Put on the three-jaw chuck with a $\frac{5}{32}$in. slot-drill or endmill in it. Adjust the vertical slide until one of the steam port markings is exactly in line with the cutter—and by " exactly," I mean just that. If the ports are " apple-pied," the engine won't give its full efficiency.

Now watch your step. Feed the casting on to the cutter (which should run at a fairly high speed) by moving the saddle towards the lathe headstock until the cutter penetrates about $\frac{1}{16}$in. Now traverse the casting across the cutter by moving the cross-slide handle, and make quite certain that you don't " overshoot the platform," as the enginemen say; that is, traverse too far, so that the cutter goes beyond the ends of the port markings. The easiest way for beginners and inexperienced workers to avoid disaster, is to set the slide with the cutter at each end of the port mark *before* feeding into cut, and carefully noting the position of the cross-slide handle. If the handle is then brought to the same place every time when cutting, everything in the garden will be lovely. As the ports are $\frac{1}{4}$in. depth, feed into cut for another $\frac{1}{16}$in. depth after making the first traverse. Two more doses of the same medicine will bring the port to full required depth. It is better to cut each port by stages, than attempt to cut full depth at one go, because the chances are 1,000 to one, that the side pressure will cause the cutter to spring. The resulting port will be about as straight as a banana.

Adjust the vertical slide until the second steam port is in the right position for cutting, then ditto repeato operations, taking the same strict caution as before. Finally, tackle the exhaust port. This merchant is double the width of the steam ports, but the same cutter will do the trick; just take two cuts, first setting the cutter to one edge, and then to the other. The little bit in between the cuts can be removed by setting the cutter right at each extreme end to full depth, and moving the vertical slide up and down, again taking the utmost care to avoid overrunning the ends.

Steam and Exhaust Passages

The steam passages between the ports and the edges of the cylinder bores are drilled exactly as described for the piston-valve cylinders, with the casting held in a machine-vice on the table of the drilling machine, and set at such an angle that the drill (No. 34 in this case) will break into the port close to the bottom. Set the machine-vice with the casting in it, just clear of

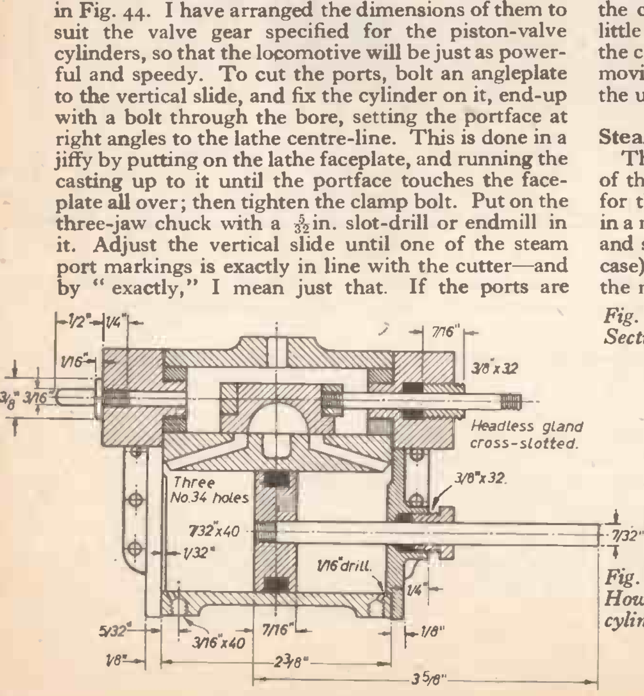


Fig. 42. (Left)—Section of cylinder.

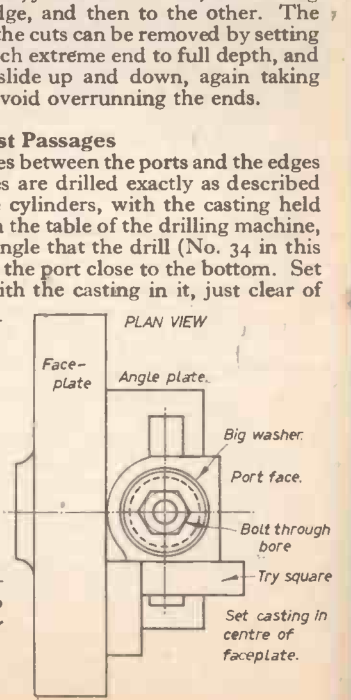


Fig. 43. (Right)—How to set up cylinder casting for facing jobs.

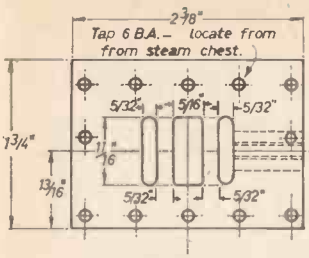


Fig. 44.—*Cylinder port face.*

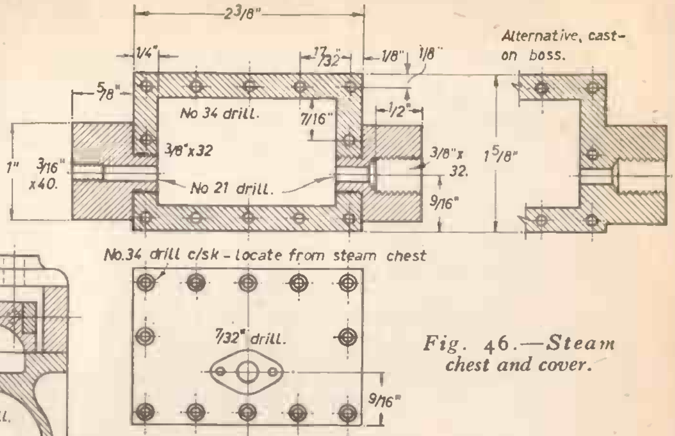


Fig. 46.—*Steam chest and cover.*

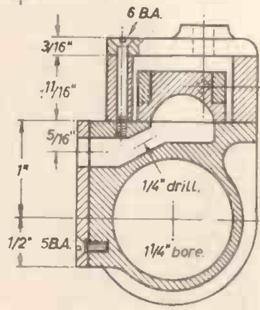


Fig. 45. (*Right*)—*Cross section through exhaust port.*

the drill; pull down the handle so that the drill comes down outside the casting, and you'll see at a glance if the angle is correct.

Mark off the location of the exhaust way on the contact face, 5/16 in. from the top of the vertical centre-line. Make a deep centre-pop, grip the casting in the machine-vice with the contact face level with the jaw tops, and drill a 5/16 in. hole 3/8 in. deep. From the bottom corner of the exhaust port, drill a 1/4 in. hole breaking into the 5/16 in. hole, as shown in the cross-section, Fig. 45. This can also be done with the casting held at the correct angle in the machine-vice. The portface can then be trued up by rubbing it on a piece of fine emerycloth, or similar abrasive, laid business side up, on a surfaceplate, piece of plate glass, or something equally flat and true. The resulting matt finish is the finest working surface you could have, as the microscopic scratches hold a film of oil, over which the valve slides like a skater on a frozen pond.

Steam Chest

The steam chest may be a plain rectangular casting with the bosses screwed in, or the bosses may be cast integral. The outside of the first-mentioned, should be cleaned up with a file, gripped in the four-jaw independent chuck, and each side faced off sufficient to bring the finished depth to 11/16 in. On each shorter side, at 7/16 in. from one edge and 1/32 in. from the middle of the width, drill a No. 30 pilot hole, open it out with letter R or 11/32 in. drill, and tap 3/8 in. × 32. Drill and tap must go through dead square with the sides. I usually hold the steam chest in the machine-vice on the drill table, put the tap in the chuck, and start it by turning the drill spindle by hand, which starts it truly. The screwholes in the walls can then be set out as shown in Fig. 46, centrepopped, and drilled No. 34. Smooth off any burring by rubbing on a piece of emerycloth as mentioned for truing up the port face.

The bosses are turned from 1 in. round bronze or gunmetal rod. Chuck a piece in three-jaw, face, centre, drill to a full 7/8 in. depth with No. 21 drill, turn 1/2 in. of the outside to 3/8 in. dia. and screw 3/8 in. × 32. Part off at a full 5/8 in. from the shoulder, reverse in chuck and take a slight skim off the end, to true it up. One boss is then tapped 3/16 in. × 40 for 3/8 in. depth. The other is opened out with letter R or 11/32 in. drill for 1/2 in. depth, and tapped 3/8 in. × 32 Screw the bosses tightly into the steam chest, with a smear of plumbers' jointing on the threads. Should the threads be slack (taps and dies don't always cut exactly to size, especially when worn) don't use the jointing, but sweat them in with soft solder after screwing. This is quite O.K. as they never have to be removed.

To machine a chest with integral bosses, chuck by one boss in the three-jaw, and set the other to run truly. Centre it with a centre-drill in the tailstock chuck, then put the centre-point in the tailstock and use it to support the boss while turning it to size and facing off to length, as far as the point will allow. Then put the tailstock chuck back, drill the boss right through with No. 21 drill, tap 3/16 in. × 40 for 3/8 in. depth, and take a slight truing-up skim off the end. Reverse in chuck, and grip by the machined boss; repeat operations on the other one, but this time, after drilling, open out and tap for the gland, as described for the separate boss.

If a milling machine is available, milling off the top and bottom is a piece of cake, holding the casting in a machine-vice on the table, and running it under a slabbing cutter on the arbor. If not, use the lathe with the machine-vice bolted to the saddle, and the casting set at such a height that a cutter on an arbor between centres, will true up the face of the casting

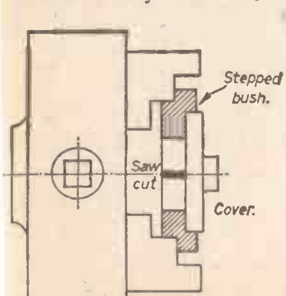


Fig. 47.—*How to set up covers for finishing.*

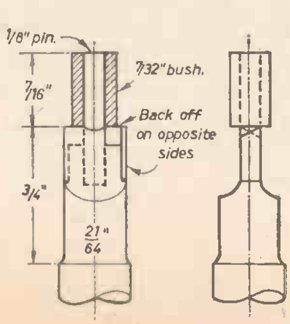


Fig. 48. (*Left*)—*Special pin drill for piston lands.*

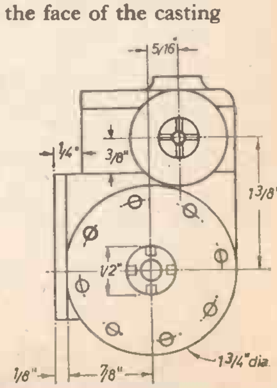


Fig. 49. (*Right*)—*Back end of R.H. cylinder.*

between the bosses. Use the widest cutter available, and take sufficient cuts to cover the whole surface.

Careful hand work would also do it, holding the casting in the bench-vice, and smoothing the face between the bosses with a big flat second-cut file held horizontally. I never despise hand work, having done enough of it, goodness only knows, in the days when I was in a perpetual state of "financial embarrassment." Incidentally, anyone not possessing a vertical slide, could cut the ports by hand, as I did in the days mentioned. Just drill 1/8in. holes 1/4in. deep inside the marked lines of the ports; one row for the steam ports, and two for the exhaust, Chip away the surplus metal between the holes, with a couple of little chisels made from silver-steel, 1/4in. wide for the sides, and 1/8in. wide for the ends, which may be left square instead of rounded. Take care to avoid chipping outside the marked lines, and making the ports too wide.

For the gland, chuck a piece of 1/2in. round bronze or gunmetal rod, face, centre, and drill to 1/2in. depth with No. 21 drill. Turn 1/2in. of the outside to 3/8in. dia. and screw 3/8in. × 32. Note—the thread must be a very good fit in the steam chest boss, so that the gland doesn't work out when the engine is running. Part off at 7/16in. from the end, and cross-slot one end with a thin flat file such as used for key cutting.

The steam chest cover will have a boss cast on it for attachment of the steampipe flange, corresponding to the boss on top of the piston-valve cylinder. Face this off and drill it 7/32in. Leave the screwholes for the time being; they are located when erecting the steam pipes. Chuck the cover in the four-jaw, and face off the plain side. Put it on the steam chest, clamp chest and cover together, and drill the holes in the cover, using those in the steam chest as guides. Countersink them on the flange side of the cover, then round off the outer edge for appearance sake, as shown in the end view of finished cylinder.

Clamp the steam chest to the portface of the cylinder with the outer edges flush, as shown in the end view and cross-section. Run a No. 34 drill through the holes in the steam chest, making countersinks on the portface. Remove chest, grip the cylinder in a machine-vice on the drilling-machine table, with the portface horizontal. Drill the countersinks No. 44, to 3/16in. depth. The middle hole on the inner side will pierce the exhaust way, which doesn't matter an Aswan; and the drill can be run right through the lip on the outer side, which makes tapping easier. Tap the lot 6 BA, and be mighty careful to avoid breaking the tap in the blind holes. It is easily done; stop immediately you feel any resistance.

Cylinder Covers

The only difference between the covers for the p-v and s-v cylinders is that the latter are 1/16in. less in diameter. Chuck by the spigot, and set to run as truly as possible; any wobbling is easily cured by a tap with a hammer, as the metal is ductile. Turn the edge to diameter shown, face off, and with a knife tool, carefully cut back the rim for 1/32in. leaving a projection, or register, that will fit the cylinder bore without shake. This is very important on the back covers. Leave the front covers solid, but centre the back covers, and run a 7/32in. drill through them.

The best way to hold the covers for turning the outsides, is to put them in a stepped bush in the three-jaw, as shown in Fig. 47. A metal ring (any kind, except aluminium would do) approximately 2 1/4in. dia. and 3/8in. thick, will be needed for the bush. Maybe our advertisers will supply a casting, with a 1 3/8in. hole through it. Chuck this as truly as possible in the three-jaw, face it off, and turn a step in it about 1/4in. deep and 3/16in. long. Reverse in chuck and grip by the step. Face off, then with a knife tool set crosswise in the toolholder, working from the hole outwards, turn a recess 3/32in. deep, to the exact diameter of the cover, which should fit the recess without a vestige of shake. Put a centrepop on the face of the ring or bush, opposite No. 1 chuck jaw. Remove from chuck, slit one side of the ring with a hacksaw, and replace with the pop mark opposite No. 1 jaw. Should there be any burr at the sawcut, scrape it off, then put the cover in the recess, making sure that the turned side of the cover is pressed tightly home against the back. If the chuck jaws are now tightened, the cover will be held both tight and true.

The front covers only need facing off to 1/8in. thickness, and very slightly chamfering, just enough to take off the sharp edge. The back covers are also faced to the same thickness, but the boss is turned to 1/2in. dia., and faced off so that it stands 1/4in. proud of the cover; see longitudinal section. The centre hole should be opened out for tapping with a pin-drill, as it is essential for easy working, that the gland should be true with the hole. An ordinary drill doesn't always follow a smaller hole truly, and if the holes in gland and cover don't line up, the piston-rod will bind. The pin-drill should be 21/64in. dia. with a 7/32in. pilot, and is easily home-made from a bit of 3/8in. silver-steel, about 3in. long (Fig. 48). Chuck in three-jaw and turn about 3/4in. length to diameter given. Face, centre, and drill to 3/8in. depth with No. 31 drill. File away each side to meet the hole, back off the end at each side to form cutting edges as shown, harden and temper to dark yellow (same process as described for D-bits), press 3/4in. of 1/8in. silver-steel into the hole, and put a 7/32in. bush over the end to fit the hole in the cover boss, and you're all set.

Put the pin-drill in the tailstock chuck and drill the boss on the cover to 5/16in. depth, then tap 3/8in. × 32, guiding the tap with the tailstock as described for tapping crankpins. Turn the glands from 1/2in. bronze or gunmetal rod, round or hexagon as desired. Chuck a piece, face, centre, drill No. 21 for 5/8in. depth, turn 5/16in. length to 3/8in. dia. and screw 3/8in. × 32. Part off at 1/8in. from shoulder. If round rod is used, file or mill four C-spanner slots in the head as shown in Fig. 49.

Drill the screwholes by jig. Get a steel washer the size of the cover, chuck it, and bore the hole to a tight fit on the register that fits in the cylinder bore. Set out and drill No. 34 holes in the washer, as shown on the cover in the back view of cylinder. Put the drilled washer over the register, hold it tightly to the cover with a toolmaker's cramp, and drill the holes in the cover, using those in the washer as guides. This saves bags of time!

The covers for the p-v cylinders will need filing at the points indicated in the drawing, to clear the flange plates and steam-chest bosses. Those for the s-v cylinders should fit without filing, being a little smaller. When fitting, set them so that the screwholes are clear of the passageways at each end of the bores. Run the No. 34 drill through the holes in covers, making countersinks on the cylinder flanges. Remove

(*Continued on page* 39).

SCIENCE NOTES

Satellite Fuel Feeder

PICTURED on the right, for the first time, is a new satellite fuel feeder which is considered a major development in ground equipment for the launching and orbiting of an Agena satellite in the Discoverer, Midas, and other advanced U.S. Air Force programmes.

The unit feeds, and also regulates, the flow of temperature-conditioned propellent to the satellite and booster at the rate of 40 gallons per minute with a near perfect accuracy of 99·9 per cent. Although this is its main use, it can also take back fuel drained from the vehicle in the event of a faulty launching.

The new satellite fuel feeder.

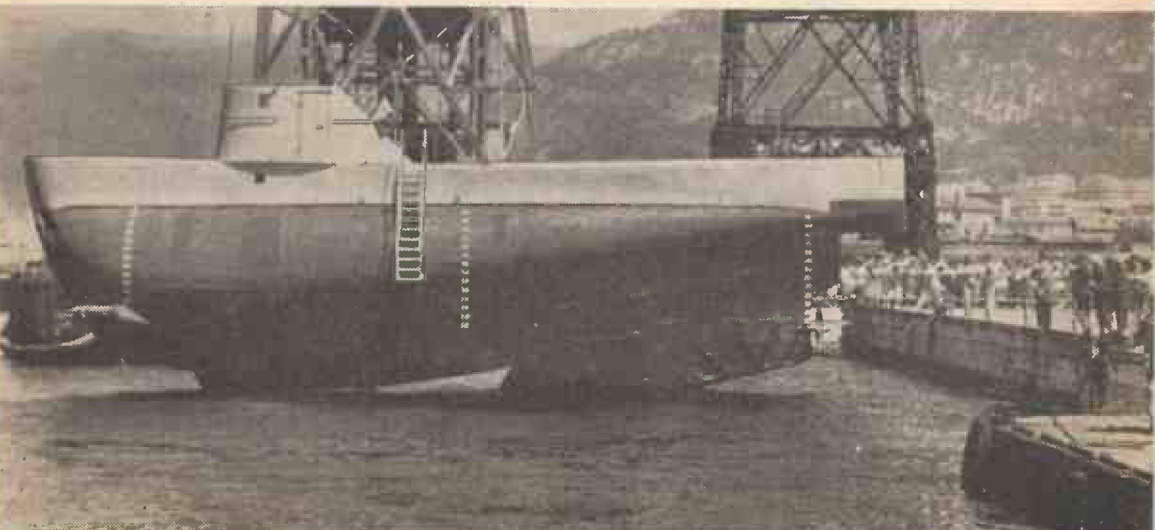
New Ignition System for 2-Strokes

AN ignition system claimed to meet all the major problems of the two-stroke engine is announced by Wipac Group Sales Ltd., Buckingham. The system, known as the "Magister," employs a high frequency condenser discharge principle with a high rate of spark. The problem of ignition failure caused by excess oil or dirt on the contact breaker is overcome by employing the closing of the contact points to produce the spark.

Basically, the "Magister" system varies from the conventional method of magneto ignition by the existing H.T. ignition coil being replaced by a feed coil. A.C. current, induced from this in the same manner as usual systems, is then converted to D.C. through a small rectifier which, in turn, charges a condenser. The charge is retained by the condenser until the contact breaker closes. At this point the store current is discharged through the ignition coil, which again uses primary and secondary windings, producing a high voltage which is taken to the sparking plug by H.T. lead.

The "Magister" high frequency ignition system.

(Below) Launched at Toulon recently was the new French Super-Bathyscape, designed by Commander Huot and capable of descending to depths of 11,000 metres.



A RADIO CONTROLLED MODEL SHOOTING BRAKE

PART II

The electrical and radio control systems are described in this concluding instalment.

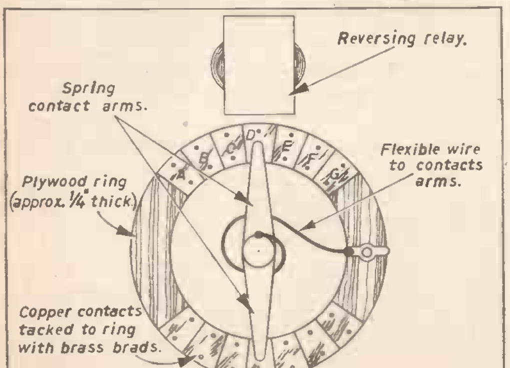
FOR the satisfactory radio control of a model vehicle a different form of control is necessary from that which may be used for model aircraft or boats. Four completely independent control channels are the minimum which can be employed and these are obtained by pulse methods in the author's model, although they could, of course, be obtained in other ways, e.g. tuned reeds. Two of these channels are used for the steering control and the other two for engine speed. Engine speed controls are also used, by means of delay circuits, to operate hooter and lamps (after an engine speed command has been given and accepted). The steering gear has already been described in article No. 1 and the engine speed control unit will now be described.

Engine Speed Control Unit

This unit makes use of the reversible sequence system. The unit is constructed on a piece of plywood and Figs. 7 and 8 show the contact side and the driving side respectively. It will be seen that two servo motors (Ever Ready) are used to drive cord operated levers which engage with the brass ratchet wheel. A current impulse to either motor will cause it to operate, the cord to be wound on to the short extension spindle, the lever pulled up to its stop and the ratchet wheel turned through 15 deg. This takes a fraction of a second to work and its effect is almost instantaneous. The servo motor is stalled on load, but seems to take no harm. On release the tension spring returns the arms to neutral and unwinds the cord. Either servo can be used as required and the model made to go one step faster or slower at will. The method used for wiring this control unit from the batteries via the reversing relay to the twin propulsion motors is given in Fig. 9. A double pole master on/off switch is required. The reversing relay should be capable of operation from a 6V. supply. The servo motors should be suppressed against electrical interference by joining a 0·1 μF condenser from each brush to a suitable small metal "earth" plate. Very short leads should be used. The propulsion motors may not need suppressing—this depends upon the receiver sensitivity. It is good practice, however, to suppress all motor bushes just "in case." They may not affect the model, but they affect the neighbours' T.V. The small resistance used for the second speed must be chosen by experiment. In the original it consisted of about eight turns of wire from an electric fire spiral.

Intergear

The term intergear is used to describe the system of relays etc., between the radio receiver proper and the servo motors, lamps, hooter, etc., which carry out the functions of working the model. In this model the circuit, which is quite involved, can best be understood by breaking it down into its basic parts. Fig. 11 shows the circuit used for steering control. Relay 1 is the receiver relay and is normally maintained steadily pulsing from side to side (Mark/space ratio approx. 50/50) at a rate of about 8/10 per second. Relays 2 and 3 are, therefore, operated in turn from the 12V. battery. The two 100 μF slugging condensers (these are 12V. bias type electrolytics) are also charged and have the effect of maintaining the two secondary relays (Ry 2 and 3) closed all the time. If pulsing is stopped, however, by sending a "Mark" or a



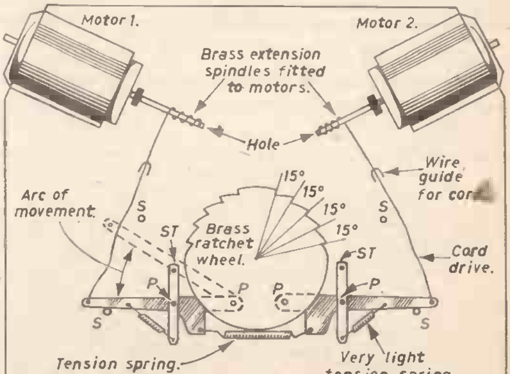


Fig. 7.—Engine speed control contact side. A = full speed ahead. B = half speed ahead. C = slow speed ahead. D = Stop. E = slow reverse. F = half reverse speed. G. = not used. Fig. 8.—(Right) Engine speed control drive side.

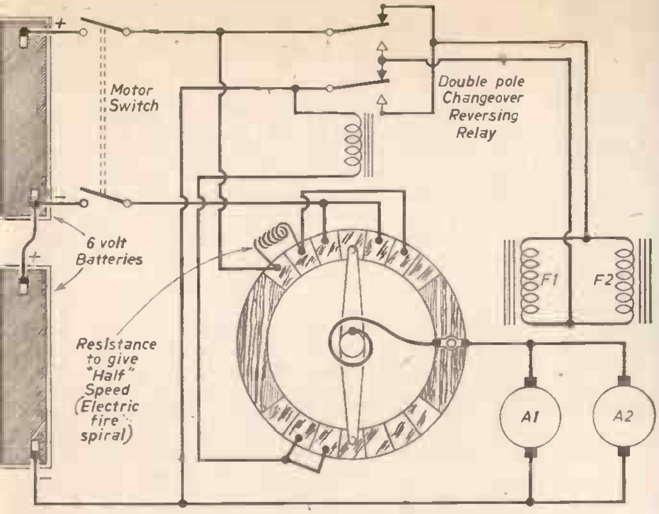


Fig. 9.—Connecting the speed control unit to batteries and motors. F = field and A = armatures.

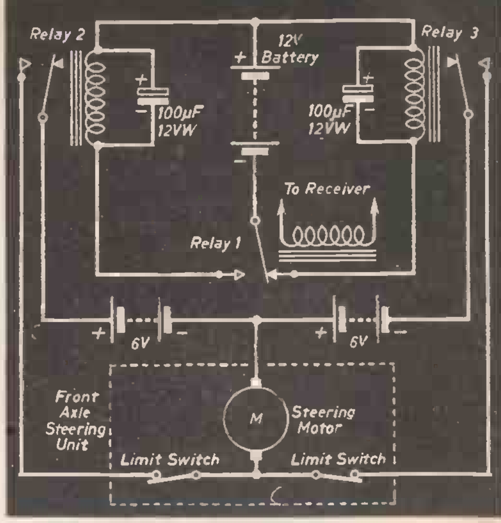


Fig. 11.—Steering motor circuit.

" Space " either Ry 2 or Ry 3 will drop out, thereby operating the steering motor. Note that the steering motor does not follow the mark/space pulsing and only works when a definite command is transmitted.

A further point about this circuit is that Ry 2 and Ry 3 will hold in regardless of the pulsing of Ry 1, providing that it pulses at a rate higher than a certain critical frequency. The critical frequency is controlled by the spring tension of the relays and by the size of the slugging condensers. 100 µF condensers were used in the original but 200 µF would probably make adjustment easier. The secondary relays will hold in at all frequencies above the critical and at all mark/space ratios (within reason). This fact enables use to be made of other circuits capable of differentiating between rates and ratios.

Fig. 10 shows the circuit used to distinguish between slow and fast pulses. This circuit is described by Mr. G. Sommerhof in his book and has been found to work very well. Ry 4 is the receiver relay and the reed is constantly moving between the two contacts. As it does so it alternately charges and discharges the two electrolytic condensers C1 and C2. The 22Ω resistor prevents contacts sticking due to arcing. The current for the charging of these condensers passes through the coil of Ry 5 which is slugged by C3. R1 controls the current flow. If a meter is placed in the HT battery circuit and Ry 4 set pulsing it will be found that the current flow depends upon the pulse rate or frequency, i.e. increasing the pulse frequency causes an increase of current. This increase is arranged so that Ry 5 closes on fast pulsing and opens on slow.

Fig. 12 shows the circuit used to discriminate between pulse ratios. Ry 6 is the receiver relay and Ry 7 is the controlled relay. If Ry 6 pulses more on the back contact "A" than on the front contact "B" then a greater current will flow through Ry 7 than if the pulsing is of the opposite ratio. The circuit is therefore arranged so that Ry 7 closes on—say—20/80 pulsing, but opens on 80/20.

The HT battery voltage used must be chosen to suit the relay resistance, etc., and 60 to 90V. have been used by the author when using Siemens' high speed relays with 2,000Ω coils. Fig. 13 shows how the relay contacts of Rys 5 and 7 are used together and integrated with a further delayed relay Ry 8 which is a double pole changeover relay slugged with 1,000 mfd. The 10Ω resistor is again to prevent contacts sticking through arcing. From the contacts of Ry 8 the engine speed control servos M1 and M2 are operated, also the horn and the lamp control servo.

These three circuits are the " bricks " used for the complete control system. Pulses, which are generated in the hand held control box, are transmitted via the radio link and operate the servos as follows:
(*a*) 50/50 ratio 8/10 per second: Neutral i.e. no action from any servo. The model proceeds in the direction and at the speed last directed. (*b*) Mark/Steer left. (*c*) Space/Steer right. (*d*) 80/20 ratio 25/30 per second. Increase speed. (*e*) 20/80 ratio 25/30 per second: Reduce speed. (*f*) short pulses of (*d*) are required to increase speed—if a long pulse is sent—and held on —the hooter blows. (*g*) short pulses of (*e*) are required to reduce speed—if a long pulse is sent—and held on

Fig. 10.—Frequency sensitive circuit.

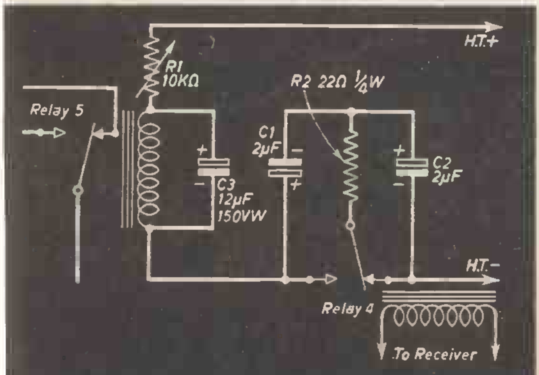
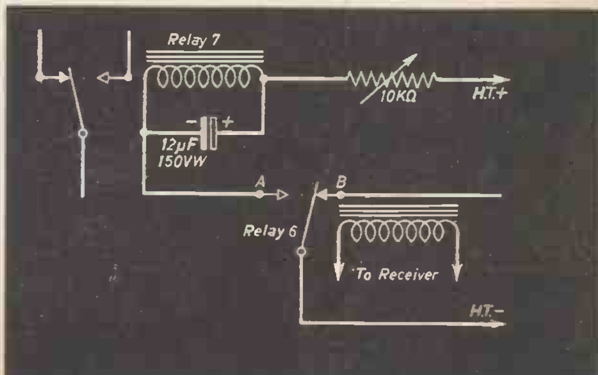


Fig. 12.—Ratio sensitive circuit.



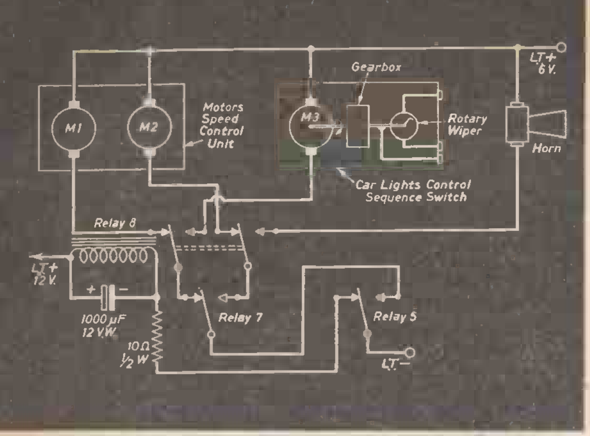


Fig. 13.—Connections of frequency and ratio circuits to servos.

—the lamp control servo motor operates and switches on and off the vehicle lights in sequence.
The three circuits can, therefore, be used to separate the various pulse forms received in the model and operate the appropriate servos.

Fig. 14 shows the composite circuit embodying all three basic circuits. As each of the three basic circuits employs a " receiver " relay and as the average receiver will only satisfactorily operate one relay Ry 6 is chosen to be the relay worked from the receiver and relays 1 and 4 work from it as slaves. Ry 6 is, therefore, the only one which needs to be a high resistance relay (3,400Ω Siemens High Speed was used by the author) whilst Rys 1 and 4 can be low resistance slaves working from 6V. source. 145Ω coil Siemens were used here by the author. Ry 5 and Ry 7 were 2,000Ω coil Siemens relays and Rys 2 and 3 were 145Ω Siemens. Ry 8 should be capable of operation on about 6/8V. leaving a good margin for the delaying action. A miniature D.P.C.O. relay was used here with a coil resistance of 170Ω. The whole unit was built on a paxolin panel and tested before being incorporated in the model. Connections to the various servos, radio, batteries etc. were made by means of small multi pin plugs and sockets of the type used for connecting deaf aid and other types of batteries. These are light and effective. A master on/off switch was arranged to cut off power from the 6/12V. source and from the H.T. battery used to supply the pulse circuits. A separate radio switch is preferable.

If the reader has not previously had experience of the basic circuits used for this system it will be found very helpful if they are wired together first on the bench in " hook up " fashion and tested. Relay setting can then be carried out and will be found to be most important. The current flow from the H.T. supply can also be checked for variation at different pulse rates and ratios. The whole unit can then be built and little difficulty should be experienced.

The Lighting Servo Mechanism

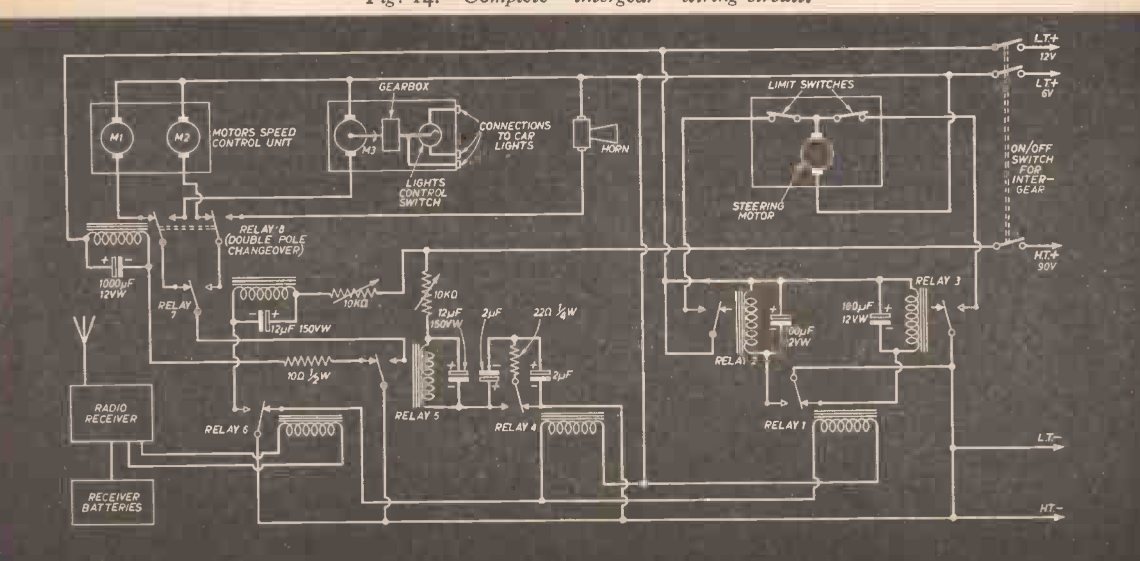
In the original only the headlamps, tail lamps and number plate lamp were made to function. A whole host of other lamps could of course also be made to work if the builder has patience to incorporate them all. The lamps are made to light in any given order by a simple sequence switch and in the author's model this was worked by an Ever Ready motor, driving through a small gear box (using two sets of worm gears) and operating a cam which opened and closed lamp contacts. This is positioned in front of the front axle—this being the only place left for it! The headlamps are able to give very convincing beams of light in the dark and it is very interesting driving the model in the dark by the light of its own lamps.

The Transmitter and Control Box

As already stated the transmitter can be of any type capable of radiating pulses and need not be of the modulated variety unless the receiver used should happen to need a modulated transmitter, e.g. some of the valve/transistor receivers now on sale need modulated transmitters. The author uses a single valve transmitter and this gives quite adequate range for a model vehicle.

The control pulses for the system are generated by a multi vibrator contained in the hand held control box. The control box contains its own power supply battery and the pulses are fed to the transmitter over a 6ft. length of coaxial cable. It is important to note that in this circuit the control box must be operated by a separate battery—the transmitter battery must not be used. Fig. 15 shows the circuit of the multivibrator. Two 1S4 valves are employed but could be replaced with 3S4 if the necessary change of filament

Fig. 14.—Complete " intergear " wiring circuit.



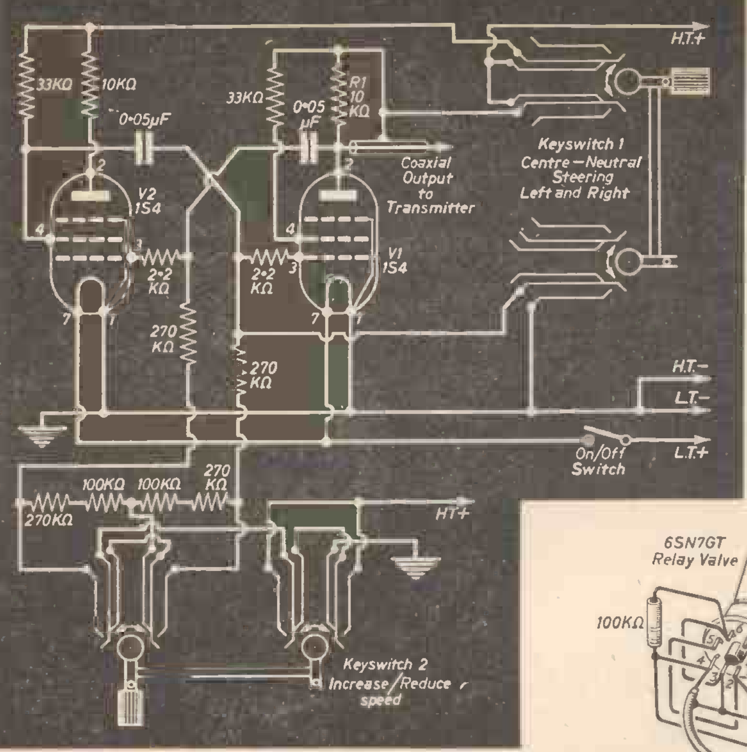


Fig. 15.—The multivibrator control box.

connections is carried out. Keyswitches are used for steering and engine speed controls these providing readily the three positions required for each, also the necessary contacts. Double bank contact types are used—the contact banks being shown side by side in the figure for easy reference. Keyswitch No. 1 is the steering control and acts by cutting off HT to either half of the M/V thereby causing a voltage to appear across R1 on " Space " and the voltage to disappear on "Mark." Due possibly to leakage a slight tendency to continue pulsing was noted in the original and this was removed by earthing the grid of V1 during " Mark ". It may be found necessary also to earth the grid of V2. Keyswitch No. 2 is used to give engine speed control and, when operated, it does two things (*a*) increases pulse rate and (*b*) sends either 80/20 or 20/80 according to which way it is operated.

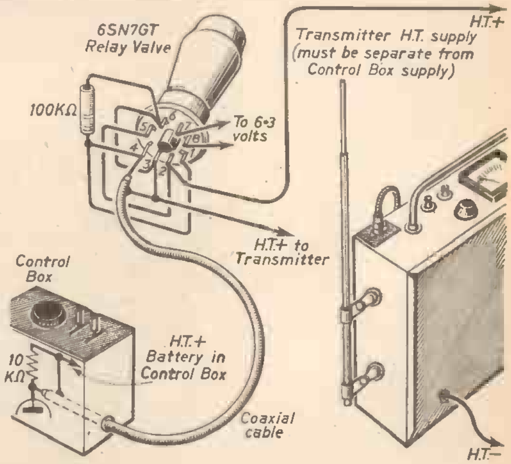
The increase in pulse speed is obtained by returning the grid leaks to HT positive instead of negative and the asymmetry of pulse by unbalancing the ratio of the grid leak resistances.

The whole unit is constructed on an aluminium chassis with an ebonite top onto which are mounted the keyswitches and on/off switch. The unit with battery is contained in a small plywood box and fitted with the coaxial lead to the transmitter.*

The Relay Valve

Fig. 16 shows the method of connecting the control box to the transmitters by means of a keying or relay valve. This is a 6SN7 in the writer's equipment and as this is a valve with separate cathodes the heater power can be drawn from the transmitter LT supply (6V.) Some voltage drop occurs, however, due to the internal resistance of the 6SN7 and this must be allowed for by increasing the HT input to the transmitter. If battery valves are used in the transmitter a separate battery must be used to heat the filament of the relay valve (this could be a 3S4 with screen and anode strapped together—be careful not to exceed the current carrying capacity of the 3S4. If need be, use two valves in parallel). It may be considered that the use of a relay valve is too complicated although the writer has found it to be highly satisfactory in operation and if so, an ordinary

Fig. 16.—Method of connecting control box to transmitter via relay valve.



high resistance relay could be used in place of the 10k. load of V1 and the transmitter keyed via its contacts. Adjustment of the relay tension here, however, will be found to alter the Mark/Space ratios and may upset the setting of relays in the model.

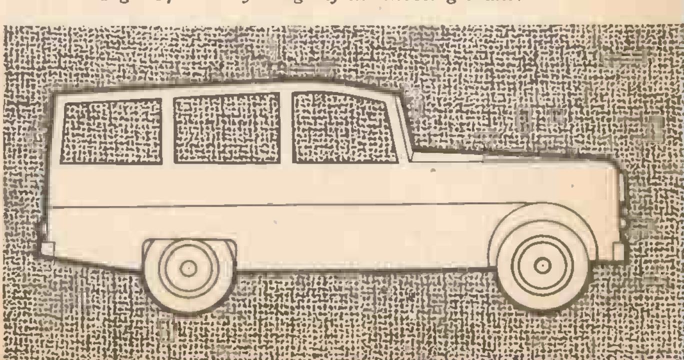
Alternative Control Boxes

If the reader desires a simpler type of control box there is no reason why a mechanical pulse box should not be made up to give the required pulses which can be selected by the appropriate switch.

A further alternative which may appeal to the reader is the use of a transistorised multivibrator. This can be made very small and has the virtue of needing only a small low voltage battery. Keying the

(*Concluded on page* 39).

Fig. 17.—Body design of the shooting brake.



* *The co-axial plug and socket at the transmitter should be insulated as these are at H.T. potential and could give a shock.*

Satellite Communications TESTS

A Commercial System will be operating within 10 years

A solar cell and transparent sapphires being attached to a developmental model of a communications satellite.

ONE of the most assured of all space projects appears to be satellite communications systems.

Already several American companies are well ahead with their plans, and Sir Ronald German, Director-General of the Post Office recently stated that, although there was still much technical work to be done, commercial communications by satellites was possible within the next ten years. The Post Office, he added, already had a site for the erection of a ground radio station, in Cornwall, with a large steerable aerial system for the tests.

Prototype Unit

The American Telephone and Telegraph Company has now received U.S. Government approval to develop TV and voice communications via space satellites on an experimental basis. The plan calls for the launching of a prototype unit to operate for 35 minutes, four times a day, using a 4ft. diameter satellite. Other plans for experimental tests of satellite communications, in which the G.P.O. will take part, will start next year. The U.S. National Aeronautics and Space Administration will launch the satellites.

Approximately 24 ground-based stations and possibly a dozen satellites would be required to provide a continuous 24-hours-a-day service to pick up broadcast messages and amplify them before they were relayed back to earth.

Before the use of satellites for commercial communications becomes practical, however, it is imperative that they become competitive with the submarine cables now in use. In this respect, some 1,500 electron tubes have functioned under the oceans for the past two to six years without failure.

Sapphire For Protection

Until now, most satellites have been designed for short-term experiments in space. The Bell Telephone Laboratories, however, have now developed thousands of pieces of man-made sapphire to cover the surfaces of communications satellites—to protect solar cells from space radiation—enabling "working" telephone satellites to endure the rigours of space for ten years or more. They are using an approach evolved in developing their submarine cables.

Satellite engineers study the problems of satellite structure, surrounded by various developmental models of satellites. The structure being held is a frame for attaching electronic equipment inside the satellite.

The Bell System has previously announced plans to develop a satellite communications system and put it into operation as soon as possible. A ground station in Maine will be ready early next year. The first test satellite will be ready at the same time, if the U.S. government designates a launching vehicle soon. The Bell System has offered to pay the costs of the rocket and launching.

The first experimental 'phone satellite will be roughly spherical but may have as many as 60 flat surfaces or gem-like facets. The solar cells on each facet would receive an equal amount of light.

The solar cells are small silicon wafers mounted on the outside surface to convert sunlight to electricity. The sapphire sheathing will protect the solar cells from the deteriorating effects of electron bombardment in space. It will also reduce the effects of proton bombardment.

Two different sizes of test satellite—with diameters of 27in. and 4ft.—are being considered for experiments. More than half the surface of the smaller one would be covered by over 4,000 Bell solar cells; the larger satellite, by 12,000 cells.

Covering the cells will be an equal number of slices of man-made, crystal-clear sapphire. Other protective materials are not being ignored, although sapphire appears most promising.

The sapphire does not cost significantly more than other high-quality materials, and only about one-third of the cost of the solar cells themselves Sapphire has other advantages. It will convey heat away, preventing the solar cells from being overheated in long periods of continuous sunlight.

Another advantage is that the use of sapphire overcomes the effects of very rapid and extreme changes in temperature. Most materials expand when heated, but by different amounts. If the rate of expansion differs too much, the materials will not stay fastened together.

The sapphire slices will be brazed to platinum sidebars which will be soldered to a ceramic base. These materials were selected because they all expand at very nearly the same rate. In addition, sapphire, being hard, will resist erosion by micrometeorites.

Reliability Tests

Under the reliability approach evolved in the development of submarine cable and other systems, the goal is to assure a predictable long life for the entire system. To do this, engineers must develop each individual component to such a reliability that its individual predicted life-length is far greater than the goal for the overall system. Environment must be studied—whether it is two miles beneath the sea or 4,000 miles above it—and all the conditions and hazards defined.

Then, in an artificially simulated environment, the effects of the hazards are intensified to make the components fail. Engineers then redesign until they can predict accurately the reliability of a required component. Finally, a real-life test programme is conducted to confirm that the system performs as predicted. Unfortunately, the space environment is not yet known precisely. The exact amounts of radiation in space, at various altitudes and under varying circumstances, have not been measured. In this respect, engineers will use their first experimental satellites to take additional measurements of space radiation and to serve as a first " real-life test " of components planned for a working satellite system.

When satellite communications systems go into effect, they will reduce the cost of transatlantic telephone calls from pounds to shillings.

An assembly of solar cells, with a covering of man-made sapphires, being set into place.

for cats and

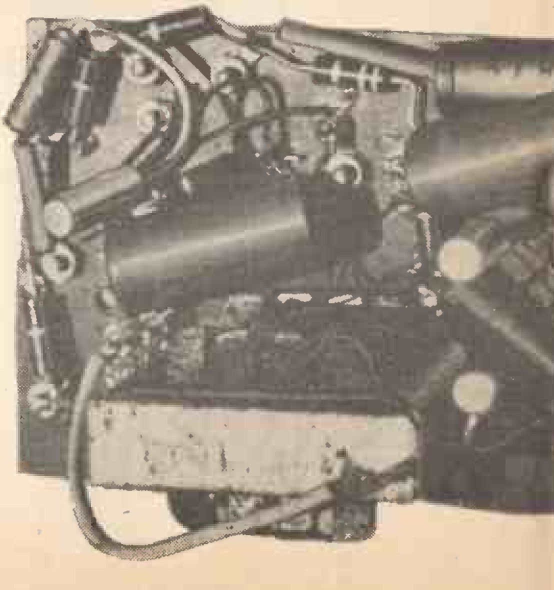
A TRANSISTOR RE

THE photographs show the record player in use and being carried. The cabinet top is a removable speaker which can be stood some distance away from the motor unit, this being good practice where a powerful amplifier is used and good quality reproduction is required. However, readers may hinge the lid if they prefer.

Fig. 2. is an underneath view of the player. The battery compartment is visible at the bottom, the amplifier (constructed on a paxolin board) is screwed to the left side of the cabinet and the on/off switch volume control (X, Y, Z) motor speed control (H, J, K) and the 8V. motor are all seen on the underside of the motor panel.

Construction

The wooden cabinet, together with the lid, is made up first. It is fitted with the motor panel, battery compartment and the pick-up unit. The speaker is mounted in the removable lid. The amplifier is then constructed and tested with the motor and speaker.



MATERIALS REQUIRED

Cabinet

Prepared ½in. softwood.
2 Pieces 9in. × 3in. (Cabinet sides).
2 „ 7½in. × 3in. (Cabinet sides).
2 „ 9in. × 4in. (Speaker sides).
2 „ 7½in. × 4in. (Speaker sides).
1 „ 7½in. × 2in. (Battery compartment).
3 „ of hardboard 9in. × 8in. (top, bottom and motor board).
2 Attaché-case type clips, panel pins and ½yd. of heavy type Fablon.

Amplifier

1 piece of Formica or paxolin 4½in. × 2½in. exactly.
Toggle Switch, any type will suit.
Transformer 1, Repanco TT21.
Transformer 2, Repanco TT22.
Speaker, elliptical 6in. × 3in. approx. 3Ω.
Volume Control, 1 MΩ potentiometer.
Speed control, if not supplied with motor, 80Ω.
Transistors. Mullard Audio Package containing:—
2 OC81's
1 OC81D

Resistors

(All 10 per cent., ½W. unless otherwise stated).

R1 220KΩ	R6 680Ω
R2 10KΩ	R7 2·2KΩ (5 per cent.).
R3 33KΩ	R8 39Ω (5 per cent.).
R4 15Ω	R10 (See text), 3·3KΩ
R5 390Ω	

Condensers

C1 „ „ 50μF, 10—24V. working.
C2 „ „ 100μF, 6—24V. working.
C3 „ „ 100μF, 10—24V. working.
C4 Miniature electrolytic 10μF, 6—24V. working.

Sundries

Two dozen 6 B.A. nuts and bolts, solder tags, red, black and green insulated fine connecting wire, cored solder and clips from an old PP9 or OT9 battery.

All these parts are obtainable from Messrs. Henries Radio Ltd., 5 Harrow Road, Edgware Road, London, W.2. No substitute parts should be used by inexperienced readers.

Motor and Pick-up Unit

The prototype uses the Garrard BA1 unit (which works off an 8V. supply) and other battery operated units may be used provided the motor panel is cut to suit. The BA1 unit is available from Messrs R.S.C., 29 Moorfield Road, Leeds 12.

quares

ECORD PLAYER

The parts are then all removed and the cabinet is covered in " Fablon " to give a " commercial finish." The parts are replaced carefully to complete the record player.

The Cabinet

Refer to Fig. 2, and make a frame with two 7¼in. battens and two 9in. battens. The motor panel is now cut to size and pinned on lightly only, making sure the " box " is quite square. The bottom is then cut from the same material, but is fixed with screws as it has to be removed to replace the batteries. The edges are then sanded all round and marks made so that two panels may be replaced exactly the same way round later on.

Motor and Control Panel

The panel is removed and a hole has to be cut in it to accommodate the motor unit. If the Garrard BA1 is used the hole will need to be similar to that of Fig. 3, where it is shown three-eighths actual size. The main point to watch is that the three motor deck fixing holes are correctly placed and that the motor unit, when fitted, does not touch the board at any point. Rubber washers are provided and the motor is simply placed on TOP of the board and bolted with 6 B.A. or similar nuts and bolts.

The control panel holes will probably be as shown, but this will depend on the parts purchased. When ready the panel is pinned permanently to the " box." The 7¼in × 2in. batten is then pinned inside to leave a battery compartment measuring exactly 2in. × 7⅛in. If this is made any larger some packing material will be necessary to prevent the batteries moving about.

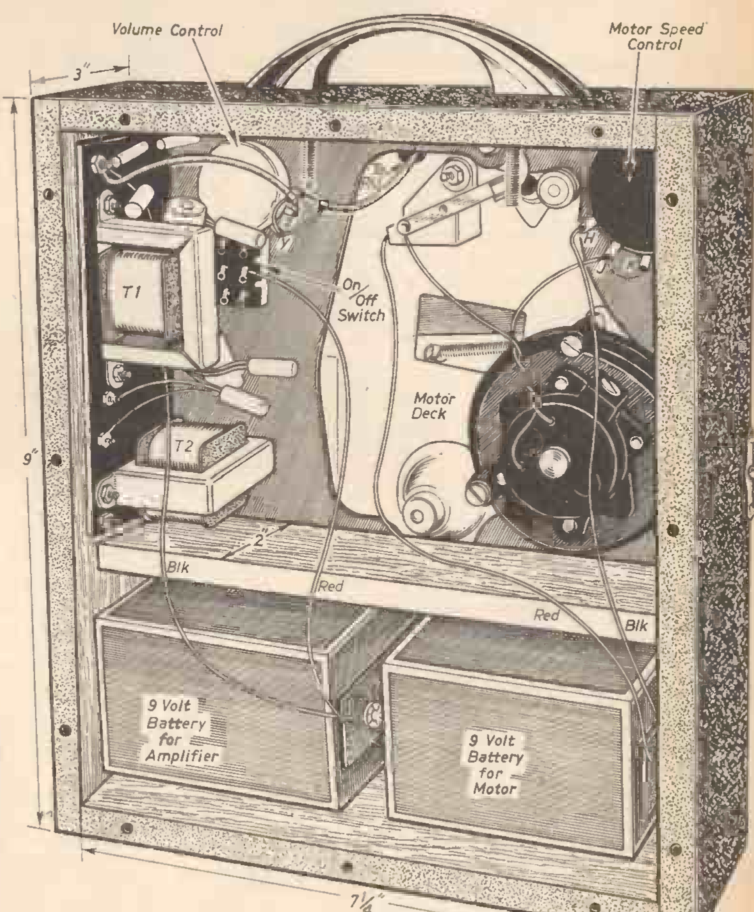


Fig. 1 (Left).—A view of the amplifier chassis.

Fig. 2 (Right).—General arrangement view of the underside.

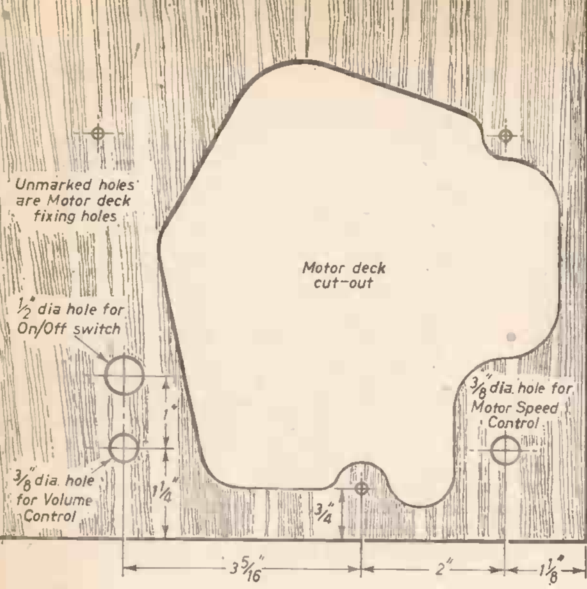


Fig. 3.—The cutaway portion and drilling positions of the motor board.

Wiring the Motor Unit

When fitted there are only two wires present which require connecting. These are red and black and are fitted with battery clips for the positive and negative poles of a PP9 or OT9 battery. On moving the pick-up carefully into the "play" position the motor will automatically start. Fit the speed control in the hole shown in Fig. 3. Split the black wire and take the motor part of it to one of the side tags (K) of the speed controls. Join this tag and the central one (J) together. Now join the battery part to the spare tag (H) of the speed control as shown in Fig. 2 Test with a stroboscopic disc and make sure a speed of 45 r.p.m. with the stylus resting on a record is obtainable.

The Amplifier

This is made on a piece of Formica measuring 4½in. × 2½in. Various holes about ⅛in. dia. are required, the exact position of them is not important except for the 2in. distance between C and D and V and K of Fig. 4.

The beginner is now advised to stick some white paper on the Formica and to label the holes with the letters as in Fig. 4. Holes X and Y are best *left undrilled* until later.

Fixing the Components

The two transformers are the most expensive part of the unit and little drilling should be carried out after they are fitted as very great caution is required to avoid damage. Their positions are shown in Fig. 4. Solder tags are fitted on the nuts and bolts used on both sides of the panel. The transformer with two very thick leads is the TT22 (Tr2).

Every hole is then fitted with a short 6 B.A. nut and bolt and two solder tags. Alternatively brass paper clips may be used. All the tags or clips are tinned with cored solder; components are then fitted as the wiring proceeds.

Wiring

The complete circuit is given in Fig. 4 and this should be followed as the wiring proceeds. Fig. 5 is the theoretical circuit which will only be of use to people used to electrical work, or to a service engineer who is required to service your amplifier.

Start by wiring the transformers in place and then all the resistors. Do not guess at the value of these but check each one with a copy of the colour code if you are not already familiar with it. Wrong wiring here could permanently damage the transistors. Wire the condensers next, paying special attention to getting correct polarity.

Underside wiring is shown in Fig. 6. When completed, check all the wiring carefully, looking for shorts, loose soldering and dry joints.

Fitting the Transistors

These should be obtained as a "LFH3 package" and separate odd ones should not be used. Cost will be about 30s. for the lot.

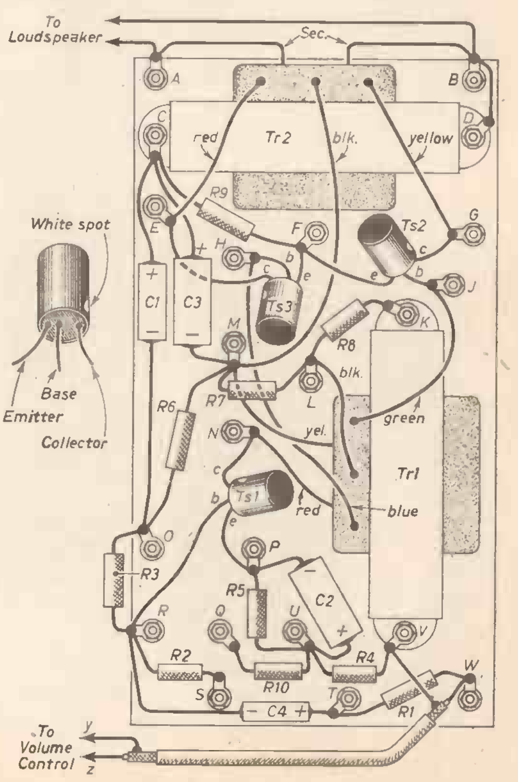
The transistors are marked by the makers and besides the type number there is a white dot on all of them and a blue circle on the driver (OC81D). The leads come out as shown on the left of Fig. 4. It is important to identify these before soldering in circuit.

Sleeving is slipped over the leads, which are left about 1½in. long. The leads are soldered in *quickly* as follows: One OC81 with Base, Emitter and Collector respectively to J, F and G, the other to H, F and E and the OC81D to R, P and N, respectively.

Testing the Amplifier

The amplifier is connected up as shown in Figs. 2, 4 and 6. It is important to note the correct pick-up

Fig. 4.—The complete amplifier wiring diagram.



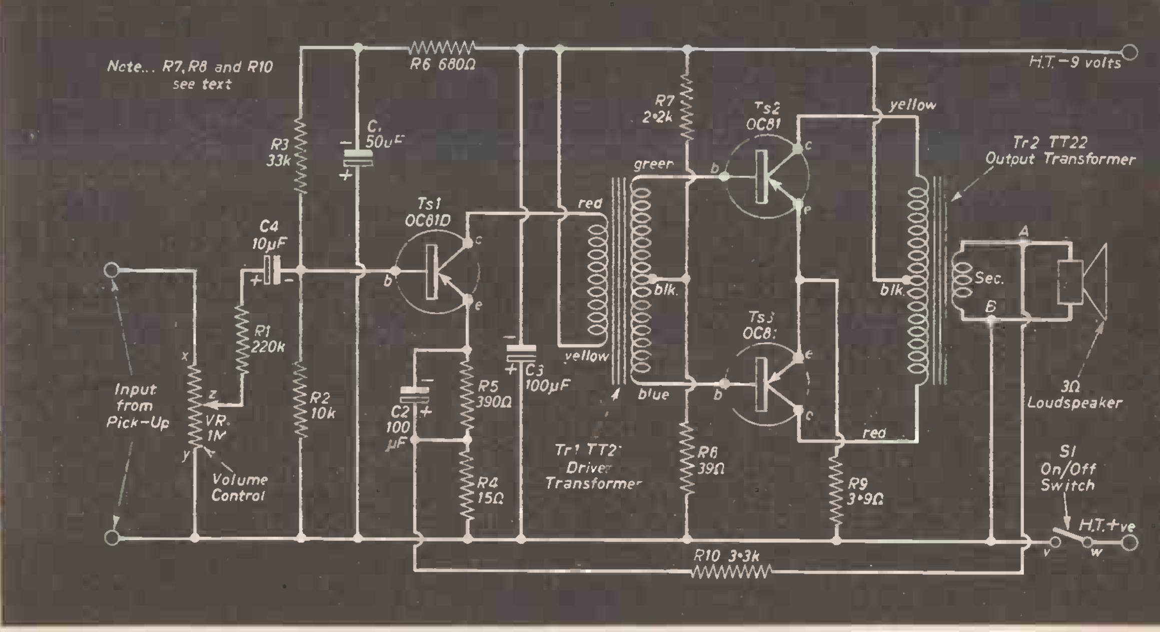


Fig. 5.—Amplifier circuit diagram. Experienced readers may prefer to use this instead of the wiring diagram.

connections. The motor unit as obtained already has the pick-up screened lead wired in and this is connected to either side of the volume control (Y and X) in Fig. 2. Another short length of cable (not necessarily screened) is connected as shown from centre tag of the control to W and from Y (earthy side to the electrician) of the volume control to V on the amplifier (Fig. 4). A separate battery is used to keep the quality of reproduction good. The speaker is placed face downwards on the table for this test. Good volume should be obtained with a fair mixture of bass and treble. More bass may be obtained by attaching a small condenser (about 500 pF. between X and Y of the volume control. Should oscillations occur on test, reverse TR2 connections to A and B.

The Speaker and Cabinet Lid

The various photographs given show the general layout. The lid is constructed in exactly the same way as the motor box. A cut out is made for the speaker and expanded metal fitted to prevent damage to the speaker cone. Although a smaller speaker than is fitted in the prototype will work, the bass response is bound to suffer, but if fitted the lid could be made less high without the speaker fouling the pick-up.

Attaché case clips are fitted to anchor the top to the motor box on two sides. Three pins are driven in the top of the motor box and are made to locate in holes in the speaker case (lid). A carrying handle is then fitted to the motor box.

Covering the Cabinet

Fablon is obtained and cut to size. The bottom and complete motor and speaker are removed. Fablon needs no adhesive and is easily removed if a mistake is made. Wherever possible take it over the edges so that it is held down i.e. by the speaker, motor assembly etc. With care a unit every bit as strong, serviceable and attractive as a commercial record-player can be made.

The various parts are then fitted. The amplifier is CAREFULLY drilled with two holes X and Y of Fig. 6 and is mounted with two screws through them as in Fig. 2. Wiring is then finally completed as for the foregoing test.

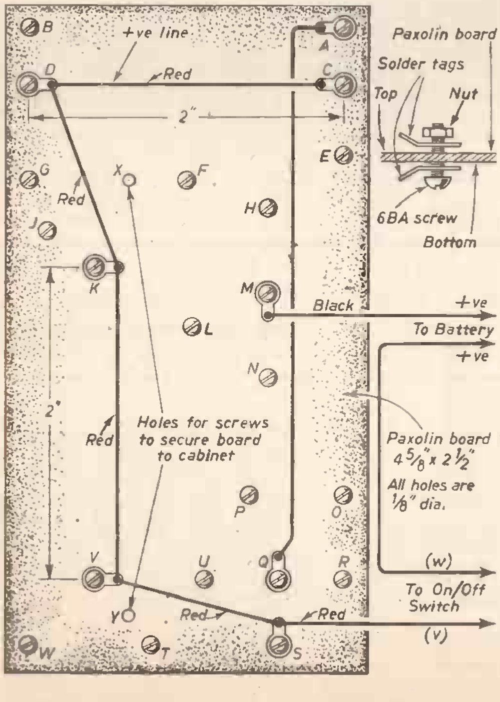
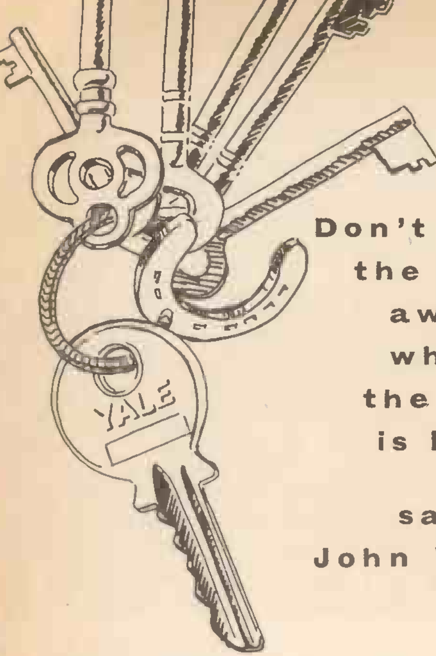


Fig. 6 (Left).—Underside wiring of the amplifier.

Fig. 7 (Right).—The complete record player with the bottom removed to show the layout.

a key for



Don't throw the lock away when the key is lost

says John Waller

AN examination of Fig. 2, which shows a Yale-type lock when the key is not in position, reveals that it works on the principle of a rotating cylinder being operated with a key, the insertion of a key lifting a series of small plungers until they assume a position whereby the lower plungers are all exactly in line and correspond to the outside diameter of the cylinder (Fig. 1). Plungers and cylinder can now be turned, operating the lock. Immediately the cylinder is returned to the vertical setting and the key withdrawn, the plungers sink into the cylinder and the upper members prevent the cylinder from again turning. It thus becomes apparent that even with only a single plunger not matching the cylinder diameter, the lock will not turn and so the door cannot be opened.

With these facts in mind any attempt to cut a key without some reliable data means that to achieve a condition with all the plungers correctly placed is largely a matter of luck, so it is suggested that a new approach is necessary which will enable you to cut the key when the lock is dismantled with the knowledge it must operate as the parts are again reassembled.

Dismantling the Lock

Having taken the lock off the door, purchase at least two key blanks from the store—take along the lock and see the new blanks fit correctly. Now take out the bar which extends from the rear of the housing (Fig. 3). This merely requires the closing up of the washer prior to sliding the bar clear. Lay this aside to prevent it from being bent and then clamp the housing securely in the bench vice, but without crushing the casting. A coarse file will soon remove the portion above the plungers, as indicated in Fig. 4, and as the metal from which all the housings are made is of the soft variety it does not take long to release the plungers, despite the fact there is often a considerable thickness above them. As there is a danger of the springs " flying " immediately they are released, gradually open out each hole starting from what is really the back of the lock. If you push a matchstick down the hole as work progresses and manipulate the file with the other, it may take a little longer but the springs cannot escape the matchstick and your fingers. Lift out the spring and gently drop the two plungers into the palm of the hand—remember the long member is the top item when assembly takes place. Lay them aside and remember to keep them in sets; otherwise you will have the exasperating problem of trying to find which pair of plungers go together.

If you have any doubts regarding the loss of your key, especially if it has been stolen and there is a possibility of the " finder " using it to gain admission to your premises, change over two or three of the sets when reassembling; this renders the old keys useless for this lock.

Once all the plungers have been shaken out of their positions, the cylinder is easily withdrawn. The inside of the lock is now a mass of filings and all the parts must be cleaned thoroughly. First push the key blank into the cylinder and hold it securely against the face by wiring both the parts together as shown in Fig. 5. This leaves both hands free and you can proceed with the next operation with the assurance that the key cannot move until the wire is unwound.

Cutting the Key

Next set the cylinder in a vee block or small vice with the plunger holes ready for drilling. A bench drill is an advantage here but it can be done with a hand brace if this is the only tool available. See how much the first plunger is standing above the diameter of the cylinder. This indicates how much metal must be removed from the blank before the plunger again resumes a position exactly flush with the diameter. Insert the drill through the hole in the cylinder as shown in Fig. 5 and carefully feed it into the blank. This requires some degree of care, and after the initial feed in which most of the metal is removed, try the plunger in the hole to see how much

Fig. 1.

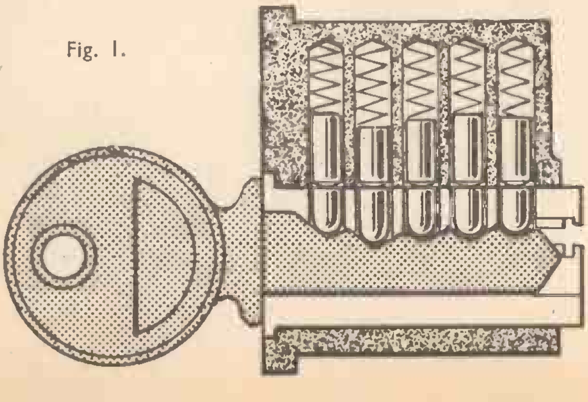
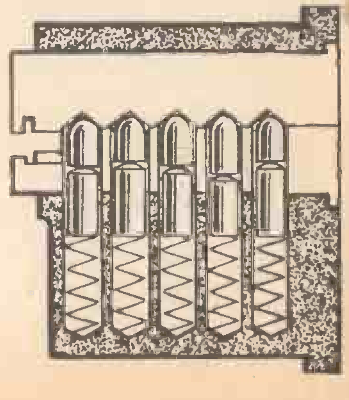


Fig. 2.



a YALE lock

more still remains to be taken out at the next application of the drill. It may take several minutes before the final depth is reached, but if the plunger is below the cylinder diameter, it will either mean rearranging the plungers or purchasing a new key.

Each step on the key is treated in the same manner and the drilling goes on until every plunger is exactly flush with the cylinder. Then the key is withdrawn after slackening the wire and the burrs filed off. These burrs generally make the withdrawal of the key difficult but a gentle tap with a thin piece of steel soon pushes the key from the cylinder. If you wish to make another key instead of availing yourself of the facilities of the key-cutting machine in the local store—bear in mind if you have cut one successfully there is no reason why you cannot produce a dozen if a little patience is exercised.

File off the burrs on the key—a brief rub with a smooth file soon accomplishes this operation—and then gently remove the tops of the inverted " vees " created by the drilling operation. This enables the plungers to slide over the projections easily as the key is pushed home in the cylinder. If a slight stickiness still remains, this can be ignored as a week or so of continually inserting the key soon wears away the offending material and causes it to operate sweetly.

Reassembly

The housing must first receive your attention, and a 16g. brass plate is cut and filed to suit the contour of the top portion. Clean off all the burrs from both parts and again reassemble the plungers and springs in the required order. A slight chamfer filed round the plate—about $\frac{1}{64}$in. will do—makes an ideal key for the solder that will eventually hold it in place. Before securing the plungers, carefully clamp the housing and plate in the bench vice and operate the key several times to ensure that the cylinder rotates without any severe interference.

Without removing the lock from the vice smear it with flux and solder the brass plate to the housing. If the surface of both details is tinned beforehand the soldering operation is simplified and final adherence is quicker and more tenacious. The work is completed by reinserting the bar and setting the lock in position on the door.

Captions to Figs.

Fig. 1.—Inserting the key aligns the lower ends of all the plungers.

Fig. 2.—Removal of the key allows the plungers to fall and prevents the cylinder being turned.

Fig. 3.—Removing the spring clip and bar.

Fig. 4.—Top of the housing is filed off to reveal holes containing springs and plungers. Use a matchstick to prevent springs " flying."

Fig. 5.—Drilling the plunger holes into the key blank.

Fig. 6.—Resealing the housing with a brass plate.

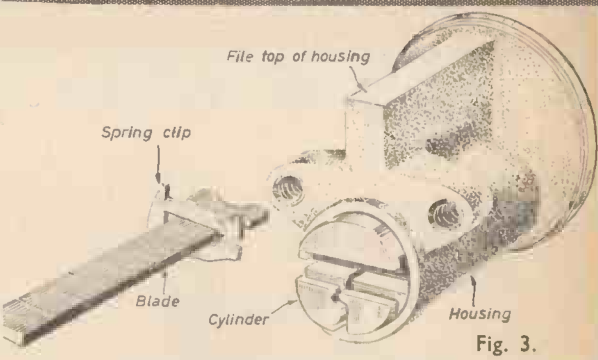


Fig. 3.

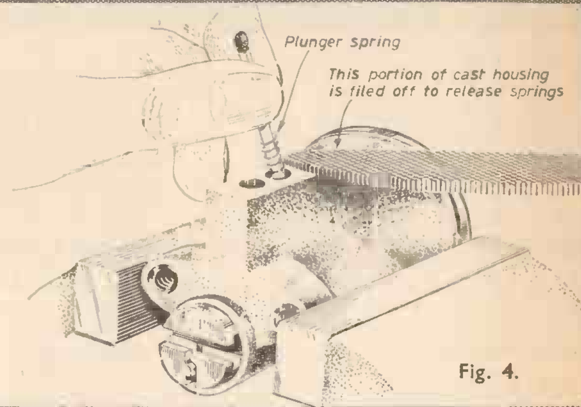


Fig. 4.

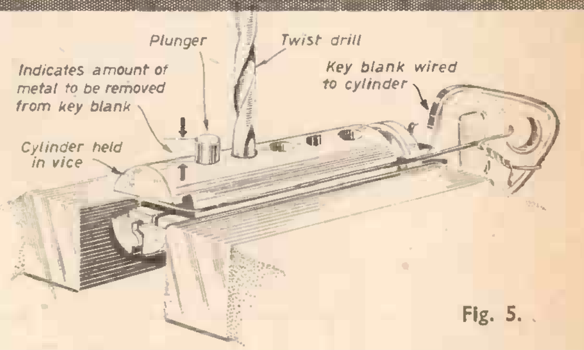


Fig. 5.

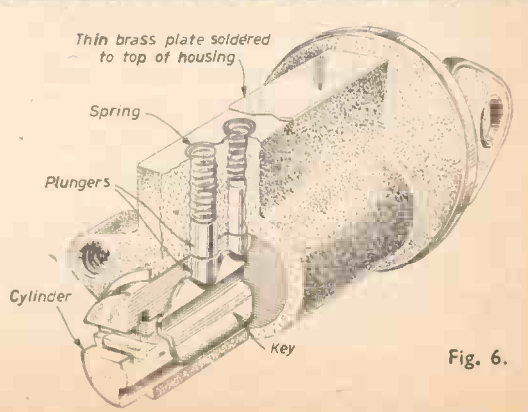
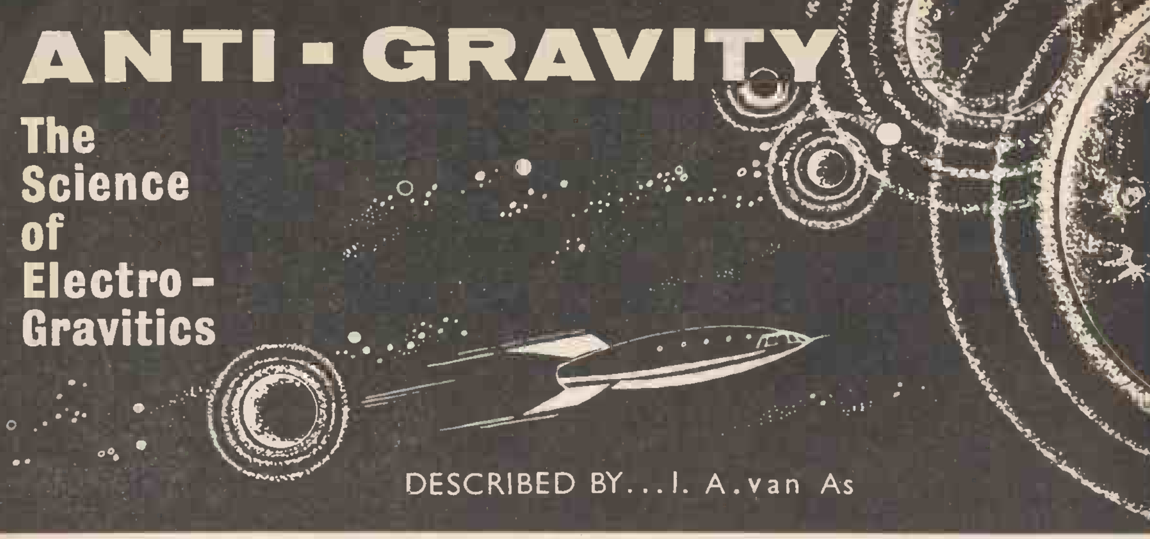


Fig. 6.

ANTI-GRAVITY

The Science of Electro-Gravitics



DESCRIBED BY... I. A. van As

HOW near are we to actual space travel? I doubt, personally if we will get to Mars with the limited power of our present rockets. Aviation and astronautics, however, stand on the threshold of a wonderful new concept—Electro-Gravitics.

New Type of Lift

Electro-gravitics is a vertical lift which is not accomplished by means of rocket thrust or propulsion by airscrews and airfoil and is not dependent on any type of atmosphere, air or a vacuum as would be found in outer space. All these methods seek to overcome gravity, but we approach a new era where man no longer seeks to leave our Earth by overcoming gravity, but instead by utilising it to his own advantage.

An anti-gravity machine is not impossible and many countries including Russia are at present investigating this new approach to aviation. Canada has its " Project Magnet " which is the production of an anti-gravity machine using the electro-gravitic principle. Many American aircraft manufacturers are spending millions of dollars on the use of gravity as applied to their industry. A number of universities are also going into the problem, which, incidentally, is not a new one. An actual flying model using this principle was made in England before the war.

Gravitational Irregularities

Before we go into how electro-gravitics work let us just consider gravitation for a few moments. The theory of gravitation as laid down by Newton in 1687 was accepted even with the discrepancies in the planetary motions which worried scientist and astronomer until this century, when Einstein proposed his new theory of equivalence and relativity. Even the new theories cannot account for gravity-defying irregularities which are noticed within the atom. Certain electrons are able to leap from one orbit to another, which results in light being emitted. (The gravitational theory applies to all bodies irrespective of their size and to account for this irregularity a new theory by Plank has been devised, called the quantum theory).

Also liquids do not conform, as is noticed by the flow of water against gravity in capillary tubes. Water will leap to a glass rod held just above it. Helium in liquid form acts even more strangely, as it will climb up the wall of its container and flow down the other side. These have been classed as oddities in molecular arrangement, but above all they do illustrate that gravity is not altogether a force of attraction.

Relationship of Gravity and Electro-magnetism

Let us get back to Einstein who informs us that the attraction between atoms, molecules, planets and even sub-atomic particles is the same as the force of electro-magnetic attraction. Any body, if it be sub-atomic or as large as the greatest star has a magnetic field.

Einstein predicted and later proved that light when passing close to large bodies, such as our sun, is bent. The stream of electrons in a TV tube is also bent in the same fashion by a magnetic field. Here we see our first glimpse of the relation between electrified bodies and gravity.

Faraday, who found the relationship between magnetism and electricity, gave us the dynamo and electric motor. He also investigated the action of magnetism on light and his experiments proved successful. He then looked for the relationship between gravity and electro-magnetism, but failed to find it. This work was carried on by James Maxwell who showed the mathematical relationship between gravity and magnetism and found they obey the same laws. Einstein in his Unified Field Theory, put forward in 1950, also attempted to unify the laws of gravity and the laws of electro-magnetism. Up to the time of his death, he was perfecting this theory.

Under electro-magnetic forces we must include radio waves, heat, light, ultra violet rays, infra-red rays, X-rays and a host of others. Furthermore, the relationship with gravity *must* hold good for all of these.

Magnetic and Gravitational Fields

Let me now show how all this is connected with our anti-gravity machine. It is well known that if two fields of a magnet which are similar in character, that is to say two south or north poles, are brought face to face the magnets will be repelled. Similarly, two sub-nuclear particles which are the same, repel each other because they have the same electro-magnetic field.

If we can give our machine an electro-magnetic field which is similar in character to the gravitational field of our planet, we will leave this Earth at the possible speed of light. We would then travel along the lines of force of the gravitational field of our planet as well as the lines of the fields of every body in the Universe. Einstein maintains that these fields which are ever present, have no end and spread out in all directions, intertwine with each other in the most complex fashion, but the strength decreases as the square of the distance from where they originated.

The problem is how do we switch our fields on and off? It has been found that there are sub-atomic particles being generated in the powerful nuclear accelerators which have the capacity to change the orbital motion of electrons and consequently the magnetic field (as will be explained later) of the substance they are bombarding. The exact nature of these rays is not yet fully understood, but they are easily generated; furthermore, it does not take much to change the orbital motion of electrons within the atom. It can be done in any physics laboratory.

Magnetism and Atomic Structure

Assuming that the reader has a knowledge of the electron theory, I would briefly like to explain how normal magnetism is brought about within the atomic structure by changes rendered in the orbital motion of the electrons.

About our positive nucleus we have the electrons spinning on different energy levels of which there are seven in number known as the K, L, M, N, O, P and Q levels. The electrons not only spin around the nucleus, but also about their own axis. Since our electron is flowing in a definite orbit, it is generating a flow of electric current which would produce a field, as current would which flowed in a wire. The electrons do not rotate in coplanar orbits, but if they did, each atom would be a minute magnet with a definite north and south pole. It would arrange itself with the neighbouring atoms so that they would align themselves in parallel directions which would give us a magnetic substance with a powerful field around it. This is known not to happen.

There are, however, certain substances which have definite orbits of rotation, but the electrons in the same atom neutralise the magnetic fields of the others because the electron spin on the axis for one electron is in an opposite direction with respect to the spin of an electron on the same energy level.

The element iron for example has an atomic number of 26. The electrons in the K, L, M and N shells are 2, 8, 14, and 2, respectively. The K level orbit, which is nearest the nucleus, contains two electrons the axial spin of which is considered to be in opposite directions, hence the magnetic fields of each are neutralised. In the L shell are eight electrons, four spinning in one direction, four spinning in the opposite direction. In the M shell a difference arises. Nine electrons are thought to be spinning in one direction and five in the other. In the N shell the two electrons spin in opposing directions.

Why then does the unbalanced effect in the M shell result in the alignment of all the atoms in the substance and self magnetisation being produced, as was explained for atoms having supposed co-planar orbits? This is due to the thermal disturbances of the atoms and molecules at normal temperatures. It has been found that in ferromagnetic substances there is a certain amount of alignment of atoms, but it does not result in magnetism because the atoms are aligned in groups within the crystal lattices of the metal and are oriented in six different directions. Each group is strongly magnetic, but is neutralised by the other groups which are oriented in five different directions. This results in the substance being entirely non-magnetic.

The piece of iron is now placed in a magnetic field, such as a current carrying coil. The orientation in one particular direction is increased, which results in a change of direction of all the groups and brings about a powerful magnet. When the current is turned off the groups rearrange themselves and the metal is no longer a magnet. In steel there is a tendency for the groups to remain oriented in one direction after the current is switched off, hence forming a permanent magnet. Heat the metal and the magnetisation is lost due to the thermal agitation of the atoms. A constant change in the external field, as that of an alternating current, will also demagnetise the substance.

Diamagnetism

I have explained what happens in ferro and paramagnetic substances; there is a further class of substances which are said to be diamagnetic, all the non-conductors belong to this group as well as a few metals and alloys. A diamagnetic substance is one which has a small magnetic susceptibility and is weakly magnetised by a magnetic field in such a way that it moves towards the weakest part of the field and at right angles to the lines of force.

It will now be seen that this type of substance is repelled by the field in which it is placed, hence the field set up in the diamagnetic substance must be characteristically the same as the field in which it is placed. This type of magnetism is also due to orbital changes in axial moment of the electrons. This phenomenon occurs in all substances to some extent although the effects of ferromagnetism are greater and so more noticeable. The most diamagnetic substance known is bismuth.

Experiment in Diamagnetism

We can perform with suitable apparatus an experiment to demonstrate diamagnetism. This experiment is the basis on which an anti-gravity craft would operate and is also the starting point of the investigations on anti-gravity.

Our apparatus is simple. We need a powerful electro-magnet and a circular alumium disc. This disc is placed on the solenoid and the current is switched on. A magnetic field is set up and aluminium being strongly diamagnetic is repelled with considerable force and speed. By shaping the disc so as to obtain an airfoil, amazing results can be obtained.

This then is the principle of our anti-gravity craft. We make our space-ship diamagnetic and travel along the lines of force of the planets. The machines would be constructed of such metals as aluminium and bismuth. This opens a new field for research to find alloys even more diamagnetic than bismuth.

We have seen that changes in orbital motion are easily brought about although it might be many years before we see machines utilising this principle in the sky. Perhaps the flying saucers are gravity ships manned by intelligences from space and using the gravitational fields of the universe as their tradewinds! We have yet to establish a really sound theory to relate gravity and electromagnetism. These problems are the ones that vex the scientists and we must patiently wait for our weightless anti-gravity machines of tomorrow. In spite of the new race to conquer space by rocket power, I am convinced that the exploration of our solar system will not come until we have our anti-gravity space ships.

HOME MADE JEWELLERY

Making a Tiara...

BEAUTIFYING styles of headwear and hair ornamentation are a form of decoration as old as history itself. Since before the famed Queen Nefertiti women have devoted long, happy hours to the choosing of head adornment—from the flower in a young girl's hair to the milliner's skilled creation and the tiara. Size and shape change with fashion but this latter item is of the utmost importance. It is certainly not an everyday accessory but for an " occasion, " the theatre or a ball, it has a fascination no other item of jewellery possesses.

Design and Stones

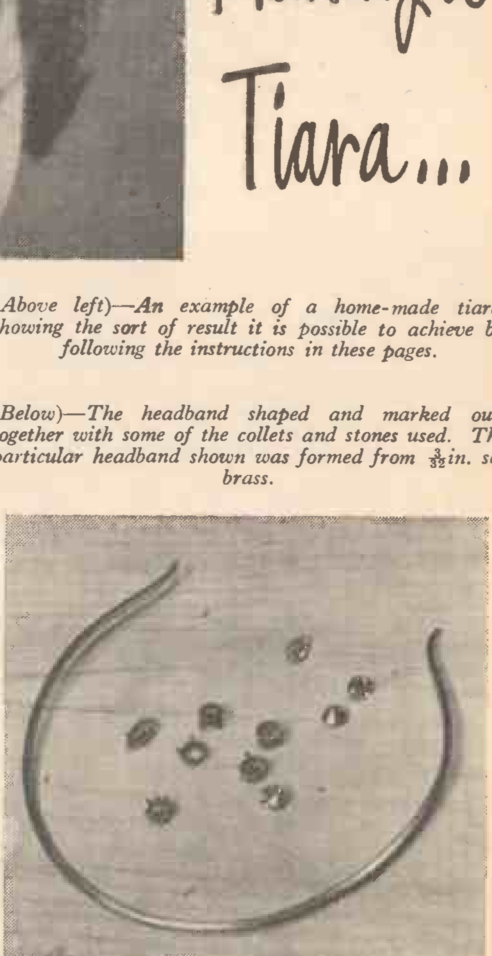
Good design is essential and the scope immense. Today the trend is towards lightweight and simple design, with fewer but larger stones embedded in the shape. Based upon the design illustrated many variations are possible without a change of procedure. (See the drawing on page 34.)

More elaborate effects are achieved through the use of various types and shapes of stones, which should be purchased together with matching bezels or collets. Open-backed collets should be combined with clear-backed stones of good Austrian quality. Closed-back collets must be fitted with foiled stones of a reasonably good quality machine-cut type, preferably Austrian.

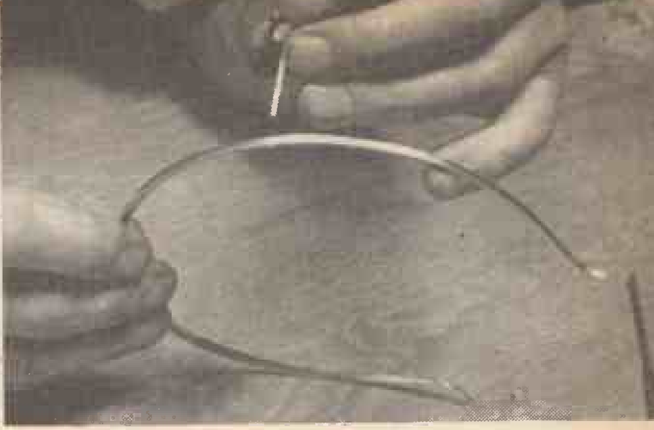
Round stones are much cheaper and more readily obtained as are round collets, though one is usually fortunate enough to find a supply of squares, pear-shapes or ovals. Other shapes are less suited to this type of article. Crystal is traditional and used most extensively in the modern tiara. Coloured stones must be used with the greatest discernment. The use of more than one colour can be disastrous, but might, with thought, be delightful. Rose or peridot are not recommended but aquamarine is charming on blonde, brunette or redhead.

(Above left)—An example of a home-made tiara, showing the sort of result it is possible to achieve by following the instructions in these pages.

(Below)—The headband shaped and marked out, together with some of the collets and stones used. The particular headband shown was formed from $\frac{3}{32}$in. sq. brass.

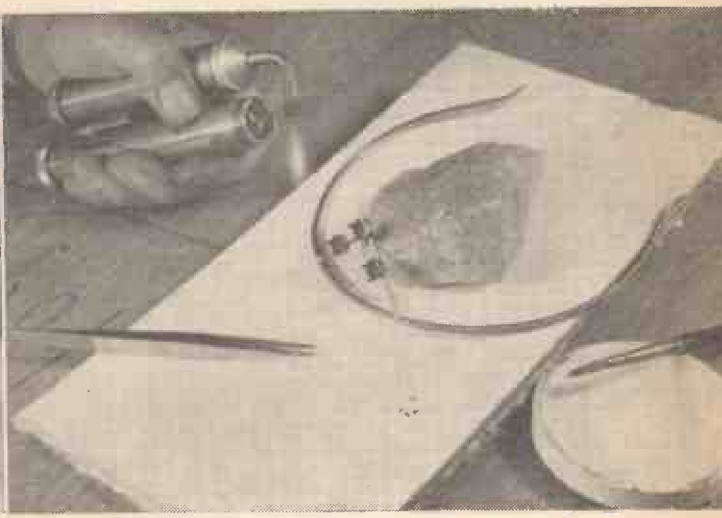


(Right)—The tiara has been returned by the plater after being acid dipped and is in process of having the stones fitted. Pliers are used to close the collet claws. The next step is the final plating and polishing.



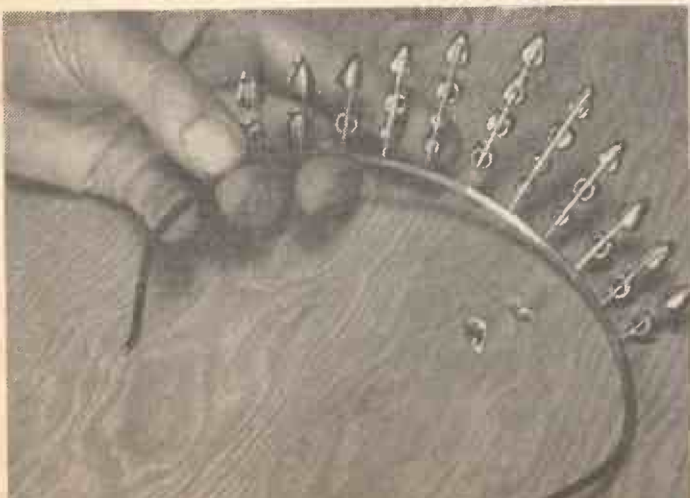
Collets are soldered to their respective stems before the latter are attached to the headband. The triangular set-up of stones was used on another tiara

Slots were cut in the headband to accommodate the stems prior to soldering. The material used for the stems was rectangular section brass wire. The slots aid soldering and alignment.



Silver soldering in progress. The headband is supported on a piece of refractory brick. The joint must be well coated with flux before heating.

Our second tiara being made. Here a sheet of asbestos and a small fragment of refractory brick were used to support the work. Flux was applied with a paint brush.



Soldering

The work entails the most elementary knowledge of hand-soldering. It is simply a matter of directing a thin flame jet at the point to be joined, first ensuring that both parts are free from dirt or grease and are sufficiently covered with soldering flux, of an easy flow variety, over the actual point of contact.

This last operation must take place immediately after degreasing and prior to application of heat. Most types of flux are ready-prepared, though certain powder types require mixing with water to a cream consistency which, in the same way, is then applied locally. To save wastage it is advisable to mix only what is likely to be required for the work in hand. The only other ingredient needed, besides flux, is a small piece of silver brazing alloy, which costs little and goes far.

In order to create a " T " shape with two pieces of average gauge wire, a piece of silver brazing alloy approximately $\frac{1}{16}$in. square is sufficient. In assessing the amount to be prepared, cut a strip of brazing alloy $\frac{1}{16}$in. wide, then into small squares, one for each of the points to be soldered plus a few spares. A steadily-held pair of tweezers will place the pieces evenly, though if the intention is to produce several articles of the same or similar design, it may be worth considering the construction of a simple jig.

A piece of asbestos sheet approximately one foot square is an ideal working surface, but any other refractory material may be used.

Construction

The tiara will be fashioned from brass wire, either square or round, though if preferred a patterned wire may be used in the three-quarter round headband. Where the collet tipped stems are cut from round wire, holes may be drilled in the headband strip, provided it is not too thin. This procedure allows the stems to be inserted almost friction tight. If square or flat wire is used for the collet stems, slots may be cut in the headband for the purpose of alignment. This is best carried out by correctly marking prior to bending, and drilling after bending. The shaping can be achieved round a tin, two or three sizes of which would allow a gradual reduction of the circle. The ends may be curved by hand or with pliers, providing the jaws are covered to avoid kinks or indentations.

It must be remembered that, after the preliminary cutting and shaping, all materials must be checked for smoothness. Once assembled it is difficult to remove roughness or scratches with a polishing mop.

Ascertain that the job is grease-free, apply flux, heat both parts, add one piece of brazing alloy to actual spot, bring both parts together and apply heat till area becomes red, confining this to a minimum locality. The flux and brazing alloy will blend and the latter will disappear, creating a permanent joint. Immediately lift the article with strong tweezers and completely immerse in water. This should be done each time such an assembly is effected.

Plating

Soldering completed, the article is ready to be plated in chrome, rhodium or gold. If foiled stones are to be used it is advisable to ask a plater to acid-dip the framework, which will avoid the mirror-foiling being attacked. Then the stones can be set and the complete article returned to the plater for the final process. Unfoiled stones are not affected by acid-dipping which must take place before actual plating. Most platers have polishing facilities and this final touch is well worth while.

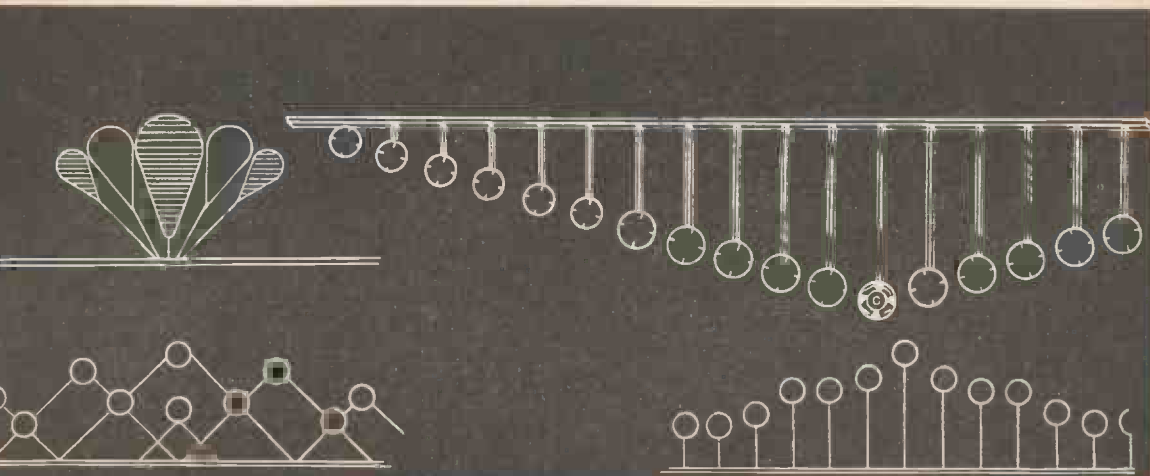
When work of this kind is done for the first time, and conscientiously performed, the sight of the finished plated article is both a reward and a spur to more ambitious projects.

Recommended wire thickness:
for headband—8 to 10 gauge,
and for stems—16 to 18 gauge.

Blowtorch Hints

A blowtorch capable of providing a fine flame-point is required. Inserting a piece of brass tube will obtain the right result from the crudest instrument. An age-old, but nevertheless effective, alternative is to be found by making use of an ordinary gas flame; a small dimension brass tube 9 to 12in. long, curved to almost an " L " shape, provides a mouthblowing instrument to guide the airstream across the tip of the flame, providing the article with all the heat required. This is an easily acquired skill and a useful one.

Some suggested designs for a tiara.



aids to accurate focusing

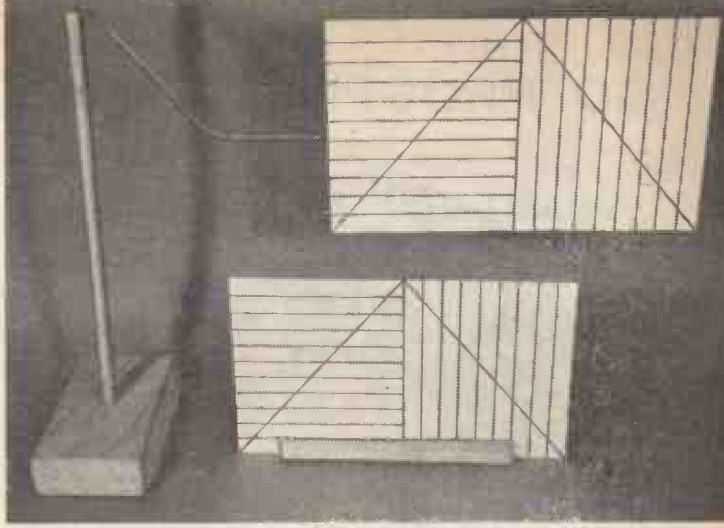


Fig. 2.—Focusing targets mounted on a foot and on a flexible arm.

By A. E. Bensusan

ACCURATE focusing is essential to good photography. However, under certain circumstances it is not always easy to find the sharpest point of focus. Perhaps the photographer's eyesight is not as good as it might be or, as often happens with close-up still-life subjects, there is no definite sharp edge on which to set the focus. The easily made accessories described here will go far towards alleviating these difficulties.

Rangefinder Spot

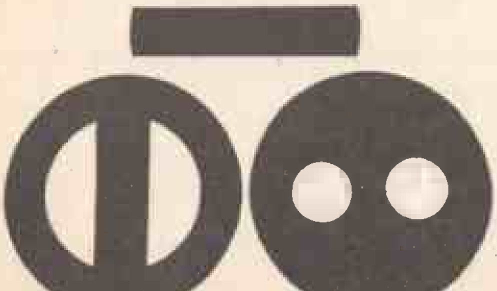
Determining the sharpest image on the groundglass screen of single and twin lens reflex cameras, or stand cameras fitted with back focusing, is always a tricky job. It can only be done by shifting the focus backwards and forwards between the unsharp limits until the image seems to be rendered most clearly. For this reason, many modern single lens reflexes using 35mm. film have a rangefinder spot incorporated in the screen. Cameras not having this feature can very simply be fitted, so that the advantages of composition on the groundglass screen are combined at will with those of precise rangefinder focusing.

The principle of this device is to obscure a central area across the lens while focusing. Obviously, the easiest way to accomplish this is to fit a central strip of blackened metal foil or paper into a filter holder and clip it over the camera lens. The width of this strip is not very important, but one-third of the diameter of the actual lens will be found most effective from the aspects of satisfactory light-passing and clear separation of the two images formed.

A more elaborate version is to have two D-shaped holes cut in a circle of foil or paper. The central divider will have the same width as the strip mentioned above, i.e. a third of the lens diameter. This modification has the advantages of greater physical strength and easier retention in the filter holder.

Yet another version, which does not pass as much light although it does give better separation of the images, is to have two circular holes cut side by side. These should have a smaller amount of solid material between them. A quarter to a fifth of the lens diameter is most suitable.

Fig. 1.—The three types of focusing beam splitter.



Beam Splitting Device

The three types of beam splitting device are shown in Fig. 1. They may be fitted over the lens so that the apertures are side by side or one above the other, depending on the vertical or horizontal nature of the principal lines of the subject. The device must be removed before an exposure is made when viewing is undertaken through the taking lens. It need not be taken off the top mount of a twin lens reflex. For greater differentiation, a light gelatine filter can be stuck over one of the holes.

The absence of a sharp line on many close-up subjects, can be overcome by making up several small focusing targets. Those shown in Fig. 2 were ruled with black indian ink on postcards. The incorporation of both horizontal and vertical lines in a single target caters for rangefinders used in either plane, and the diagonal lines prevent the possibility of matching up the wrong images. This system may also be used very successfully with reflex and stand cameras.

The target mounted on a foot can b- sited on, in, before or to one side of the subject matter, according to requirements, while that fitted to a flexible wire arm may be adjusted to any position even when it is not possible to stand it directly on the subject. For greater permanence, the targets may be mounted on wood, metal, hardboard or stout cardboard. Remember to remove them before making the exposure.

GO PROSPECTING . . .

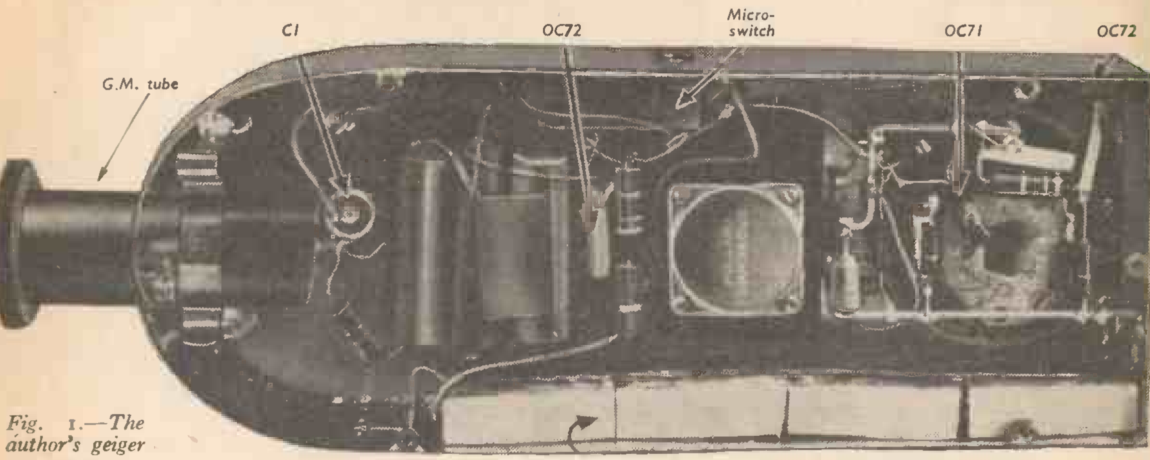


Fig. 1.—The author's geiger counter.

. . . WITH THIS GEIGER

A worthwhile project whether for fun or

THE Geiger counter to be described is a simple straightforward design, without frills of any kind. It can be built as a highly portable unit, or bench mounted as required.

For those not familiar with Geiger counters, a brief description of their operation will be useful.

The radiation sensitive portion of any counter is the GM (Geiger Müller) tube (Fig. 3). This consists of a cylindrical cathode about 2cm. in diameter, along the centre of which is a wire anode. The intervening space is filled with a gas or a mixture of gases which are readily ionised, together with a small amount of quenching gas.

If we apply a positive voltage to this wire anode, and earth the cathode or outer shell, any particles of radiation which enter the tube cause the gas to ionise and produce electrons. These are in turn attracted to the anode wire, where they are rapidly absorbed and produce a negative pulse. The pulses produced are then fed to an amplifier. We can then use them to drive a speaker, meter, or, as in laboratory work, a scaler or electronic pulse counting device.

Fig. 2 gives the circuit diagram of the portable model; it will be seen that instead of using batteries for the high-voltage supply, a transistor oscillator giving approximately 270V. (depending on battery input), which is then doubled by the Cockroft-Walton method to 540V., is employed. This voltage is applied to the anode wire of the GM tube via a 2·2MΩ resistor. This resistor serves only to limit the current in the event of a breakdown in the tube.

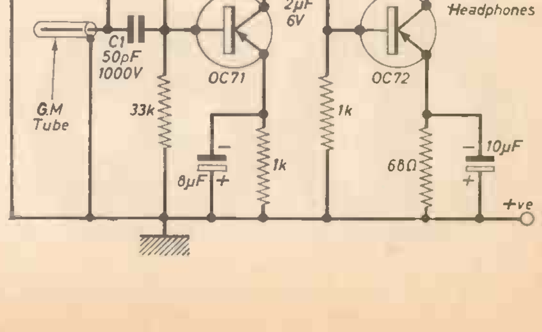
The pulses are fed from the GM tube via a blocking capacitor C1 (this isolates the high voltage) to a conventional two-transistor amplifier; as an indicating device an ex-Government headphone of the low-impedance type is used (external 'phones can be employed in place of this if required).

The batteries used in the portable version to drive the high-voltage supply, plus amplifier, were small 2V. cells of the electric cigarette lighter type. These are excellent little cells as they can be recharged when required; four are used in series to give 8V.

When winding the transformer (Fig. 4) for the high-voltage unit, the final voltage will depend on the number of turns on the secondary; as the average GM tube has a plateau length (Fig. 5) of 100-150V., the number of turns is not critical. In the writer's case, the two remaining sections of the cup former were simply filled with 43 SWG enamelled wire.

As can be seen by the photograph (Fig. 1), the overall size of the completed unit is fairly small. The

Fig. 2.—Counter circuit diagram.



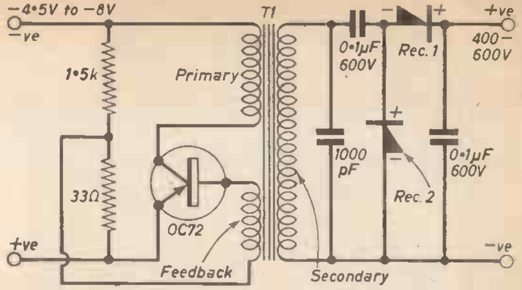


Fig. 4.—Circuit and transformer winding details for high voltage supply.

T1...... Ferroxcube cup core, 4 section former

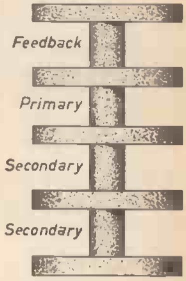
Primary...... 40 turns 30S.W.G. enamel

Feedback...... 28 turns 30 S.W.G. enamel

Secondary..... 2000 turns 43S.W.G. enamel

For correct operation wind as shown in diagram on right

Rectifiers 1 and 2...... K8–15T or Silicon diodes



case was made up from 20 SWG tinplate and joints were soldered. The inclusion of a micro-switch in the side makes for easy handling, and if one wishes to leave it on, the act of placing the unit on a table or bench automatically depresses the switch.

Testing

After all wiring and fitting of batteries is completed, the unit can be tested; a watch or clock with radium-coated hands or figures is especially useful here. Within 2-3 seconds after switching on (if all is correct), an occasional sharp click will be heard from the miniature speaker. This is due to cosmic rays which are bombarding the earth continuously; if the GM tube is placed near the watch or clock face, the speaker will give forth with a multitude of clicks, the repetition rate depending on the activity present.

The counter can also be taken out when going on a picnic if one wishes to prospect for uranium. Old quarries and such are ideal places. As far as the writer knows, the Government do not pay for any discoveries, but it's fun anyway!!

COUNTER

By J. Wyer

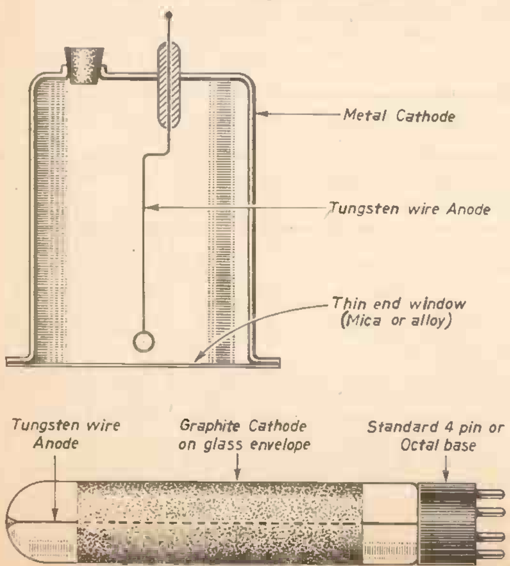
serious study.

In the prototype, a 6in. speaker was used with a 4-transistor amplifier; this gave ample volume even in noisy surroundings or for demonstrating to pupils, etc.

The GM tube used in both cases was a Mullard MX124, which is a thin end window counter operating on approximately 550V. (A word of warning: the end window of these tubes is very fragile and it is suggested a gauze cover be fitted.) A well-known walk-round store have on the market GM tubes which are very cheap. Whilst these are not as sensitive due to the thicker glass walls, they can still be used.

In conclusion, let it be stated that this counter in any form (portable or not) is a very simple and efficient piece of equipment; also the high-voltage power supply can be used for many other items of electronic gear; the same applies to the amplifier.

Fig. 3.—Two types of counter.



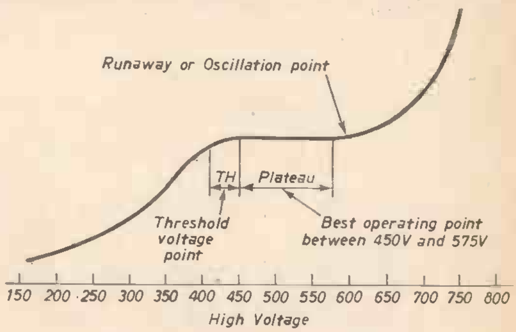


Fig. 5.—Typical Geiger plateau.

Bedtime Listening

By J. D. Hytch

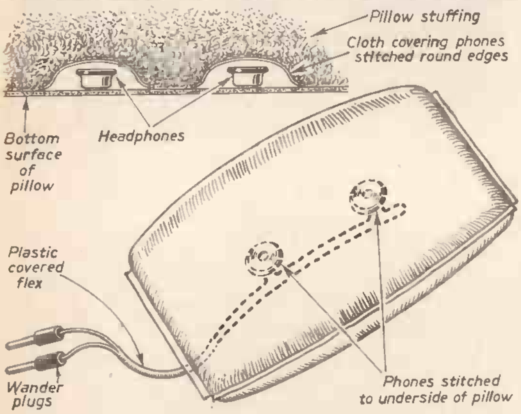


Fig. 1.—Installing the earphones.

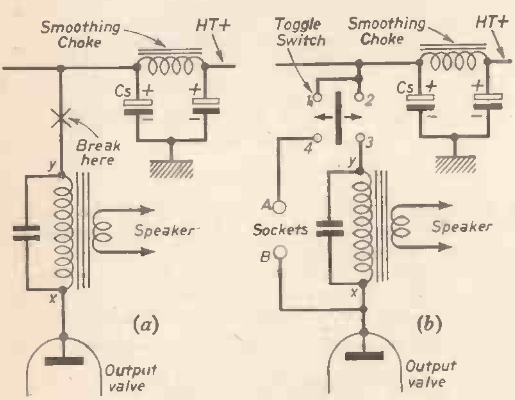
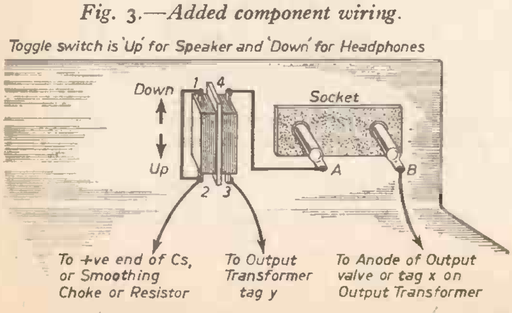


Fig. 2.—(a) Typical output circuit. (b) Modified output circuit.

Fig. 3.—Added component wiring.

Toggle switch is 'Up' for Speaker and 'Down' for Headphones



BEDTIME listening can be pleasant at the end of the day; but it may often disturb other people's rest; especially so if programmes at a really late hour are preferred, such as the concert which starts at midnight on Sundays on A.F.N.

Some form of " personal " reception is the answer. The use of earphones was quickly rejected owing to discomfort; the idea of a pillow was " stolen " from a new hospital installation.

Materials Required

A foam rubber pillow was purchased for 7s, 6d. from a local store. Such material as " Dunlopillo " might equally be used, though the expense might be greater. An old pair of high impedance earphones was split and the 'phones stitched into the pillow as shown in Fig. 1. Careful spacing of the 'phones in the pillow will allow comfortable listening with either ear. A length of plastic-covered flex, attached to the 'phones, terminates in two wander plugs. These plug into a " Radiospares " socket, fitted to the rear of the bedroom receiver chassis. Any dual pin plug and socket would suffice, providing that the socket may be easily accommodated in the chassis.

The only other necessary component is a toggle switch. This is best fitted close to the socket on the rear of the chassis. The switch is designed to alternate listening between loudspeaker and pillow.

Wiring

This is shown in Fig. 3 with theoretical circuit in Figs. 2a and 2b.

Once the switch and socket have been mounted the alterations in wiring are simple. First break the connection from the output transformer primary (tag Y) to the H.T. + line (see Fig. 2a). Join tags 1 and 2 of the switch and take a lead from either of these tags to the H.T. + line. This wire may go to the + end of the smoothing capacitor Cs or to the end of the smoothing choke/resistor away from the mains input (see Figs. 2a and 2b.)

Now connect a short lead between tag 4 of the switch and socket A (see Fig. 3). Connect tag 3 of the switch to the output transformer primary tag Y (the tag broken from the H.T. supply). Finally run a lead from socket B to either the anode pin of the output valve or tag X on the primary of the output transformer; the former connection is often easier and better.

The reader may find his own variations based on the same idea; for instance, two pillows may be wired to the same receiver, each with individual on/off torpedo switches by the pillow. At any event the reader will discover comfortable bedtime listening, without fear of disturbance to others.

A RADIO CONTROLLED MODEL SHOOTING BRAKE

(*Concluded from page* 21)

transmitter must, however, be done via a keying relay as insufficient voltage would be available to give grid cut-off of the 6SN7 keying valve. The writer has not tried this however, and cannot give component values.

Steering Control

A refinement which the author has included in the original model relates to the speed or rate of steering, i.e. the length of time taken for the steering motor to traverse from the full left to full right lock. It will be obvious to those used to driving, that at low speeds a lot more use is made of the steering wheel for manœuvring than at high speeds when steering is normally only used for correcting drift when going along a straight road. Thus in the model it will be found that if the speed of steering is correct for low speed it will be too fast to permit the model to steer easily at high speeds. This difficulty was overcome by arranging for the engine speed control switch to energise a relay in the full speed position which connected a resistor into the steering motor circuit. The speed of response was thus cut down at full speed and the model became much more easily handled. A proportionate cutting down of response would also be an advantage in the second speed but the author has not incorporated this so far.

A TALKING LIGHT

(*Concluded from page* 7)

electrons, whirling about in highly energetic states, are now in a very unstable condition and are ready to jump down to lower energy levels at the first opportunity. The opportunity is given to them when red light is shone on the ruby. The new light provides the necessary jostling and the electrons begin to jump to the lower levels. As they do so, they give off their excess energy in the form of a pure frequency of red light.

But the ruby is coated with silver except for a small hole at each end. The silver mirror reflects the light back and forth inside the ruby, causing more electrons to give up the extra energy. All this happens so fast that the only result visible to the human observer is a narrow intense beam of ultra-pure red light emerging from a hole in the mirror. Other colours should be capable of amplification in future versions of the device.

Prior to the development of both of these machines, light has not been used for communications because there was no way to generate it at closely controlled frequency.

THE EVENING STAR

(*Concluded from page* 16)

covers, drill the countersinks with No. 44 drill, and tap 6 BA, buth don't screw on the covers yet.

The small covers for the ends of the p-v liners are turned from $1\frac{1}{8}$in. round rod, cast or drawn. Chuck a piece in three-jaw, face, centre, and drill No. 21 to $\frac{3}{8}$in. depth. Turn $\frac{3}{8}$in. length to $1\frac{1}{16}$in. dia., further reduce $\frac{3}{8}$in. length to $\frac{13}{16}$in. dia. (a tight push fit in the end of the liner), part off at a full $\frac{1}{8}$in. from shoulder, reverse in chuck, take a truing-up skim off the end, and round off the flange. Two of the covers are tapped $\frac{3}{16}$in. × 40 for $\frac{3}{8}$in. depth, to take tail-plugs. These are turned from $\frac{3}{8}$in. round rod. Chuck a piece, turn $\frac{7}{16}$in. length to $\frac{5}{16}$in. dia., round off the end, and part off at $\frac{3}{16}$in. from shoulder. Reverse in chuck, turn $\frac{1}{4}$in. of the other end to $\frac{3}{16}$in. dia. and screw $\frac{3}{16}$in. × 40. Plugs for both types of cylinder are identical. The covers are prevented from coming out of the liners by a $\frac{3}{32}$in. or 7 BA countersunk screw running through a No. 41 hole in the liner, into a tapped hole in the cover spigot, as shown in the longitudinal section; a simple job requiring no detailing out.

BOOKS Received

"Motor Cycle Data Book" by P. M. Williams and J. A. Reddihough. 207 pages. Price 10s. 6d. net. Published by Geo. Newnes, Ltd.

THIS book contains maintenance and servicing data for more than 450 motor cycles, scooters, mopeds and three- and four-wheeled light cars. The data is presented in two parts: (1) Brief specifications and (2) Maintenance and servicing data and dimensions.

PUZZLE CORNER

1.—Higher or Lower?

A SHIP was floating in a lock in the Panama Canal and the lock gates were closed. For some reason the ship's anchors were dropped to the bottom of the lock. What happened to the water level in the lock?

2.—Four Fours

THE problem is to express all the numbers from 1 to 100 by means of four fours, no more and no less, using the customary mathematical symbols, e.g.

$$7 = \frac{4}{4} + 4 + \sqrt{4} \quad 15 = \frac{44}{4} + 4 \quad 21 = \underline{|4} + \frac{4}{4} - 4$$

$$35 = 44 - \frac{4}{\dot{.4}} \qquad 41 = 44 - \sqrt{\frac{4}{\dot{.4}}}$$

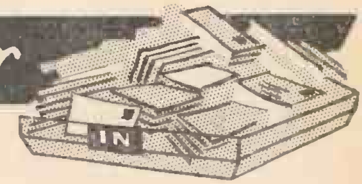
Answers

1.—The water level in the lock dropped. According to Archimedes' Law of Flotation a floating body displaces its own weight of water, therefore initially when the anchors were stowed in the ship they caused their own weight of water to be displaced. However, when lying on the lock bottom, each anchor displaces only its own volume of water and, since iron has a relative density slightly more than 7 times greater than water, they will now displace just over one seventh the initial displacement and the water level in the lock will be lower.

2.—It is possible to express all numbers up to 112 in this way, but 113 is a stumbling block. By the use of symbols of doubtful admissibility, it can be done, e.g.

$$\frac{\underline{|4}}{\dot{.}\sqrt{4}} + \frac{\sqrt{4}}{.4}$$

LETTERS TO *The Editor*



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

Colouring Ping-Pong Balls

SIR,—I was interested in Mr. Tate's query in the August issue concerning the colouring of ping-pong balls. I have on occasions coloured celluloid and certain forms of Perspex with ordinary Tincture of Iodine. This gives an amber colour, which can be graded from a pale amber to a rich deep tone, according to the amount of iodine used. I have used this method very successfully in making photographic filters, using a clean piece of film and iodine; grading it to a desired density. Leather dyes will dissolve in colourless iodine and I have used this to cover Perspex models, but it is not quite permanent. Tincture of Iodine is.—D. E. Banks (Workington).

Home Made Laboratory Apparatus

SIR,—I notice on receiving my copy of the August issue that Part 12 of Home-made Chemical Laboratory Apparatus is the concluding instalment. This seems a good time to write and tell you how much my son and I have appreciated the series. I started making some of the apparatus so that my son could augment the instruction he received on chemistry at school with experiments at home. I became so intrigued that we now have almost a complete laboratory and have started borrowing books from the library so that we can go further with our experiments. The apparatus we have made ourselves would have cost a great deal of money had we had to buy it. Thank you, Mr. Given.—R. S. Tovey (Yorks).

Soldering Tip

SIR,—The other day I had some rather ticklish soldering to do on a couple of my wife's brooches on which the pins had broken. I could not use the vice to support them so hit on the idea of pushing them into a lump of modelling clay. It held the brooches beautifully steady while the work was carried out.—R. F. Gaze (Croydon).

Recording Radio Programmes

SIR,—With reference to J. Hyde's query on page 465 of the June issue regarding the recording of radio programmes by the ringing of the telephone. If any of your readers are thinking of building devices which rely on, or are linked with, their telephone in any way, may I draw their attention to Regulation 48 of the (Statutory) Telephone Regulations 1960.

This calls for the prior consent or approval of the Postmaster General in a number of cases. There are several reasons for this. Some fitments, for instance, can cause interference with the public telephone system. The Regulations may be inspected at the local telephone manager's office or may be obtained from H.M.S.O. price 2s. 3d. Telephone Managers will also be pleased to offer advice on the need for such consent or approval if your readers care to write saying precisely what they have in mind.—T. A. O'Brien, Public Relations Officer, General Post Office.

Electric Shaver Modification

SIR,—I have used an electric shaver since before the war and having tried several different makes I have always found one point against them and that is the wear of the outer foil or shear. This did not really matter when the foils were cheap to renew, but since then they have got quite expensive. I find that the cause of this trouble is that the springs that press the cutter to the foil are far too strong for the job. This applies to every shaver I have had. I therefore make the springs much weaker and the result is that the last foil I had new has lasted me two years, instead of the usual six months.

The cutting heads of some shavers are difficult to take apart, but the springs can be got at easily and I found mine were between $\frac{1}{16}$in. and $\frac{1}{8}$in. too long. The pressure required is very slight, just sufficient to keep the cutter against the foil and no more. My two-year-old foil shows no signs of wanting renewal neither does it get hot. Do not try greasing or oiling as this together with the hair tends to clog the head badly.—C. V. Thompson (Herts).

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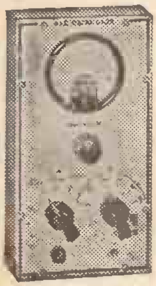

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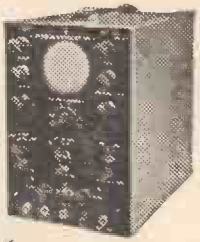

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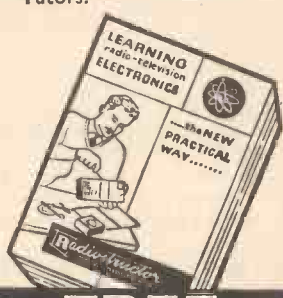

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TRADE NOTES

A REVIEW OF NEW TOOLS, EQUIPMENT, ETC.

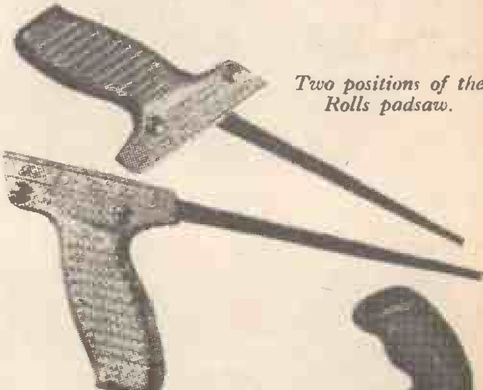
"Portacutta" Cut-off Machine

ALL those concerned with an engineering workshop or some similar business will be interested in the "Portacutta" Cut-off machine shown on the right. The unit's portability is its chief asset, fulfilling as it does a longfelt need for a unit which can be taken to the job, instead of vice versa. The power unit is made by Black and Decker. Further details are available from Pee Cee Engineering Supplies Ltd., 115-119 West Street, Bedminster, Bristol, 3.

"Portacutta" Cut-off Machine.

Rolls Padsaw

A NUMBER of variations are possible with this tool and two alternative positions are shown in the photograph on the right. The 9in. tapered keyhole type blade can be fitted into the light alloy pistol grip handle in eight different positions and can be used at its full length or shortened as required. A 10in. hacksaw blade for cutting all metals is included with the padsaw. With the tapered blade in various positions, it is possible to cut in corners, close to walls or floors and in other awkward places. The makers are Rolls Tools Ltd., 154-156 Blackfriars Road, S.E.1, and the kit is marketed at all branches of Woolworths at 5s.



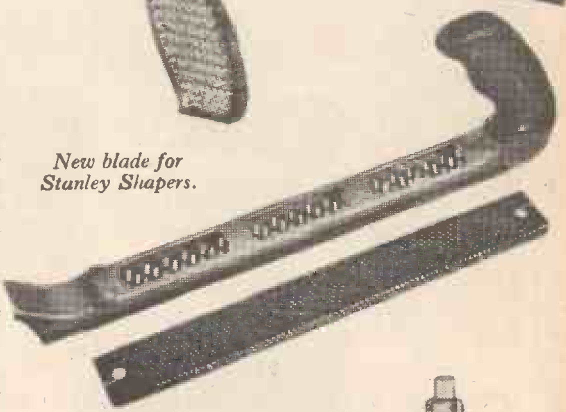
Two positions of the Rolls padsaw.

New Blade for Stanley Shapers

A SPECIAL new wood-cutting blade designed to cut faster on the timber most commonly used by home handymen has been introduced for use with Stanley shapers. It costs 3s. and can be interchanged with the present general purpose blade by loosening one screw which can be turned with a coin.

New customers will be able to buy the Stanley shaper-plane as a complete two-blade kit for 18s. 6d., containing both the new wood-cutting blade and the general purpose blade designed for use on metals, including mild steel, and other materials.

The shaper-file will continue to be sold with the general purpose blade for 12s. 6d., but the new wood-cutting blade may be bought as an extra.



New blade for Stanley Shapers.

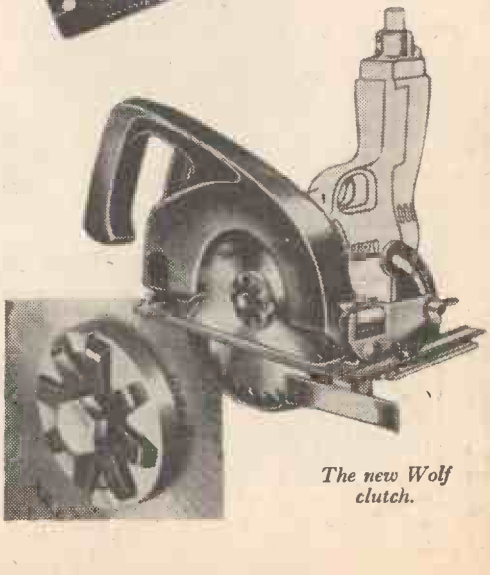
Clutch for Wolf 6in. Portable Saw

WOLF Electric Tools Ltd., are now supplying their No. 112 6in. Portable Saw and Groover with a special clutch fitment which controls the correct cutting speed of the saw and saves exessive wear to the gears and bearings of the power unit. (The saw attachment will now be designated the 'No. 112c.')

The clutch will also eliminate the possibility of a motor burn-out due to stalling—the motor will run free if the blade should accidentally jam in the material being cut.

The 112c saw, complete with this mechanism, will retail at £5 10s.

Owners of the Wolf No. 112 Portable Saw can purchase the clutch for fitment to their machine. Retail price is 10s. (complete with simple fitting instructions).



The new Wolf clutch.

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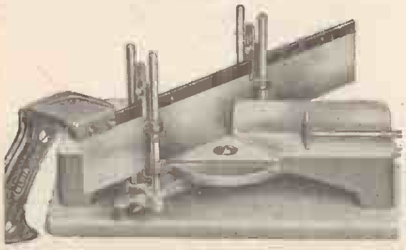

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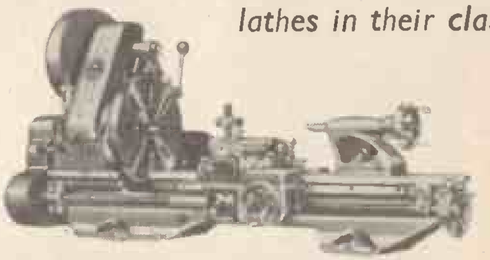

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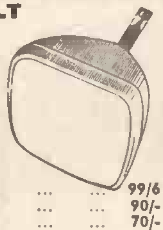

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Recording Rain Gauge

I WISH to construct a tilting bucket rain gauge with a dial to record the amount of rain which has fallen. After discharging the water from the first bucket, another bucket comes into position to receive the next amount of rainfall. Can you explain the principle?—D. G. Walters (Carmarthen).

ONE type of recording rain gauge consists essentially of a chain of small buckets attached to an endless chain that passes over a sprocket wheel.

A funnel collects the rain and this delivers the water drop by drop into a bucket and when the mass of water in one bucket reaches a pre-determined weight, the bucket pulls on the sprocket and moves down one cog. The dial of the recording gauge is calibrated accordingly. Obviously the mechanism must be lightly built so as to move easily, stage by stage.

Full information on this subject can be obtained from Negretti & Zambra, Regent Street, London, W.1.

Obtaining "Brass" Finish

COULD you please tell me if it is possible to put a "brass" finish on iron or steel at home? I wish to renovate some old carriage lamps.—R. J. Shaw (Dungannon).

THE depositing of brass on a ferrous base is performed by applying about 20A. per sq. ft. to obtain a thickness of about 0.0005in., and this is oxidised in a polysulphide to give the usual finish which we believe is finally lacquered. Such a process is generally outside the scope of the homeworker for colouring single items—it is, we might add, the way door handles and catches are coloured and the colour is permanent. The type of article you wish to work upon is again not suitable for heat treating as a way of introducing a colour to the material.

Whether lacquering will give the desired degree of finish is a matter of opinion but it would appear to be the only satisfactory way of overcoming this problem as the shape of the article is complex and does not permit dismantling. We suggest you write to Messrs. Johnson & Bloy Ltd., of 5 Hind Court, E.C.4, for a suitable lacquer giving details of the article. They will, no doubt, recommend a material for the work with perhaps just the right degree of "brassiness" for such old pieces. Whether you can spray the surfaces—obviously a much better approach to the job than endeavouring to brush them, will depend on the spraying equipment available. We note you say you are interested in renewing carriage lamps which indicates you are possibly anticipating performing this work commercially. The purchase of a spray unit might then be an economical proposition, but for single articles you might find that the firm mentioned would undertake the work for you.

Burnt Outlines

SOME years ago there was an advertising medium known as an Oracle. It consisted of a piece of tissue paper, printed with advertising slogans, with the instruction to apply a glowing cigarette to a particular spot, when the paper would smoulder into whatever picture had been printed. Could you please tell me how this effect is achieved?—O. B. Oakley (Birmingham).

WE can only suggest that the effect you describe is obtained by using a highly concentrated solution of potassium nitrate. This solution can be used by some form of pen to trace out the design on paper; and as the dried-out salt renders these parts of the paper upon which it has been applied more inflammable, the trail will smoulder along these lines when a lighted cigarette is applied to some portion of it.

Solvent for Polythene

WHAT is a suitable solvent for Polythene?—C. Holwill (Portsmouth).

POLYTHENE is soluble in:

	Optimum Temperature
Glacial acetic acid ..	20° C.
Trichlorethylene ..	70° C.
Xylene	75° C.
Tetra hydronapthalene	76° C.
Petroleum ether ..	80° C.

Demineralised Water

WOULD you please tell me how to obtain demineralised water.—A. O'Neill (Eire).

DEMINERALISED water is, as we expect you know, water rendered free from salts—as is distilled water—but by a process of ion exchange. A substance such as Zeolite can be used. You would merely need a vessel which would carry the base-exchange material on a tray or filtercloth and circulate your untreated water through this. The recognised authorities on this process are: ELGA Products Ltd., Lane End, Bucks. They might let you have small quantities of the base-exchange material.

Aluminium Castings

I WISH to make some aluminium castings using plaster of paris as the mould. After experiment I have found that I cannot get very good detail and I would be pleased if you could advise me on the best procedure. At present I melt the aluminium while the mould dries out in the oven, when the metal has melted, I pour while the mould is hot from the oven. The mould is of the open type and I find that the metal has taken very little detail from the mould on the bottom.—A. S. Hussey (Essex).

THIS is an unorthodox method of casting and we hazard a guess that air is being trapped in the cavity or that you are not heating the metal sufficiently and it cools immediately it contacts the mould. A riser in a top portion of a mould performs the duty of acting as extra weight and makes sure the metal does fill a cavity and as this is lacking in your case, there is little chance the metal can completely fill it.

Without actually seeing your method we are naturally limited in the advice we can give you. Try venting the mould at the lowest points by pushing a cycle spoke or similar small diameter rod completely through the mould. The metal will tend to run down this hole, but being small the metal solidifies before it goes more than a ½in. and it can be easily dressed off afterwards. This method makes an opening for any air and the inrush of metal forces it through the hole.

Finally we would mention that if you are trying to re-produce the sharp outline achieved on many of the present day toys—small railway engines, carriages and the like, then we must point out that this is impossible by hand methods as these parts are pressure cast by a machine with the metal injected under pressure; hence the sharp outline. On the other hand you can make simple castings by this method, but the emphasis is on the word simple as aluminium is generally moulded using the two-box method with proper runners and risers.

Guitar Construction

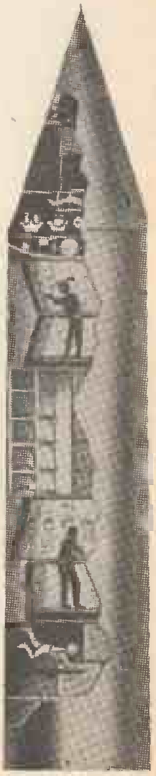
I WISH to form a domed back and sound board for a guitar. Could you please tell me how I could bend the material permanently and at the same time maintain the edge contour in a single plane to facilitate the fitting of the sides?—P. B. Shelton (Doncaster).

FITTING a domed back and sound board to a guitar is an extremely difficult job for the amateur. Commercially it is done using heated machine presses. It can, however, be done by carving the back and sound board from wood of sufficient thickness to give the required "belly." This is a job that requires a lot of patience and a lot of skill with carving tools, but there is no reason why an amateur should not try it. Should this method be adopted, carve the inside curve first so that there will always be a flat surface to lay on the bench.

If it is only required to give the instrument a slight "belly" then the following method can be adopted. Make the body in the normal way with flat sound board and back. Using a rubber tube fitted over the spout of a kettle introduce steam into the body through the sound hole. Leave the tube in for at least half an hour. While this is being done cut a peg of ½in. dowel about ⅜in. longer than the distance from the inside of the back to the underside of the sound board. After half an hour steaming force the peg firmly to the upright position under the bridge position. Leave in place until the wood of the body has thoroughly dried out and then remove. A "belly" will be obtained in this way but this method should not be tried unless you are sure that the back board and sound board are very securely glued to the ribs (sides) with waterproof glue.

The Saturn Rocket C-2

I AM at present building a scale model of the Saturn Rocket C-2, but I have insufficient information on the interior. As the model will be of perspex it is important that the interior be more or less accurate. Have you a sketch of this rocket? — R. Briggs (Northants).



RIGHT is a possible version of the top stage of the Saturn Rocket C-2 showing the crew capsule for powered flight, emergencies and re-entries; instrumentation and working areas; and the supply storage compartment.

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

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