PRACTICAL MECHANICS

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contents

Transistor Model Control Receiver

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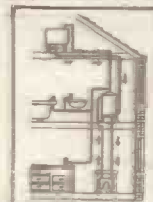

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CONTRIBUTIONS

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

FAIR COMMENT

MAN-MADE FOOD

THE idea that the population on the Earth might one day exceed its capacity for food production is not new; in fact it has been discussed for many years. Now, however, it has gone far beyond the idea stage. In about 60 years' time the Earth's present population will double, if the rise in the birth-rate continues, and it will be impossible, by conventional agriculture, to feed so many people. The fearful spectre of starvation has always haunted some part or other of the human race, but now it would seem that man, as a whole, is threatened.

Obviously, some new method of food production must be found and found quickly. It is comforting to know that work has already been started on the problem.

A dish quite commonly found on the menu in Thailand is plankton. This comprises millions of tiny marine organisms, which can be harvested in fine nets trawled behind boats. Scientists have already found that its fishy taste can be eliminated. The amount of plankton known to be in the vast storehouse of the sea is almost inexhaustible.

The sea, of course, also provides man with a vast quantity of food in the form of fish, and although modern science has enabled the quantity of fish caught to be increased, the whole fishing industry could be revolutionised by the introduction of fish farms. If some way could be found of building sea fences (electric fences, perhaps) shoals could be kept in one area, the natural feeding amenities improved and the fishes' enemies kept out. The quantity of fish on the farm could be kept always at a certain level and the surplus taken out with nets for consumption as required.

Another source of food has been established in algæ, an example of which is the green scum seen on ponds, etc. Despite its unwholesome appearance this is completely edible and has ten times the calorific value of wheat. It can be grown in huge shallow trays both cheaply and quickly.

Finally, scientists have a master plan to make food on a factory scale synthetically by imitating the process of photosynthesis used by plants. The raw materials used will be water, air and mineral salts and the products will be the basic food elements, fats, proteins and carbohydrates. Further processing will turn these into synthetic meat, bread, etc.

The taste of food will not be neglected either. The basic substances which give foods their characteristic flavour will be analysed and incorporated in the new synthetics. Nor is there any reason why the texture of natural foods cannot be imitated. Even the most fastidious of gourmets will not have cause for complaint.

PRIZE FOR FIRST MAN-POWERED FLIGHT

MAN-POWERED flight has been much in the news of late, and the Man-powered Aircraft Group of the Royal Aeronautical Society has been interested in the problem for some time. To encourage other interested persons or groups a prize of £5,000 has now been offered by Mr. Henry Kremer for the first successful flight of a man-powered aircraft designed, built and flown within the British Commonwealth under conditions to be laid down by the Royal Aeronautical Society.

In the past, our readers have frequently surprised us with their ingenuity, and we hope that the challenge of man-powered flight and the large reward so generously offered will capture the interest of more than one "practical mechanic." We should be pleased to hear from anyone who has experimented with this type of craft.

INDEXES FOR VOLUME 26

A COMPREHENSIVE index for volume 26 of PRACTICAL MECHANICS, which incorporates issues dated from October, 1958, to September, 1959, inclusive, is available price 1s. 3d. from Post Sales Dept., George Newnes, Ltd., Tower House, Southampton Street, London, W.C.2. We would also remind readers that attractive self-binders for PRACTICAL MECHANICS are available, price 11s. 6d. Copies can be inserted as received.

The March, 1960, issue will be published on February 26th. Order it now!

Transistor Model Control Receiver

By F. G. Rayer

An Indoor Close-range Set for the Model Control Enthusiast

Only One Transistor is Used and Power is Obtained from 4½V. Dry Batteries

THIS receiver is for short range control only, and can be fitted in quite small boats or other models, as it is only approximately 1⅛in. × 1¾in. × 3in., including the relay. A good approximation of the size can be gained from Fig. 6. The current needed is under 2mA, at 4½V., and this can be obtained from three small dry cells in series.

A small mobile model can be run indoors, while small boats can be operated successfully on small garden or sailing ponds which are unsuitable for large models. The receiver is intended for such purposes, where the range is small, and high sensitivity is not needed. As a guide to the results to expect, a single valve transmitter drawing 30mA at 230V. and equipped with a 3ft. aerial was found to cause a current change of about .2mA in the receiver, when the latter was used with no aerial at all, at about 8ft. to 10ft. range. This was easily sufficient for a small model indoors, because the usual type of model control relay can be adjusted to open and close with a .1mA current change. With a longer transmitter aerial, or an aerial on the receiver, range can easily be increased. But this is scarcely necessary when working a model within the confines of an average room.

The circuit is shown in Fig. 2, and uses a crystal diode which provides bias for a cheap red-spot type transistor. The relay is the popular twin-coil 3,400 ohm model control type. Receiver adjustment is extremely easy, compared with a super-regenerative valve set. But more careful setting of the relay is required, because the current change is not very great.

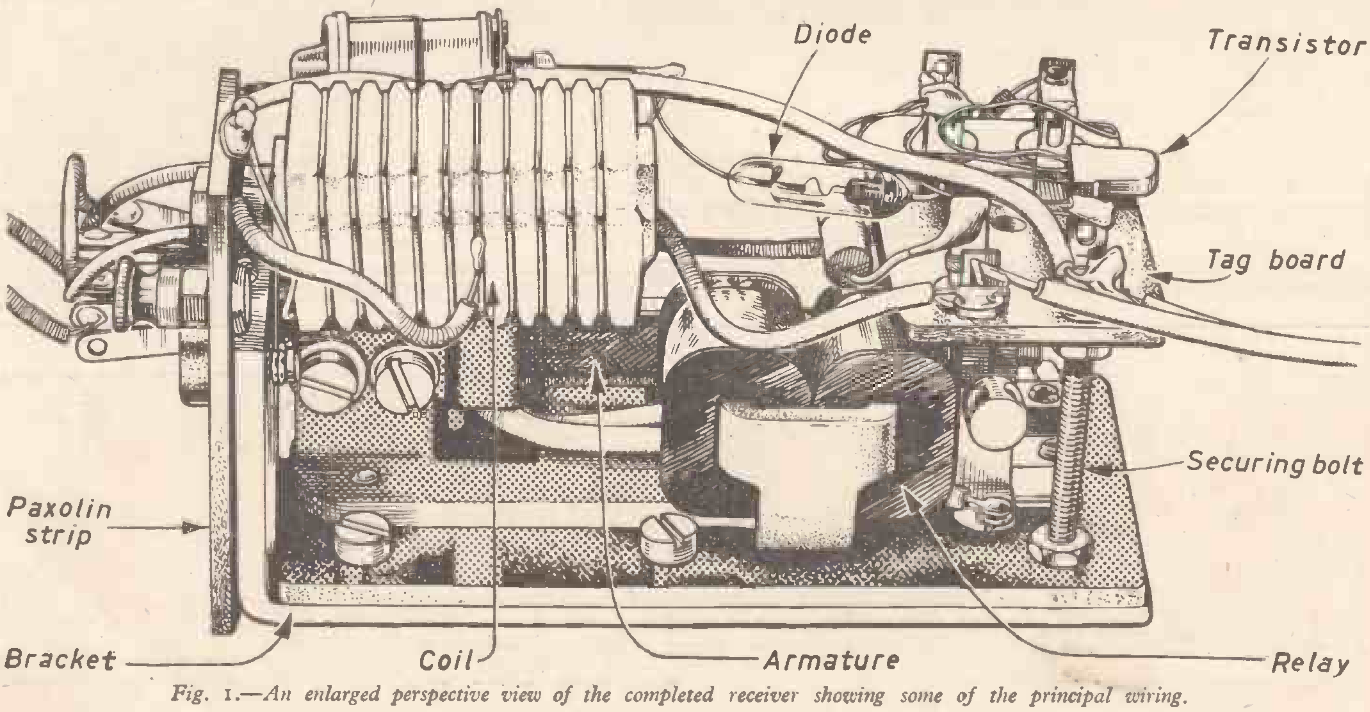


Fig. 1.—An enlarged perspective view of the completed receiver showing some of the principal wiring.

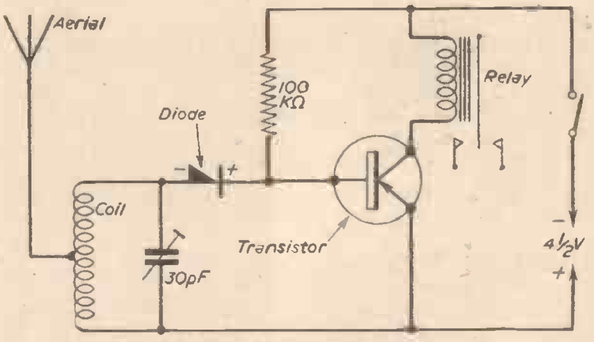


Fig. 2.—The theoretical circuit.

Receiver Construction

Any small coil tunable to 27 mc/s will do. It can be self-supporting, or consist of eleven turns on a ¾in. diameter former. A notched and ribbed former simplifies winding, but is not essential. Wire of 22 to 18 s.w.g. or so is satisfactory. For a self-supported coil, 18 to 14 s.w.g. will be more rigid.

Receiver wiring is shown in Figs. 1 and 4. The aerial tapping is at about the centre of the coil. If a very short aerial is used, this can be taken directly to the diode end of the coil.

The transistor leads are left reasonably long, and soldered to tags which serve as junction points for other wiring. Short, stiff connections support the 30pF air-spaced trimmer.

The tag board is held by a long bolt, as shown in Fig. 5. A bracket and Paxolin strip support the coil. This type of relay is often sold with a metal bracket forming a base plate, and holding tags for winding and relay connections, and it is only necessary to bolt the Paxolin strip to this. Note that battery positive is common to this bracket, through the tag mounting bolt.

Further aid for wiring can be obtained from Fig. 3.

Receiver and Relay Adjustment

A piece of ebonite rod or tube should be shaped to engage with the rotating top of the trimmer. A 2mA, 5mA or similar meter

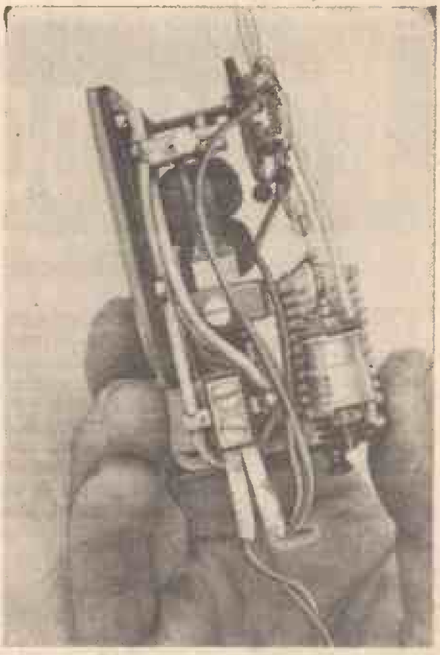


Fig. 6.—A photograph giving an approximate idea of size.

is connected in series with the battery. The transmitter is then switched on, and the trimmer rotated until a dip in current is observed on the meter. This will be from 1½mA or so, according to the transistor, down to 1mA or so, depending on range. If an aerial is added, or changed, or any modification made which may change stray capacity across the coil, the receiver should be re-tuned. The correct tuning point is that where the meter falls to the lowest reading.

The relay should be adjusted so that the movement of the armature is extremely small, and the distance between armature and bobbin poles should also be as small as possible. Armature tension is then set so that the armature is *just* held when the transmitter is off. Keying the transmitter will then cause the relay armature to be released, up to such distance (depending on aerial, etc.) where the current drop becomes too small to work the relay. This point will be the maximum working range of the equipment, and the model must, therefore, be kept within this limit. Most models, even of very small size, can easily carry a stiff vertical wire some 12in. or so long, as aerial without this looking out of place. This will usefully increase range, compared with that achieved with no aerial at all.

No licence is necessary to operate a radio control receiver, but one will be required to operate a transmitter. This must be obtained from the following address: Radio and Accommodation Department, Headquarters Building, G.P.O., St. Martins-le-Grand, London, E.C.1.

There are no tests to be passed or other complications and the licence is valid for five years.

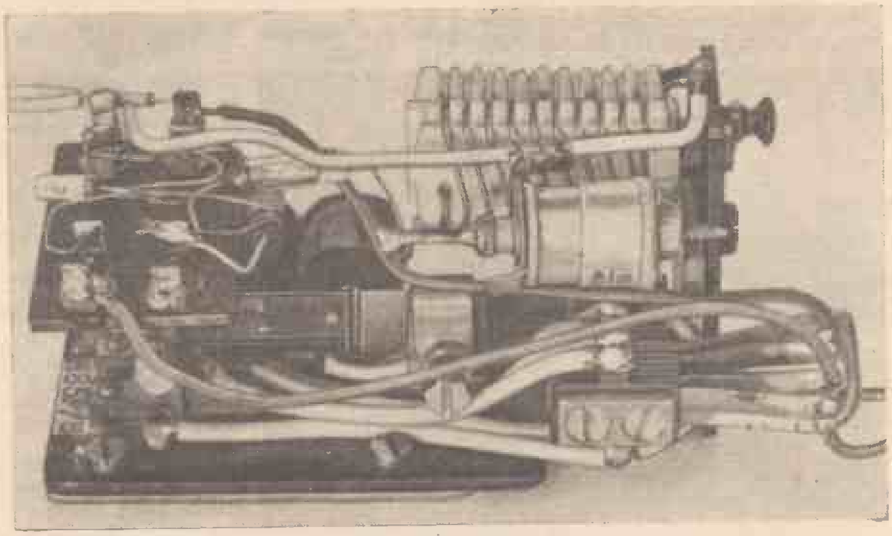


Fig. 3.—Photograph of the completed receiver.

Fig. 4 (Right).—Wiring details.

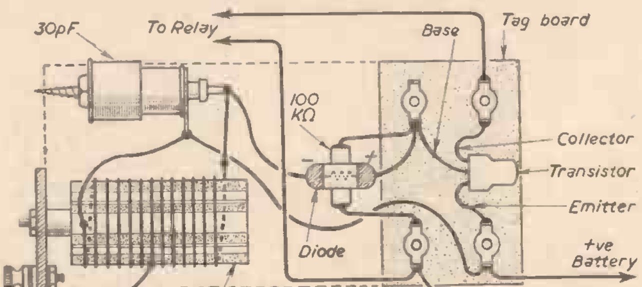
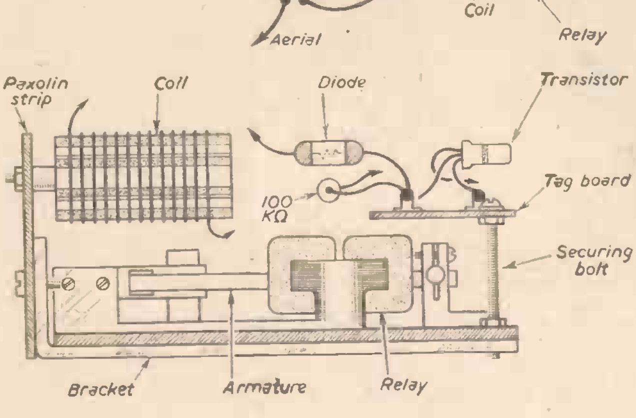


Fig. 5 (Below). — A view showing coil and tagboard mounting.



USING RESIN-BONDED GLASS FIBRE

A Description of Some of the Basic Procedures

THIS material is still comparatively new when considered in relation to wood and metal, but offers numerous advantages such as ease of working, strength and lightness and simple repair techniques. It is basically a combination of glass fibre material and a cold cure liquid resin used in conjunction with a hardener or catalyst. Other materials will be found useful in the various aspects of using resin-bonded glass fibre, but these will be dealt with as the need for them arises.

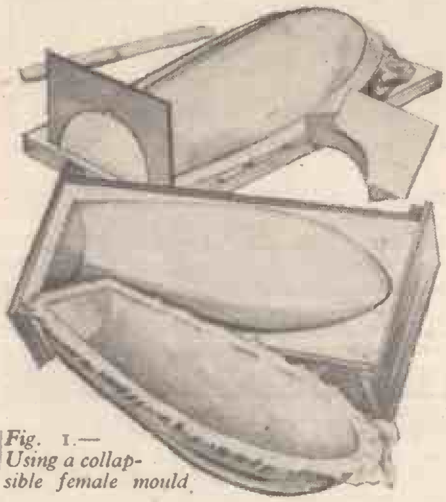


Fig. 1.—Using a collapsible female mould.

Making Moulds

The one item that is, in almost every case, essential is some sort of mould and this, of course, varies a great deal according to the laminate being made.

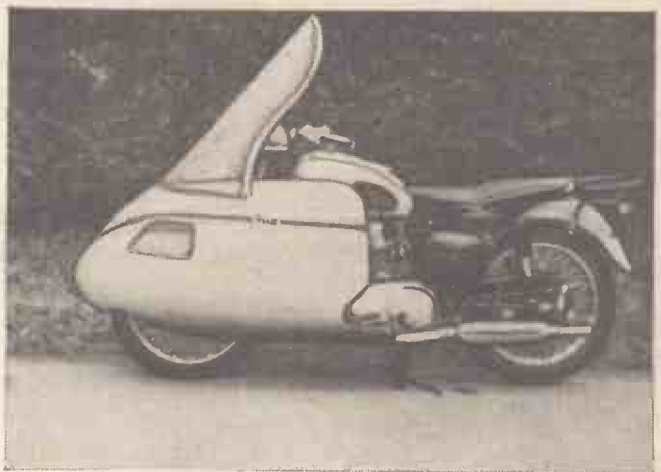
The simplest form of mould is that used for moulding a flat panel and in this particular case a sheet of glass can be used, covered with wax-polish to facilitate the removal of the finished laminate. It will be noticed that one side of the panel is smooth, i.e., the side in contact with the sheet glass, while the other shows the pattern of the material used. The principle applies throughout all glass fibre moulding work—one side takes on the same surface as the mould, while the other surface depends upon the work of the constructor.

Male or Female?

This question of a smooth or rough surface is one of the deciding factors between the use of a male or female mould. If a smooth outer surface is required, such as for a boat hull, a female mould must be used, see Fig. 1. If an item such as a hand basin is being built up requiring a smooth inner surface, a male mould must be used (Fig. 2). The terms "male" and "female" are always used to describe moulds and refer to whether the laminate is made over them or in them. A female mould is more often used as it is the outside of the laminate which usually has to be finished, as in a car body. These are far more difficult to make than a male mould. The problem is sometimes solved by making a male mould first, laminating over it to form a female mould and using this to produce the final laminates, see Fig. 3. The female mould made in this technique can be used over and over again, but the male mould is possibly no longer required and may be scrapped.

Male moulds are often made on a temporary basis, with their future destruction in mind. Thus a wide variety of materials can be used, including cardboard, wood, modelling clay, plaster of paris, and wire netting. Fig. 4 shows a typical mould for making a car body. A wooden frame is covered with chicken wire, which is used to support plaster of paris, sanded smooth when set. In cases like this, where it is obviously impractical to make a female mould, the finished laminate can be formed over the male mould, using suitable fibre glass materials and being finished with disc sander and files, etc.

Fig. 2.—The principle of the male mould.



The streamlining and scooter shield above were made from glass fibre by amateurs. Photos by courtesy of Bondaglass, Ltd., South End Rd., Croydon.

Whatever technique is used, the surface of the mould which is to impart the final surface to the laminate must be finished as smooth as possible, because all imperfections will be faithfully transferred to the laminate. Smoothing can be done by using shellac or mould release agent on the mould to avoid a porous surface and small inequalities, this being finally sanded when dry.

Sometimes it is possible to use the actual article being copied as the mould, e.g., a motor-car wing or boat hull could be used as a male mould for a laminate and this used as a female mould for making the copy. This was the technique shown in Fig. 3.

Other more complicated and more accurate techniques are used in industry, but the foregoing is in general the best method for the amateur.

Making a Laminate

As already described, the mould should be coated with shellac to eliminate porosity and this should be followed by a coat of release agent, so that the laminate can be removed when it is finished. As a final step before starting the laminate proper a gel coat is applied, i.e., a layer of resin, plus 10 per cent. Thixotropic paste resin, with no glass fibre. Catalyst should be added to the resin as per the maker's instructions, but in general this can be a quick-setting mix as it does not take long to apply. Use a brush to put on an even coat and allow to gel. While this is taking place, wash out the brush with methylated spirits or cellulose thinners. When the surface has reached a firm, tacky state, another coat may be applied and left to set to the same state of tackiness.

Mix the resin and catalyst to impregnate the glass, making sure when adding the catalyst that sufficient time is allowed for impregnation. Now apply the first lamination coat, add the glass fibre to the wet surface, smoothing out any wrinkles and creases. When thoroughly mixed it should be painted or rather pressed into the first layer of glass mat by means of the fingertips or a roller or by using a stippling action with the brush. Make sure that the glass cloth is completely covered and thoroughly saturated. There must be no air bubbles left and the cloth should adhere closely to the mould.

Apply a second coat of laminating resin with a brush. This is followed by the second layer of glass mat and the impregnating coat of resin. This will take longer to saturate the glass cloth but will do so after about ten minutes; stippling and rolling will cause the layer to settle down smoothly. This procedure should be repeated until the desired thickness is built up. Leave the completed laminate to harden for about 24 hours and then start removing it by easing it away from the mould round the edges. Judicious treatment with a soft-headed mallet may help and finally a thin knife blade or a screwdriver will help to ease the two apart.

Trimming

Use a hacksaw blade for trimming or, better still, an electric saw or abrasive wheel. Do not use tinsnips. For any finishing work which may be required, sharp coarse-cut files can be used and either Surform or Stanley shapers will be found useful. This can be followed by treatment with "wet or dry" auto papers, used for rubbing down cellulose, followed by an ordinary metal polish.

Before painting, all traces of release agent must be removed by washing with warm water, as they will prevent adhesion of paint.

Reinforcements and Stiffeners

When it is required to add rigidity to a large flexible panel, ribs may be bonded to either surface. They may be of any form—

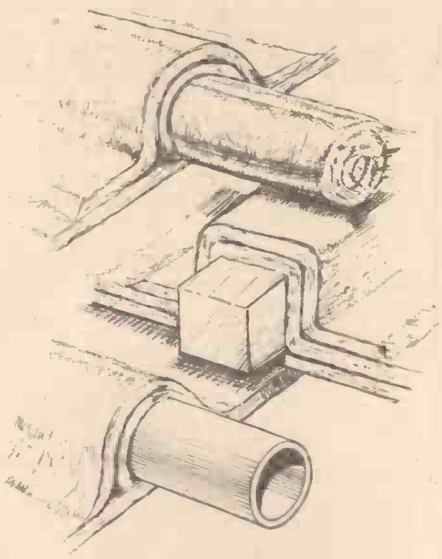


Fig. 5.—Three examples of bonded ribs for reinforcement.

round, wooden dowels, hollow metal tubes, square section wooden bars or a preformed tube made from glass scrim and resin. Alternatively, the rib may be left hollow. The method of including these ribs can be seen in Fig. 5. The ribs are best planned in advance and included as the lamination proceeds, but they can be added to an existing sheet, provided the surface is well roughened before bonding the reinforcement to the surface with layers of glass and resin.

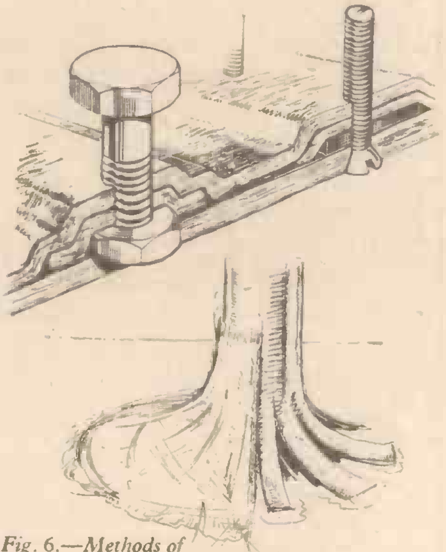


Fig. 6.—Methods of including nuts, bolts and brackets in a laminate.

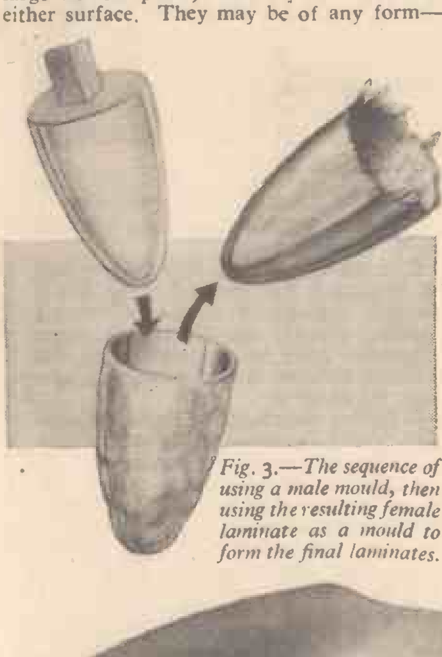


Fig. 3.—The sequence of using a male mould, then using the resulting female laminate as a mould to form the final laminates.

Panels which have to be bolted together may have either the bolts or the threaded nuts included in their fabrication, as shown in Fig. 6. Similarly, brackets may be included in the laminate by spreading the ends and covering with layers of glass and resin.

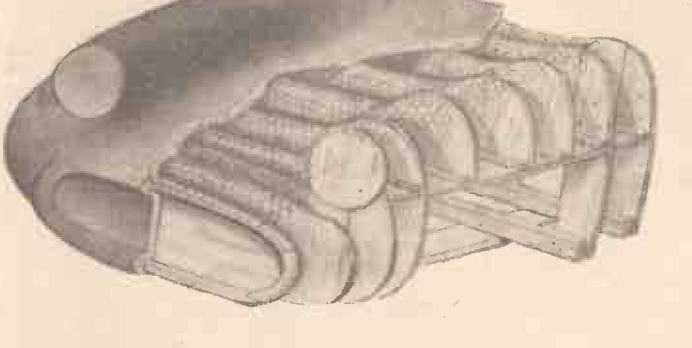


Fig. 4 (Left).—A typical temporary mould for moulding a car body.

Jointing

Fig. 7 shows butt and lap joints. The procedure is first to clean the surfaces with a wire brush or sanding disc. Then put the sheets into position and cover the area of the joint with glass cloth and resin as shown. The method of adhesion of a lap joint is a layer of resin, but unless the sheets are to be very close, they should have a layer of glass ribbon in between.

Riveting and screwing procedures are the same as for other materials.

Repairing with Glass Fibre

Varying methods of repair of damage to glass fibre structures are employed according to the nature of the damage. Where the laminate has not been fractured, but surface cracks have appeared, one or two sheets of tissue-thin glass fibre should be used. Cut these until they overlap the crack by about 2in. on each side. Brush the resin and hardener over the area to be covered and apply the glass tissue, stippling until well-saturated. Repeat the process if necessary and leave to dry for about 24 hours. Finally sand the repair with a disc sander to the surrounding contour and finish with "wet or dry" paper, using soap as a lubricant. Finally, finish to match the surrounding area.

Repairing Tears and Splits

Use a thicker type of glass material for this repair, cut about 2in. wide. Three pieces will be required and they should be laid as shown in Fig. 8, after roughening the base material. The same procedure of laying each piece of glass cloth on a coat of resin and impregnating it with more resin must be followed, also the same technique of sanding and finishing. The only difference in procedure is that all rough and jagged holes must be filed down or cut away before sanding the area surrounding the repair to avoid splits remaining.

Large Holes and Contoured Surfaces

In repairing large holes, it is usually necessary to have access to the underside of the part to be repaired, so that some support for the glass mat repair material may be arranged. With flat surfaces, this can be a permanent application of glass fibre on the under surface. With a curved surface the

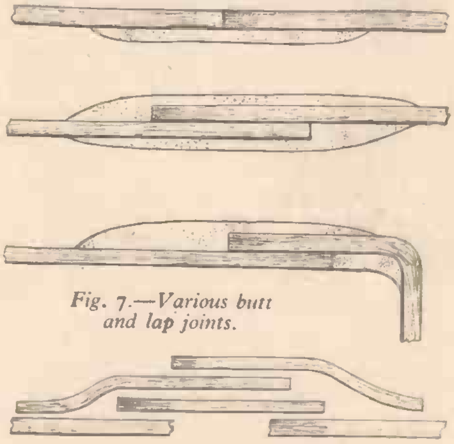


Fig. 7.—Various butt and lap joints.

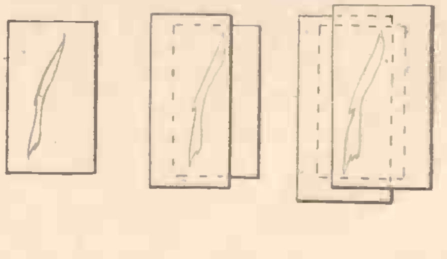


Fig. 8 (Right).—The procedure for repairing tears and splits.

support must be shaped to conform to the existing contour. It can be prefabricated from almost any suitable material and to ensure easy removal the shaped surface should be coated with release agent.

Trim or file away the jagged edges of the hole and sand the surrounding area. Put the support into position and apply a coat of resin mixed with hardener over the support and the surrounding area. Place a piece of glass mat, shaped to fit the hole, in position and thoroughly impregnate it by stippling. If necessary insert further layers to fill the hole. When this has been done, a larger piece of a size sufficient to overlap the area of the hole by about 2in. all round is positioned and stippled to saturate in the usual way. Sanding, finishing and painting are as previously described.

Skinning Wooden Boats, etc.

The terms "skinning" or "sheathing" refer to the process of enclosing the wooden hull of a boat or covering a caravan roof or commercial vehicle body with a skin of glass fibre and polyester resin. This process preserves the woodwork against deterioration and rot and, in the case of boat hulls, gives extra protection against termites and marine borers, gives extra waterproofing and water tightness and reduces the maintenance and repainting necessary.

Woven glass fibre cloth is best for this operation and the number of layers required depends upon the strength required and the size of the boat. Boats up to 14ft. long require only one layer; it makes no difference whether they are clinker- or carvel-built.

Preparing the Boat Hull

Allow to dry out thoroughly and remove all paint and varnish with a disc sander. Leave the surface rough and remove all metal fittings. Any protruding nails or rivets must be punched below the surface and cracks, holes and joints filled with a mixture of resin, hardener and filler powder, mixed to the consistency of putty.

Cut the glass cloth to the size required —it should be laid in a fore and aft direction along the hull and athwartships when covering decks. At least 2in. overlap must be allowed for each piece. Precutting is important because the pot life of the resin after the hardener has been added is only about 45 minutes at 68 deg. F.

Start with a gel coat of the resin (plus Thixotropic paste resin as before). When this has been evenly applied with a brush and has become tacky, smooth the glass cloth into position over the area being covered using drawing pins to hold it if necessary. This is followed by the impregnating coat, which should also have colour included if required. This is stippled into the glass cloth, making sure that it is completely saturated and that there are no air bubbles and no creases or folds left on the surface. Use the minimum amount of resin that will saturate the glass cloth. When a satisfactory surface has been obtained, leave to harden for between 12 and 24 hours.

Finishing

Trim off all ragged edges with a hacksaw, file, etc., and sand them smooth, finally sealing with resin mixture. Give the whole hull a final coat of resin mixture. When this is dry sand down ready for polishing or painting. Replace the metal fittings with a little resin mixture round the screws for waterproofing. The boat should only be skinned on the outside, as a double skin would cause rot.

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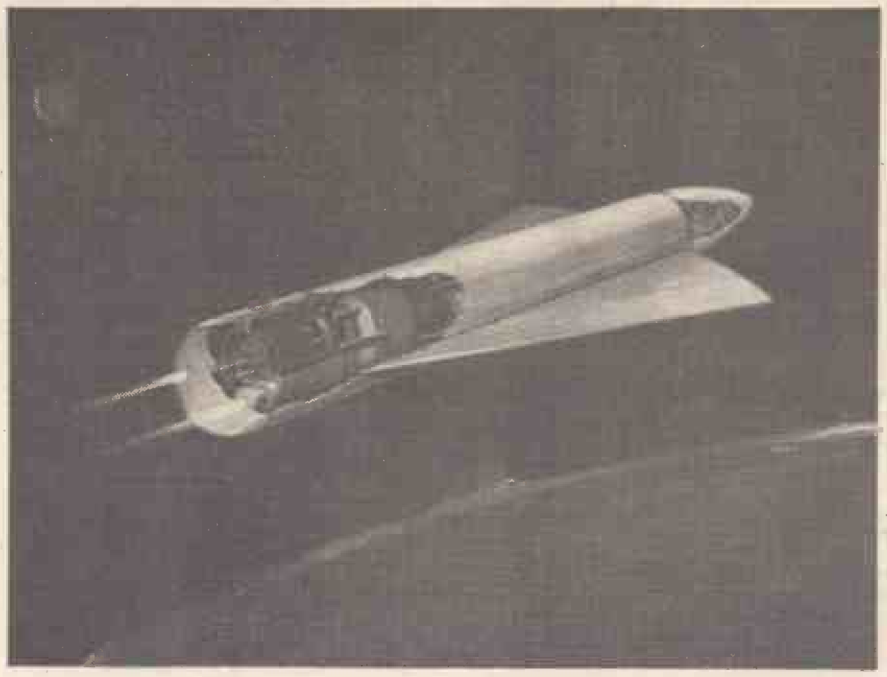
An Ion Rocket for Space Travel

A Three Million m.p.h. Space Ship Visualised

THE illustration below is an artist's conception of an ion rocket vehicle of the not-too-distant future. As big as to-day's generation of inter-continental ballistic missiles, it would be propelled through the vacuum of space at thousands of miles an hour by a few pounds of thrust.

The propulsive force for such a vehicle would be provided by the discharge of ionised particles, rather than gas as in conventional rockets. The wing-shaped attachments to the vehicle illustrated are radiators to reject excess heat. The direction of flight would be controlled by swivelling rockets.



An artist's conception of an ion rocket vehicle of the future.

Rocketdyne, a division of North American Aviation Inc., has a team of scientists and engineers studying ion propulsion and designs for nuclear rocket engines. It says that "practical steps" have been taken towards the first ion rocket vehicle.

How it Works

Project engineers foresee ion rocket craft being thrust through space by a light-giving current of charged particles a million times greater in number and weighing 350,000 times as much as the stream of electrons in a television picture tube.

A stream of "heavy" ions accelerated through a thrust chamber to velocities of 400,000 miles an hour could produce about one pound of thrust. This force would be ineffective for propulsion at sea level, but in space it would suffice to accelerate a five-ton vehicle to speeds of thousands of miles an hour.

A Rocketdyne engineer says a rocket engine that could create ions and harness them for propulsion would employ a chemical propellent whose molecules offered the highest possible weight. He suggests as the best propellents uranium tetrachloride, thorium, mercury and the alkali metals cesium and rubidium.

Vaporised, the propellent would be fed into an electrically charged chamber. There, an electric arc or a metallic plate generating 100 times the heat of a large electric stove would knock loose an electron from each molecule of vaporised propellent. In losing an electron, each molecule would assume a positive charge and its remaining bulk thus become an ion.

The newly created ions would be pulled out of the ionising chamber by the attraction of an electro-static field and then jolted by 12,000 volts to effective velocities of 300,000 to 400,000 miles an hour.

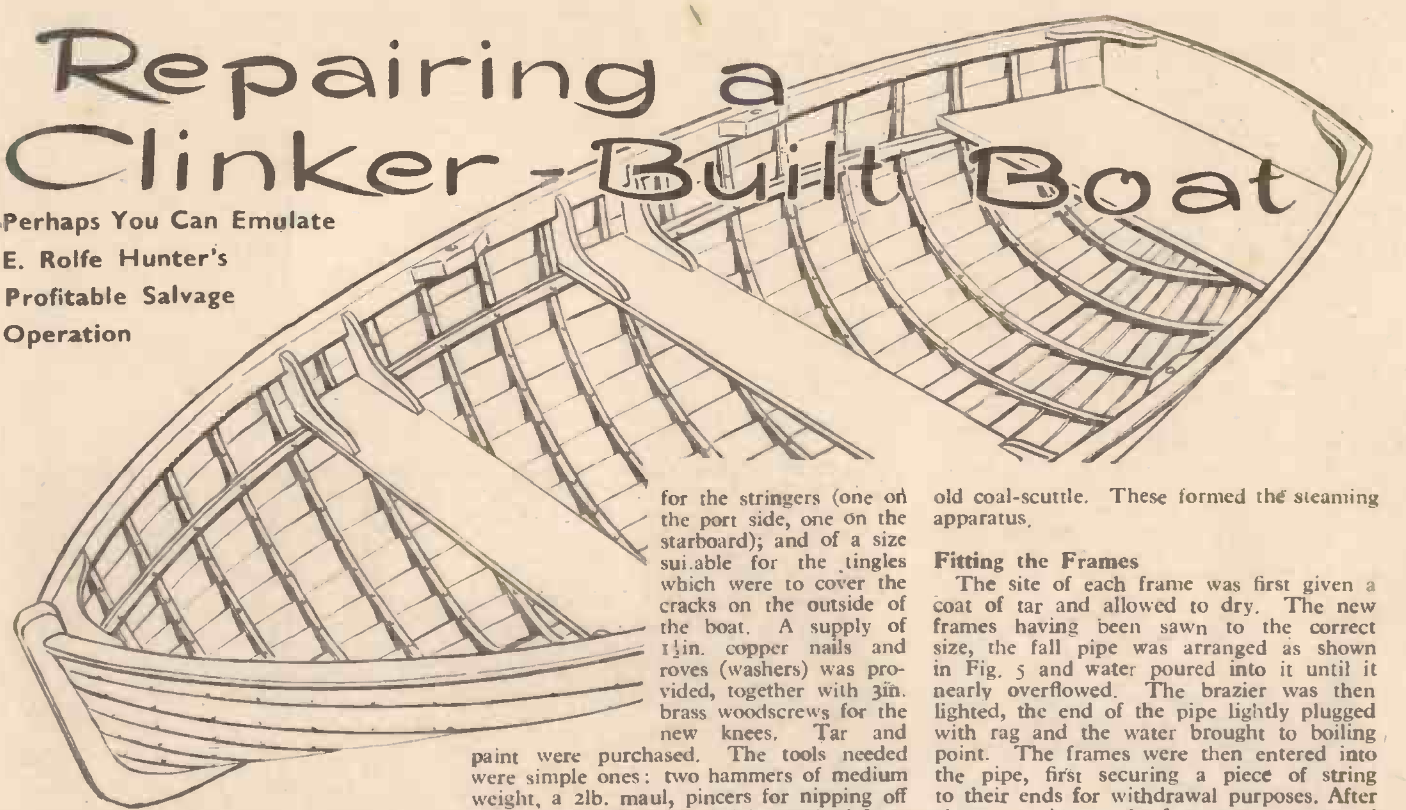
The current of speeding ions would be harnessed for propulsion by being directed through a cylindrical thrust chamber roughly 2ft. 9in. in diameter. Propulsive force would come from the vehicle's reaction to the escape of ions from the chamber.

A further view held is that ion propulsion would supplement the capabilities of chemical and nuclear rocket engines and that development of a usable ion rocket engine would be centred in thrust chamber investigations, propellent studies and the development of high specific power generation systems.

It is interesting to note that Rocketdyne is thus planning a unit with only a few pounds of thrust at the same time as it is working towards a rocket engine in the one million to one-and-a-half million pound thrust class. This is the engine ordered by the National Aeronautics and Space Administration for American space exploration in unmanned, or perhaps, manned, vehicles by the mid-nineteen-sixties. The projected ion engine would be capable of acceleration to three million m.p.h. and would operate on a "commonly obtainable" material costing 1s. 9d. to 4s. per pound.

Repairing a Clinker-Built Boat

Perhaps You Can Emulate E. Rolfe Hunter's Profitable Salvage Operation



SMALL boats which have been carried ashore and left by their owners to deteriorate are frequently to be seen along the coast. Many of these boats are in a repairable condition, a fact of which the owners appear often to be either ignorant or indifferent. The author purchased one such boat for a few shillings and, after repair, sold it for £25, making an estimated profit of about £15. The boat was 12ft. long and "clinker-built," i.e., the strakes formed the hull overlap.

Condition

At least two-thirds of all the frames (wrongly called "ribs") were fractured, some of them in more than one place. The stringer (see Fig. 1) was badly broken and sprung. Several strakes ("planks") were split in a fore-and-aft direction and two knees were entirely missing. However, on probing the garboard strake with a penknife the woodwork here was found to be sound and since this part of the boat is invariably the first to be attacked by rot, it was apparent without much further examination that the remainder of the woodwork was quite sound.

Procedure

The first step was thoroughly to burn off all the old paint, first removing the existing stringer, which was to be completely replaced. It was decided to leave all the existing frames, including the defective ones in position and to fit new ones alongside them, thus increasing to a considerable extent the original strength of the boat. The next step was to fit wooden tingles (patches) over those strakes which were split and finally to secure new knees as required. It was known by experience the gaps between the strakes caused by shrinkage would "take-up" if the boat were allowed to float in a waterlogged state for a few days.

Materials

Elm, ½in. thick, was cut into suitable lengths ¾in. wide for the frames, 1in. wide for the stringers (one on the port side, one on the starboard); and of a size suitable for the tingles which were to cover the cracks on the outside of the boat. A supply of 1½in. copper nails and roves (washers) was provided, together with 3in. brass woodscrews for the new knees. Tar and paint were purchased. The tools needed were simple ones: two hammers of medium weight, a 2lb. maul, pincers for nipping off the surplus nail and a tool improvised from a 2in. length of iron piping, the bore of which was just wide enough to take the shank of the copper nails. This tool was used to force the rove firmly over the shank of the nail and into the frame before the final riveting process (see Fig. 4). In addition, a 10ft. length of fall pipe was fitted with a tightly-fitting wooden plug at one end and a coke brazier was improvised from an old coal-scuttle. These formed the steaming apparatus.

Fitting the Frames

The site of each frame was first given a coat of tar and allowed to dry. The new frames having been sawn to the correct size, the fall pipe was arranged as shown in Fig. 5 and water poured into it until it nearly overflowed. The brazier was then lighted, the end of the pipe lightly plugged with rag and the water brought to boiling point. The frames were then entered into the pipe, first securing a piece of string to their ends for withdrawal purposes. After about 15 minutes, the frames were extracted one at a time, carried quickly to the boat and made to conform to the curve of the boat by applying pressure from the feet and from the weight of the maul applied at the position of maximum curvature across the bilge. The nailing positions had been previously marked on the outside of the boat with a piece of chalk and holes drilled with a 1/16in. drill. The first nails were

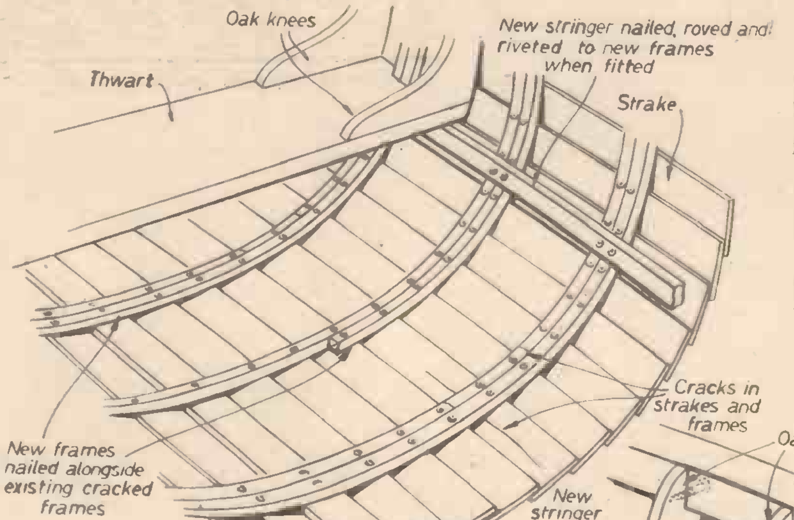


Fig. 1 (Left). — Perspective sketch showing part of the boat.

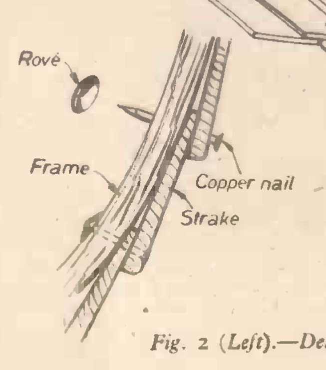


Fig. 2 (Left).—Details of the nailing points.

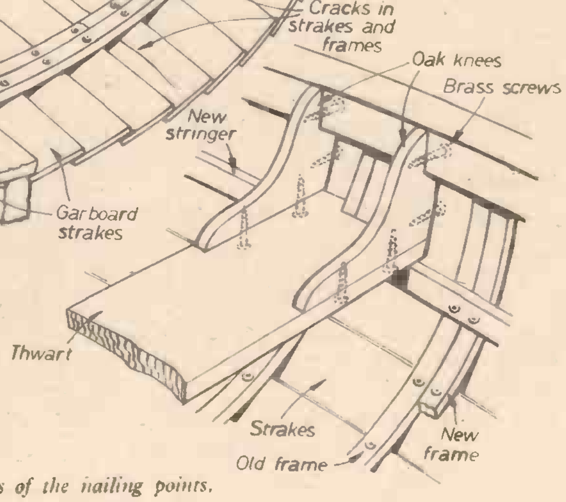


Fig. 3 (Below). —Fitting the knees.

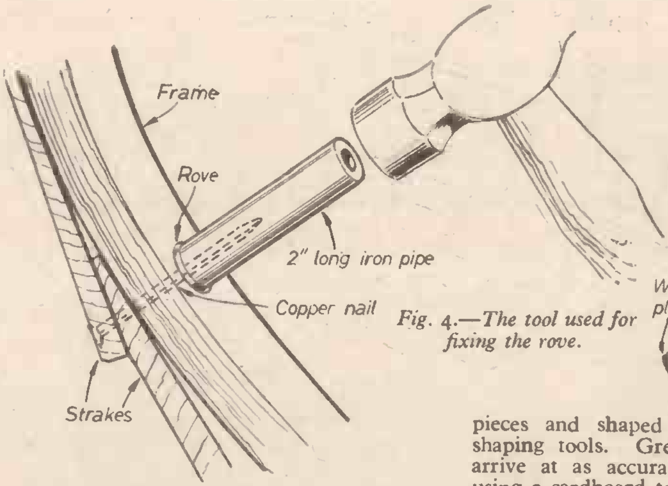
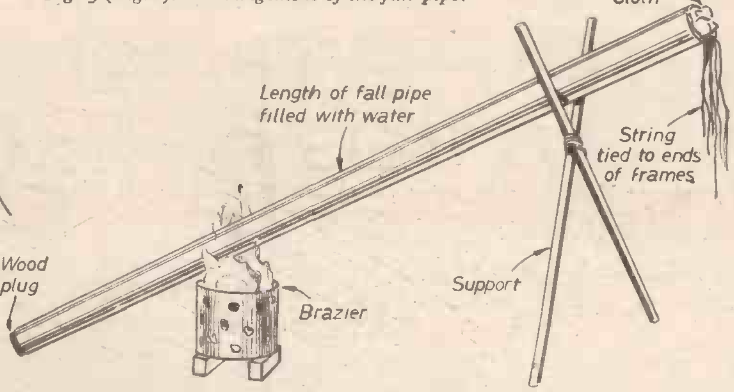


Fig. 4.—The tool used for fixing the rove.

Fig. 5 (Right).—Arrangement of the fall pipe.



entered where the curve was most abrupt.

After the nails had been hammered home, a copper rove was slipped over each of their shanks, forced home with a hammer and the tool previously described, and the surplus nipped off with the pincers. The end was then riveted. Having fitted all the frames, the stringers were put into the steamer and fitted in a similar manner to the new frames. It should be carefully noted that, in the case of the frames, the nailing points are located through the overlap of the strakes. (See Fig. 2.)

Fitting the Tingles

The boat was turned upside down and the tingles were checked for size and shape over the cracked parts of the strakes. They were then put into the steamer, withdrawn when ready and nailed into place, commencing in the middle and working towards each end alternatively. (See Fig. 6.) Roves were fitted and the nails were riveted in the usual way.

The Knees

A piece of oak grown to an L-shape was cut into the required number of similar pieces and shaped with one of the new shaping tools. Great care was needed to arrive at as accurate a shape as possible, using a cardboard template. On completion the knees were drilled to take 3in. brass woodscrews. (See Fig. 3.)

Painting

The bottom of the boat, both inside and out, was given three generously applied coats of hot tar. The rest of the boat was given a priming coat and two topcoats of boat-paint. When dry, she was moored and allowed to fill with water. After three days the shrunken woodwork had completely taken-up and the boat was thoroughly seaworthy.

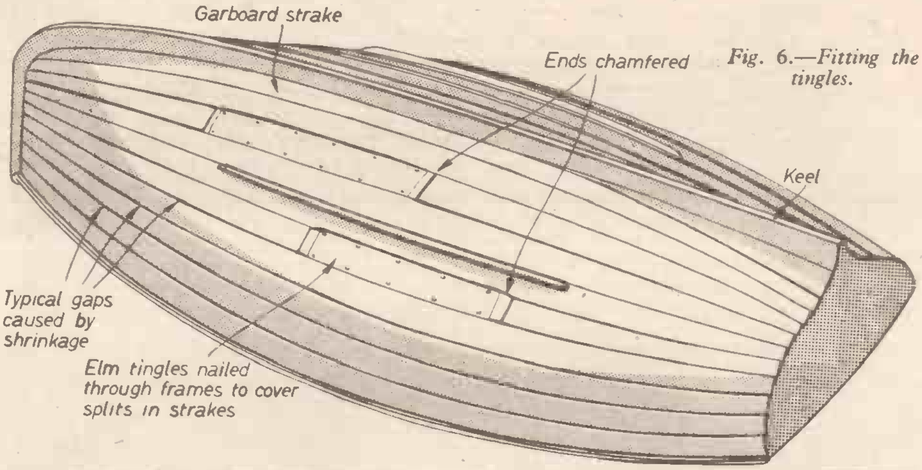


Fig. 6.—Fitting the tingles.

SCIENCE —notes—

Unbreakable Mainspring

SAMUEL FOX AND COMPANY, LIMITED, a subsidiary of The United Steel Companies, Limited, have developed a new stainless alloy specifically for the manufacture of watch and instrument springs. Known as Fortinox, the new alloy is already being used in the large-scale production of stainless unbreakable mainsprings for watches and precision instruments.

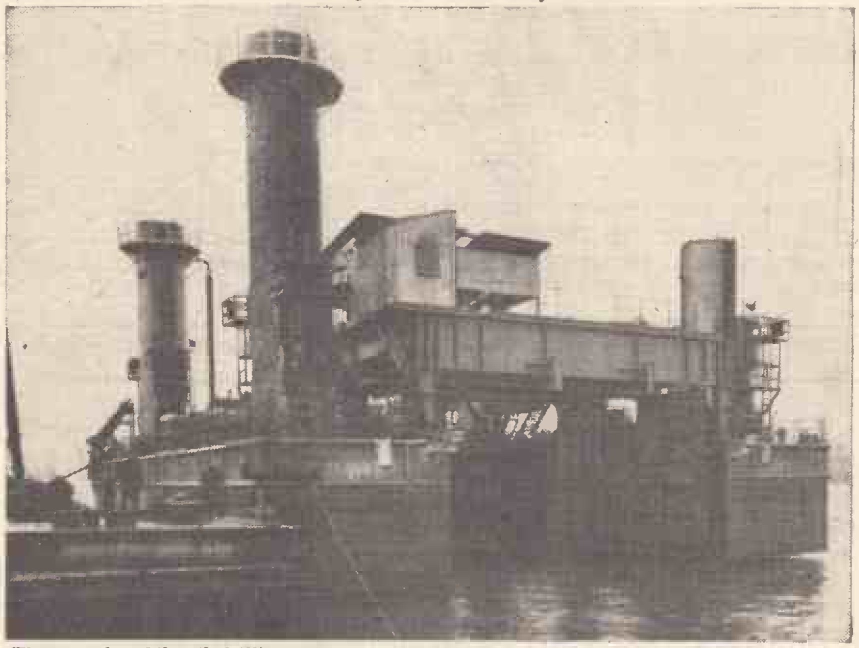
Previously, unbreakable stainless spring alloys have had to be imported into this country.

World's Longest Moving Sidewalk

ENGINEERING history will be made early this year when Australia's first—and the world's longest—moving sidewalk is built in Sydney.

It will be more than 700ft. long and will run underground from a car parking station in the Domain to a subway.

A Newcastle firm, Morison and Bearby Pty. Ltd., has secured a contract with the Sydney City Council for the construction and installation of the sidewalk at a cost of approximately £86,000. Sydney's sidewalk, a twin-track type, will have a capacity of 600 persons a minute and will travel at 132ft. a minute (about 1½ m.p.h.). Passengers will be spaced at an average of approximately 2ft. when fully loaded.



The second mobile oil drilling platform to be constructed in the United Kingdom has been built at Wallsend-on-Tyne. The £500,000 Triton *contains 1,500 tons of steel, has been built for operations in water depths up to 120ft. and is fitted with four retractable legs, each of 200ft. in length and 8ft. in diameter.*

BUILDING YOUR OWN 3-4 Berth Caravan

This Instalment Concludes Body Construction and Deals with Making the Windows

(Continued from the January issue).

THE tops of the side-frames have to be "nipped-in" two inches on to the headboards of the ends. This places the side under slight tension, and helps to give rigidity and stability.

The middle spars of the end frames are attached to the corner bends with small right-angle brackets, as can be seen in Fig. 9b (January issue). This saves cutting an awkward joint which might weaken the bend.

The Roof Framing

The three roof bends can have their curves shaped whilst the sides are being

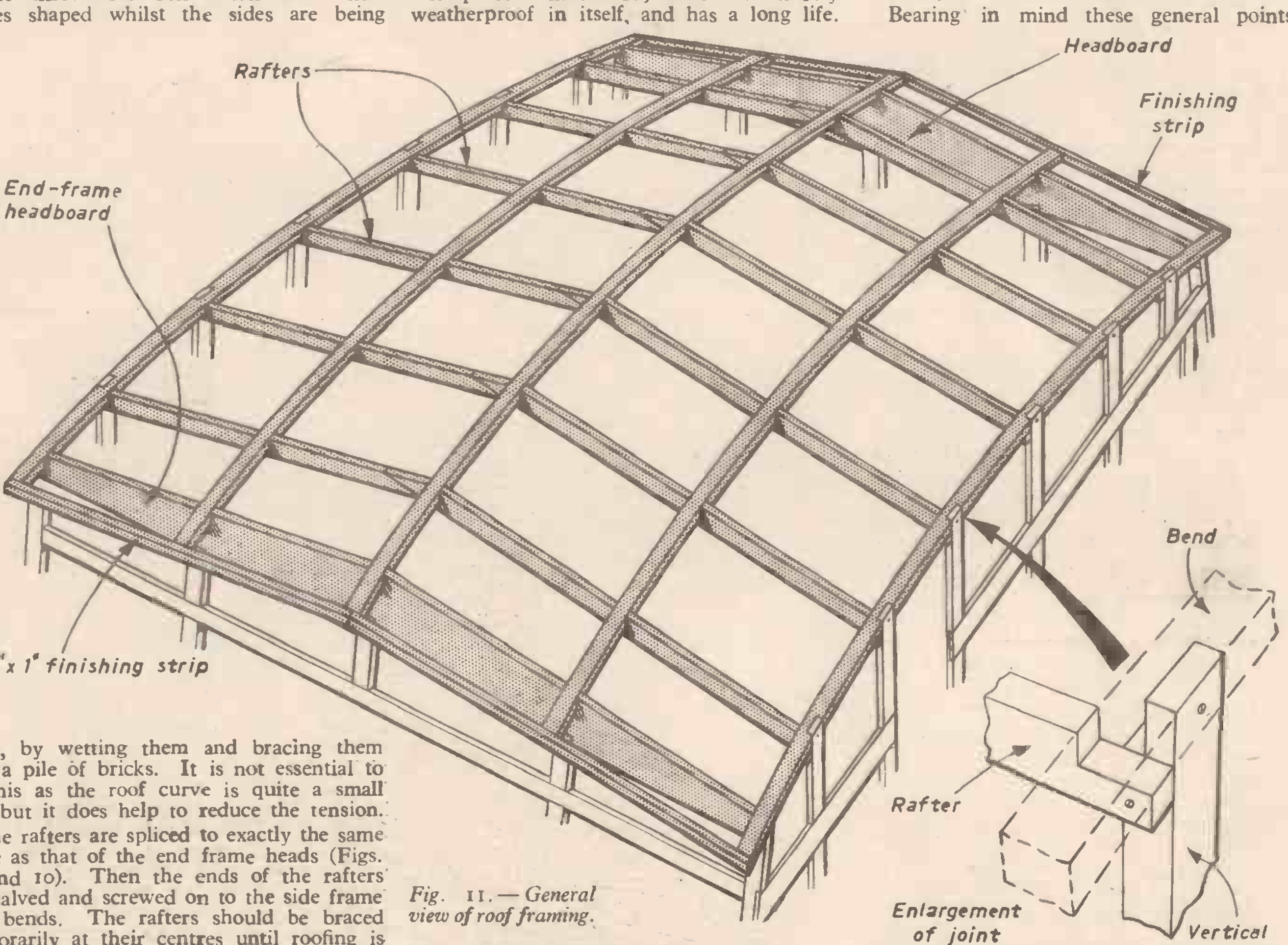


Fig. 11.—General view of roof framing.

made, by wetting them and bracing them over a pile of bricks. It is not essential to do this as the roof curve is quite a small one, but it does help to reduce the tension.

The rafters are spliced to exactly the same angle as that of the end frame heads (Figs. 9b and 10). Then the ends of the rafters are halved and screwed on to the side frame roof bends. The rafters should be braced temporarily at their centres until roofing is completed.

The roof bends are set down into their sockets, being held with cramps until the screws are put in.

It is as well to offer everything on screws only at first, leaving the final gluing until all adjustments have been made.

Finally, the ends of all rafters are faired-off to the sides. The ends of the roof-bends are cut level, and are joined across with finishing strips of 1in. × 1in. soft wood, glued and nailed into place (Fig. 11).

The rafters and the centre roof-bend, together with all other protrusions on the roof, must all be faired-off to the main run of the curve and slopes so as to get the maximum surface for setting-down the roof surface.

Wheel Boxes

It is useful to build these in before the van is skinned. The construction is quite simple and shown in detail in Fig. 12.

Skinning the Caravan

At this stage the frame appears unduly fragile and not very rigid, but the application of the skin will soon correct this.

On the van shown, the skin is ⅛in. thick "tempered" hardboard, which is entirely weatherproof in itself, and has a long life.

Hints About Hardboard

A few general points about the fixing of hardboard will be found useful. Each board should be well soaked with water for at least 48 hours; the backs should be sprayed quite wet, and the boards stored back to back. This treatment, together with adequate fixing battens (the recommended distance is 1ft. 3in., but the 1ft. 6in. of the framing seems adequate), will help to prevent distortion. The best nails to use are the special hardboard nails with square shanks and "lost heads" made in coppered steel. They should be used at 3in. to 4in. intervals, and fixing should begin at the middle of each panel, working outwards to the edges and corners, making sure that all kinks are removed and that the work lies flat. Panels should not butt up tight against each other; a gap of ⅛in. is permissible.

On the caravan all hardboard edges should be bedded on to a good layer of mastic sealer, and all points filled with this substance well pressed home.

Before painting, the hardboard should be primed with special hardboard sealer paint. All nails should be driven flush or a little below the surface. All holes and blemishes should be stopped up after priming (putty will do) and rubbed down well.

Bearing in mind these general points, the skinning of the caravan will present few problems. The van shown was skinned with large surfaces for quickness, cut from 12ft. × 4ft. sheets. Apart from some waste involved at the curves, this method has shown no drawbacks, although the use of smaller sheets may be more economical. However, the large joint-free surfaces are certainly neat and watertight.

The Sides

The bottom side panels were put on first, having been offered to the framework for careful marking out. The top sides followed,

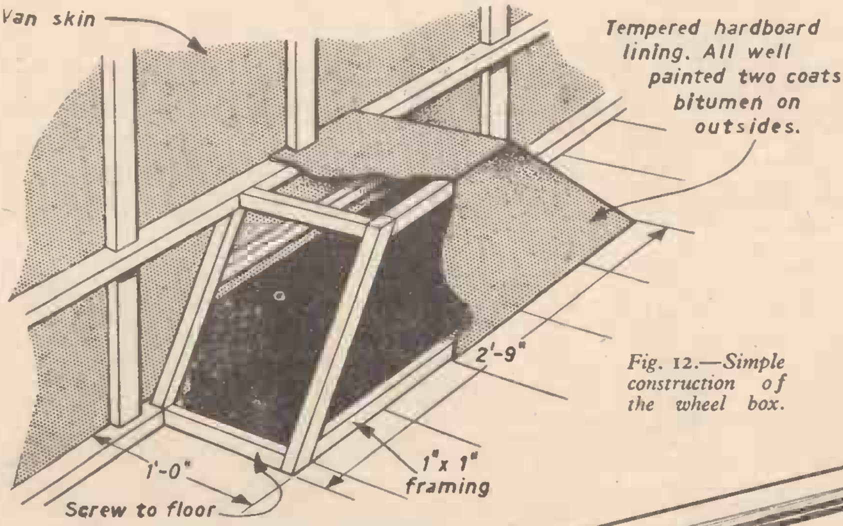


Fig. 12.—*Simple construction of the wheel box.*

the windows being cut out beforehand. Then the ends were dealt with, being allowed to overlap the sides at the corners.

The Roof

The roof was put on in two pieces, these being offered to the job, marked off and cut. The first piece is fairly easy, being adjusted to the middle of the centre roof bend first and trimmed off at the edges after fixing. The second piece has to be adjusted to give a neat joint against the first at the centre. This is best done by trial and error; the hardboard is easily cut and planed. Again it is better to allow the roof to overhang at the eaves, and to make this tidy after fixing. All sharp corners should be glass-papered off, and all nails made flush before applying the roof canvas.

This is plain canvas and need not be of exceptional quality. It should be 4yd. long and 6.t. 6in. wide. From one end strips 4in. wide are cut, which are used first to seal the central joint, and any others if the roof has been put on in smaller sections.

The canvas can be fixed either with an adhesive, or bedded down on to wet paint. A liberal coat of either is applied along the joints, and the canvas strips are pressed firmly into place. When the sealing strips are dry, the main canvas is rolled and placed conveniently at one end of the roof. An area about 1ft. or so wide at a time is painted with adhesive and the canvas is unrolled on to it, being pressed down and smoothed to remove wrinkles, before proceeding with the next area. The canvas should not be stretched tight, as it may split as it dries.

Any surplus canvas is trimmed off so as to leave an overhang of about 1½in. This is turned under and pressed on to fresh adhesive at the eaves, being fixed with copper tacks at 3in. to 4in. intervals. At the ends the canvas is taken right under the overhang, and is glued and tacked into the finishing strips.

When dry, the canvas is given a priming coat of lead-base paint as soon as possible. This may be followed with several more coats at the time of painting the whole van.

The Windows

All surplus spars across door and window spaces should be cut away, and the inner edge of the spaces rendered smooth.

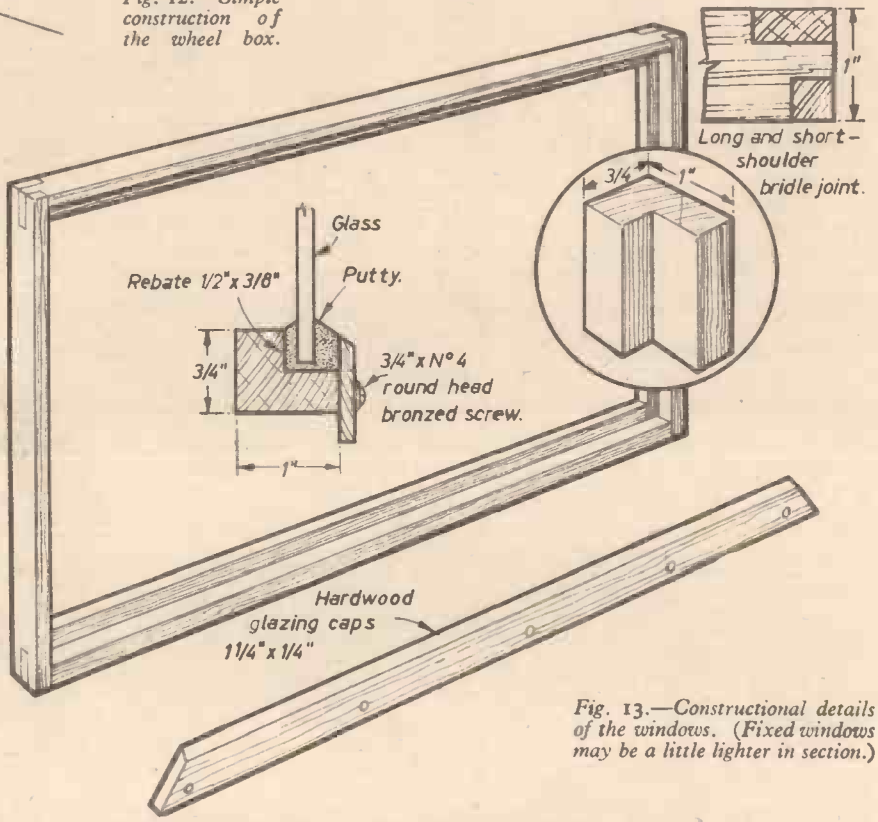


Fig. 13.—*Constructional details of the windows. (Fixed windows may be a little lighter in section.)*

The spaces for the door and opening-windows should be primed and any holes stopped. They may then be undercoated to help seal the hardboard. One excellent finish for these edges is to glue strips of Formica along them.

After finishing the spaces they should be most carefully measured and the making of the doors and windows put in hand.

The windows are simple enough, being plain, rebated soft-wood, with dowelled bridle-joints at the corners, as shown in Fig. 13. The hardwood glazing strips are fixed with raised-head bronzed screws, using mitred corners as shown. It is as well to make up the whole window before glazing. This is done with 24oz. glass on ordinary linseed putty, and it is necessary to prime all parts where the putty is going.

The fixed-window frames are nailed into place before glazing, and the opening-windows are best hung without the glass. If the frames have not been made too tight little difficulty will be had with fitting these.

Each of the opening windows requires two friction staysets and at least one screw-up type of window-fastener of the type shown in Fig. 14.

(This short series will be concluded next month.)

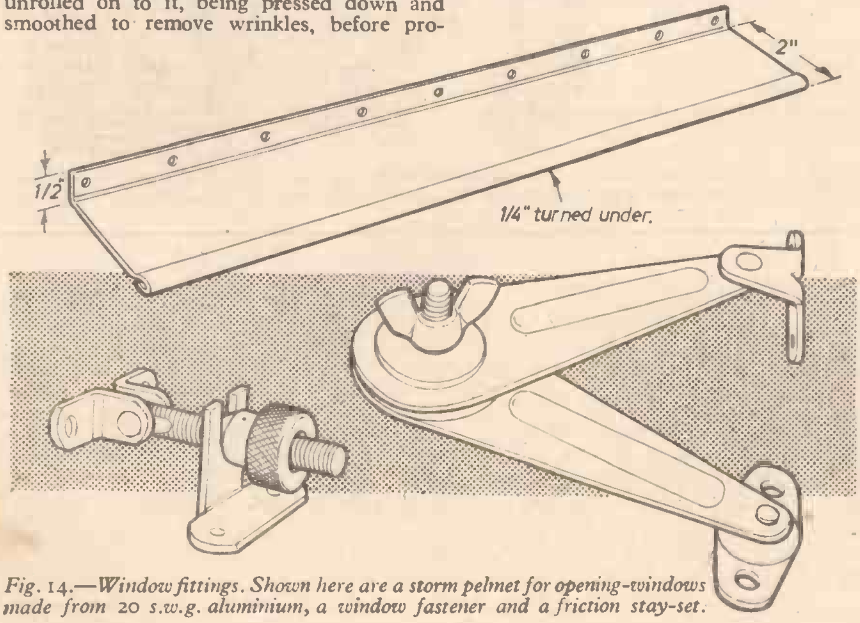


Fig. 14.—*Window fittings. Shown here are a storm pelmet for opening-windows made from 20 s.w.g. aluminium, a window fastener and a friction stay-set.*

Choosing a 'MIKE'

This Question is Discussed with Particular Reference to Tape Recording

By B. F. Wilkinson

The heading photograph shows a dynamic low impedance microphone on a table base.

A TAPE recording system may be considered as a chain, and as with most chains, it is only as strong as its weakest link. In electrical systems, the weak links are at points where electrical energy is transformed into some other form of energy or vice versa. Distortion is generally introduced due to non-linearity in the characteristic of the transfer device. In electro-acoustic systems such as record players and radio receivers, the loudspeaker is a particularly weak link, and while the tape recorder shares this weakness, it can show yet another, the microphone. It does not matter to what expense one is prepared to go over the rest of the equipment, the quality of reproduction will be as good, and only as good, as the microphone. There are, however, different types of microphone and, as may be expected, they are not all suitable for use under all conditions. A description of the various types of microphones available and their uses, with particular reference to tape recording, follows.

The Carbon Microphone

The carbon microphone is probably the best known of all microphones, and is certainly the earliest. It consists, as shown in Fig. 1a, of two plates, and between them a number of loosely packed carbon granules. One of the plates forms the diaphragm and a connection, while the other plate forms the second connection and the backing plate to the instrument. The microphone works on the principle that sound waves falling on the diaphragm cause a pressure to be applied to it, so that the carbon granules become compressed, thus decreasing the resistance of the microphone. The resistance of the microphone thus follows inversely the amplitude of the sound pressure applied to the diaphragm. Owing to the inverse nature of resistance in Ohm's Law, the current flowing from the microphone is a replica, both in amplitude and frequency, of the original sound.

This type of microphone suffers from the disadvantage that it must be polarised. Studying Fig. 1a again, we see the necessity of the battery in the microphone circuit. In order to keep this polarising voltage away from the circuit which follows, a microphone transformer is connected into the circuit. The secondary of this transformer would be wound to match the circuit it was designed to feed.

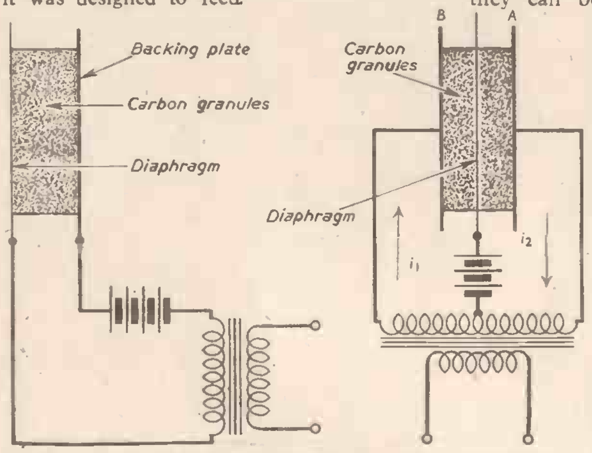


Fig. 1.—(a) Carbon microphone, (b) carbon microphones in push-pull.

Fig. 1b shows a more elaborate circuit, using a special kind of microphone, consisting basically of two carbon elements with a common diaphragm between. When a sound pressure wave falls upon the diaphragm in the direction shown by the arrows, the resistance of microphone A decreases, while that of microphone B increases. This means that i_1 becomes larger while i_2 becomes smaller. In responding to the negative half cycle of pressure the conditions become reversed. In this way the output of the microphone is considerably greater than for a standard carbon instrument.

Now carbon microphones have important uses in telephone systems, where their robustness is a considerable advantage, and they are also used in radio telephone systems. While they can be used in magnetic recording systems, they can only be recommended for use in systems recording speech only, owing to the poor quality of reproduction. While the output is good, carbon instruments tend to be noisy. Sound waves cause the carbon granules to be compressed, and this motion gives rise to a harshness of tone, which would not be tolerated in a system where quality was required.

The Condenser Microphone

The output of the carbon microphone depends on the deflection of the diaphragm—that is, the farther the diaphragm is moved by the sound pressure the greater the output. This kind of microphone is known as a pressure-operated microphone. A similar instrument, but one capable of much better quality, is the condenser microphone, which consists basically of two plates insulated from one another. One plate forms the diaphragm, while the other becomes the backing plate. The instrument is virtually a condenser, with capacity between the two plates. Sound waves falling upon the diaphragm, deflect it so that the capacity of the instrument varies. Since capacity is itself a passive quality, it is necessary to polarise the microphone, and amplifiers intended to work with condenser microphones, usually bleed a D.C. voltage from the H.T. line as a polarising source. This potential, is usually of the order of 120-180 volts, and in order to keep it from the grid of the first valve, a blocking condenser of suitable value is connected between the microphone and the grid.

(Left)—A dynamic low impedance hand microphone.

(Right)—A ribbon velocity "studio" microphone.

All the photographs on this page are of Lustraphone microphones and we are indebted to them for permission to publish.

With most microphones, the output is a function of the active area of the diaphragm, and the frequency response is an inverse function of the area. This means that to increase the output, it is necessary to increase the diaphragm area, but in doing this the frequency response falls off in the region of the higher frequencies. In the case of the condenser microphone, however, while the output is a function of the diaphragm area, it is also a function of the polarising voltage. So that we can improve the frequency response by reducing the size of the diaphragm, and keep the output at a reasonable level by increasing the polarising voltage.

The condenser microphone is particularly suitable to tape recording due to its good frequency response, especially at low frequencies (below 30 c.p.s.) and sensitivity. It should be remembered, however, that it cannot be used alone, with long lengths of coaxial cable, as the cable itself has capacity which must not be allowed to approach the capacity of the microphone. If we assume the capacity of the condenser microphone to be 50 $\mu\mu$F, then at a frequency of 1,000 c.p.s. the impedance will be 3 Megohms. Coaxial cable has a capacity of about 30 $\mu\mu$F

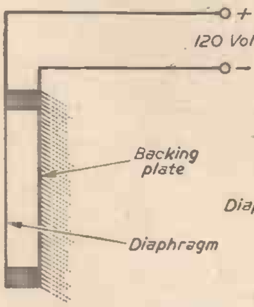


Fig. 2.—Condenser microphone.

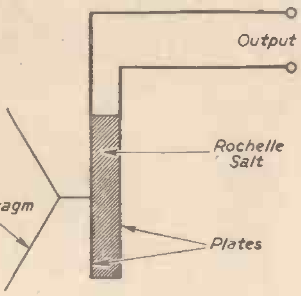


Fig. 3.—Crystal microphone.

per foot. Thus 12ft. of coaxial cable will constitute a serious drop in output, since the cable impedance at 1,000 c.p.s. will be approximately .5 Megohm. If it is desired to use more than a short length of microphone cable, it is necessary to use either a preamplifier at the microphone, or a cathode follower, in order to reduce the impedance to a suitable level for transmission over long distances. As to the cost, a reasonable instrument can be bought for between £6 and £12, but a really good one may cost up to £250. Finally, it should be remembered that being high impedance instruments, condenser microphones should be kept away from electrostatic fields, and should be handled carefully as they are easily damaged mechanically.

The Crystal Microphone

The last of the pressure-operated microphones we shall discuss is the crystal or piezo-electric microphone. The principle is the piezo-electric effect, which is that carefully selected and cut slices of certain types of crystal, namely quartz, Rochelle salt and tourmaline exhibit the property that when compressed between two metal plates, a potential difference is developed between the plates. If a diaphragm is fixed to one plate, then the sound-pressure waves falling on it can be made to distort the crystal, thereby generating small potential differences. Fig. 3 shows the principle of the crystal microphone.

Crystal microphones are particularly popular, but it should be pointed out that input circuits should be properly designed to receive them, as they have a tendency to accentuate the higher frequencies. Being of the high impedance type, they require no matching transformer, but may feed the grid of the first valve directly. Like condenser microphones they cannot be used with long leads, although up to about 10ft. is generally possible without loss. For leads longer than this, it would be necessary to use a preamp. with a low impedance output. Crystal microphones are susceptible to heat and damp and should be treated carefully in this respect. They are popular with manufacturers of average tape recorders as they are not expensive—a good one may be bought for as little as £2. They are light and small, and for this reason are suitable for portable recorders, where convenience is an important consideration.

Dynamic Microphones

All the microphones we have so far discussed depend for their output on the amount by which the diaphragm is deflected. Dynamic microphones operate on the dynamo effect, namely that an e.m.f. is induced in a conductor, when the conductor cuts or is cut by a magnetic field. A further extension is that the e.m.f. induced is proportional to the rate at which the lines are cut. Thus, in microphones working on this principle, the output depends not on the diaphragm deflection, but on its velocity.

Anyone who has taken a headphone to pieces will know that it consists of a magnet, pole pieces wound with coils, and a thin iron diaphragm. The diaphragm is balanced in such a way that there is a very small gap between it and the pole pieces to allow movement. There are microphones working on this principle. Sound waves falling on the diaphragm cause it to vibrate, varying the distance with the pole pieces. This creates a variation in the magnetic circuit, which in turn induces e.m.f.s in the coils wound around it.

Unless one is using an old high resistance headphone as a microphone, most of the microphones of this type are of the low resistance type, and can be found in ex-Government equipment, usually as intercom instruments. Being low impedance, they are suitable for use with long leads, but are generally only capable of rather low quality. They can, however, be used successfully with dictation machines or portable tape recorders where only speech reproduction is required.

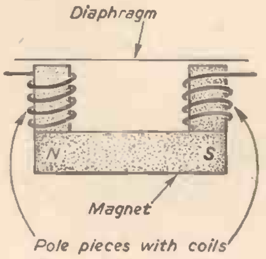


Fig. 4.—Dynamic microphone.

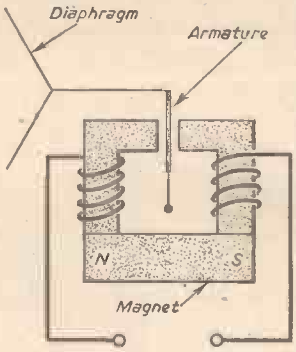


Fig. 5.—Balanced armature microphone.

Balanced Armature Microphone

The balanced armature microphone (Fig. 5) can be considered as a more advanced version of the previous type. The diaphragm does not itself form part of the magnetic circuit, but has attached to it a thin bar connected to an arm of soft iron between the pole pieces of a magnet. The bar follows the movement of the diaphragm, and the arm follows the movement of the bar, causing variations in the magnetic circuit. These microphones are of the low impedance type and are generally found in ex-Government telephone equipment. For recording systems where speech only is considered they are admirable due to a good output and a tendency to accentuate the higher frequencies, but they are not suitable for the recording of music.

Perhaps the most popular of all microphones is the moving coil microphone. The instrument is internally similar to a loudspeaker, except that it is smaller. The diaphragm is a cone, generally of paper, carry a light coil. The coil is wound on a thin paper cylinder and is suspended between the poles of a powerful magnet. The coil moves with the diaphragm, and its motion within the magnetic field induces e.m.f.s in it. Most moving coil microphones are of the low impedance type, as it is essential that the inertia of the coil be kept as small as possible. Moving coil microphones are particularly suitable for use with tape recorders, but they must feed a low impedance circuit. Some instruments are designed to feed high impedance inputs by the inclusion in the stand of a matching transformer. However, this immediately limits the amount of cable with which the microphone can be successfully used. They are better than crystal microphones as regards sensitivity to heat and damp, but must not be knocked or treated roughly, as this is liable to alter the orientation of the coil in the magnetic field and thus affect the output.

The Ribbon Microphone

All the microphones we have so far discussed are omni-directional, that is they tend to pick up sound from all directions. Now we come to two microphones which can be used to restrict the sound pick-up from certain directions. The ribbon microphone is of the dynamic type, and consists simply of a piece of extremely thin corrugated metal ribbon suspended between the poles of a powerful magnet. Sound waves falling normal to the surface of the ribbon induce e.m.f.s between its ends, but sound waves falling normal to either edge do not appreciably affect the diaphragm. Thus there are dead spots on either side of the microphone. Advantage is taken of this by arranging the wanted signal to be at right angles to any undesirable noise which may be present. So that if a programme was being recorded in a hall the ribbon microphone on the stage could be positioned such that the audience would not be picked up as effectively as the artist. Since the ribbon is fairly short, it follows that the impedance of the instrument will be very low. It is in fact so low that a special transformer is needed.

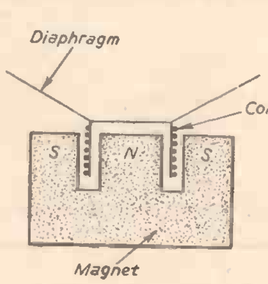


Fig. 6.—Moving coil microphone.

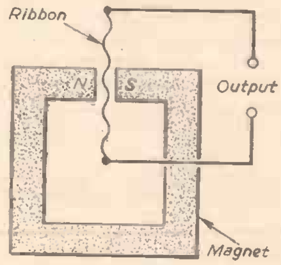


Fig. 7.—Ribbon microphone.

Ribbon microphones are very delicate and cannot stand rough handling. Although they are difficult to manufacture, a good one can be obtained for £10 to £12. The frequency response is good, but if the sound source is close to the diaphragm there is a

(*Concluded on page 222*)

Building the 'Luton Minor'

Part 6.—Completing the Fuselage and Attaching the Tailplane

Tube Bending

WHEN bending a tube, due to the fact that it has no resistant central core, the tube will tend to flatten at the bend. This results in an increase of the axis at right angles to the bend and a corresponding decrease in the axis in the plane of the bend.

However, by bending the tube round a block of the same radius as the desired bend and having a groove in it equal to the tube diameter, this deforming can be resisted to a large extent. Special tube-bending machines are available which almost eliminate deformation of the cross-section of the tube.

Thin tubing is the hardest to bend, for the inner radius tends to buckle. Some expensive machines are made which make use of a "mole" which is a shaped rod

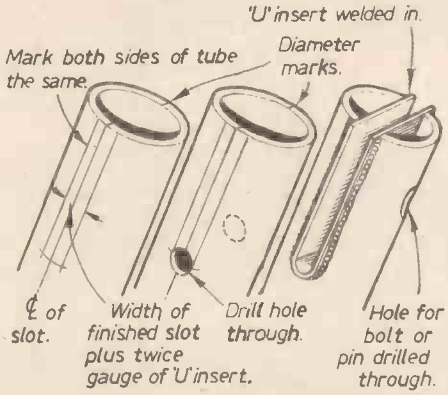


Fig. 37.—The three stages in marking out, cutting and finishing a tube fork-end.

slipped inside the tube and which follows up the bend, ensuring a smooth, uniform section.

Thin steel tubes can be bent using a well-greased spring whose outside diameter is the same as the inside of the tube.

Other methods include the use of a fusible alloy or low-melting-point metal which fills the tube, is bent with the tube and then flowed out by immersing the bent tube in boiling water or oil.

The method which the amateur can best adopt is to plug one end of the tube with wood, pack the tube tightly with sand (it must be *dry* sand) and plug the other end. The tube is then heated with a torch or blow-lamp and bent over a radiused former. Make the former of durable wood such as oak.

Alternatively, the amateur may enlist the assistance of a co-operative plumber and his tube-bending machine. Remember to use the right bending former and follower for the diameter being bent.

Slotting Tubes

To slot the end of a tube as, for example, to take a "U" insert, mark out the full width of the slot from the centre-line of the tube on each side (Fig. 37) and drill a hole to mark the termination of the slot.

Now cut with the hacksaw and finish off with a thin flat file to size. On large-diameter tubes, it is better to hold the saw at an angle and cut each slot individually, eliminating the chance of inaccurate cutting of the other side.

Fig. 38 shows the right method to employ when flattening the ends of tubes symmetrically or asymmetrically. If tubes are to be closed completely flat at the end, always heat the tube red hot first. Crush the end, using a block of wood, end-grain on. Never hit direct with the hammer.

When cutting a narrow slot in a tube as, for example, to weld in a single 16 s.w.g. plate, use two hacksaw blades together in the saw. Cut carefully, for one blade will be slightly tighter in the frame than the other.

Use a hacksaw blade with the right number of teeth per inch when cutting tubing. Very thin tubes can be sawn by keeping the hacksaw at a tangent to the surface all the way round by rotating the tube as it is cut. Remove the internal burrs

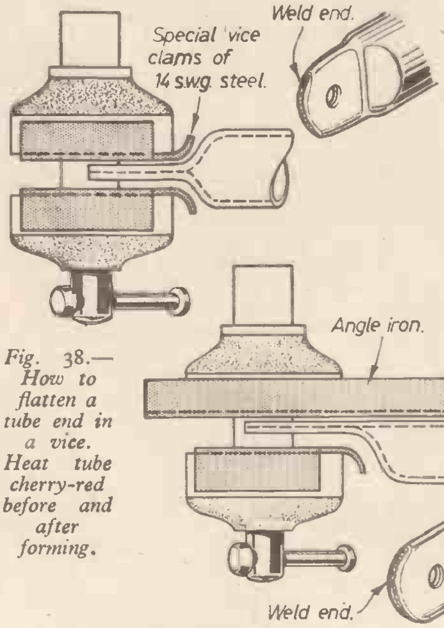


Fig. 38.—How to flatten a tube end in a vice. Heat tube cherry-red before and after forming.

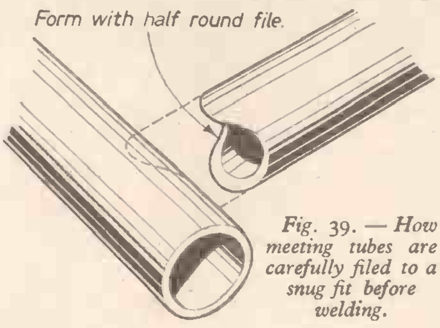


Fig. 39. — How meeting tubes are carefully filed to a snug fit before welding.

with a half-round smooth file.

Where one tube meets another, the meeting tube should be filed to a snug fit all round (Fig. 39). This is done with a round or half-round bastard file.

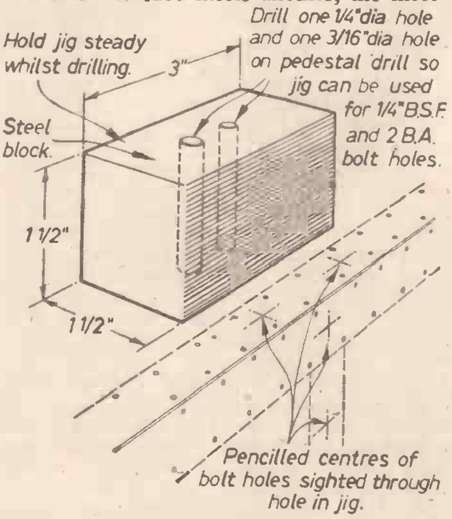


Fig. 40.—Jig for aligning drill when boring holes.

Preparing for Metal Fittings

The next job is to glue in the corner blocks between the fuselage longerons and the side bracing at the engine bulkhead. These blocks must be a true and accurate fit.

Fit the rudder bar which pivots on the support bracket bolted to the top of the rudder bar support cross-member in the front fuselage and the ½in. spruce web between it and the engine bulkhead.

The top decking of 3/32in. plywood can now be glued and tacked into place on top of the cross-member and plan-bracing at the nose.

If it is desired to cover the plywood structure of the fuselage with madapolam fabric to preserve and strengthen it (this is strongly advisable in very hot or humid climates), the fabric should be applied to the sides and bottom at this stage. Instructions for doing this will be given later on. In any case, it is recommended that a 2in. wide serrated edged fabric tape be doped to the lower corners along the fuselage length, around the edges of the stern-post and engine bulkhead and along the top longerons from the engine to the seat-back to seal the edges against moisture and preserve the wood.

Fig. 41.—*Control column and bracket assembly.*

Apply two coats of red oxide tautening dope along the corners; then apply the tape with another liberal coat of dope as described further on. This is done *before* any metal fittings are bolted on.

Drilling Bolt Holes

The bolt holes through the fuselage members for the attachment of the metal fittings must be drilled accurately. Ideally, an electric drill should be used. Back up the member being drilled with a flat piece of scrap wood so that the drill passes through into it. This way, the drill will not tear the surface grain as it breaks through.

A useful jig can be made to ensure perfect alignment of the drill. This is shown in Fig. 40. The jig is placed over the pencilled location of the hole and the drill bit carefully centred through it.

All bolts in the fuselage pass from the outside inwards and all nuts are on the inside. Where no fitting backs on to the inside, make use of large duralumin "penny" washers to avoid crushing the timber. Trim them to fit if necessary, but always see that the trimmed edge is smooth and straight otherwise the nut will pull it into the surface grain and cause damage. Unless otherwise specified, mild steel hexagon-headed cadmium-plated bolts are used with a plain shank of such a length that no more than one thread-pitch shall come into contact with the wood through which they pass. Use self-locking stiff nuts except where otherwise stated.

Begin assembling the engine mounting bulkhead brackets, the wing pylon fittings, the undercarriage and lift-strut brackets and the fish-plates which join the fin-post to the stern-post. Fit also the reinforcing gusset, Pt. No. 8F, having first drilled the solid ash block to take the tailwheel leaf spring. The shield plate, Pt. No. 9F, is also fitted.

Assemble and fit the control column and its bracket (Fig. 41). Do not fit the swivelling aileron cable pulleys and their brackets to the fuselage sides until the wings are fitted later.

The Rear Decking

Cut out all the decking formers from ⅛in. plywood (grain vertical) and fix these in place to the fuselage cross struts. Cut notches for the stringers in the first one (immediately above the bulkhead at the rear of the cockpit) and the last one (at the forward end of the tail-plane table). Lay in the spruce stringers and, keeping them straight, mark where they touch each of the other formers and cut notches.

The curved seat-back former must be fitted next. Leave the ply protruding above the longerons at least 8in. at the centre and then spile off the developed curve of the decking. Do this with a batten of wood held against the first two decking formers as shown in Fig. 42.

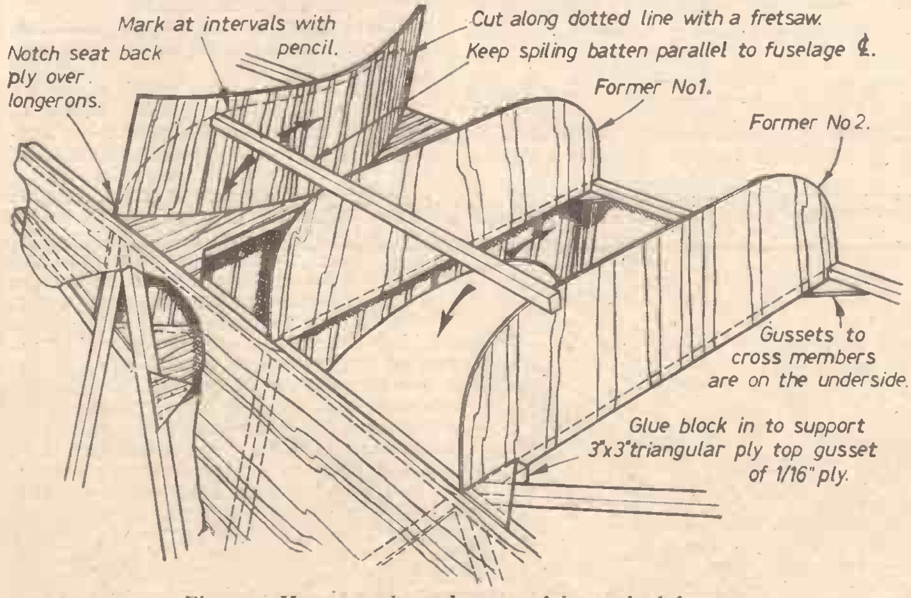


Fig. 42.—*How to mark out the curve of the seat back former.*

Cut the curved ply back to this line and mark the positions of the stringers. Do not notch the ply here—the ends of the stringers are supported behind the ply by the special saddle-gussets.

Glue all the stringers into place and fit the saddle-gussets (Fig. 43). Strengthen the seat-back ply on the aft side with shaped pieces of ¼in. thick spruce which will also provide a larger gluing surface for the curved rear decking of plywood which is fitted next.

Bend a sheet of fore-and-aft grained 1/16in. ply over the decking and tie it with string round the fuselage whilst marking the shape with a pencil. Leave plenty of spare on the front and rear edges which can be trimmed off later. Cut a scarf on the fuselage side plywood where the decking skin will meet it, transfer the exact location of the scarf to the skin, remove it and cut the scarf on the port and starboard sides of it. Remember that this skin will be scarfed on the "inside."

Glue it on, stapling the ply to each stringer, starting from the top centre one,

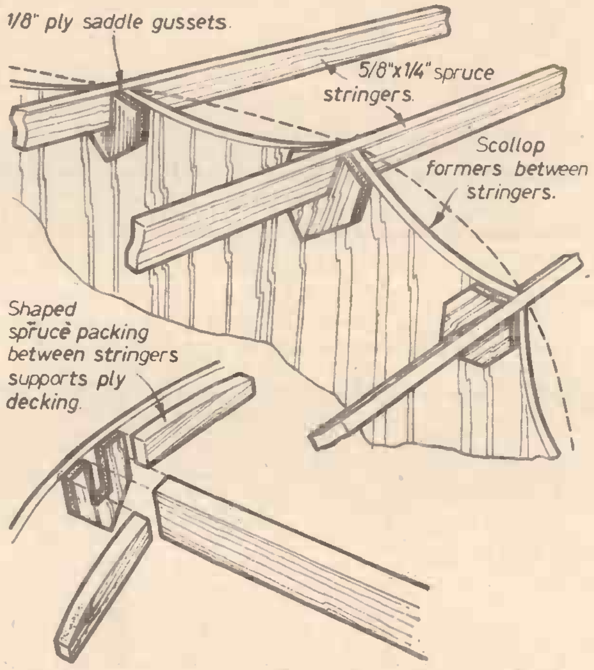


Fig. 43.—*Attaching the stringers to the curved seat back former.*

Strap the ply round the fuselage to avoid unevenness due to the spring of the ply. Use tacking strips to apply setting pressure to the scarfs at each side.

When the glue has set, trim back the excess ply to the correct line and scollop the rear edges between the stringers as shown on the plan. This can best be done with a very sharp modelling knife followed by a rub with a piece of glass-paper wrapped round a cardboard or metal tube of the right diameter.

Finish off by scolloping all the decking formers (except the last) in the same manner between the stringers. This will prevent the edges of the formers from showing through the fabric covering. Likewise carefully sandpaper each stringer to remove the sharp corners. This can be done before fitting them if preferred but, if so, remember not to radius the edges over the front portion of the stringers to which the ply deck is glued.

Tailplane Attachment

The front tailplane attachment fittings are now offered up to their correct locations on the rear top longerons. The tailplane decking is not yet fitted, so pack under the top flange of the fittings with scrap 1/16in. ply.

Drill and temporarily fit the two front fittings, making certain that a line stretched between them is exactly at right angles to the fuselage centre-line.

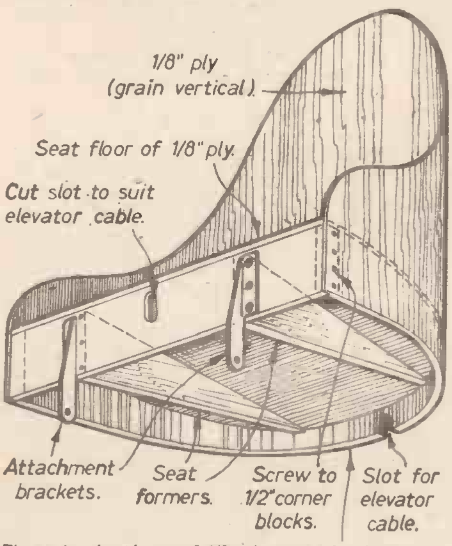
Put on the tailplane and bolt the two front spar lugs to the fuselage fittings. Now position the rear spar fittings and mark their locations. Remove the tailplane and drill the bolt holes for these rear brackets. Take off the four attachment brackets, cut and fit the tailplane table and, when set and trimmed to size, finally bolt on the brackets.

Make the inspection panel in the port side of the fuselage at the tail and position the tailplane again. Offer up the elevator and mark the location of the slot in the tailplane table through which protrudes the elevator lever.

The bracket which locates the leading edge of the fin and the top elevator cable pulley is next fitted to the last decking former. Fit the fin, ensuring that it is vertical to the fuselage. This is best checked with a spirit level across the longerons and a plumb bob.

Cut the slot for the elevator lever in the fin base rib.

Now make the cockpit seat (Fig. 44) and temporarily fit it to the brackets on the seat rails screwed to the cockpit floor.



Three laminations of 1/8" short-grained ply glued to seat ply to support seat all round.

Fig. 44.—The pilot's seat. It is hinged by the attachment brackets to allow access to the luggage compartment behind the seat.

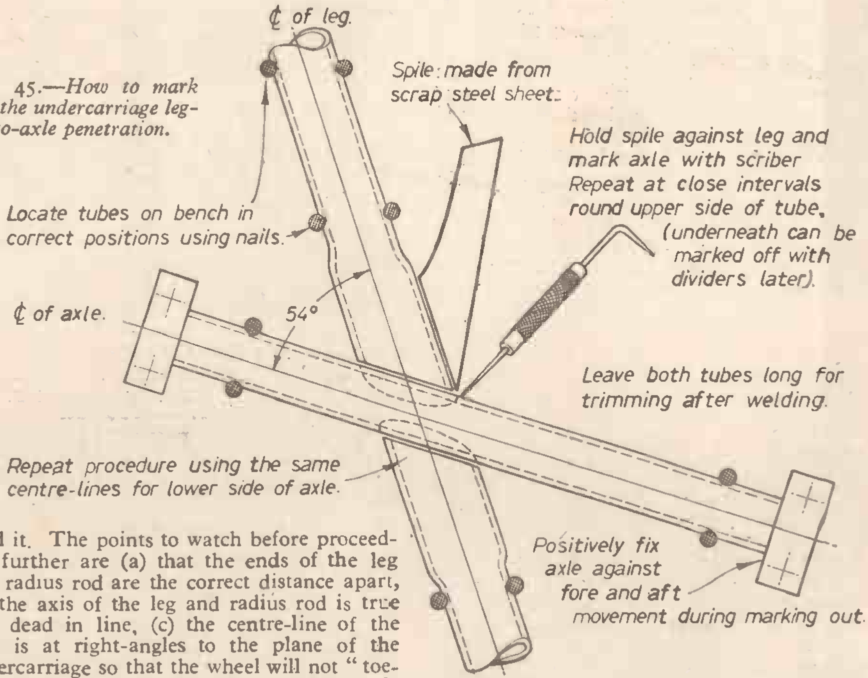
The Undercarriage

Start by making the main leg-axle assembly. Flatten the end of the leg tube and spile the shape of the interpenetration with the axle tube. This is shown in Fig. 45. Repeat the spiling for both sides of the axle tube and cut out the oval-shaped hole using a drill, a rat-tail and a half-round file. Work carefully so that the leg tube is a snug fit inside the axle holes. See that the angle is correct and weld all round, top and bottom. Now measure off the length of the leg and complete the top end where it picks up in the fuselage brackets. The collar assembly and brake-drum back-plate (if brakes are to be fitted) are welded together. Thread the assembly on to the axle and weld it to the axle *from the brake-drum end only.*

Shape the inboard end of the axle tube where it connects to the tension strut assembly.

Set up the leg on the bench. Take a piece of ¾in. × 17 s.w.g. T.45 tube to make the radius rod, bend the end and form it for attachment to the fuselage lug. File the other end to a snug fit between the axle tube and the axle collar assembly and tack-

Fig. 45.—How to mark out the undercarriage leg-to-axle penetration.



weld it. The points to watch before proceeding further are (a) that the ends of the leg and radius rod are the correct distance apart, (b) the axis of the leg and radius rod is true and dead in line, (c) the centre-line of the axle is at right-angles to the plane of the undercarriage so that the wheel will not "toe-in" or "toe-out," and (d) that the angle formed by the leg and the axis of the leg frame is ninety degrees.

The tie tube is next filed to shape and tack-welded into place. Since the tube is larger in diameter than the radius rod, this end should be slightly flattened to avoid a bulge at the join. Repeat this procedure for the other, opposite-handed, undercarriage frame.

Welding Up the Frame

If the constructor enlists the services of somebody else to weld up the undercarriage, tell the welder the gauges of the various tubes to be welded.

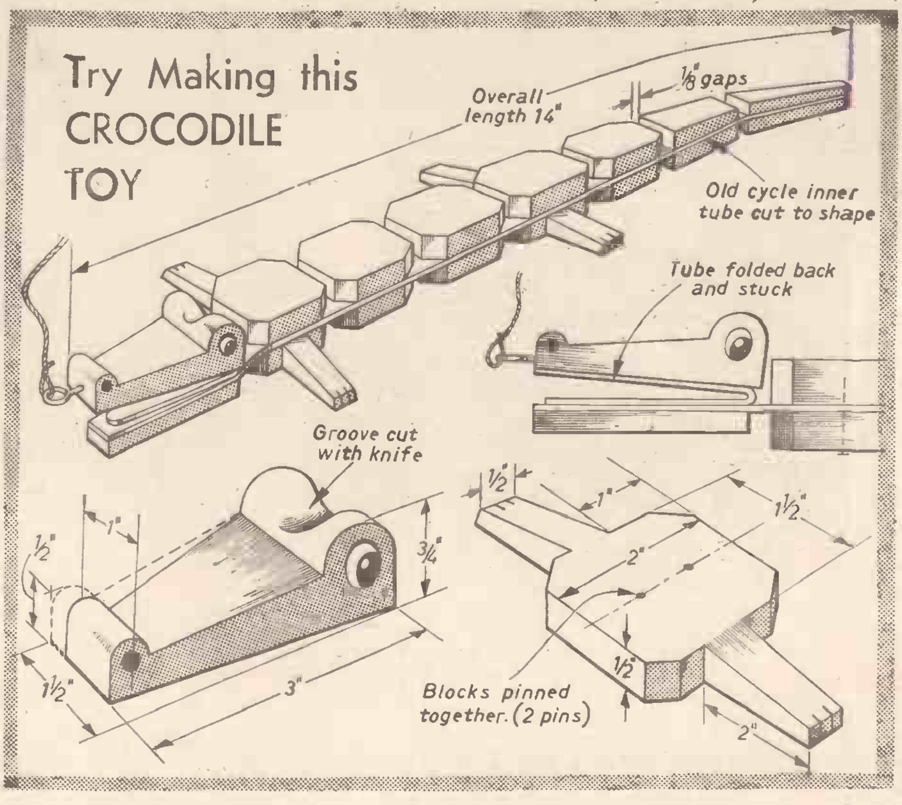
In welding up the side frame, preheat the tubing if possible to minimise distortion. After the welding is complete and before cooling off, pass the welding torch up and down each tube by the weld with a "warm" (not welding) flame to relieve the stresses set up in welding. Never quench a welded part. This makes the metal dangerously brittle. A strong weld is cooled slowly.

The remainder of the undercarriage parts are now made up. As soon as possible after welding tubular parts, flush them out in boiling water and strong detergent and, when dry, fill them with a good metal primer paint and stand them to drain overnight. If parts are to be cadmium-plated, flush them out in oil to prevent corrosion until the plating is done, and then paint the insides.

Special Phoenix undercarriage rubbers are used in the tension strut. These should be assembled to the tubes using talcum powder or french chalk. The completed undercarriage can now be assembled to the fuselage.

(*To be continued*)

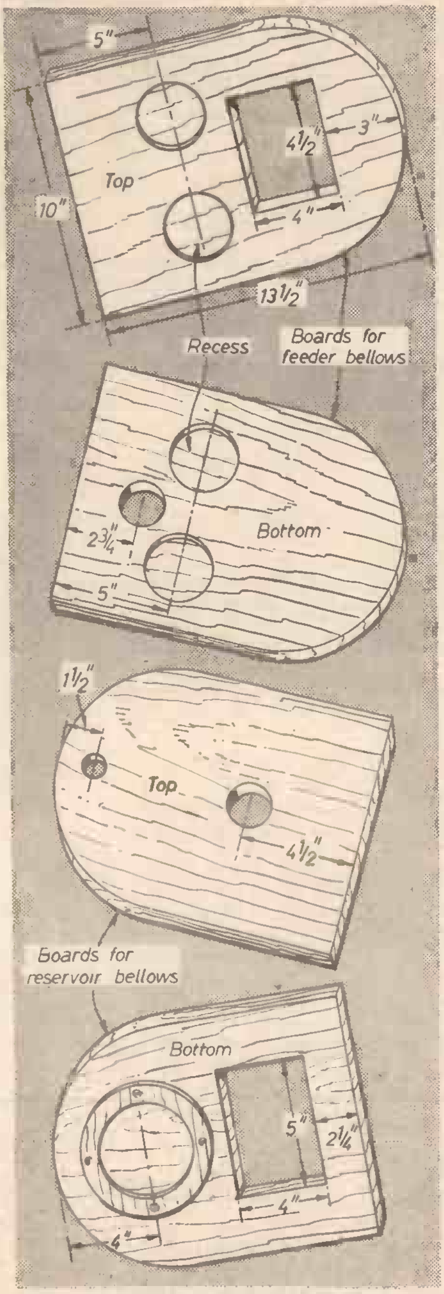
Try Making this CROCODILE TOY



Foot Bellow
for Brazing and
Small Forges

Descri d
A. Lutma
they are a
suitable
Bench Gla
Blowing

WHEN joining metals together soft soldering often does a good job and is adequate for many repairs in the household, but if the particular article needs greater strength, perhaps under conditions of high temperature, then brazing or hard soldering is much more satisfactory. Brazing is no more difficult than soft soldering; it is sometimes easier, and certainly neater in appearance. A gas blowpipe or hand torch will be needed, and foot bellows to supply the air blast. The latter give much more control over the flame than any other means. Those who like doing decorative iron and metalwork generally, will find the bellows can handle a small forge, work crucible furnaces for bronze and brass melting—in fact, give ample blast for most purposes including laboratory work and bench glass-blowing.



Figs. 1 and 2.—Details of the top and bottom of the feeder bellows and reservoir bellows respectively.

Construction

Fig. 4 is a cut away perspective view of the bellows, showing the position of the various parts and the working angles of feeder and reservoir. The first thing to tackle is the main woodwork, which comprises the baseboard, 19in. long, 10in. wide × 1in. in finished thickness, and four identical pieces intended for the bellows boards, 13½in. long, 10in. wide × ¾in. in finished thickness. All these boards should be straight grained. The cheaper and softer hardwoods like Japanese oak are quite suitable, but Spanish mahogany is ideal for the purpose as it does not warp. "Canary pine" is nearly as good. Having decided on the kind of wood to suit pocket and purpose, the four bellows boards should be clamped together and dressed to shape. The semi-circular ends can be cut out with a bow-saw, or failing that, the job can be done by cutting away the surplus wood in triangles with the panel saw or fine cross-cut and trimming up with plane and rasp.

Two small upholsterer's seating springs of standard pattern can be procured at this stage as the diameter of the ends determine the size of the recesses that are cut ¼in. deep on the inner faces of the pair of boards selected for the feeder bellows. These recesses accommodate two springs and the diameter varies from 2½in. to 3¼in. Instead of recesses, rings of 3/16in. thick

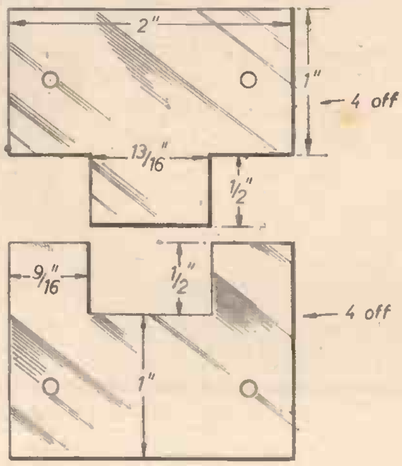


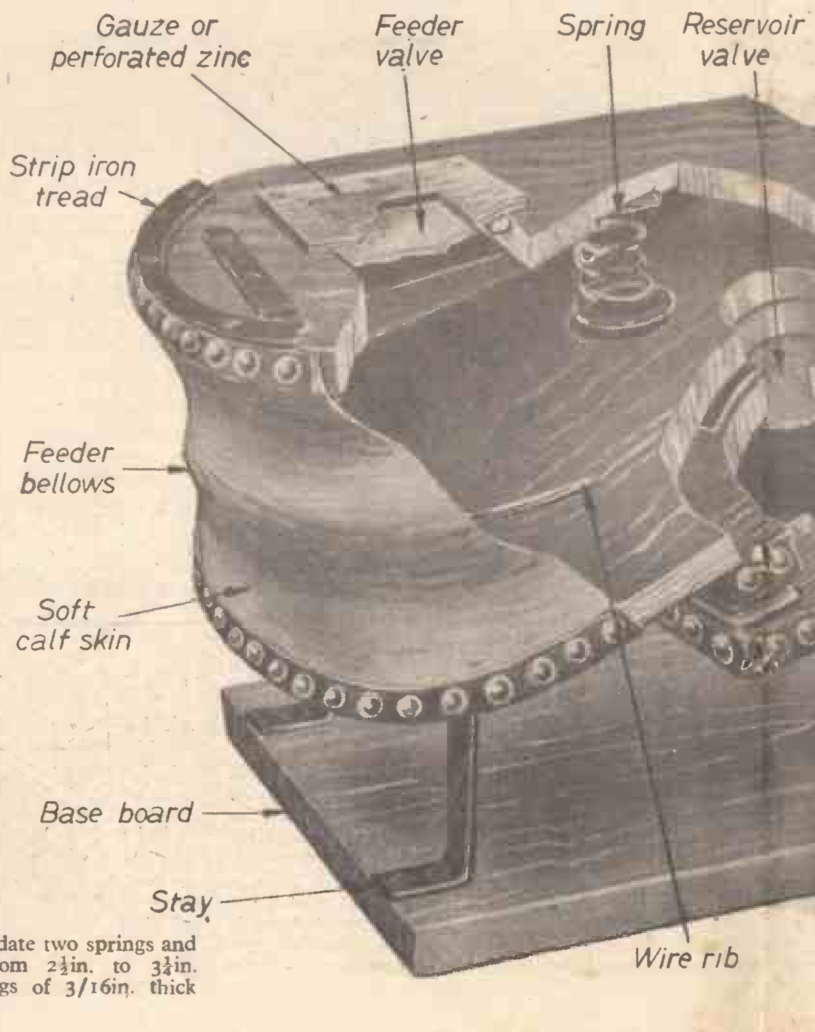
Fig. 3.—Hinge plates.

plywood can be cut with a fretsaw to the required size allowing a rim of ⅛in. across, and then fixed with screws or panel pins in position as shown in Fig. 2. A hole is cut through the top board, 4in. × 4½in. This can be done by boring with brace and bit a hole at each corner and sawing out the piece with a pad or bow-saw; the corners being finished with a sharp chisel. The bottom board of the feeder has a hole 1¾in. in diameter and the positions of both holes will be clear by referring to Fig. 1.

The pair of boards intended for the reservoir can now be tackled and the work here consists of two holes in the top board, one ¾in. in diameter and the other 1¾in. The bottom board has a large hole 4in. × 5in. cut near the hinge end to act as a sort of manhole. The positions are made clear in Fig. 2.

The Hinges and Metalwork

Each pair of boards needs now to be hinged together and the best way to do this is to cut from a piece of 20 s.w.g. sheet brass four blanks each of the two shapes



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shown in Fig. 3. These blanks when filed up and flat should be drilled, countersunk, and each pair bent to shape on a temporary pin of 8 s.w.g. rod or wire. The trouble entailed in making the hinge system can be minimised by purchasing steel or brass flap hinges, withdrawing the pins, and drilling out, if the hole or barrel is too small to take 8 s.w.g. rod. Two ribs of 8 s.w.g. galvanised iron wire are now made, one for each bellows, to support the leather cover, and are shaped as in Fig. 5, the ends being turned back to form the hinge pins. No difficulty will be experienced in hinge-ing up each pair of boards if they are laid flat on the floor or bench, end to end and the rib with its hinges screwed down in this position. We now have two separate units each having a pair of boards and a stiff iron rib capable of free movement. An opportunity should be taken at this stage to grease the hinges and stain the wood-work.

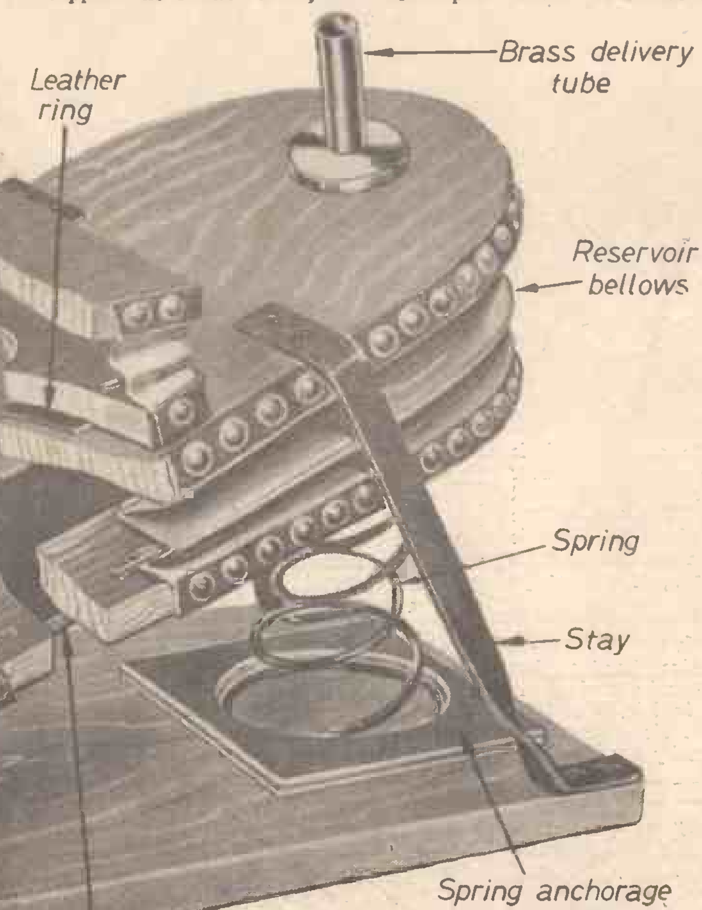


Fig. 4.—A perspective view of the bellows cut away to show the valves and springs.

Two pairs of stays or supports will be required, and these are shaped as in Fig. 6, the long ones having a half twist near the base. The section of these stays is ⅝in. × ⅛in., but any other convenient size may be chosen as long as the result is sturdy. Mild steel strip of the above size can be worked cold, the twist being managed by fixing the strip in a vice and applying an iron clamp or a pair of tongs. Do not forget that each of the long stays needs a left- and right-handed twist respectively. The shorter supports only need bending. The holes can now be drilled and countersunk, and the two pairs laid aside until needed.

Material for Bellows

The first thing to do is to make a stiff brown paper template of the shape needed for the two covers. A pair of the hinged boards should be taken and propped open to a distance at the mouth of 10in. and temporarily fixed in this position.

With the paper on the floor the unit can be rolled from one side right over to the other, whilst marking the resulting shape with a soft pencil. The template is shown in Fig. 7 and should be arranged with 2in. overlaps round the hinged end of the boards. The leather used is strong, soft calf skin with no thin patches, but a visit to an upholsterer's might be worth while as very often good leather in sufficiently large pieces is stripped from upholstery which needs recovering. Enough should be bought to make two pieces the size and shape of the template; two extra pieces 1¾in. × 10in., and four strips ⅝in. wide × 4ft. long will also be required though the latter can be made up from shorter pieces if 4ft. lengths prove difficult to get. This strip can be a little thicker with advantage than that used for the body of the bellows. About 1lb. of clout-head bellows nails will be required, the length being ¾in. with a ½in. head.

Covering the Bellows

Assuming the leather to be cut to the shapes required, take one of those intended to cover the body of the bellows and damp it equally and on both sides with a wet cloth. Rest a pair of the bellows boards with the hinges on the floor and the semi-circular ends pointing upwards. Having hammer and nails handy, commence covering by placing the leather in a central position on the apex of the boards with equal amounts of leather at either side. With a piece of the strip resting on top of this and on the edge, drive in two nails with the heads spaced 5/16in. apart. Open the bellows and keep the iron rib, from now onwards, to one side as it must not interfere at this point with the stretching of the leather. Drive in two more nails with the cover and strip in position on the apex of the other board. The two boards can now be propped open with a piece of wood. This done, the bellows should be tipped over on to its side and the cover stretched by pulling towards the hinged end. Nailing can be continued, doing a few inches at a time alter-

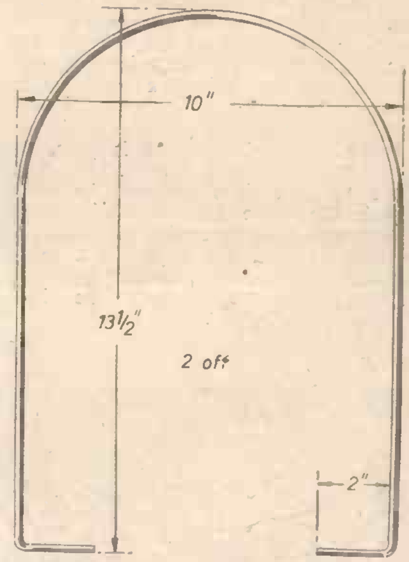


Fig. 5.—Wire ribs to support leather covering.

Fig. 6 (Below).—The supporting brackets. The long pair are right and left handed.

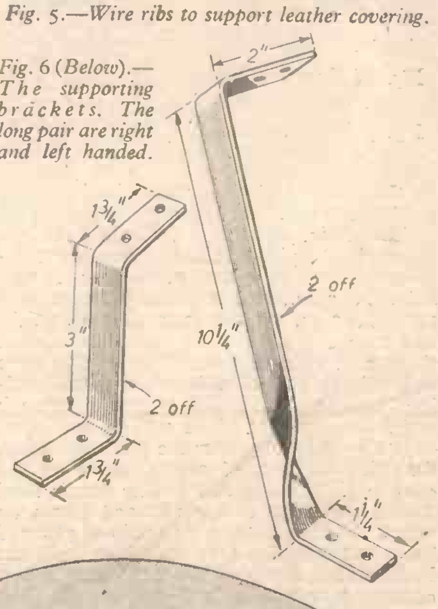


Fig. 7.—Template shape for leather cover.

nately at both sides until the hinged end or the corners are reached. The overlaps can be folded over and one of the pieces of leather 1¾in. by 10in. fixed firmly over them with adhesive. The hinged end is now completed by folding the four strips over along the edge and nailing. Before setting the bellows aside to dry, put your hand inside and pull up the iron rib into mid-position; the stretched leather will hold it quite firmly here without further worry, and after some weeks of use the bellows will develop a neat, concertina appearance as in Fig. 4.

The Valves and Springs

When both bellows have been covered and are quite dry, they should be fastened together, that is, the bottom board of the feeder and the top of the reservoir screwed together. Drill six holes in the top board of the reservoir and in a rectangle about the valve hole; the size of this rectangle should be that which is conveniently dealt with from the reservoir "manhole." The holes should be countersunk on the inside of the reservoir. Cut a leather ring with a hole 1¾in. in diameter, thoroughly grease it and place it in position over the reservoir valve hole; put the two bellows units together so that they overlap 7½in., or until the two holes coincide, and drive in six 1½in. countersunk head woodscrews. The operation will be easily done if the reservoir is flattened or compressed as far as it will go.

The feeder springs can now be pushed through the valve hole and clipped into position with the ends resting in the recesses. This should hold the bellows out to full capacity.

Two valves are needed; the intake

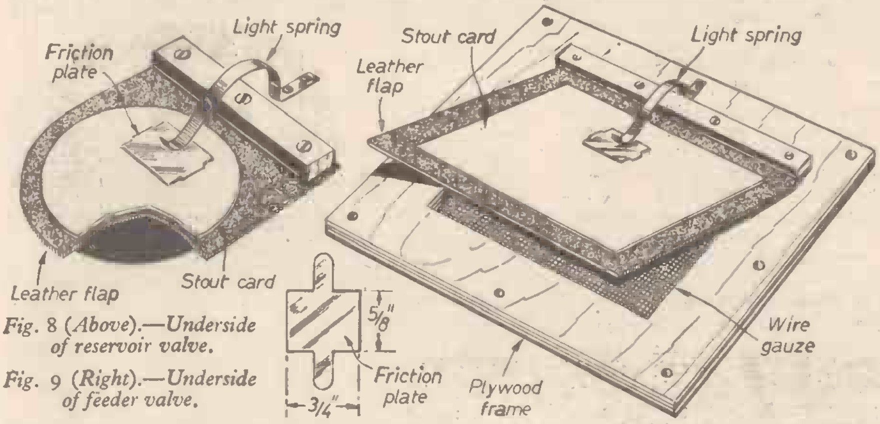


Fig. 8 (*Above*).—*Underside of reservoir valve.*

Fig. 9 (*Right*).—*Underside of feeder valve.*

on the feeder and the communicating valve on the reservoir. The intake valve is built on a piece of ¼in. plywood 5in. × 5½in., the hole being 2in. × 3in., the effect being a rectangular frame. A piece of leather is cut 2¾in. × 3¾in., and a piece of stout card 1⅞in. × 2⅞in. on the long side of which, and near the edge, a friction plate of thin tinplate or brass is fixed. This can be done by cutting a pair of tabs on the piece, bending them at right-angles, tongueing through and flattening over. The card is now stuck centrally and firmly over the piece of leather, the friction plate, of course, being on the outside. The completed leather flap is fixed to the underside of the plywood frame on one of the long sides; a thin strip of plywood being screwed down or nailed to hold the leather edge firmly. We have now a sort of trap door with a leather hinge. A light spring made from a length of clock or watch mainspring is fixed to the plywood frame with the free end resting lightly on the friction plate. This spring should be so adjusted that it gives only sufficient pressure to keep the valve lightly closed, so that the slightest air pressure from the other side will open it.

The whole valve assembly is shown in Fig. 9. After putting a little grease on the spring and plate contact and staining the woodwork, the valve frame should be fixed on the top of the feeder bellows by screws spaced about 2in. apart. It is a good plan to grease the contacting surfaces before fastening up to make the unit airtight. A piece of wire gauze should be fixed over the outside of the valve to prevent the entry of foreign matter. The reservoir communicating valve is shaped as in Fig. 8, with a ¼in. overlap, and is treated in the same manner as the feeder valve; the card disc being 1½in. in diameter. This valve or flap is fixed directly to the inner face of the top reservoir board. The pressure of the spring should be a little stronger than that fixed to the feeder valve.

Finishing

A piece of ¼in. thick plywood can now be cut 5in. × 6in., this "manhole cover" being fixed over the reservoir hole by screws spaced 2in. apart. Two rings of plywood ⅜in. thick are now fixed to the baseboard and the underside of the reservoir. These provide the anchorage for the reservoir spring and are fixed in the position shown in Figs. 2 and 4. This spring is the large standard pattern with a diameter at the ends of about 4in.

The whole bellows unit is fastened to the baseboard in the proper working position by fixing the two small angle irons under the feeder, and the two long ones to the top of the reservoir, with ample clearance for the bellows to inflate without abrasion at the sides. The reservoir spring is placed in position.

A short piece of brass tube ½in, bore, fitted with a brass plate at one end, is screwed to the top of the reservoir and over the delivery hole; a leather washer will make the faces airtight. The top surface of the feeder bellows where the foot is applied can be shod with an iron plate, a piece of thick rubber tread, or with strips of iron.

Hand Torch and Hearth

Very good—and expensive—hand torches can be bought, but one can be made from standard gas fittings as in Fig. 10. The right-angled bend on the air pipe shown by a dotted line, is done by cutting out a

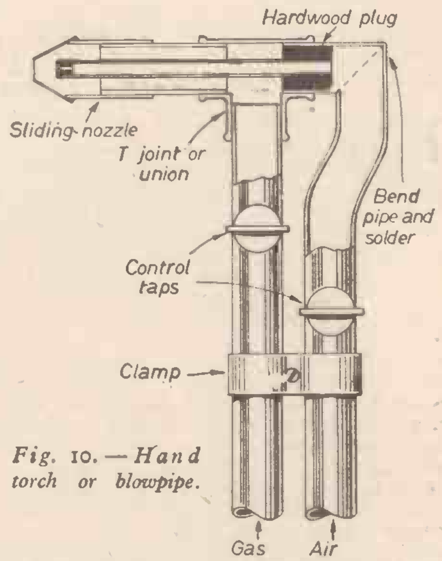


Fig. 10. — *Hand torch or blowpipe.*

45 deg. wedge leaving about ¼in. of metal to bend over when the join is soldered up airtight.

The central jet tube is fixed by a plug of hardwood or brass inside the air pipe. For the air jet itself a motor-cycle carburetter jet is suitable, drilled out to about 1/16in. in diameter. Interchangeable jets of various sizes are an advantage. A combined forging and brazing hearth made from an old metal bowl if big enough, is shown in Fig. 11. The rough filling is done with a 1 : 3 mix of portland cement and sand with pieces of broken brick. This should be left to dry out before putting on a smooth layer of ¾in. thick of fireclay. This can be bought in powder form at your local builders' merchants quite cheaply and is mixed to a workable consistency with diluted waterglass. Allow the hearth to dry out naturally before subjecting to heat.

Brazing and Forging

The job to be brazed should be packed around with small coke to conserve and reflect the heat, and the pieces to be joined held firmly by clamps or wire. The flux can be borax, and the surplus can be washed off with warm water after the joint is made. Special brazing spelter or just plain brass wire can be used, and the aim should be to use as little as possible leaving no ragged lumps to be filed down. Just a word of warning. The heat from large brazing jobs can be considerable, and to protect the eyes a pair of tinted glasses should be worn. The coke packing too sometimes spits and cracks, shooting off small particles. Precaution never belittles achievement.

This is too big a subject to do more than touch upon, and the interested reader should purchase a good handbook dealing with every operation. The bellows and hearth described will handle a lot of work including iron and steel welding up to ⅜in. diameter rod. The aim should be to produce a smooth steady blast without blowing the fire about, and this means skill in placing and packing the coke or breeze and regulating the air supply.

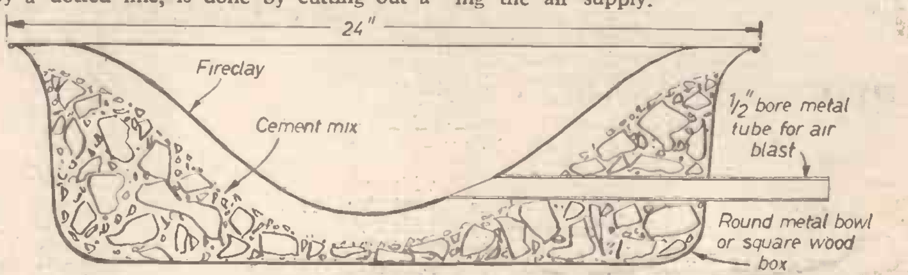


Fig. 11.—*Section of hearth.*

PRINCIPLES AND PRACTICE OF FOCUSING

J. Lowden Gives a Full Explanation for the Benefit of the Camera User

TAKE into the sunshine a simple lens. Hold it above a sheet of paper, and move the lens up and down until a sharp image of the sun is resolved upon the paper. The lens is now focused upon a source of light, the sun, which is at a distance which might well be regarded as "infinity." In photographic practice any distance in excess of 100ft. (30 metres) is regarded as infinity, usually designated by the symbol ∞.

The distance between the lens and the paper would be equivalent to the focal length of the lens. The plane in which the image was formed, as represented by the paper, would be the focal plane. If we took the same lens indoors and focused the image of a small lamp at a distance of only a few feet, we should find that the distance between lens and paper had increased. On further testing we would find that the nearer we approach the lamp, the more the lens would have to be moved away from the screen before a sharp image could be formed.

A camera lens works in exactly the same way—the nearer you approach the "subject," the greater must be the separation between lens and negative.

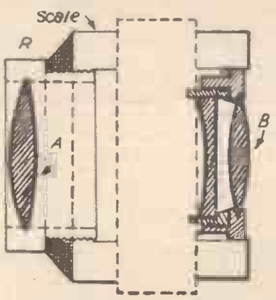


Fig. 2.—Rotation of the inner screws, by focus ring R, varies the position of front cell A in relation to fixed back cell B.

A box camera lens is fixed by the designer to give sharpest focus on an object 21ft. from the camera. This distance has been chosen to meet the desires of the great mass of amateur snapshotters. The more ambitious worker, however, cannot tolerate these restrictions, and most cameras with an aperture of f/8 or greater have variable focusing.

There are two principal methods of focusing. One is where the entire lens is moved to or from the negative. The second is "front-cell" focusing, which will be treated separately.

Focusing Mechanisms

The simplest focusing mechanism is that type where the lens panel and the camera back are both mounted upon one or more rails, with the bellows between. Rough focus is made by hand movement of the lens panel along the rail, fine focus by rack and pinion or screw thread feeds. Focus is checked by observing the image directly through the lens, a screen of ground glass being placed temporarily in the focal plane. The screen can be replaced by a negative (usually plate or cut film) at will.

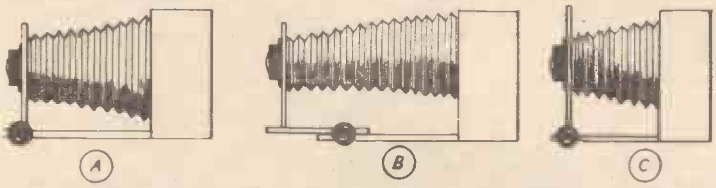


Fig. 1 (A).—The lens at normal closest focus—about 3ft. ; (B) using double extension, lens distant twice its focal length from negative, giving life-size image ; (C) distant view—lens closer to negative than at (A).

Hand or Stand Cameras

These are smaller and handier and have a small pointer directly below the lens. This pointer slides along a scale calibrated in distances, thus allowing the user the choice of focusing by measurement or on the screen. Although a few types of roll-film cameras do employ this type of focusing, entire lens movement is more usually found on plate apparatus.

Focal Plane Focusing

When the position of the negative is fixed, focus is obtained by movement of the lens. Conversely, when the lens is fixed, focus may be obtained by movement of the focal plane or, more correctly, by movement of the negative lying upon the focal plane. Despite the excellent performance of cameras which have used the method, focal plane focusing has not been widely used.

Helical Screw Focusing

Miniature camera lenses, designed for tiny negatives, can be mounted in internal fitted or sliding tubes. For precise control of movement these tubes are "married" with a multi-start screw thread of coarse pitch. Motion is given by partial rotation of the thread, by means of a small lever, the exact range focused being shown on a circular scale. The helical screw found in high-class miniatures is a miracle of precise screw design and cutting. One of the great advantages of helical screw focusing is the ease with which lenses can be interchanged.

The Extension

The amount of lens movement permitted by the bellows is known as the extension.

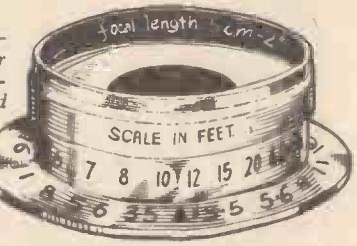


Fig. 3.—A circular scale engraved upon the lens mount.

Most cameras extend far enough to permit sharp focus on a subject as close as 3ft. (see A in Fig. 1).

Good hand and stand cameras usually have an auxiliary rail fitted upon which the lens can be racked out until it is at a distance not less than twice its focal length from the negative (B). This "double extension" permits very close-up work, with life-size images of small objects. A camera which offers triple extension will give "larger than life" photos of very small objects at the closest quarters. Such a camera is

Fig. 4 (left).—Ranged to give clear focus on copy No. 1, f/4.5 (Above) Range unchanged, f/9 (Right) Range setting unchanged, f/22.

an invaluable tool for the naturalist, philatelist, etc.

Extension Tubes

Miniature cameras with interchangeable lenses can be given fantastic extension by the use of extension tubes. One end of the tube screws into the camera body flange while the other end carries the lens.

Front Cell Focusing

A box camera user, wishing to take a "close-up" at about 5ft., places a supplementary lens in front of the main lens. The effect of this is to change the focal length of the lens to give sharp definition at this close range.

In a more ambitious camera the lens is a compound of two or more elements (Fig. 2). The lens is described as being of a definite focal length, and for most purposes it is just that. But the focal length of the unit can be changed by alteration of the distance between the two elements. This principle is utilised in "front cell focusing." The rear element (B) is fixed, but the front element (A) is mounted in a cell with a helical screw. Rotation of the helical screw gives a controlled "fore and aft" movement of the front cell, thus adjusting the focal length of the entire lens.

This adjustment is translated into distance shown in the normal way on a circular scale engraved upon the lens mount. An example of this lens is shown in Figs. 2 and 3.

Front cell focusing is virtually the rule on non-specialist roll-film and 35 mm. cameras. The shutter and diaphragm are usually sealed between the two elements of the lens.

The front cell is always secured so that it cannot inadvertently be unscrewed by the user, and the two elements should never be separated unless it is absolutely essential, as the helical thread is a multi-start type, and if it is not re-united in exactly the same fashion the definition of the lens will be ruined.

Depth of Field

Sharp focus is not revealed only on an object at the precise distance focused, but is given on a zone of a definite depth.

Taking the box camera as an example, the lens is so fixed as to give sharpest focus on an object some 21ft. distant, but all objects lying within a zone between 10ft. and 30ft. distant are in tolerably sharp focus with quite acceptable definition to infinity distance.

This zone is properly termed the "depth of field." The term is often confused with "depth of focus," which is properly applied to the amount by which the distance between lens and film plane can be varied without losing the necessary standard of definition.

Depth of field is governed by three factors —the focal length of the lens in use, the distance between subject and lens, and the aperture or "f" ratio employed. The focal length of the lens being a fixed factor (for this purpose) only two factors remain to be controlled by the user. The "range" is selected by means of the focus mechanism, while the aperture is determined by use of the iris. Depth of field is a vital factor in the taking of any picture, and the user *must* be skilled in its application to make the best use of his instrument. The three photos (Fig. 4) show how depth of field varies as the f/No. is changed.

The table on the right gives a few examples of the depth of field given by three lenses of popular focal lengths at different distances and apertures.

Fig. 5.—The coincident image system. (Left) The double image showing that the rangefinder has been adjusted to an incorrect range. (Right) The two images are fully harmonised and the finder correctly set.

Fig. 6.—The split image system. (Left) The horizontal splitting of the image. (Right) The image accurately aligned.

2 in. (5 cm.) Miniatures 35 mm.			
Range	f 3.5	f 9	f 18
4 ft.	3′ 9″ to 4′ 3″	3′ 6″ to 4′ 8″	3′ 1″ to 5′ 8″
10 ft.	8′ 9″ to 11′ 8″	7′ 4″ to 15′ 9″	5′ 9″ to 37′ 0″
50 ft.	29′ to ∞	17′ 8″ to ∞	10′ 9″ to ∞

3 ins. (7.5 cm.) 2¼ in. square			
Range	f 3.5	f 8	f 16
4 ft.	3′ 10″ to 4′ 2″	3′ 8″ to 4′ 4″	3′ 5″ to 5′ 0″
12 ft.	11′ 0″ to 14′ 0″	10′ 0″ to 16′ 0″	8′ 0″ to 25′ 0″
50 ft.	35′ 0″ to 140′	23′ 0″ to ∞	15′ 0″ to ∞

4¼ in. (10.5 cm.) 120 size			
Range	f 3.5	f 8	f 16
4 ft.	3′ 10″ to 4′ 1″	3′ 8″ to 4′ 4″	3′ 6″ to 4′ 8½″
12 ft.	10′ 10″ to 13′ 6″	9′ 9″ to 15′ 8″	8′ 2″ to 22′ 9″
50 ft.	34′ to 99′	26′ to ∞	16′ 9″ to ∞

Tables worked to great extents can be found in most good standard reference books. The serious worker should never be without the depth of field table for his particular lens, especially if he is working at short range.

The main point to be observed in this table is the much greater depth of field given by the lens of short focal length as compared to those of longer focal length. The miniature worker, tackling the same subject as, say, the "120" worker, can obtain the same depth of field using a much wider aperture. Thus he can use a much higher shutter speed and obviate the risk of a blurred picture either by camera shake or by subject movement. Otherwise, if he chooses to use the same shutter speed as his "bigger brother," and the same aperture, he has the advantage of a much greater depth of field, and therefore a much greater tolerance of error in range.

Focusing Scales

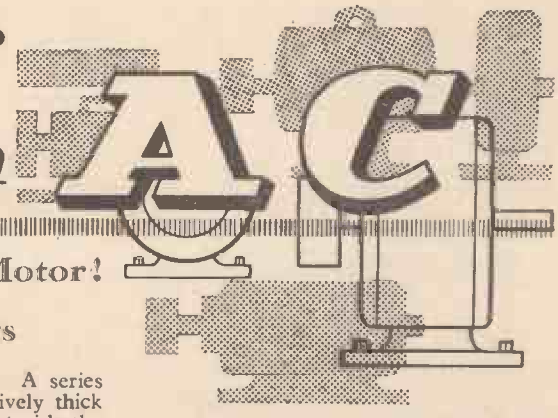
On most up-to-date front cell focus lenses will be found a Depth of Field Indicator. The circular scale carries two sets of "f" numbers with a datum arrow between them. The datum arrow points to the distance setting scale. When the range is selected the scale then shows the depth of field at any given aperture.

Visual Inspection

By far the most efficient method of determining the depth of field is by inspection of the image shown on a ground glass screen. Half an hour of this fascinating observation teaches more about the principle

(Concluded on page 222)

The use of D.C. motors on A.C.



This May Help You to Employ Your Spare Motor!

By J. L. Watts

THE electricity supply in most districts is now A.C., the standard domestic supply being 240 volts single-phase at 50 cycles. Most practical mechanics at some time or other wish to introduce electrical power into the home workshop for driving tools, or may wish to drive some domestic appliance which they have made. These requirements are well catered for by various motor manufacturers and small tool makers.

However, there are occasions when it may be desired to make use of an existing D.C. motor, or where a D.C. motor can be obtained at low cost, as from an ex-Government surplus stores, and the question arises as to whether this can be utilised on an A.C. supply or can be modified so that it can be used on such a supply.

The first thing to be borne in mind is that the design of a small motor is quite a complex operation and is carried out by experts. Once a design has been prepared the manufacturer also carries out fairly exhaustive practical tests to ensure that the performance of the machine is within close limits of certain standards. It is most unlikely, therefore, that an amateur can modify a machine for a different purpose than that for which it was expertly and economically designed without some deterioration of the performance, to say the least. In particular some reduction of output must be expected, and often the conversion is so impracticable as to be not worth attempting.

However, there are cases when it may be possible to adapt a D.C. motor so that it can be used on A.C. to serve the user's purpose; even if its power output is less than before, or if it cannot be run continuously due to the temperature rise of the machine being greater than before. It will be realised that, since the design details of the motor are generally unknown, the performance under different conditions cannot be accurately predicted, and some experiment may be necessary in order that the machine may be used.

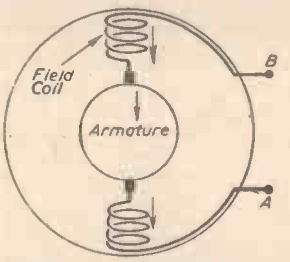


Fig. 1.—Connections of a two-pole series motor.

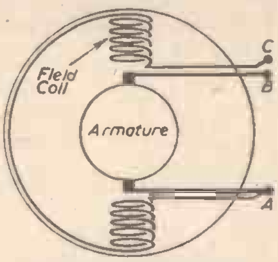


Fig. 2.—Connections of a two-pole shunt motor.

Types of D.C. Field Windings

In general it is not worth while attempting to modify a motor of more than one horse-power, and fractional horse-power motors are usually of the two-pole type to which this article refers. A small D.C. motor may have series or shunt connected field windings, and it is necessary to know how the field windings are connected before its conversion can be considered. A series motor has field coils of comparatively thick wire which are connected in series with the armature, so that the same current passes through the armature and field coils in turn. Often the two field coils are connected on either side of the armature, i.e., one coil is connected between one brush holder and one terminal, as in Fig. 1. The speed of a series motor varies appreciably on a varying load.

A shunt motor has field coils of fairly thin wire, the field coils being connected in series with each other. The complete set of field coils may be connected in parallel with the armature at two terminals, as in Fig. 3. Alternatively one end of the field windings may be connected to a common terminal with the armature as at A in Fig. 2, with a separate (third) terminal C connected to the field windings alone. The speed of a shunt motor does not fall very greatly from no load to full load.

Checking the Motor Connections

It is usually possible to trace the internal connections to identify whether the motor is a series or a shunt machine. If this is impracticable the type of motor can be identified by the use of a battery and some device for indicating a small current, such as a low-reading ammeter, voltmeter, or telephone receiver. The brushes should be removed from their holders, or raised clear of the commutator, and the test circuit connected as in Fig. 3. If current is indicated by the ammeter or voltmeter needle, or by a click in the telephone receiver when the test circuit is closed, this indicates that the motor is a shunt machine.

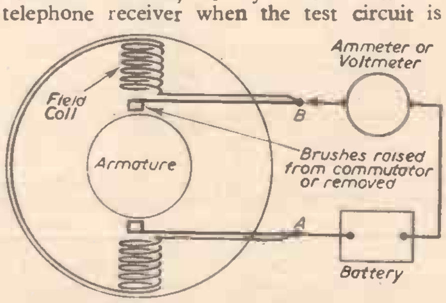


Fig. 3.—Method of testing connections of field windings.

The Field Iron System

A D.C. motor has its armature core constructed of thin laminations. In some cases the field poles and yoke are cast in one piece; in other cases the poles are built up of laminations bolted to a mild steel shell. Sometimes the complete field system is built up from laminations as indicated in Fig. 4. It is important to ascertain whether the field iron system is completely laminated or not. In a D.C. motor the magnetic flux which passes through the yoke between the poles is unidirectional, and has a constant value on a given load. In an A.C. motor the magnetic flux through the yoke is alternating. When an alternating magnetic flux is passed through a solid iron yoke it induces eddy currents in the yoke, which cause unwanted heating and loss of efficiency. These eddy currents depend on the magnetic flux density and the frequency of the alternating magnetic flux. It follows that a motor which has a solid iron field system, or solid parts such as the yoke, may overheat due to eddy currents if run for a long period when converted for use on A.C. This is one possible limitation.

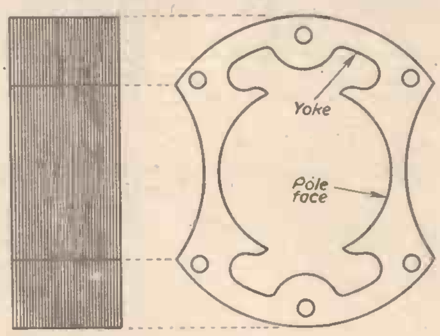


Fig. 4.—A laminated stator field system.

Possible Motor Conversions

All D.C. motors have a commutator and brushes and have salient (projecting or shaped) poles. The only types of single-phase A.C. motors which have a commutator and brushes are series and repulsion types of motors. In the latter category are plain repulsion motors, repulsion-induction motors, and repulsion-start-induction motors. Series A.C. motors usually have salient poles, whilst repulsion types have a laminated slotted stator iron system. Repulsion-start-induction motors have a special centrifugal device which short circuits the commutator as the motor accelerates at starting, which device is not fitted on a D.C. motor.

A.C. induction motors (including capacitor types of motors) do not have a commutator; instead they have a rotor which is fitted with a short-circuited squirrel-cage winding. Apart from the rather inefficient shaded-pole and reluctance-start types of induction motor, the stator system of an induction motor is quite different from that of a D.C. motor. The speed of an induction motor on a varying load does not vary to anything like the same degree as that of a series or a plain repulsion motor. The speed of a repulsion-induction motor also does not vary greatly

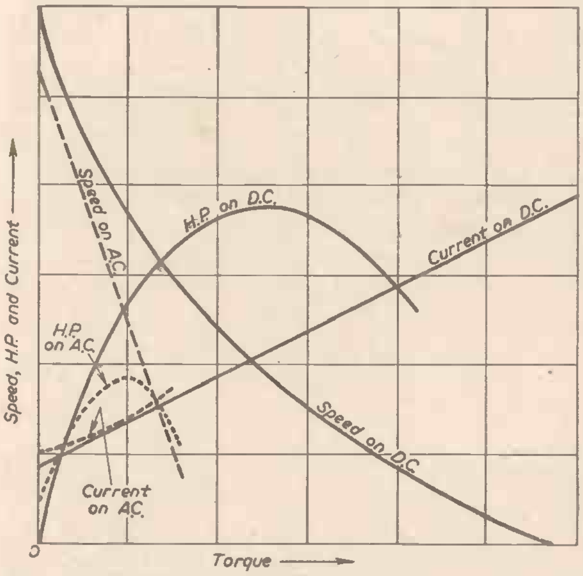


Fig. 5.—Operation of a particular series motor on D.C. and A.C.

on a varying load within the range of the machine.

The possibilities to be considered are, therefore, conversion of a D.C. motor to a series A.C. or plain repulsion motor (with considerable variation of speed on a varying load); a repulsion-induction motor (generally only practicable if the machine has two separate armature windings as in the case of a rotary transformer); or a rather inefficient shaded-pole or reluctance-start motor.

Conversion of the Supply

The other possibilities are to convert the A.C. to D.C. to feed the machine at its normal voltage. In this case the horse-power, temperature rise and speed/torque characteristics will be practically unchanged. This solution may be particularly desirable if a high percentage of the rated horse-power is required, a fairly constant speed is required, the motor has a solid yoke, or is a very low voltage machine having few commutator segments and fairly large brushes. In the case of a very low voltage motor a suitable source of supply may be an accumulator, which can be charged from the A.C. mains through a transformer and rectifier.

A D.C. motor may also be fed direct from a full-wave bridge-connected metal rectifier energised from the A.C. mains through a suitable transformer. The mean D.C. voltage output of the rectifier on load may be about 75 per cent. of the applied A.C. voltage from the transformer secondary windings, but as the voltage is pulsating it is not possible to predict the performance of the supplied motor accurately. Consequently, it is best to feed the rectifier through a tapped transformer so that the voltage can be adjusted if necessary.

Operation of an Unmodified D.C. Series Motor on A.C.

It may be possible to operate a series D.C. motor on roughly the same voltage A.C. without much alteration, particularly if the field iron system is completely laminated. Apart from the laminated field system of a series A.C. motor, this machine is usually designed to operate with a lower magnetic flux density in the field system than in the case of a series D.C. motor. There are two reasons for this. First, the A.C. magnetism induces a voltage in the field windings on A.C. which reduces the voltage applied to the armature, causing the motor to run at reduced speed on a given current. This effect is indicated in Fig. 5, which refers to the operation of a particular series D.C. motor, with laminated field, on the same voltage A.C.

On a given current the speed is reduced. The horse-power is proportional to the product of speed and torque, and is also reduced. Since overheating will be experienced if the motor is loaded so that it takes a greater current than that for which it was designed there is, therefore, a limitation of horse-power. In the case of a motor designed as a series A.C. machine the field magnetism is usually limited by winding the field coils with rather fewer turns than would be used on a corresponding D.C. motor.

Reduction of Field Flux

When a series D.C. motor is to be used on a somewhat similar voltage A.C. the field magnetism obtained with a given armature current can be reduced by connecting a diverter resistor across the field coils, so that only part of the armature current passes through the field coils. This is one method which may be adopted to run a series D.C. motor on A.C. to raise its speed, although the torque will be reduced thereby. This method is particularly desirable if the field system is not completely laminated. Fig. 6 shows how this may be done. It is first necessary to connect the two field coils on the same side of the armature, taking care that the current enters each field coil at the same lead as before. The resistor should be capable of carrying at least half the motor current without overheating, and various values of resistance may be tried out.

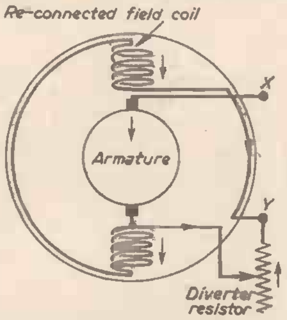


Fig. 6.—Use of a diverter resistor with a series motor.

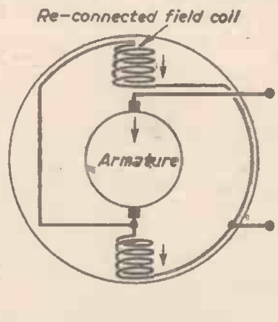


Fig. 7.—Reconnection of series field coils in parallel with each other.

A second method of reducing the field current on a given armature current is by reconnecting the two field coils in parallel with each other, with the set of field coils in series with the armature, as in Fig. 7. Again care must be taken that the current enters each field coil at the same lead as before. With this arrangement the field current through each field coil is halved to reduce the magnetic field flux, thus raising the motor speed, with reduction of motor torque.

Commutation Difficulties

One inherent difficulty in connection with a series A.C. motor is that completely sparkless commutation is difficult to obtain because the alternating field flux induces a voltage in each armature coil as it is short circuited by its commutator segments passing under the brushes during commutation. This induced voltage causes an induced current to pass between the commutator segments and brushes. The value of the induced voltage is proportional to the value of the field magnetic flux, its frequency, and to the number of turns in each armature coil. In addition to designing a series A.C. motor to have a comparatively low field flux the machine is usually designed with a comparatively small number of turns in each armature coil. This means that, for a given voltage, the commutator has a fairly high number of segments.

Thus some sparking may occur at the brushes when a series D.C. motor is used on A.C., particularly if the number of commutator segments is

TABLE 1.—APPROXIMATE FULL-LOAD CURRENTS OF D.C. MOTORS

Rated horse-power	Full-load current at 110 volts	Full-load current at 220 volts	Full-load current at 240 volts
1/30	0.65 amps.	0.32 amps.	0.3 amps.
1/20	0.77 ,,	0.38 ,,	0.35 ,,
1/16	0.92 ,,	0.46 ,,	0.42 ,,
1/12	1.15 ,,	0.56 ,,	0.54 ,,
1/10	1.3 ,,	0.65 ,,	0.6 ,,
1/8	1.54 ,,	0.77 ,,	0.72 ,,
1/6	2.1 ,,	1.0 ,,	0.92 ,,
1/4	2.7 ,,	1.35 ,,	1.24 ,,
1/2	5.1 ,,	2.55 ,,	2.34 ,,
1	9.1 ,,	4.55 ,,	4.2 ,,

TABLE 2.—TURNS PER SQUARE INCH WITH VARIOUS CONDUCTORS

Size of wire s.w.g.	Turns per square inch.				
	Ordinary double-cotton covered	Double-silk covered	Single silk and enamel	Single silk covered	Enamelled
16	171	216	201	221	219
17	222	277	256	287	286
18	286	384	359	400	388
19	384	540	500	567	550
20	450	655	610	692	670
21	565	815	755	865	850
22	730	1,040	975	1,110	1,110
23	860	1,369	1,300	1,480	1,500
24	975	1,600	1,560	1,770	1,800
25	1,110	1,890	1,890	2,110	2,150
26	1,370	2,350	2,300	2,560	2,650
27	1,550	2,800	2,740	3,180	3,180
28	1,760	3,330	3,300	3,850	3,900
29	1,960	3,850	3,800	4,500	4,550
30	2,400	4,500	4,500	5,300	5,550
31	2,600	5,000	5,100	6,000	6,300
32	2,830	5,625	5,810	6,800	7,300
33	3,080	6,400	6,600	7,800	8,400
34	3,450	7,300	7,700	9,000	10,000
35	3,700	8,400	8,900	10,300	12,000

rather low. The induced current, and consequent sparking, may possibly be minimised by slightly shifting the brushes round the commutator if the brush position is adjustable. In any case the induced current can be limited by using brushes of high resistance, such as the Morgan Crucible Company's grade I.M.3 brushes. High resistance brushes are generally advisable on all single-phase A.C. commutator motors.

In some cases it may be practicable to reduce the sparking by limiting the number of commutator segments which are covered by each brush, even though this reduces the contact area and increases the nominal current density in the brush. The effect can easily be tested by simply filing away opposite sides of the brush for a very short distance from the contact face, as in Fig. 8. The brush thickness should be reduced by a very small amount each time, and the motor should then be run for an appreciable time to see whether the brushes overheat due to increased current density. If they do, or sparking is worsened, the reduced area can easily be filed off to provide a greater surface area of contact. Thus sparking may limit the use of a D.C. motor on A.C. particularly if there are not many commutator segments.

It will be appreciated that if the field system is laminated, and the machine well insulated, it may be possible to run a series D.C. motor on a slightly higher voltage A.C.; the increased volt drop on the field windings automatically reducing the voltage applied to the armature. If a series D.C. motor is to be used on a much higher voltage A.C. the best plan is to feed it with D.C. of the correct voltage from an accumulator or rectifier, as mentioned above, particularly if the field is not completely laminated and there are not many commutator segments.

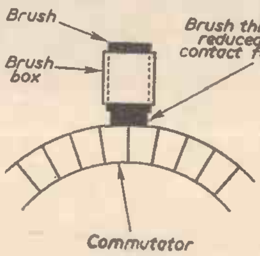


Fig. 8.—Method of reducing brush thickness.

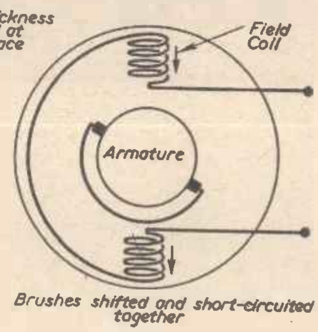


Fig. 9.—Arrangement of a repulsion motor.

TABLE 3—CURRENT LOADING OF CONDUCTORS WITH VARIOUS CURRENT DENSITIES

Size of wire s.w.g.	Diameter (in.)	Sectional area (square inch)	Current loading with current densities of			
			2,000 amps. p.s.i.	3,000 amps. p.s.i.	4,000 amps. p.s.i.	5,000 amps. p.s.i.
16	0.064	0.00322	6.4	9.7	13	16
17	0.056	0.00246	4.9	7.4	10	12
18	0.048	0.00181	3 6	5.4	7.2	9.1
19	0.040	0.001256	2.5	3.8	5	6.3
20	0.036	0.001018	2.0	3.1	4.1	5.1
21	0.032	0.000804	1.6	2.4	3.2	4.0
22	0.028	0.000616	1.2	1.8	2.5	3.1
23	0.024	0.000452	0.9	1.4	1.8	2.2
24	0.022	0.000380	0.76	1.1	1.5	1.9
25	0.020	0.000314	0.63	0.94	1.3	1.6
26	0.018	0.000254	0.50	0.76	1.0	1.3
27	0.0164	0.000211	0.42	0.63	0.84	1.1
28	0.0148	0.000172	0.34	0.52	0.69	0.86
29	0.0136	0.000145	0.29	0.43	0.57	0.72
30	0.0124	0.000121	0.24	0.36	0.48	0.60
31	0.0116	0.000106	0.21	0.32	0.42	0.53
32	0.0108	0.0000916	0.18	0.27	0.37	0.46
33	0.0100	0.0000785	0.16	0.23	0.31	0.39
34	0.0092	0.0000665	0.13	0.20	0.27	0.33
35	0.0084	0.0000554	0.11	0.17	0.22	0.27

Rewinding the Field Coils

If the field is completely laminated, and there are ample commutator segments, the armature is well insulated and robust, and the motor is designed for at least half the A.C. voltage, it may be possible to use the existing armature with rewound field coils. In this case the field coils could be rewound with about 75 per cent. of the original number of turns, using the same size of wire as before. Alternatively the field coils may be connected in parallel or used with a diverter resistor.

If the series motor is designed for a much lower voltage than the A.C. supply it may be possible to feed the machine through a step-down transformer at no more than twice the rated voltage, possibly with reconnected field coils or a diverter resistor. High resistance brushes, brush shift, or reduced brush thickness may be advisable. It is best to feed the motor through a tapped transformer in this case, and the motor should not be used on a drive which can become unloaded.

Conversion of a Shunt Motor into a Series A.C. Motor

It is impracticable to operate a shunt D.C. motor on A.C. without modification. If the rated voltage does not differ very greatly from that of the A.C. supply it may be practicable to rewind the field coils to convert it into a series motor. The two field coils must be connected to create poles of opposite polarity. Again, if the field system is not completely laminated the motor may overheat on a prolonged run, sparking may be experienced if the number of commutator segments is low; high resistance brushes, brush shift or reduced brush thickness may be advisable.

The first need is to ascertain the full-load current of the motor; if this is not marked on the machine a value may be obtained from Table 1. It may be noted that the full-load current of a given size of motor is approximately inversely proportional to its rated voltage. The difficulty in connection with designing new field coils is that the design of the armature is unknown, so only an approximate indication can be given; which may need modification as the result of experiment.

The radial air gap clearance between the centre of each pole face and the armature should first be measured by means of feeler gauges $=r$ inch. Then if I (amps.) is the full-load current, the number of turns for each field coil may be made very roughly equal to $\frac{7{,}500 \times r}{I}$. An increased number of turns will reduce the speed, and vice versa. It is suggested that the largest size of wire be used which can be accommodated on each pole with the required number of turns. Table 2 provides a guide as to the turns which can be accommodated per square inch with close winding; although allowance must be made for getting the coils into position, etc. A current density of about 3,000 to 4,000 amps. per square inch may be satisfactory, and Table 3 provides a further guide to the wire which may be used. When used as a series motor the speed will change considerably on changed load.

Conversion to a Repulsion Motor

Another possibility is the conversion of a series or a D.C. shunt motor into a plain repulsion motor. In this case also, the speed will vary considerably with the load. One advantage of such a conversion is that it can often be adopted even if the voltage of the D.C. motor is much different from that of the A.C. supply. However, it is usually only practicable if the brushes can be shifted something like 90 degrees round the commutator. High-resistance brushes, and/or reduced brush thickness may be advisable.

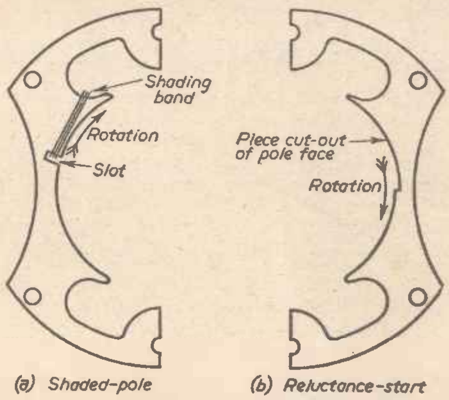


Fig. 10.—Modification of laminated field systems for operation on A.C.

The field coils will require rewinding in most cases. The area of each of the two pole faces should first be measured $=$ A square inches per pole. For a two-pole motor which is to be used on V volts at a frequency of f cycles per second the number of turns on each field pole may be made very roughly equal to $\frac{375 \times V}{A \times f}$. Again the largest size of wire should be used which can be accommodated with the required number of turns. The two new field coils should be connected in series with each other in such a way that they create poles of opposite magnetic polarity. The brushes should be short circuited together as in Fig. 9, by means of a substantial copper conductor. The performance of the machine will very largely depend on the brush position, which is likely to be critical. The effect of slight changes of brush position up to about 90 deg. in either direction should be tried. The direction of rotation will also depend on the brush position. The converted machine is likely to overheat on a prolonged run if the field system is not completely laminated.

Modified Repulsion Motor

If the field system is not completely laminated, and the armature is wound for approximately the same voltage as the A.C. supply, an improved perfomance may be obtained by feeding the brushes (not short-circuited) from the supply, and short circuiting the new field windings instead. Small rotary transformers can sometimes be converted by connecting the mains-voltage brushes to the supply, possibly in parallel with the field windings; the low-voltage brushes being short circuited together and shifted round the commutator.

Conversion to an Induction Motor

If the field system is completely laminated

(*Concluded on page 222*)

AUTOMATION in America

D. S. Fraser Describes the Latest Trends

SOME North American modern mechanical methods, devised to short-cut old-time procedures would have seemed fantastic not so many years ago. Today, scientists have perfected electronic equipment that not only thinks for itself, but for everyone else as well. Many of the new uses to which electronics are being applied, a few of which are reported here, stagger the imagination.

In the United States, the Louisiana Light and Power Company are constructing a fully-automatic 225,000 kW electrical power-generating station where all phases of operation, from start-up—right through operations—to shut-down, will be controlled automatically by a special electronic computer. While the real advantage of automation, in this respect, is faster reaction and greater sensitivity, it is interesting to note that the new station will be staffed by a complement of only three human operators for safety and maintenance.

Automatic Letter Sorter

Another unusual electronic machine—an automatic letter sorter—is now being used by the U.S. Post Office Department. (See Fig. 1.) This machine sorts 18,000 letters per hour, and arranges them so that the addresses on the envelopes can be read.

The operator then types an abbreviation for the address, which appears on the back of the envelope. After that the machine takes over entirely. An electro-mechanical optical device looks up the destination for each address and routes a letter correctly in one-tenth of a second.

" Pathway in the Sky " is the name given by the U.S. Navy to an electronic computer, developed to simplify an airline pilot's task of reading the complicated instrument panels of modern planes.

When the pilot feeds a few basic facts into it, this machine combines them with all the other information that the dials and gauges would normally supply. It then shows the pilot an image of a roadway on a television screen mounted on his windshield. As long as as he follows this imaginary road he will be on a safe flight-path.

Studying Wolves

In an effort to solve some of the mysteries surrounding the wolf, one of Canada's most savage and relentless killers, Ontario's Department of Lands and Forests has hit on a novel plan. With the aid of biologists, an electronic-age Peeping Tom programme is being started to find out some of his will-o'-the-wisp habits. It will involve trapping the wolves alive and then releasing them with a small radio transmitter that will broadcast a constant beep-beep to reveal at any time the whereabouts of the ghostly wolves.

Cigar-size transmitters attached to a leather collar will be fastened to the wolves. A transmitting aerial will form a loop around the collar which will be expansible and stretch as the wearer grows. When the wolf's radio battery begins to weaken, the biologists should know his habits so well that they can retrap him and replace the power unit. Similarly, when he dies they will follow the " beep " and take the transmitter for use again.

Another remarkable electronic machine, a high-speed electronic brain, is now being used by New York City as a superhuman payroll clerk. It is a mammoth new electronic cheque-writing and computing system that handles the payroll for the city's 190,000 employees. (See Fig. 3).

The machine computes each employee's gross pay, the amount to be witheld for income-tax, Social Security, pension contributions and other expenses, and then writes a cheque for the correct amount.

Electronic Book-keeping System

Banks are now relying more and more upon various electronic machines to do their book-keeping. The National Cash Register Company in the United States, for example, has

Fig. 1 (Above).—The automatic letter sorting machine being used in a Washington post office.

supplied more than 2,000 of them, and the Burroughs Corporation has orders for 2,000 machines of a similar nature.

One of the United States' largest toll road systems has found it necessary to use an electronic book-keeping system to look after its operations because the original accounting staff found themselves hopelessly overloaded with work. The system—the New York State Throughway Authority—must analyse more than 46,000,000 trips a year, using some 16,000 different combinations of toll rates based on the weight of the vehicle and the length of its journey.

Money-changer

Just coming into wider use in the United States is an electronic money-changer which can both read and count. (See Fig. 2.) This is used in connection with vending machines which, in recent years, have been used to sell an increasing number of different products. These machines can also take your photograph or record your voice, and in some places will even park your car. They have one important limitation, however, they can handle only metal coins, which means that the customer must have the exact number and kind of coins required.

Fig. 2 (Above).—This electronic cashier which gives change for dollar bills, will accept wrinkled, crumpled or torn bills but rejects counterfeits.

Fig. 3 (Below).—Payroll cheques for New York city's 190,000 employees, being delivered by an electronic computing machine.

The electronic money-changer solves the problem by changing paper money into coins of different values. It can also be combined with a standard vending machine so that it will accept a bill, deliver the desired article from the machine, and return the correct change in coins. The device can be adjusted to take one particular kind of bill so precisely that it will reject foreign bills and even well-made counterfeits.

PRINCIPLES AND PRACTICE OF FOCUSING

(*Concluded from page 216*)

of focusing and depth of field than all the text books ever written.

Selective Focusing

By careful definition of the depth of field the worker can decide what shall be sharp and well defined in his picture, and what shall be hazy and blurred. If you *must* pose your model against a wall, the patterned paper or harsh brickwork can be subdued by careful use of the iris diaphragm.

The miniature, with its vast depth of field, is sometimes at a disadvantage in this respect.

Estimating Range

The whole secret of accurate focus lies in good rangefinding. If the object you are photographing is under 6ft. away measure it. Depth of field at such short range is reckoned in inches and there is little permissible margin of error. A 6ft. spring steel tape costs little, and takes up little room. "Pacing" the distance, if the range over 6ft., is adequate.

Rangefinders

In these very useful devices the images from two mirrors or prisms are made to converge before a single eyepiece, and the range is read off on a scale. Two different types are shown in Figs. 5 and 6. Rangefinders are not expensive, and if treated with care they are very reliable.

The coupled rangefinder is included in top class cameras. The scene is viewed through the rangefinder, and as the images are made to coincide, so the lens is brought into accurate focus. Practically every format of camera, even folding cameras, can be fitted with a coupled rangefinder. The lens can always be set independently of the rangefinder if required.

Reflex Cameras

For ease and accuracy of focusing the reflex type of camera is in a class by itself. Reflexes are divided into two distinct groups, the single lens and the twin lens.

In the single lens type the lens is unobscured by the shutter. Light transmitted by the lens falls upon a silvered mirror which is set at an angle of 45 deg. to the lens axis and the image is reflected on to a ground glass screen on the top of the camera body. Focus, which may be by entire lens movement or occasionally front cell movement, is checked visually. The screen is usually hooded to assist vision. At the moment of exposure the mirror is raised to allow the light to fall upon the fabric of the shutter blind, and then the shutter operates. As the travel of the blind ends, the mirror is lowered back into position.

Twin Lens Reflexes

The twin lens reflex is essentially a pair of identical cameras, one mounted above the other. All focusing is done by means of the upper unit. In the top class twin lens reflexes, the focusing lens and the taking lens are mechanically linked, so that as focus is made and checked visually through the viewing lens, the taking lens is automatically in focus.

Whatever type of camera is used, accuracy of focus is vital if good work is ever to be achieved. Any error is indelibly recorded on the negative, and no amount of manipulation in the enlarger or after-treatment of the print can improve matters.

CHOOSING A "MIKE"

(*Concluded from page 208*)

tendency to exaggerate the bass notes. Ribbon microphones are not recommended for outdoor work on account of their fragility and also because of their sensitivity to air currents. While they are far superior to crystal microphones, they are only really of much use in tape recording in conjunction with high fidelity equipment.

Finally, we have a remarkable microphone which does not boast quality but is of great use in recording speech in high ambient noise levels. It is known as the noise cancelling microphone. These instruments generally consist of a dynamic element, with the diaphragm extended away so that sound waves may fall on both sides of it. In a high ambient noise level sound falls on both sides of the diaphragm, the result being that it is virtually unaffected. When in use the microphone is held close to the mouth, so that speech is permitted to fall only upon the front face of the diaphragm. The microphone thus picks up the speech, but not the noise. Such instruments are used in aircraft and industrial applications where communication is necessary in high ambient noise. So far as tape recording is concerned, this type of microphone is useful for interviews out of doors where it is desired to eliminate background noise. Noise cancelling microphones can be obtained in various impedances depending on the input impedance of the circuit they will feed.

USE OF D.C. MOTORS ON A.C.

(*Concluded from page 219*)

it is just possible that a D.C. motor can be converted into a single-phase induction motor even if designed for a much different voltage than that of the A.C. supply. However, the output is likely to be much reduced and the starting torque may be so low that the motor will not start against load.

For conversion to an induction motor the brushes and their holders should be removed and a few turns of bare copper wire wrapped tightly round the commutator to short circuit the segments. If the conversion proves satisfactory this wire may be soldered to the segments. The field coils will require rewinding, and the suggestions made for converting a D.C. motor to a repulsion motor may be adopted in this connection. When switched on to a single-phase supply after spinning the rotor by hand it should run in whichever direction it is started. A two-pole motor should run at practically 3,000 r.p.m. on a 50 cycle supply, and the speed should not vary greatly on load. The motor can be used in this way if it is not required to be self-starting.

It may be practicable to make the motor self-starting when practically unloaded by increasing the air gap under half of each pole face by about 0.040in. so that the motor operates as a reluctance-start motor. One pole of such a motor is shown in Fig. 10b. Since the motor will run in the direction of the untouched half of each pole face, the forward half of each pole should be untouched. The conversion may be unsatisfactory if the insulation between the stampings is much damaged, however.

Another method of making the motor self-starting is by converting it to a shaded-pole motor. A slot about 3/32in. wide $\times$ about 5/32in. deep may be cut in each pole face about one-third of the pole face from the leading tip of the pole. The motor will run in the direction shown in Fig. 10a, which refers to one pole of a two-pole motor. A few turns of bare copper wire are then wrapped round the leading part of each pole face to form a shading band, as shown. The ends and opposite sides of the wires should be soldered together to form short-circuited turns. As a very rough approximation the total cross sectional area (in square inches) of the short-circuited turns on each pole may be made equal to $\frac{N \times a}{10}$, where N is the number of turns of insulated wire on each pole and a the cross sectional area of the isulated wire.

It must, however, be repeated that, due to the various limitations mentioned, too much must not be expected from any D.C. motor which is converted for use on A.C.

PUZZLE CORNER

1.—Railway Problem

Two railway trains, one 400ft. long and the other 200ft. long, run on parallel rails. When they travel in opposite directions they pass each other in five seconds; when running in the same direction the faster train passes the other in 15 seconds. What is the speed in miles per hour of each train?

2.—Changing a Three-penny Piece

Including the use of farthings, how many ways of giving change for a three-penny piece can you think of? Don't be in a hurry; it is quite easy to miss a few.

Answers

1.—In five seconds both trains (together) go 600ft., or 81 and 9/11ths m.p.h. In 15 seconds the faster trains gains 600ft., or 27 and 3/11ths m.p.h. Thus 54 and 6/11ths m.p.h. is the speed of the faster train and 27 and 3/11ths m.p.h. that of the slower one.

2.—There are 16 different ways. Did you get them all?

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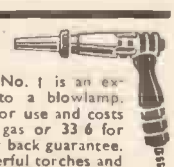

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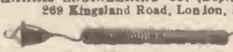

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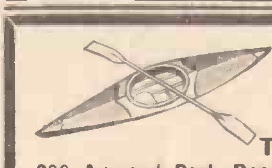

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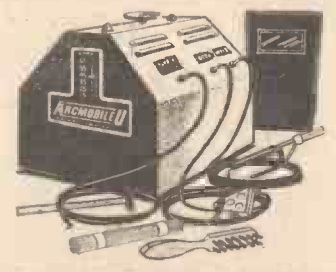

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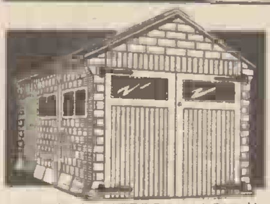

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Letters to the Editor

The Editor does not necessarily agree with the views of his correspondents.

Mary Celeste — A Naval Man's Theory

SIR,—I read in your December issue the article on page 129 on "Space Raiders." Being a practical navigator and having commanded a gunboat in the Royal Indian Marine, H.M.S. *Sussetta*, I consider there are points which "Theorist" may not have thought essential to portray in his article about the *Mary Celeste*.

The brigantine *Mary Celeste* had a cargo of spirits on board. Now vessels carrying this cargo have to have plenty of ventilation to allow the alcoholic fumes to disperse. Unfortunately Captain Briggs had had very bad weather for the first part of his voyage. To have opened the hatches (as brigantines are not like modern steamers and replete with ventilators) would have had suicidal results, the ship would have been swamped and foundered. The ship's log (*this has to be entered up each day at noon and the position stated*) had not been entered up for over a week.

The cabin details are correct except that in the depositions of the *Dei Gratia* crew no mention was made about the stove being warm or that there was a cat on board. This latter is very interesting as under the Laws of Oleron—in the 12th century and accepted today in the 20th century—a ship's cat on board could be defined as a member of the crew and a legal dispute could have arisen as to whether *all* the missing crew were lost. I saw a number of years ago in *Sea Breezes*—a maritime monthly—this case set out. The writer reproduced photostat copies of Vice-Consul (U.S.A.) Spragges's (at Gibraltar where the case was tried) reports and *no cat was mentioned*.

The strange mark was actually in the quarter *not the bow*—and it seemed as if a heavy weight had rubbed against a mooring chock in the ship's rail around the stern counter.

My reconstruction of the case is this: The spirits in the casks burst upwards on a seemingly fine morning and carried away the hatches, a great cloud of vapour from the fumes rising. The crew, except the helmsman and the officer on watch, would be at breakfast and this tremendous explosion startled everyone. The boat, in these craft, generally hung on davits *over the stern*, was hastily lowered. Putting everyone in, the master took his chronometer and sextant. As it was thought to be only a temporary measure, perhaps he did not see to the provisioning and water supply. If another explosion occurred they were clear and could perhaps return. To make this sure, he ran a painter from the bow of the smaller boat *through* the quarter chock on to a bitt or perhaps round the main mast. The wind was still choppy and the vessel, having nobody to steer her, was flung about by the wind, first on one course and then on another. Captain Briggs waited too long to return on board. A position arose where the boat and the ship were at opposite angles and at this precise moment one of the vessels found itself in the hollow of two seas and the other on top of a following sea. The strain proved too much and the painter snapped. The brigantine at once freed from her heavy tow—the laden, waterlogged boat—jumped away and fled on the new tack, being speedily lost to sight. The laden boat, half filled with water through the seams and probably shipping a quantity over the gunwales, gradually sank lower and lower and took her inmates to "Davy Jones's Locker."

In those days ships' boats were seldom inspected and many had never been in the water for years. Until the planks swelled the water would have flooded in.—GEORGE PERCIVAL KAYE, F.R.G.S., former Lieutenant-Commander R.N.

Is It Worth While?

SIR,—This question is asked about space research in Fair Comment in the December issue and in my opinion, it is not! Surely our scientists would be far better employed trying to find out more about our own planet—particularly about what lies under the earth and at the bottom of the sea.—E. D. (Tooting).

Mary Celeste — No Mystery at All!

SIR,—Re "Space Raiders" in the December, 1959, issue. "Theorist's" choice of the *Mary Celeste* incident is rather unfortunate since there is no mystery at all as to what happened. The truth was suspected at the time and was confirmed by statements from two surviving members of the crew, Jack Dossel and John Pemberton in 1917 and 1925 respectively. The complete account is given in "The Great *Mary Celeste* Hoax," by Laurence J. Keating (published in 1929), and a short summary is included in "Myth and Mystery," by Rupert Furneaux (published 1955).

At the Admiralty inquiry at Gibraltar the Admiralty Proctor, Mr. Flood, was far from satisfied with the evidence. For one thing the *Dei Gratia* disembarked an unnamed passenger at Gibraltar and again the condition of the cabin as found by Mr. Flood did not agree with the statement made by Mr. Deveau, the mate of the *Dei Gratia*. In the event Captain Moorhouse was awarded the relatively small sum of £1,700, less costs, not for salvage but for "rendering assistance to a distressed vessel." He can hardly have been satisfied with this but he does not seem to have made any complaint.

There is one error of fact in Theorist's account, there was no child on board. Capt. and Mrs. Briggs had only been married two years and had no children; the small size of the female garments found was due to the size of Mrs. Briggs who was practically a dwarf!

Briefly what happened was this; the mate and crew of the *Mary Celeste*, with the exception of the cook, John Pemberton, deserted in New York. The *Dei Gratia* and the *Mary Celeste*, both under charter to the same firm, were lying alongside each other in harbour and Briggs arranged with Moorhouse to borrow three of his crew in return for Moorhouse taking on board some surplus cargo which the *Mary Celeste* could not carry. They agreed to meet at the Azores where Briggs expected to be able to engage new hands. The remainder of the crew consisted of the mate, Hullock, and three rather unsavoury characters, Sanson, Dossel and Venhold. Mrs. Briggs met with an accident and died and her husband took to drink, Venhold went overboard in a fight with the mate; during the night of November 26th the ship ran into a submerged hulk and while this wreckage was being cut away Briggs disappeared—either by accident or design. Near to the Azores, Hullock, Dossel and Sanson left the ship, presumably in the missing boat, leaving on board Pemberton and the three *Dei Gratia* men. It is significant that just before *Dei Gratia* sighted the supposed derelict the freighter *Ebro* had 'spoken" to both ships. The mysterious passenger landed at Gibraltar was Pemberton who sailed almost at once for the Far East. Sanson died in New York in 1873, Hullock at Curaçao in 1887. A member of the *Dei Gratia* crew made a statement to the New York police in 1903 but was not taken seriously. The marks on the hull were presumably made by the submerged hulk.

The story has, of course, become a myth which loses nothing in the telling and the popular account in fact owes more to Conan Doyle's short story than to Mr. Flood's inquiry.—K. R. MATTHEWS (Northumberland).

Mirror Silvering Difficult

SIR,—We would venture to disagree with the advice given to S. N. Gaythorpe in "Your Queries" who asks about resilvering astro mirrors. It is not at all easy to silver a mirror adequately and quite difficult to polish the silver deposit to give anything approaching the 90 per cent. maximum reflectivity required; the silver coating tarnishes in a few weeks. It is far preferable to have the mirror aluminised professionally—the cost is often less than the cost of the chemicals for silvering, and the coating will last for years at about 70 per cent. efficiency. A suitable aluminiser, whom we have found most reliable is Messrs. High Vacuum Deposits Ltd., Forest Road, Barkingside, Essex.—pp. Seren Astronomical Supplies, D. G. HINDS.

Freshwater Aquarium

SIR,—Your reply to a querist in the October issue on an aquarium problem interested me greatly.

I think that it is the opinion of experienced aquarists that three plants as suggested for a tank 18in. × 10in. × 12in. would be insufficient; a dozen would be more appropriate.

Regarding Hydra, this is an enemy to the fishkeeper, and should on no account be tolerated, as it preys on most fishes and live foods. It is also difficult to eliminate in a tank without stripping it down and sterilising, as any broken bit of Hydra soon develops into a complete individual Hydra.—J. E. MORRIS (Bath).

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New Stanley Hammers

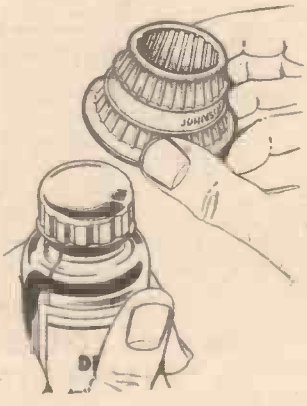
A STRONG, serviceable and yet economically priced claw hammer has been introduced as part of the Stanley "Handyman" range of tools. Hickory handles are fitted. Two sizes are available: 20oz., costing 10s. and 16oz., costing 9s.

Stanley are now also producing Warrington hammers in four sizes. The handles are made of selected, young, straight-grained ash, the heads are rim-chamfered to minimise the danger of chipping and hardened and tempered on the faces and peins. The four sizes of Stanley Warrington hammers are 8oz., 10oz., 12oz. and 14oz. They retail at 7s. 6d., 7s. 9d., 8s. and 8s. 6d. respectively.

Handles are pre-shrunk and treated to make them impervious to moisture. This prevents shrinking, the commonest cause of loose hammer heads. All, with the exception of the smallest size of Warrington, are triple-wedged.

Bottle Screw-cap Remover

JOHNSONS OF HENDON LIMITED, Hendon Way, Hendon, London, N.W.4, have placed on the market a flexible rubber bottle screw-cap remover. This appliance fits over the screw cap and by means of its ridged surface obtains a firm grip and enables even the most obstinate screw caps to be removed. The Johnsons bottle screw-cap remover can be purchased at 9d. each from any good chemist, photographic dealer or store.



The Johnsons bottle screw-cap remover in use.

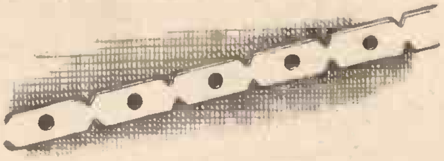
Water Tank Protection

A NOVEL and unique method of preventing rust formation on the inside of water tanks of 100 to 1,500 gallons capacity has been evolved by Southern Metalife Ltd., Station Square, Harrogate, Yorks. In this case the Metalife has been cast in a solid form, so as to form an anode in a cathodic protection system.

The solid Metalife Anodic Metal Unit is easily installed by anyone in a few minutes and the tank need not be emptied or put out of action. Once installed the unit will give 8-12 years' service, depending on the exact size of the tank and the type of water, and needs no further attention. All the metal below the water line will be protected even if the water is so hot that coatings and galvanised iron break down. Any rust that has already formed in the tank will be removed. Details are obtainable from the above address.

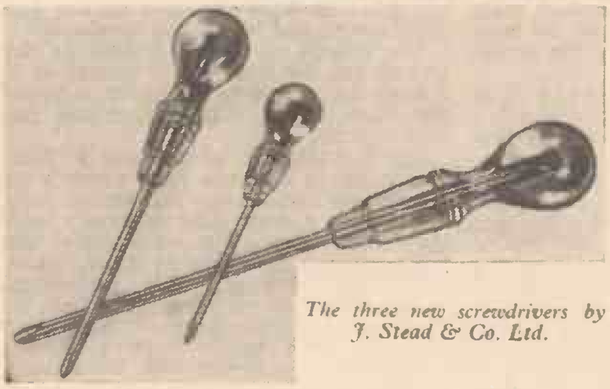
Addyco Steel Strip

THIS steel strip, which is sold in 18in. and 6ft. lengths, can be used for making and fixing shelf brackets, pipe clips, plant supports, shop window displays, exhibition stands and laboratory apparatus, etc. It can also be used to repair furniture, doors, racks, ladders and many other first-aid jobs around the home and workshop. The strip is manufactured by Addy Products Limited, from 16g. mild steel and is rust-proofed. The 18in. strip retails at 1s. 3d. net. The 6ft. lengths are of electro-zinc galvanised steel and retail at 5s. net. Addyco all-purpose steel strip is obtainable from most ironmongers or tool merchants.



All-purpose steel strip.

Phillips Type Screwdrivers



The three new screwdrivers by J. Stead & Co. Ltd.

THREE new screwdrivers are being produced by Messrs. J. Stead and Co., Ltd., Manor Works, Cricket Inn Road, Sheffield, 2, for use with Phillips recess-head wood screws as well as metal screws. They are fitted with cabinet handles of plastic and are particularly suitable for use with self-tapping screws. They cost 5s. 4d., 7s. 6d. and 9s. 3d. according to size.

The New "Carol" Tape Recorder

THE "Carol" tape recorder produced by Contronics Limited, of Garth Works, Deepcut Bridge Road, Blackdown, Nr. Aldershot, Hants, uses the new B.S.R. tape deck. Tape spools up to 5¾in. are also used, giving a total playing time with standard tape of 1½ hours, at the single speed of 3¾in. per sec. The two-tone red and grey case has gilt fittings and incorporates a 7in. × 4in. speaker. The amplifier has radio and microphone inputs, with an extension loudspeaker output. The "Carol" is suitable for 200-240v. A.C. only. The price, complete with 850ft. tape, spare spool and crystal microphone, is 19 guineas.

The new tape recorder

Perkins Outboard Motors

IT was recently announced that the new 1960 range of Perkins streamlined motors is now available on hire purchase terms. The announcement was made at the recent opening of a new British plant, specially equipped to produce the Perkins outboard motors. The modern production methods used in this plant have enabled Perkins to slash the prices of their petrol outboard motors by amounts varying up to 20 per cent.

"Home Photography"

THE fifth edition of "Home Photography," published by Johnsons of Hendon Limited, Hendon Way, London, N.W.4, is now available. The book discusses action, architectural and colour photography, etc., and also gives instructions for developing and printing. Available from most photographic dealers, this well illustrated, 104 page book costs 3s.

New Thermostat Plug

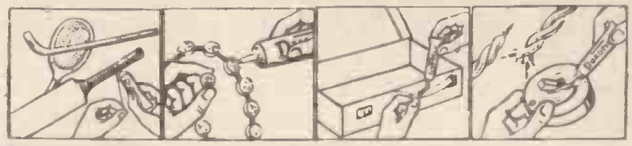
A HANDY device for controlling the heat of electric kettles, percolators, soldering irons, drying cabinets, blankets, carpet underlay heating or any other electrical heating appliance not fitted with a built-in thermostat has recently been introduced by Messrs. Sunvic Controls Ltd., 10, Essex Street, London, W.C.2. Known as the "Reguplug," this device comprises either a 15A (round pin) or 13A (flat pin, fused) three-pin plug with a built-in heat regulator. The "Reguplug" will maintain heat at any desired level between zero and full, and is for use on 220/240v. A.C.

It costs 35s. for the 15A type, 37s. 6d. for the 13A version and is on sale at Electricity Board showrooms, electrical retailers, etc.

(Left)—The 13A flat pin, fused Reguplug.

RAWLPLUG
Recommendations

DUROFIX
FOR MAKING AND MENDING ANYTHING



1/- PER HANDY TUBE

If it can be stuck Durofix will stick it because it is a universal adhesive which is heatproof, waterproof and being transparent makes almost invisible joins. Valuable ornaments and trinkets can be repaired. When dry and hard it will not become tacky in the hands so it is ideal for sports goods. Once you have proved how useful and reliable Durofix really is, you will never be without a tube in your home.

Durofix Thinner and Remover 1/6 per 2 oz. bottle.

1/6 per large tube
2/9 per ¼-lb. tin
10/6 per 1-lb. tin
Commercial size tubes 5/-

PLASTIC WOOD
FOR FILLING AND MAKING WOOD GOOD

It is surprising how many uses you can find for Rawlplug Plastic Wood in the home. Filling cracks and flaws, making woodwork good before decorating, repairing furniture, making models and so on. Plastic Wood dries hard and can be cut, planed, sanded, painted and varnished like real wood. You can even drive nails and screws into it.

Colours:— Natural, Oak, Mahogany and Walnut.

Plastic Wood Softening Fluid 1/6 per 2 oz. bottle.

1/- PER TUBE

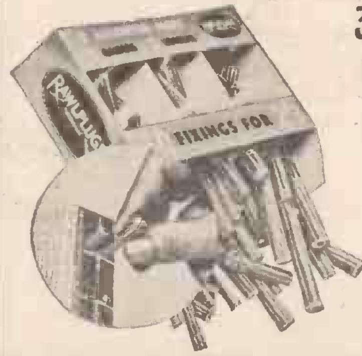
2/3 per ¼-lb. tin
3/9 per ½-lb. tin
6/6 per 1-lb. tin

TILE CEMENT
FOR FIXING LOOSE TILES

A very strong white waterproof adhesive for quickly and securely replacing loose or displaced tiles. ¼-lb. tins cost only 2/9.

1/3 PER TUBE

RAWLPLUG FIXING DEVICES, TOOLS & PRODUCTS
can be obtained from Ironmongers, Hardware Dealers, Builders' Merchants and Stores everywhere.



3 sizes of RAWLPLUGS in one carton 2/3

This very useful assortment of Rawlplugs in three gauges and three lengths provides 50 No. 8, 10 and 12 fixings for 2/3. The window carton is divided into three compartments and the lid incorporates a Rawlplug and Screw gauge making it easy to select the right drill and screw to use. Get one now for your tool box.

for masonry drilling *the easy way*

RAWLPLUG METALIDE
REGISTERED TRADE MARK

Here is a cheap reliable masonry drill for the household handyman. Four sizes are made for use in a hand brace or suitable electric drill. Just what you need for that occasional domestic fixing job.

Each Metalide drill is packed with an instruction leaflet in a strong plastic wallet with transparent window.	No. 8 (3/16") Green Wallet	No. 10 (7/32") Blue Wallet	No. 12 (1/4") Brown Wallet	No. 14 (9/32") Grey Wallet
	5/6	6/-	6/6	7/-

The most efficient, precision made, long lasting masonry drill is the Rawlplug DURIUM (with the free re-sharpening service). We strongly advise this drill for continuous drilling (such as industrial operation). 13 sizes are from No. 6 to No. 30; 4 Rawlbolt sizes and 11 sizes for drilling right through walls. Prices are from 9/6 each. For drilling glass use the special DURIUM GLASS DRILL. Made in nine sizes from ⅛" to ½" at 6/6 to 10/6 each.

Free Re-sharpening Voucher with each drill.

The handiest of handy outfits for the household handyman

In this attractive box there are seven of the most popular Rawlplug products complete with a 64 page Instructional booklet: Rawlplugs, a No. 8 Metalide Masonry Drill, Durofix, Duroglue, Plastic Wood, Fuse Wire and six Rawlnuts (for making strong fixings to thin and hollow materials)

Rawlplug DO-IT-YOURSELF OUTFIT—12/6

Don't Scrap it—Solder it

No handyman should be without this sturdy electric soldering iron which can be supplied with standard bit at 32/6 or Pencil or Hatchet bit at 33/6. Voltages 100/110, 200/220, 230/250 Volts. Universal A.C./D.C. Consumption 110 Watts.

SIX MONTHS GUARANTEE

STANDARD BIT

RAWLPLUGS WALL PLUGS *make light work of strong fixings*

B666A

THE RAWLPLUG COMPANY LTD., CROMWELL ROAD, LONDON, S.W.7.

The books for the man who likes to make things for himself—

Shows you how to make over 30 magnificent articles. 224 pages and 320 diagrams and illustrations.

THE 1st "PRACTICAL MECHANICS" HOW-TO-MAKE-IT BOOK

Edited by F. J. CAMM

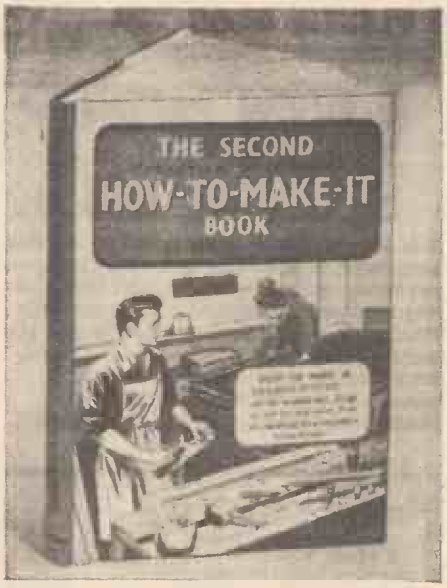
THIS is a book for the man who likes to make things for himself. It has been compiled from the columns of "Practical Mechanics," the monthly journal for the handyman and model maker. Everything herein described has been designed, built and tested in the "Practical Mechanics" workshop, and may thus be built with confidence.

CONTENTS : *TAPE RECORDER . MASTER BATTERY CLOCK . ELECTRONIC ORGAN ELECTRIC WASHING MACHINE . HAND VACUUM CLEANER . ELECTRICALLY-OPERATED GARAGE DOORS . BAGATELLE TABLE . REFLECTING TELESCOPE HARMONOGRAPH . "DESIGNOGRAPH" . 15IN. FOUR-HEDDLE HAND-LOOM POTTER'S WHEEL . POTTERY KILN . ELECTRIC OVEN . WESTMINSTER TUBULAR DOOR CHIMES . CYCLE TRAILER . PEDAL-CYCLE SIDECAR . PORTABLE AIR COMPRESSOR . WATER SOFTENER . SPANISH HAWAIIAN GUITAR . STEEL-STRINGED UKELELE . DOUBLE-SEATER CANOE . RADIO DEAF-AID UNIT . GARDEN POOL VERTICAL ENLARGER . PHOTO-ELECTRIC EXPOSURE METER . SYNCHRONISED FLASHGUN . COMBINED PRINTING BOX AND SAFELIGHT . DIASCOPES AND EPISCOPES . STEAM-DRIVEN MOTOR BOAT . ELECTRIC WALL BRACKET INEXPENSIVE HOUSE TELEPHONES . ELECTRIC GAS-LIGHTER . ADJUSTABLE DRAWING-TABLE . TOBOGGAN.* 12s. 6d. net (13s. 6d. by post).

THE 2nd "PRACTICAL MECHANICS" HOW-TO-MAKE-IT BOOK

Edited by F. J. CAMM

THE great success of the first "Practical Mechanics 'How-To-Make-It' Book," which has run through several editions, has encouraged the publishers to produce this second volume, describing the construction of a wide variety of articles which will appeal to the home mechanic and model maker. Like the first volume, this has been compiled from the most popular features appearing in "Practical Mechanics," the established monthly journal for practical amateurs.



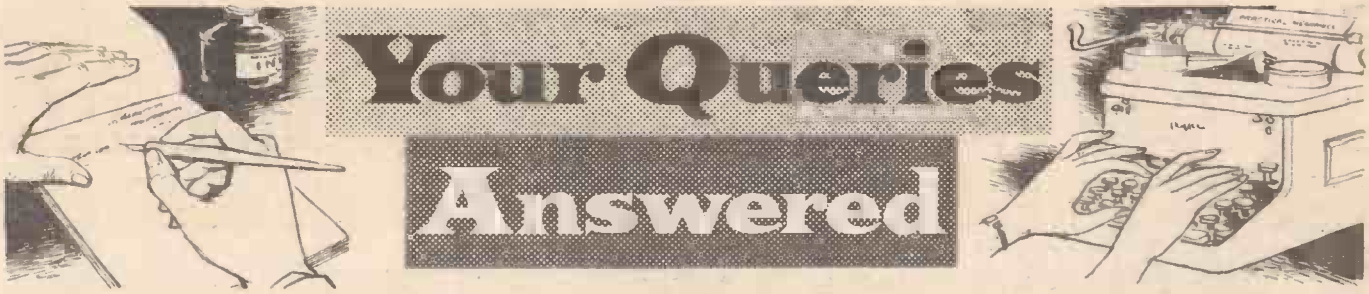
Details for making 35 valuable articles throughout 192 pages. 306 illustrations.

CONTENTS : *A REFLECTING ENLARGER . ONE-STRING FIDDLES . FOLDING STEPS AND AN EXTENDING LADDER . AN ELECTRIC GUITARETTE . A MINIATURE BILLIARD-TABLE . A SYNCHRONOUS ELECTRIC CLOCK . A GLOVE PUPPET THEATRE AN AUTOMATIC GARDEN SPRINKLER . A MIDGET CAMERA . A POTTER'S WHEEL A CATAMARAN . A ROWING MACHINE . AN AQUALUNG . HOME-MADE FISHING TACKLE . INSTALLING A TROPICAL AQUARIUM . A SNOW SCOOTER . UNDER-WATER PHOTOGRAPHY . A PAIR OF SKIS . PROJECTING TIME ON THE CEILING . A HARPOON GUN . SMALL WIND-POWER PLANTS . AN ELECTRIC HEDGE TRIMMER . BATHROOM SCALES . A FOLDING OUTBOARD MOTOR-BOAT . FLASH PHOTOGRAPHY . GAS FIRED POTTERY KILNS . A BACK-PROJECTION EPISCOPE . MOTORISING YOUR LAWN MOWER . A SKELETON SYNCHRO-ELECTRIC CLOCK . A VIEWER AND PRINTER FOR 35 MM. FILM . A CYCLE TRAILER . AN ELECTRIC IMITATION COAL FIRE . A MECHANICAL POTATO PEELER . A HOME-MADE DUPLICATOR . MAKING RUBBER STAMPS.* 15s. net (16s. by post).

These are the most practical constructors' books yet . . . the articles are not toys but things of real use and value!

FROM ALL BOOKSELLERS *. . . or in case of difficulty at the post prices shown from GEORGE NEWNES LTD., Tower House, Southampton Street, London, W.C.2.*

NEWNES



Connecting Flashing Indicators

I AM going to fix on my motor cycle a flashing direction indicator set. I have on the machine an A.C. generator with rectifier for D.C. battery (Varley) 6 volts 9 amps. (A). What is the best way of tapping the existing circuit so that I am able to keep the accumulator charged up during my trips which are not of long duration?—C. W. Pool (Birmingham, 11).

THE indicator circuit could be connected direct to the terminals of the battery, or to any two terminals in the circuit which are connected directly to the battery.

If you find that the machine is not used sufficiently to keep the battery charged we suggest that you obtain or make a battery charger with D.C. output, which can be fed from your home supply and connected directly to the battery terminals. Alternatively if your home supply is A.C. you could use a step-down transformer to supply the A.C. side of the rectifier on the machine, fitting a switch to disconnect the A.C. side of the vehicle wiring while the external charger is being used.

Camera Repair at Home

I HAVE a 35mm. Exakta camera (pre-war) fitted with a 2.8 Tessar lens. The front of the lens needs repolishing. Could I do the job myself? Could you recommend a cheap book on the focal plane shutter of this camera? The slow speeds seem all right but 1/250, 1/500 and 1/1,000 sec. are out of order, only exposing part of the negative. Could I repair this myself?—P. A. Carroll (Ireland).

ATTEMPTS to repolish the lens to remove scratches are unwise because changes in curvature will spoil definition. Small scratches will not reduce definition, and their area, compared with that of the lens surface, is normally so small that the loss of contrast they cause is of no importance at all.

Servicing information is usually available to repairers, etc., only. Incorrect operation of a focal plane shutter at high speeds may arise from dried lubricant on the blind wind mechanism, dirt, etc., a weakened spring, wear or incorrect setting of the speed adjusting trip mechanism, or from a blind losing its flexibility. Whether or not you could correct this defect depends on your own skill and care, and the actual cause.

Cutting Toughened Glass

I WISH to cut some car windows from toughened glass. Can you tell me the correct method?—L. Conway (Lincs).

THIS operation is difficult unless you are skilled. It should be carried out in a room of moderate temperature (not cold) and the orthodox diamond used. Having made your cut tap along the cut very cautiously and avoid uneven strain by failing to support the waste piece evenly.

Additional Circuit

I LIVE in a four-roomed house with the ordinary lighting points, i.e., two downstairs, two bedrooms, with a two-way light for stairway all run from the fuse box situated in the living-room.

I wish to run an extra light under the stairs and put a power plug in the kitchen. There are no power plugs at all anywhere in the house.

Can I do this job from the present lighting circuit without running any leads from the front room fuse box?

The two-way switch for the stairway is situated at the doorway leading from the front room to the kitchen.—C. Dillon (Blackpool).

IT will be necessary to run a separate circuit for the power socket-outlet, this being fed through a double-pole switch with fuse in the live pole (assuming the supply is A.C. with its neutral point permanently and efficiently earthed). The supply authority should be asked to inspect the new circuit and to connect it to the supply.

An additional lighting circuit may be fed from a live (L) and a neutral (N) point on the existing lighting circuit, through 3/0.029 cables. The lamp switch must be connected in the live pole. The L and N points will be available at the fuse box. If the existing ceiling rose in any room has three terminals it is also likely that the L and N points will be available at the ceiling rose; otherwise the N point will be available at the ceiling rose and the L point at the lamp switch.

In order to locate the L and N points you may proceed as follows: Connect two leads to a lampholder, in which is placed a mains-voltage lamp to act as a test lamp. Remove the lamp connected to the ceiling rose, together with the ceiling-rose cover and the cover of the lamp switch, which should be switched off. Connect one lead of the test lamp to a sound earthing point, such as a main cold water pipe. Place the other lead in turn on each terminal of the ceiling rose. If the lamp lights on one terminal that is an L point. If the test lamp fails to light repeat the test at the lamp switch to find the L terminal there. Having found the L terminal hold one test lamp lead in contact with the L terminal and place the other lead in turn on the contacts of the ceiling rose. The test lamp will then light when connected between L and N points to which the new lighting circuit may be connected.

RULES

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

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

Polychromatic Cellulose Lacquer

I WISH to spray my bicycle with a polychromatic cellulose. I am told that clear cellulose mixed with tinted aluminium dust dries with a very good finish. Could you please give me some advice on spraying and what amount of aluminium is required for mixing with ½ pt. cellulose.

Can you suggest a source of supply for these materials?—John Dewar (Harrogate).

IN order to obtain a polychromatic cellulose lacquer mix together about equal parts (by measure) of clear cellulose lacquer and tinted aluminium powder. The resulting mixture is then sprayed on the metalwork, care being taken that the spraying mixture is not too thick. You can obtain cellulose lacquers from any firm of paint and varnish dealers. Usually, aluminium dust can be obtained from the same source.

Waterproofing Fishing Lines

PLEASE could you kindly give me a formula using benzene and copper naphthenate for sea-proofing hemp lines ?—H. D. Griffiths (Llanelly).

A SOLUTION of 10 parts of copper naphthenate in 90 parts of white spirit, paraffin or benzene makes quite a good waterproofing preparation for sea and river fishing lines. The copper naphthenate is soaked cold in the required amount of solvent overnight, after which the solvent is heated and the naphthenate is stirred until its solution takes place. The lines are then soaked for about 12 hours in the solution. They are afterwards hung up to dry in a current of air. Such lines will be quite waterproof, but, unfortunately, the naphthenate may render them toxic to fish, vegetable or other forms of marine life.

It may be possible for you to use the naphthenate solution at one half of the above strength, that is to say five parts of the naphthenate in 95 parts of the solvent, but, usually, a 10 per cent. solution, such as the above-mentioned one, is of all-round efficiency and application.

6V Car Radio on a 12V Battery

I NOW have a new car with a 12V battery and want to operate my 6V radio. I am told there are several methods. What do you suggest ?—W. L. Edwards (Sheffield, 2).

IN our opinion, the best method would be to use half the battery (i.e., make a tapping at 6 volts). Although this arrangement would provoke uneven charging of the battery, we feel that a balance would quickly be restored during the periods when the radio is not in use.

Dropper resistors are employed for this purpose, of course, but the actual value of the resistor is governed by the average current taken by the receiver when working at full 6 volts. You should have this measured on an accurate meter and compute the resistance value in ohms by dividing the voltage to be dropped by the resistor (i.e., 6 volts) by the current reading in amps. Heavy resistance wire will need to be used to produce the dropper; an electric fire element provides a good basis for the component, which should be mounted with due regard to ventilation.

Crackle and Matt Black Paints

I HAVE constructed a projector for 35mm. colour slides and I wish to complete it by painting the inside matt black and the outside casing black crackle.

1. Please supply a formula of a good quality matt black paint, which is heat resisting and suitable for brass sheet and aluminium alloy sheet.

2. Can you furnish the name of a supplier or manufacturer of a good-quality black crackle or shrivel paint.

3. Please suggest treatment for the bright metal surface to achieve maximum adhesion of the paint.—Eric Ryding (Preston).

FOR painting the inside of the projector we know of nothing better than Vegetable Black, which is a very fine, soft and light vegetable carbon, made into a paint with a mixture of Japan gold size, one part, and pure turpentine, three parts. As an alternative brown shellac in methylated spirit, with the same vegetable black powder added, may be used. Line the inside of the lamp housing with asbestos cardboard and treat this with either one or the other of the blacks or with water colour "poster" black or even Indian ink.

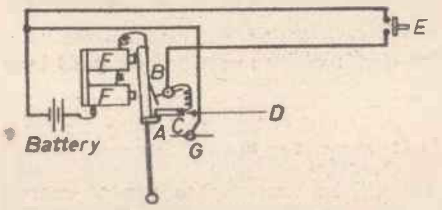
There are numerous crackle finishes available; one is available at most paint stores under the trade name "Krackle," and another made by Pinchin Johnson and Co., 4, Carlton Gardens, London, S.W.1.

Marking the surfaces with emery cloth, fairly coarse, rubbed on in all directions, provides quite a good key for paint.

Continuous Ringing Bell

I WISH to either make or buy a continuous ringing bell similar to one produced several years ago and now discontinued. The bell was battery operated and continued ringing when the first contact had been broken. Would you also advise me regarding the best battery to use. I am using a $7\frac{1}{2}$V battery which, at the moment, allows 3 amps. to flow when connected directly to the bell and only 1 amp. when used in circuit in which I wish to use it. This does not give a very good ring. What larger battery can I use in safety without burning out the bell ? I assume that most battery operated bells work on $4\frac{1}{2}$V. I used $7\frac{1}{2}$V to overcome the resistance in my circuit. The resistance is essential and will not vary. —E. Smith (Southampton).

IN view of the remarks in your letter it would appear that the resistance of the wiring is at least three times that of the bell, which accounts for the comparatively low bell current. Better operation would be obtained by replacing the bell wiring by new wiring having a cross-sectional area about three times that of the present wire. Alternatively, you could use a battery of about 20 volts, although this method is rather uneconomical.



Modification for standard bell.

You might be able to obtain a continuous-ringing bell from one of the following firms:

Gent & Co. Ltd., Faraday Works, Leicester.

Phoenix Telephone & Electrical Works, 38, Newman Street, London, W.1.

Ever-Ready Co. (G.B.) Ltd., Hercules Place, Holloway, London, N.7.

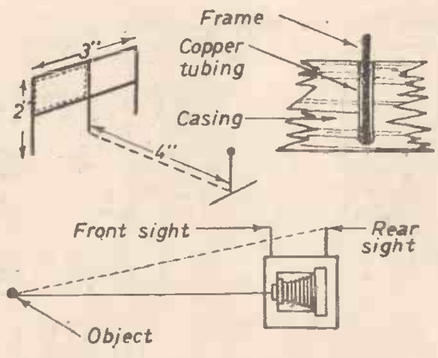
Cox-Walkers Ltd., North-Eastern Electrical Works, Darlington.

It is also possible that you could modify a standard type of bell by fitting a small lip A at the bottom of the armature B as in the sketch. A weighted contact C is pivoted at D so that, when the push-button switch E is pressed and the armature B is attracted by the coils F the contact C swings down to make contact with a fixed contact G. The contact C could be reset by means of a lever, cord or similar device.

Underwater Camera

I HAVE boxed and waterproofed my camera for underwater photography and I am fitting a film winding knob and focusing mount. I am, however, puzzled about the eye level viewfinder which, after several attempts is still not accurate. I would welcome any information.—Peter Hayes (Manchester).

THE eye-level viewfinder you have constructed is inaccurate, but you do not give a precise account of the exact trouble. To start with here are details of a simple wire frame viewfinder which is constructed out of thick copper wire. The dimensions of front frame depends on the size of the negative format. If it is $1\frac{1}{2}$in. × 1in. the size of the front would be 3in. × 2in. The distance between the plane of this frame and the rear sight depends on the focal length of the camera lens and is in the same proportion as the front frame, i.e., since the focal length of my lens is 2in. the separation is 4in. This finder will give an approximate size of the field of view, although it must be remembered that every frame finder will give a field that includes slightly more than is actually photographed at close distances whilst at a distance slightly more is included on the photograph than is indicated by the finder.



Details for waterproofing a camera.

If this "field of view" is the trouble then the proportion given before should eliminate the trouble. The other inaccuracy is one of parallax since the viewfinder is mounted a considerable distance higher than the lens. The only way of compensating for this is to set up the camera at the distance it will most likely be used away from an object, so that the camera is pointed in a horizontal line at it. The "eyepiece" of the finder is then raised or lowered until the centre of the frame is coincident with the object. The wires can be attached to the camera casing in many ways but perhaps one of the most convenient is to drill holes in the wood of such a size that a small piece of copper tubing can be firmly cemented in place. The inside diameter of the tubing must be of such a size that the ends of the wire are a good firm fit, if too small then the ends can be pinched with a pair of pliers. If this is done then the finder can be dismantled for easy storage. A cross-sectional enlarged diagram of this is shown here.

Mirror and Glass Queries

I WISH to cut letters and designs on the back of silvered glass, i.e., old mirrors, how do I remove the silver, without scratching the glass, or rotting the edge of the remaining silver?

What adhesive will stick two pieces of glass together, such as finger pulls on sliding doors?—H. Dilloway (Portsmouth).

THIS is a very difficult art and involves nitric acid which is an unpleasant substance to use. The principle involved is to cut stencils from thin strips of lead and to seal the possible interspaces between the lead and the glass with beeswax. The mirrored silver surface is then removed with nitric acid, all traces of which must be removed before taking away the lead stencils.

A strong medium for sticking glass is Canada balsam. This is best applied by holding a fairly hot flat iron on either side of the pieces of glass (blotting paper between) and then squeezing out all air bubbles from the pre-heated Canada balsam after it has been applied to the inner surfaces.

East Budleigh, Devon.

THE CYCLIST

All letters should be addressed to the Editor, "THE CYCLIST," George Newnes, Ltd., Tower House, Southampton Street, Strand, London, W.C.2

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Vol. XXVIII No. 449

COMMENTS OF THE MONTH

Planning Club Runs

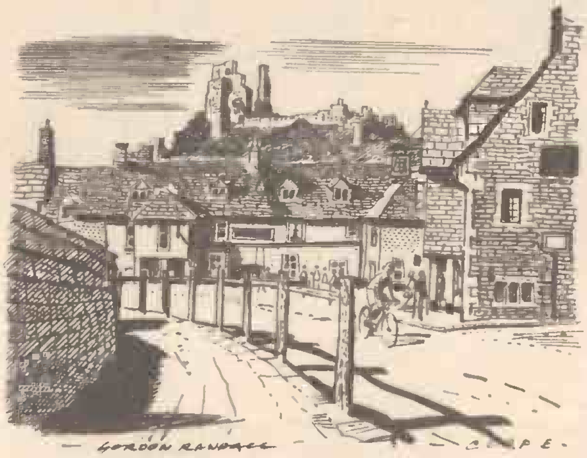
WHERE shall we go this Sunday? This is the vexed question which the Club Runs Captain must ask himself every week. The question is a vexed one, not because there is a shortage of places to visit, but because it is almost impossible to please every member, even if two or three runs are scheduled. Many factors complicate the selection. There may be one or two groups away on local courses on which they have been timetrialling early in the morning. All the riders will not be up to the same standard and will wish to travel different distances and at different speeds and, to make things more difficult, it is preferable to have all the club meeting some time during the day. Finally a café or restaurant must be selected which can provide the club with lunch and tea.

Too often the result is either one section of the club having to ride long distances at high speed in order to rendezvous with the others or else one group having to wait and kill time until joined by the remainder.

It is not good enough, as some clubs do, to make out a list of Sunday runs months in advance and then adhere religiously to it regardless of weather conditions and other circumstances. For instance a 100-mile run to the coast may have been decided several weeks earlier and then when the weekend arrives, it is found that several members have entered a road race in another area. A large section of the club want to go and see the race and in addition, the weather is unsuitable for a day by the sea. Obviously the majority of members will follow their own inclination and watch the race and, however disappointing this may be to the club runs organiser, he cannot insist on members attending the official club run. It is discipline of this sort which drives an independent cyclist away from the club and turns him into a lone rider.

On the other hand, if runs are not decided until the club meeting immediately prior to the weekend, members unable to be at the club meeting will not know where the Sunday run is to be. A member who turns up at the meeting place on Sunday morning to find that the scheduled run has been changed and that everyone has left earlier for another destination is likely to be considerably annoyed and perhaps leave the club because it is badly organised.

Altogether the club runs organiser's job is not an enviable one. What, then, can he do to overcome some of these difficulties? They cannot all be overcome and the first step is to make sure that club members realise this. Point out to them, via the club magazine or notice board, that club runs are arranged to fit in with as many groups as possible but that it is not always possible to accommodate everyone. Next ask the Racing Secretary to pass on the movements of the various teams who are out at events to the Runs Captain. This will ensure that he doesn't choose the wrong route through lack of knowledge of members' movements. Perhaps the most important thing is to make sure that the weekend's runs are posted where everyone can read them; outside a local cycle dealer's shop or outside the clubroom for instance. Sometimes a tobacconist will allow the use of his "Sales and Wants" advertisement board. It is useful too if someone who has knowledge of the runs can be contacted by telephone.



Famous Corfe. The picturesque village sleeping beneath its ruined castle.

With regard to the actual planning of the run itself, it is difficult to make any general observations as every case is different. But if the clubman's habit of taking the most direct route is broken, a big step has been taken towards overcoming the route difficulties. A devious route among the minor roads and lanes will provide a run free from petrol fumes and motor traffic, on which there is a much better chance of appreciating the beauties of the countryside and the picturesque architecture of villages, away from the commercialisation and ribbon development of the main road. The main advantage so far as the Runs Captain is concerned is that, using minor roads, he can find two routes to a given spot, which are different in length and difficulty, far more easily than if the object of the run was merely a straight dash along a main road.

The position of Runs Captain is one of the most responsible and exacting in the club organisation. Not only must he have an exact knowledge of the surrounding countryside and what can be seen there, but he must also be prepared to sacrifice his own preferences to suit the pace, cababilities and interests of the majority. Also, although discipline is a word which can only be very distantly associated with the pastime of cycling, the Runs Captain should have a certain amount of authority. Enough merely to ensure that the pace is suitable for everyone and that members are prevented from annoying other road users.

Fortunate indeed is the club which has a Runs Captain with all these qualifications and it would be well if members remembered some of his difficulties before they criticised his planning because it does not coincide with their own arrangements.

B.A.R. Audience. Can It Be Controlled?

As we have now come to expect the B.A.R. Concert this year presented a very high standard of entertainment and the prize-giving was well arranged and spectacular. The only note of discord was—as usual—struck by the audience, or part of it.

Noise was continual and missiles were thrown on to the stage.

This sort of thing is so easy to start and impossible to halt. An appeal is useless. Stopping the concert savours of cutting off one's nose to spite one's face. One solution might be to double the price of tickets and point out that the price is necessary to bribe the artistes to put up with the behaviour of the audience.

Everyone will agree that the audience's reaction must be controlled sufficiently to give the artistes a chance, but it would be a pity to curb it altogether. It is so seldom that one hears a really uninhibited audience to-day, as were those who used to attend the old-time music hall. The artistes, too might regard it as a challenge! If you please such an audience they are not stingy with their appreciation.

RIDING WITH THE CYCLISTS' TOURING CLUB

A Brief Summary of the Activities of this Organisation and What It Offers the Cyclist

THE CYCLISTS' TOURING CLUB is well known and its badge, shown in the heading, may be seen on appointed hotels, resthouses and cafés throughout the British Isles. For its members the C.T.C. issues rail, sea and air tickets, makes seat reservations, obtains foreign currency, passports, etc., and arranges organised tours in all the popular European countries.

The C.T.C. is, in fact, a travel organisation specialising in the needs of cycle tourists. But it is more than that. In addition, it does much to promote, assist, and protect the use of cycles on the roads—and has been doing so ever since 1878, long before the first motor-car appeared, and when machines like the Boneshaker and the Penny-Farthing were "modern."

The C.T.C. sees that the cyclists' point of view is heard in Parliament and among local authorities. It is represented on the Minister of Transport's Committee on Road Safety, and on committees of the Royal Society for the Prevention of Accidents. It is a founder-member of the Alliance Internationale de Tourisme.

Safe Cycling

One of the most recent actions of the C.T.C. was to publish a leaflet, based on official government statistics, which shows that, contrary to the impression which many people have, the bicycle is actually the safest vehicle on the road. Cyclists have by far the best record so far as freedom from accident is concerned, and it is actually more dangerous to travel as a motor-vehicle passenger than on a bicycle.

The Cyclists' Touring Club has also issued literature calling attention to bad road surfaces, particularly at road edges, and to the use of studs and steel plates which, by causing skidding in wet weather, are a great danger to cyclists.

C.T.C. members are insured free against third-party risks up to £10,000 anywhere in the world, and can obtain additional personal, cycle and luggage insurances if desired. Free legal aid is given to any member who is hurt or whose cycle is damaged in a road accident.

Club Activities

Within the framework of the C.T.C. are over 50 District Associations, which provide members with the amenities of a local club but without payment of any extra subscription. Every C.T.C. member is automatically a member of the D.A. in whose area he resides, and may take part in all its activities.

The D.A.s further localise their activities by forming sections (there are over 300 of them), and cater for all members who appreciate the companionship of like-minded cyclists in their particular district. There are sections for easy riders, hard riders, campers, youth hostellers, photographers, juniors, veterans, etc.

In addition to week-end outings and holiday tours, the C.T.C. District Associations organise large-scale tourist trials, junior cycle trials, rallies and sports days, cycle-rail excursions, map-reading competitions and other outdoor contests. During winter months there are attractive social programmes, dances, travel talks, film shows, etc.

For Youth

Many schools, youth clubs, etc., have cycling groups, and the C.T.C. works in collaboration with the Central Council of Physical Recreation and other organisations.

The Cyclists' Touring Club took a leading part in the development of the cycling proficiency scheme which has been run for some years by the Royal Society for the Prevention of Accidents.

Competitions and Rallies

In addition to local activities mentioned earlier, the C.T.C. sponsors several important cycling events on a national scale. Foremost of these is the British Cycle Tourist Competition.

Claimed to be the greatest all-cycling rally held anywhere in the world, the National rally of the Cyclists' Touring Club takes place at York every August, and annually attracts a crowd of about 20,000.

Membership Subscriptions

Membership of the Cyclists' Touring Club costs 25s. a year for adults, and 15s. for persons under age 18. Children under 15, if they have passed an approved cycling proficiency test, can join for 5s. The address of the C.T.C. is 3, Craven Hill, London, W.2.

(Above) One of the cycle-rail excursions organised regularly by the C.T.C. (Above right) Kent C.T.C. members consulting a map. (Right) Members touring the Austrian Alps.

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