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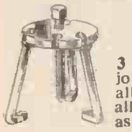

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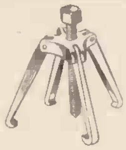

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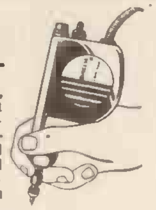

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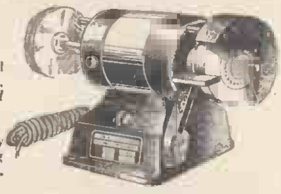

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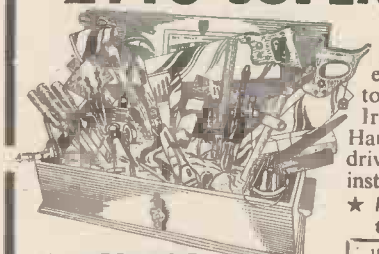

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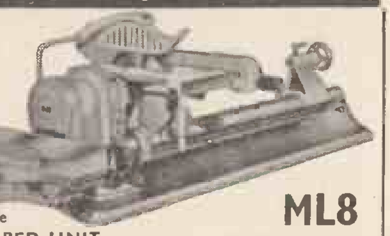

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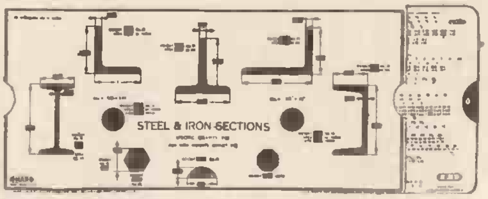

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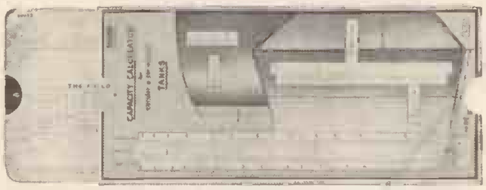

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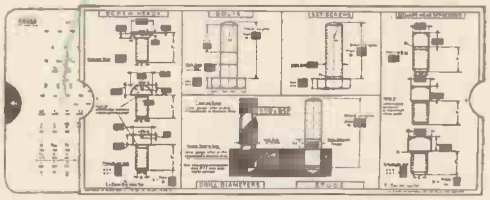

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Practical Mechanics

JULY, 1960

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CONTENTS:

CONTRIBUTIONS

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

FAIR COMMENT

SECOND CHANCE FOR STEAM

A FEW months ago, when details of the revolutionary fuel cell first became known, this device was tipped as the power unit for the motor car of the future, which would be gearless and silent. Now comes news of another gearless and silent motor car. This is not merely the prediction of a scientist describing what he thinks might be formulated at some date in the nebulous future; this car already exists. At the moment it is a prototype sports car with a fibreglass body which is capable of over 120 m.p.h. and *is powered by steam.*

Steam cars of the past such as the White and the Doble have long been described as the ultimate in private car travel. The sensation of unlimited power available and the uncanny engine silence produced, according to steam enthusiasts, smooth, fast and comfortable travelling, which even today has never been matched by the I.C. engine. The experts have always admitted that the steam engine has a number of most desirable features. The chief among these are silence, infinitely variable speed, without the necessity for gear changing, low operating costs and tremendous power. It is true that many of today's cars have automatic gear-boxes, but this is achieved by the addition of extra machinery to the car, whilst the steam car achieves the same result by eliminating both gear-box and clutch. The only controls in the car in question are a foot throttle pedal, a hand lever and a starting switch.

Since the days of the early steam car, tremendous strides have been made not only in the design of the actual steam units but also in the fields of metallurgy and lubrication. Those enthusiasts who have always advocated steam as the ideal source of power have maintained repeatedly over the years that, given the proper amount of research, a modern lightweight steam engine which would compare in every respect with the I.C. engine could be evolved. If the facts contained in the report of the performance of the new steam car in America are true, the ideal modern steam car unit would seem to have arrived.

Now for facts and figures. The car is powered by what is known as the Williams steam power plant, which has resulted from over 40 years of research and development. The actual Williams Steam Cycle, which is covered by patents, obtains high thermal efficiency using simple expansion without recourse to re-heating or re-cycling or incorporating a vacuum exhaust. The engine is a vertical 4-cylinder in-line design with 3in. bores and 2in. stroke, single acting, uniflow expansion. The engine is mounted in the normal engine position in the front of the car and drives the rear axle via a tubular shaft. The 12V alternator, 3-cylinder feedwater pump, lubricating pump and condenser fan are all driven from the front of the engine. The 19in. × 24in. monotube steam generator is mounted horizontally at the rear. A pressure atomising fuel oil burner is used and working pressure steam is available between 20 and 30 seconds after switching on. Steam is fed to the engine at 1,000 p.s.i. and at 1,000 deg. F. and both steam pressure and temperature are automatically controlled.

One of the greatest disadvantages of the old-time steam car was that its consumption of fuel oil was very heavy—it would only do about 14 m.p.g. This has apparently been rectified in the latest design, where figures of 30-40 m.p.g. of fuel oil have been quoted. The car will travel some 400 miles on less than 7 gallons of water.

The high performance of this car has been achieved by the research and experiment of a small concern. What might the results be if the design of a lightweight modern steam-power unit for the private car were seriously considered by the world's motor car industry? It would be ironic if the power source abandoned—so far as road locomotion was concerned—at the beginning of the century should return as the motor car engine of the future. In any case, it would appear that steam may be presented with a second chance.

THIS article describes a reasonably cheap and satisfactory way of converting a hand lawn-mower to petrol drive.

In common with quite a number of the motor lawn-mowers on the market today, the conversion described is not for a self-propelled mower; only the cutting cylinder is driven and for most users this is sufficient.

It is interesting to observe that the majority of motor lawn-mower manufacturers today are incorporating the four-stroke engine instead of the two-stroke; the engine used is of the former design, and performs the work admirably.

The Unit

The unit required is now available in good supply, and can be obtained from ex-W.D. depots, new or second-hand, at prices ranging approximately between £3 to £8; it is known as the 80-watt Lightweight Charging Set, Cat. No. ZB.11761.

If a new engine is purchased, this is supplied crated for tropical conditions, and is complete with a set of spares sufficient to outlast the lawn-mower; a set of maintenance tools and an instruction manual are also included.

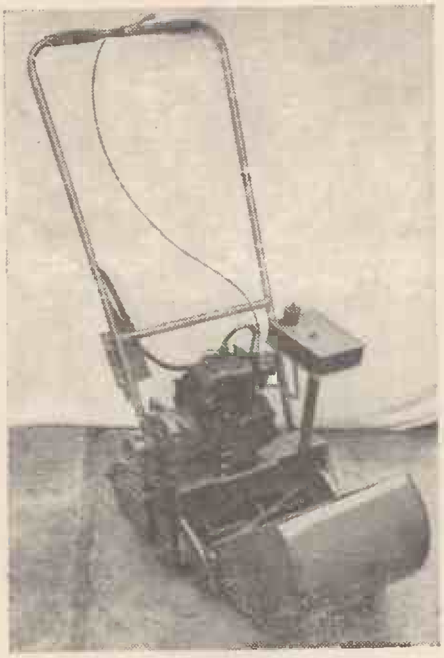
Brief details of the engine are given below:

Bore	1⅜in.	Magneto Ignition.
Stroke	1½in.	Fan Cooled.
Cubic Capacity	35 c.c.	Splash Sump Lubrication.
Approx. r.p.m.	3,000.	

A Petrol Motor Lawn Mower

Using an ex-Government unit

By J. M. Holmes



Lawn-mower with all modifications completed.

Engine

Remove the engine from its cradle. Take off the rectifier and the associated electrical parts, petrol tank and carburetter. (Note the existing carburetter is of the suction type without throttle control, and is therefore not suitable.) Remove the starting pulley. The pulley end bearing casing can now be unbolted and drawn off complete with bearing, revealing the alternator field windings, etc. These should also be removed. Replace end bearing casing and fit a driving and starting pulley as shown in Fig. 2. A suitable carburetter, Type 379, complete with air filter, cable and bar-mounted throttle control, can be obtained from Messrs. Amal Ltd., Holdford Road, Birmingham 6. Jet 22 and 8mm. bore should be specified when ordering.

This carburetter has a clamp-type fitting and is easily fitted to the engine by means of two 2BA cheesehead screws and adaptor (Fig. 1).

The magneto end of the engine should not be disturbed. The engine can now be mounted on the engine mounting plate (Fig. 3) by using five 2BA. × 1¾in. hex. hd. bolts, and support packers (Fig. 4).

Close-up view of the drive assembly.

Petrol Tank

The existing petrol tank which is provided with a tap and screw cap can be used. Fig. 5 shows the necessary modifications.

In the prototype the gauze petrol filter, which is situated within the neck of the petrol tank, had a tendency to rattle. This should be squeezed slightly so that it is oval; it will then be a tight fit in the petrol tank filter neck.

To complete the tank, the existing flexible hose must be removed. A tapered end is left; to this fit approximately 8in. of $\frac{3}{16}$in. bore wire-reinforced transparent plastic hose.

Lawn-Mower Modifications

By removing the chain cover, the chain and cylinder driving sprocket are revealed. These items must be removed. In place of the driving sprocket fit the adaptor detailed in Fig. 6 and a 3in. dia. Picador " V " belt pulley bored ¾in. dia. A hole 1⅛in dia. must be drilled in the chain cover through which the adaptor will project. Fig. 7 shows this assembly.

Next, fit the main engine support plate (Fig. 9) to lawn-mower side plates by means of four ⅜in. Whit. bolts and nuts, by drilling four $\frac{13}{32}$in. dia. holes in both lawn-mower side plates to suit. The petrol tank support bracket (Fig. 8) can now be bolted to the main engine support, and the petrol tank secured by petrol tank fixing bolt (Fig. 10). This is one of the original petrol tank bolts modified.

The Silencer

This must be secured to the lawn-mower frame, and a suggestion of how this can be accomplished is given in Fig. 11. In most cases, it will be found necessary to reduce the length of the flexible exhaust pipe, but before doing this make sure that enough flexibility is available, and that the free movement of the lawn-mower handle is not impeded.

All that now remains to be done is to bolt the engine, with mounting plate, to the main engine support plate, using ⅜in. Whit. hex. hd. bolts and nuts, fit the " V " belt, and the throttle control on to the lawn-mower handle and connect the flexible petrol feed pipe to the carburetter.

The 80-watt lightweight charging set, available from ex-W.D. equipment dealers advertising in these pages.

Hints on Starting

When cold, wind the starting cord on the starting pulley tightly in a clockwise direction, close the choke on the carburetter, open the throttle to about $\frac{3}{16}$in., and give a strong steady pull on the starting cord. Immediately the engine commences to run, open the carburetter choke, and set the control to a suitable speed. It will be found that if the throttle is set to about ¼in. open, this will suit most operating conditions.

For starting when warm, proceed as above, but the carburetter choke must be left open.

The " V " belt should not be too tight, as this will slow the engine when it is being started, thus reducing the size of spark from the magneto ignition system. Driving belt tension can be adjusted by means of the slots provided in the engine mounting plate (Fig. 3).

An attempt was made to incorporate a starting handle in place of the pulley and rope, but sufficient revs could not be obtained with this method and the original rope starting as described was reintroduced.

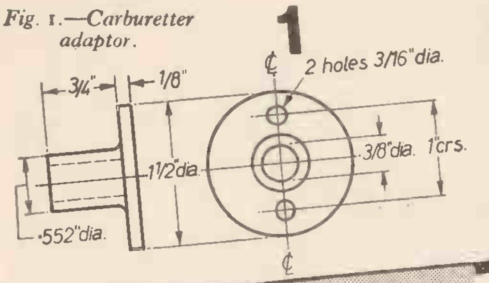


Fig. 1.—Carburetter adaptor.

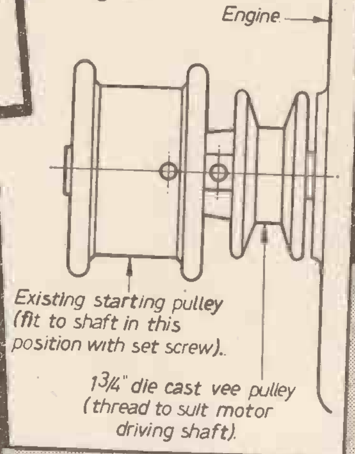


Fig. 2.—Assembly of motor driving end.

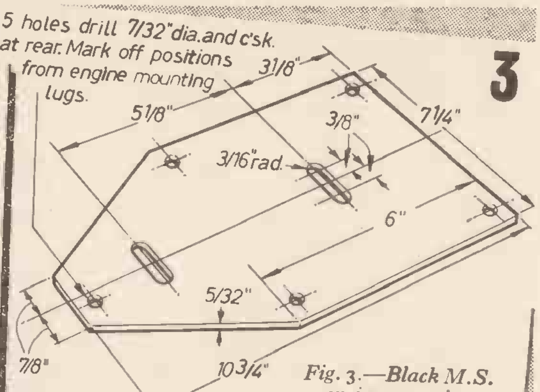


Fig. 3.—Black M.S. engine mounting plate.

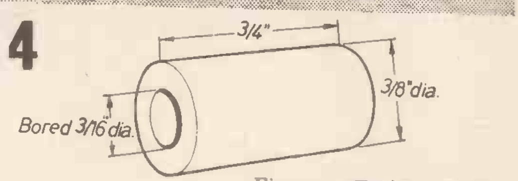


Fig. 4.—Engine support packers (Bt. M.S.)

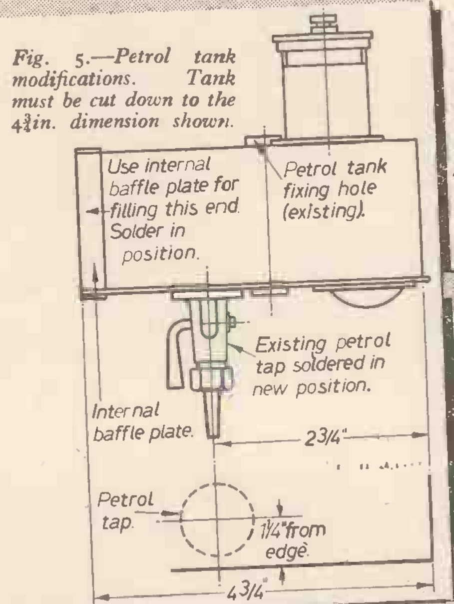


Fig. 5.—Petrol tank modifications. Tank must be cut down to the 4¾in. dimension shown.

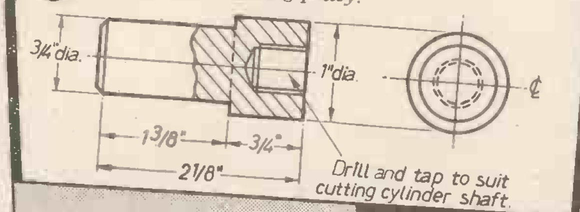


Fig. 6.—M.S. cutting cylinder adaptor for driving pulley.

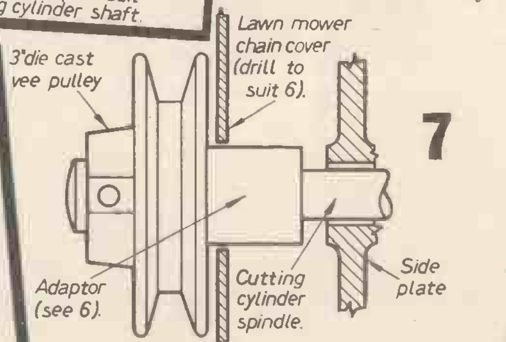


Fig. 7.—Cutting cylinder drive assembly.

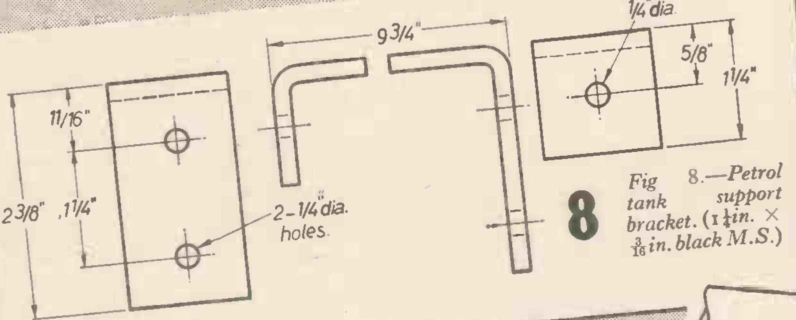


Fig 8.—Petrol tank support bracket. (1¼in. × 3/16in. black M.S.)

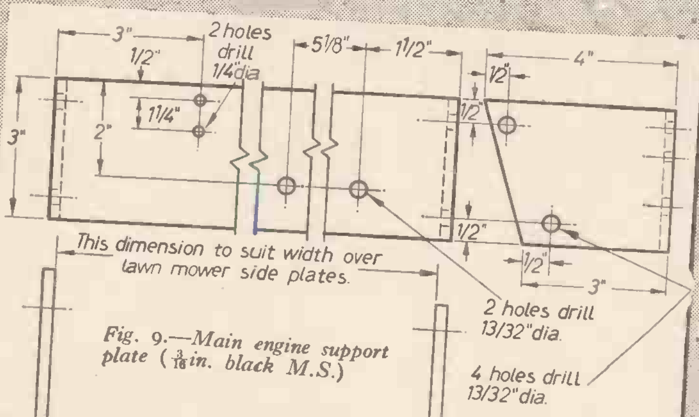
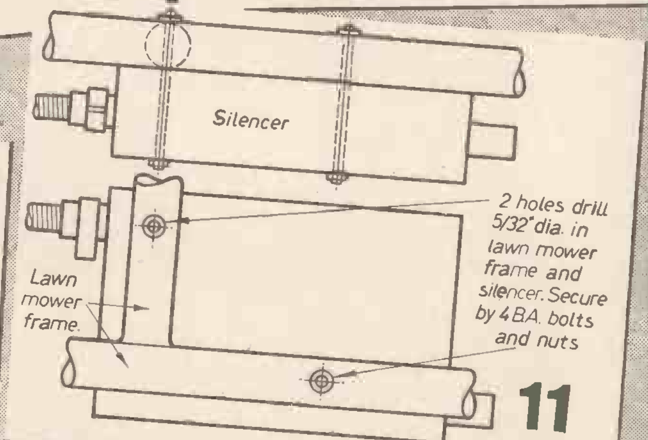


Fig. 9.—Main engine support plate (3/16in. black M.S.)



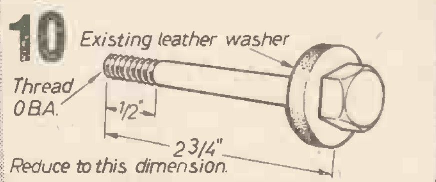
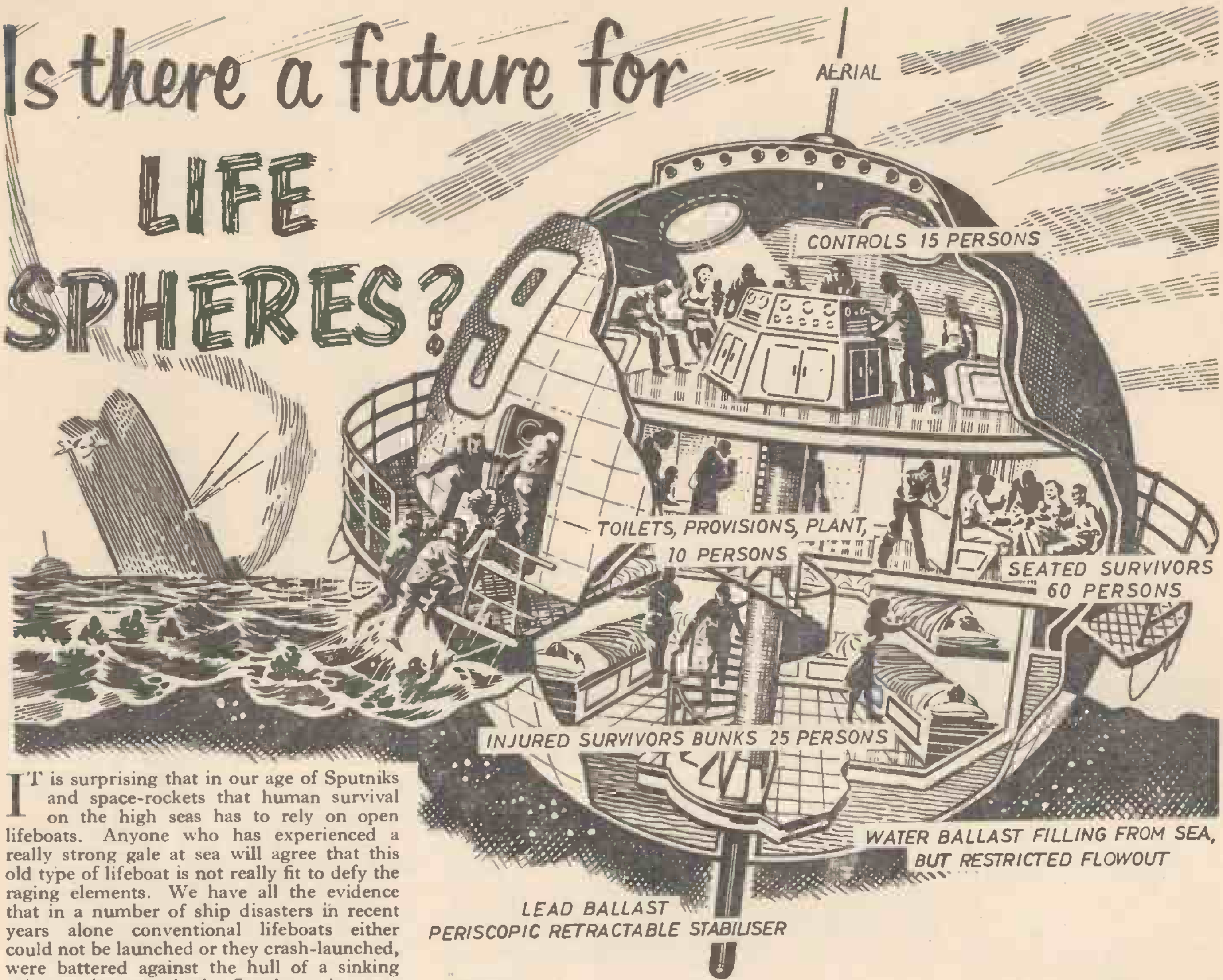


Fig. 10.—Modification to petrol tank fixing bolt.

Fig. 11.—Method of securing silencer to lawn mower frame.

Is there a future for LIFE SPHERES?



Will they make the lifeboat obsolete? **By Karl H. Albers.**

IT is surprising that in our age of Sputniks and space-rockets that human survival on the high seas has to rely on open lifeboats. Anyone who has experienced a really strong gale at sea will agree that this old type of lifeboat is not really fit to defy the raging elements. We have all the evidence that in a number of ship disasters in recent years alone conventional lifeboats either could not be launched or they crash-launched, were battered against the hull of a sinking ship or they capsized. Survivors in open lifeboats have not infrequently been washed overboard or died of starvation.

Is it not time to consider something more advanced?

What about a lifeboat of spherical shape? An idea for such a life sphere is shown in the illustration. There may be much room for improvement, but at least a life sphere would be better than open lifeboats in many respects, and no worse in others.

The Requirements

A modern lifeboat must provide shelter from the elements. It needs a reliable communication system, and some sort of propulsion if only to travel short distances. Conditions in the life sphere would be safe enough for survivors to wait until they were picked up.

The spherical body is best suited to withstand external forces and pressure, it also provides most room for least surface.

A periscopic stabiliser containing lead ballast at the base of the sphere would render the sphere stable enough for launching. A water ballast compartment into which sea-water enters after launching would stabilise the sphere further.

When full, the water ballast compartment could be sealed, or there could be a restricted flow out. It is obvious that the water does not actually add to the weight of the sphere when in the water, but any tilt of the sphere will be counteracted by the water ballast, which, in a sealed compartment will move with the sphere. Sea-water ballast thus employed will mean no added weight while the sphere is carried on the ship.

The Outer Deck

Although it would be preferable that the life sphere should have an unobstructed and smooth exterior surface, something like an outer-deck would be needed to pick up survivors out of the water. The outer-deck should be constructed so that it offers least resistance to water pounding on to it.

The interior design could be as illustrated. There would be a top compartment for radio control (this is essential), a centre deck with seats and a lower deck with bunks for injured survivors. There would also be emergency toilets, drinking water compartments and food stores; perhaps heating, too.

A sphere 26ft. in diameter could accommodate 110 persons under normal conditions and a considerable number more if necessary.

Propulsion

Propulsion of the sphere could be by means of a type of engine which sucks in water and discharges it at a high rate. The discharge could be directed into one or two of four discharge pipes, all situated at right angles to each other, thus controlling the direction the sphere is to travel.

Apart from the outer deck the sphere would be completely enclosed, sealed off by watertight doors or hatches.

DESIGN DATA

Outer diameter of sphere ..	26ft.
Surface area of sphere ..	2,123sq.ft.
Normal capacity, persons ..	110
Dead Load	
2 skins of plastic or similar sheeting at 4lb. per sq.ft...	8,492lb.
Structural webbing at 2ft. centres, aluminium ribs, or similar, at 10lb. per sq.ft.	21,230lb.
Structural material to decks, at 8lb. per sq.ft. ..	8,264lb.
Plant and equipment ..	1,120lb.
Ballast (lead)	5,000lb.
Superimposed Load	
Average weight of 10st. per person	18,500lb.
Provisions for each person 28lb.	3,100lb.
Sea water ballast	77,872lb.
Total weight	143,578lb.
Buoyancy	
Weight of water displaced by sphere at nominal draught of 8ft. 3in., actual distance of lower deck to water surface is 4ft. 3in.	143,600lb.

THE AUTOMATIC HOUSE
PART 5

COMMERCIAL TIME SWITCHES

By E. V. King

They have many applications in the home

TIME switches may be used in the automatic home to perform many operations at preset times, keeping time either with sunrise and sunset (solar system) or with G.M.T.

Among the many possible applications are automatic switching of porch and other outside lights, immersion heaters to provide hot water when required, electric heaters to warm the house before rising or coming home from work or to switch on an electric stove and start the meal cooking. A radio could be switched on together with a tape recorder in the owner's absence to record a programme he does not want to miss. They can be used to switch passage and staircase lights on and off at preset times and shopkeepers can use them to switch off window display lights at, say, midnight.

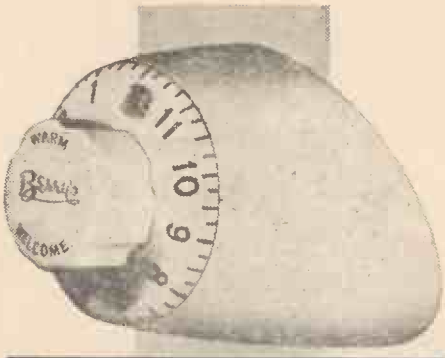


Fig. 33.—" Warm Welcome " time switch

Fig. 34.—" Relyon " MB/TS Switch.

Time switches are of special use to poultry keepers for additional lighting and heating at certain times increases the egg yield. Almost any type of time switch can be used for automatic feeding.

When the house is to be left empty for a period, it is a good idea to wire up a few lamps with a time switch so that would-be burglars believe the house is occupied.

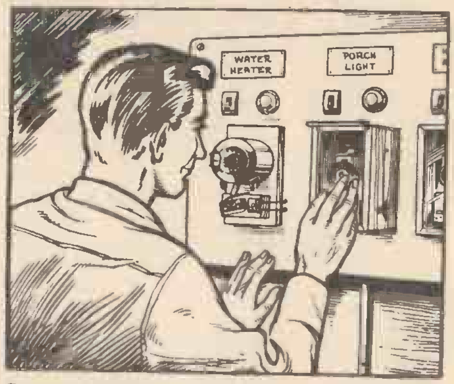
Commercially available time switches will be dealt with first.

The " Warm Welcome " Time Switch

This is shown in Fig. 33. It is very cheap, will switch mains or battery electrical systems and is suitable for use with electric fires and radiators, small cookers, and all forms of lighting. The dial is set to the number of hours delay that is required and after that number of hours the circuit will switch on. It can be reset easily and cancelled if necessary. It is available from most electrical suppliers and showrooms. For safety an earth (green wire) connection is necessary.

Relyon MB/TS Switch

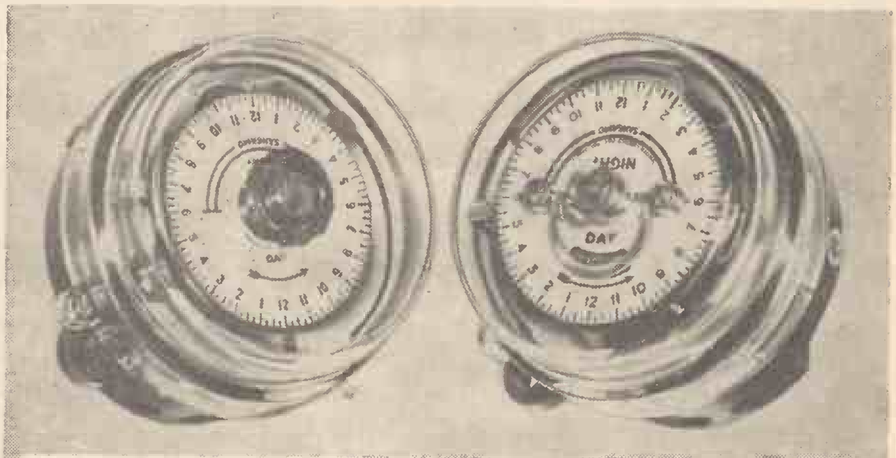
This is a reasonably priced switch very suitable for use in the home for all forms of time control. It is shown in Fig. 34. It needs no winding, and is suitable for A.C. mains only, and will switch up to 20A. Slightly modified versions can be obtained for giving artificial dusk, etc., for increased egg production in chicken houses. Wiring is quite straightforward, the red lead being in the switched circuit. In the case of domestic immersion heaters which may be wired with a time switch the thermostat may be left in position, this is also in the red lead.



Sangamo S251

This is a small neat time switch also ideal for use by the home mechanic and will perform the same functions as the switch described above.

Fig. 35 shows this switch fitted with a day-omitting device especially useful for shopkeepers and Fig. 36 shows the switch fitted with a solar dial. When solar dials are fitted to any switch (often this has to be done at the works) the correct dial for the latitude of the location must be considered. Although the difference in this country is not great,



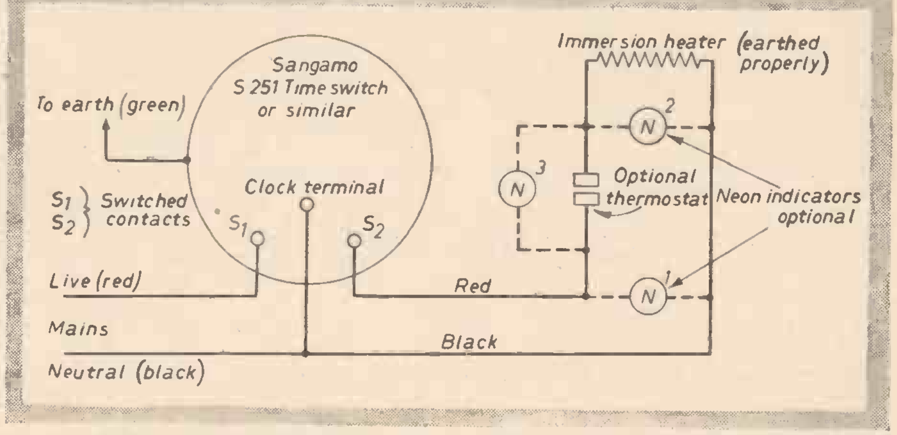


Fig. 35 (top left).—Sangamo S251 time switch.

Fig. 36 (top right).—Sangamo switch fitted with a solar dial.

Fig. 37 (bottom).—Wiring to control an immersion heater.

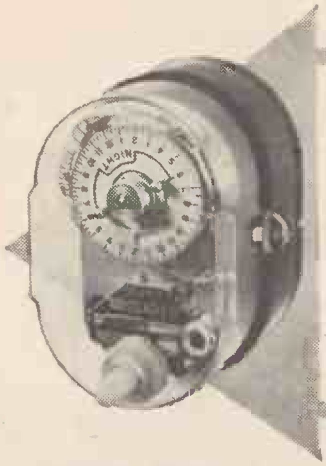


Fig. 38.—*Venner QP switch.*

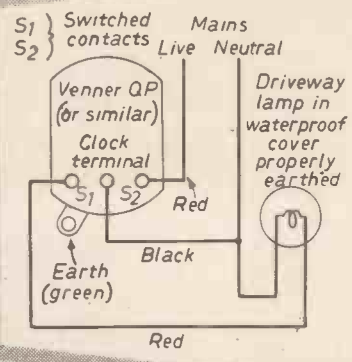


Fig. 39.—*Wiring for a drive-way light.*

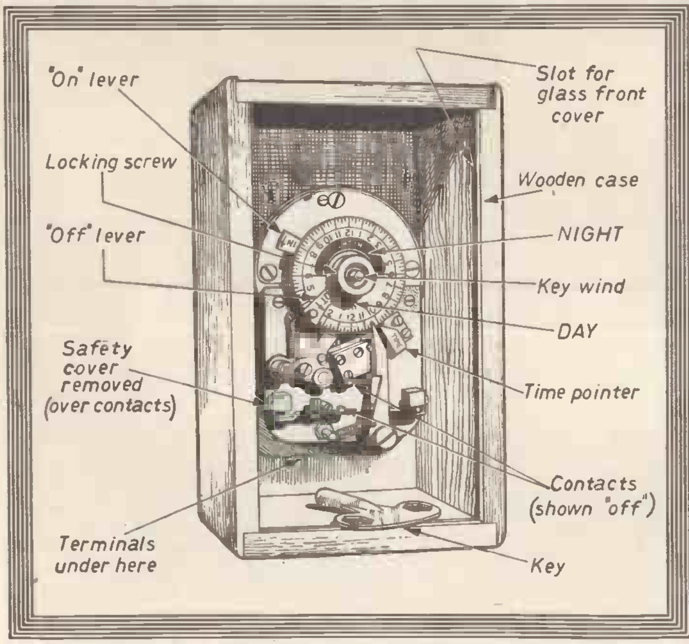


Fig. 40.—*A useful reconditioned time switch.*

surplus American dials are often quite useless. Sangamo dials are zoned approximately as follows:

Zone 1. British Isles south of 51 deg. N. (almost through Dover).
Zone 2. 51 deg. to 53 deg. N. (through Hunstanton).
Zone 3. 53 deg. to 55 deg. N. (through Gretna).
Zone 4. British Isles north of 55 deg. N.

Thus places such as Gretna and Dover have the choice of two suitable dials.

Fig. 37 shows the complete wiring for this switch where it is used to control an electric immersion heater in a hot water tank.

Venner QP Switch

This is a well tried time switch suitable for most uses in the automatic home and easily fitted by the amateur electrician. The usual precautions are taken, especially making sure the red lead is in the switched circuit. A diagram showing how this switch is wired for a drive-way light is shown in Fig. 39.

Fig. 38 shows this switch fitted with a Solar Dial which would be highly suitable for the above circuit.

The Swiss firm of Sauter Automatic Controls manufactures both clockwork and synchronous types for complete mains operation. The S251 unit will switch 25A. on 240V. A.C. and will thus deal with most cookers on full load. The address of the London agents is 70 Dudden Hill Lane, London, N.W.10.

Reconditioned Time Switches

Good, serviceable reconditioned time switches are available very cheaply from surplus dealers in Lisle Street, London, W.1, and Messrs. Donohoe, 2 Upper Norfolk Street, North Shields. One purchased four years ago for £2 10s. is still working. It is shown in Fig. 40 and is still available at the same price. It has a 14-day clockwork movement and can be set for on/off at any part of the 24-hour dial. Fig. 41 shows another time switch recently bought as reconditioned for 37s. Both are rated at 5A.

How to Use the Switches

Fig 42 shows the simple circuits required with various switches. Where single pole switches are used care must be taken to make sure that the phase (red) lead is the one which is cut out or there will be danger of shock when removing lamps, etc., from circuit. The switch should be mounted above the level of young children and contacts should be inaccessible. Where daily resetting is necessary make sure that sufficient light is available to do it properly. If the unit is fitted outside or in a garage, a completely enclosed metal watertight box, properly earthed is required. Outside fitting is not recommended.

Some switches, such as that in Fig. 41 must be mounted perfectly vertical or they will not switch on again automatically. The red pointer must be placed at the top.

Setting the Switches

The switch when fitted must be set to the correct time. This is usually done by rotating the dial (with the numbers on) until the correct time in hours (i.e., 7.30 is 7½ hours) is shown at the red pointer or other pointer marked "TIME." The clock must be wound,

(*Continued on page* 432)

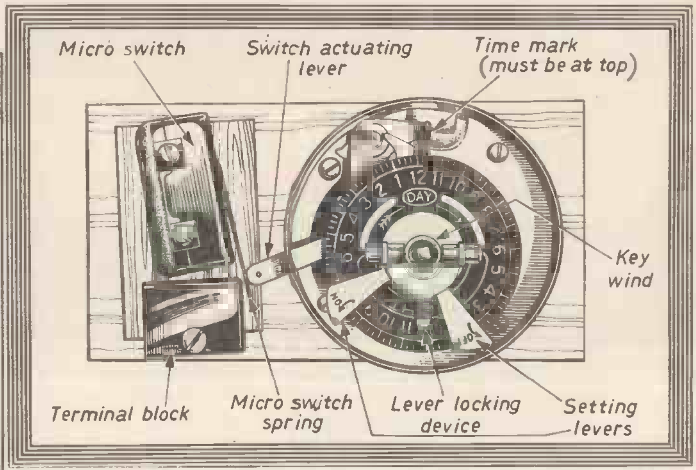


Fig. 41.—*Another reconditioned timeswitch suitable for use in the home.*

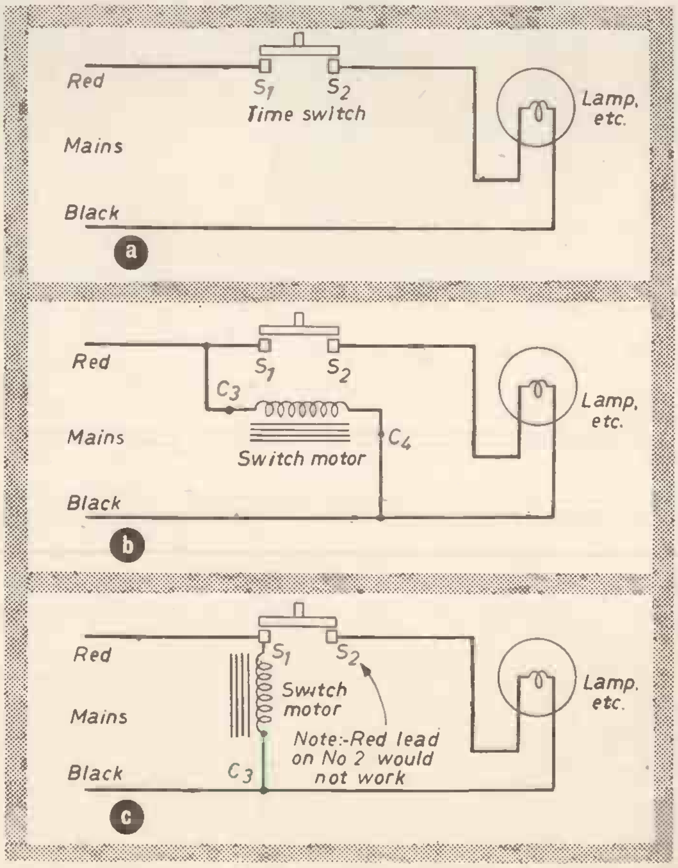
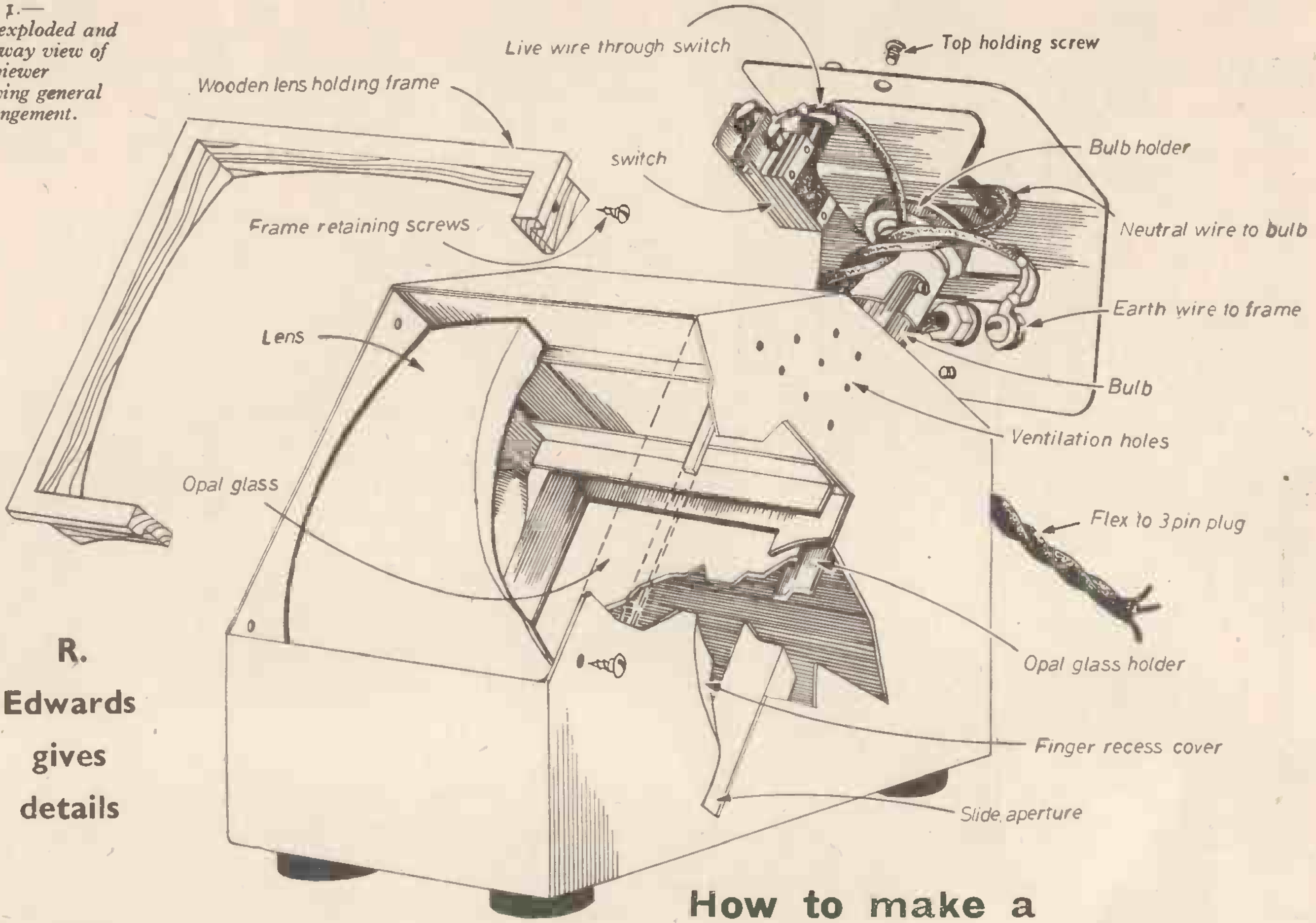


Fig. 42.—*Time switch wiring (earth omitted); a—clockwork motor (2 terminals); b—synchronous motor (4 terminals); c—synchronous motor (3 terminals).*

Fig. 1.—An exploded and cutaway view of the viewer showing general arrangement.



R. Edwards gives details

How to make a
TRANSPARENCY VIEWER

THE viewing box shown in Figs. 1 and 2 was designed for 2¼in. square transparencies in the standard 2¾in. square holders. Smaller size colour films suitably mounted will give a satisfactory enlargement.

The writer has found that batteries have a bad habit of running down just when they are wanted, so efforts were made to find a suitable mains voltage lamp which did not emit too much heat. The Philips 10-watt film viewing lamp answers this purpose admirably.

The lens used is a 3in. square plano-convex type, 7in. focus, and diffusion is by means of a piece of flashed opal glass, 2⅝in. square.

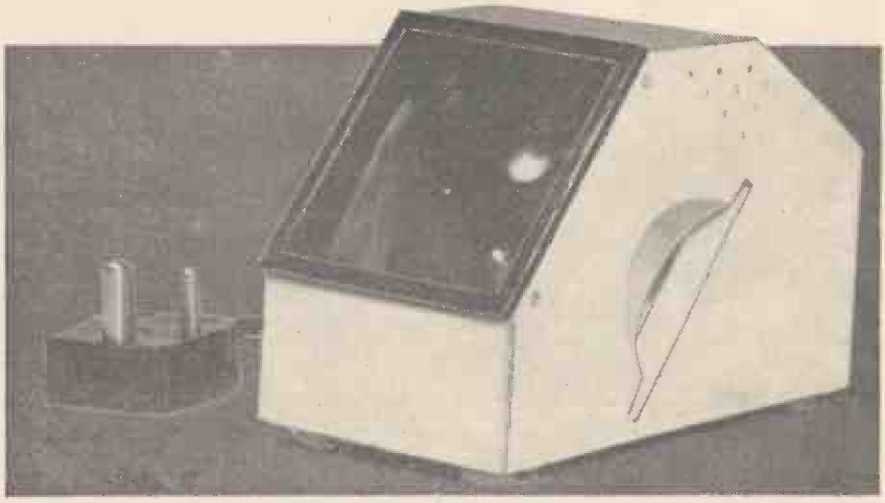


Fig. 2.—The completed viewer.

Making the Base

Sheet brass was selected for ease of soldering, and a piece 14in. square 26 gauge is required.

A large size electric soldering iron will greatly simplify the construction, as this enables the operator to have sufficient heat at his command. Well cleaned and tinned edges will ensure that no difficulties arise. A small vice and two pieces of ½in. × 1in. strip mild steel with square edges are useful for bending over the brass to form a clean edge.

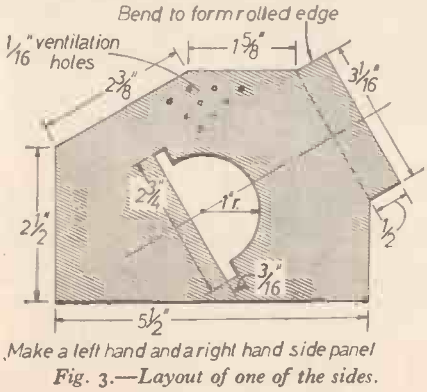


Fig. 3.—Layout of one of the sides.

Commence by marking out the frame and base section (Fig. 4) allowing ¼in. turn up all round. The two large square holes should be cut out roughly and filed to shape when the frame is completed. When finished and the base is attached, the whole should appear as at bottom right of Fig. 4.

An accurately cut block of wood 3in. square by ½in. thick is useful for checking the lens mount from time to time during construction.

Slide and Diffuser Holder

Next cut out and prepare slide and opal glass holder, soldering on the slide guides (A measures 3 1/16in. × ½in. and B, 2⅜in. × 7/16in.) and cranked pieces (Fig. 5). Solder into the frame.

Mark and cut out sides (Fig. 3) allowing 1/16in. all round which can be trimmed and filed to frame size after soldering. The half-round recesses are to enable the slide to be pushed right through with the fingers, but may be omitted if considered difficult to construct. They are made by cutting out the shape shown top right of Fig. 4 and bending round as shown, soldering the 1¼in. radius edge around the curve of the opening in the side. The slide can, of course, be pushed through with another transparency if the

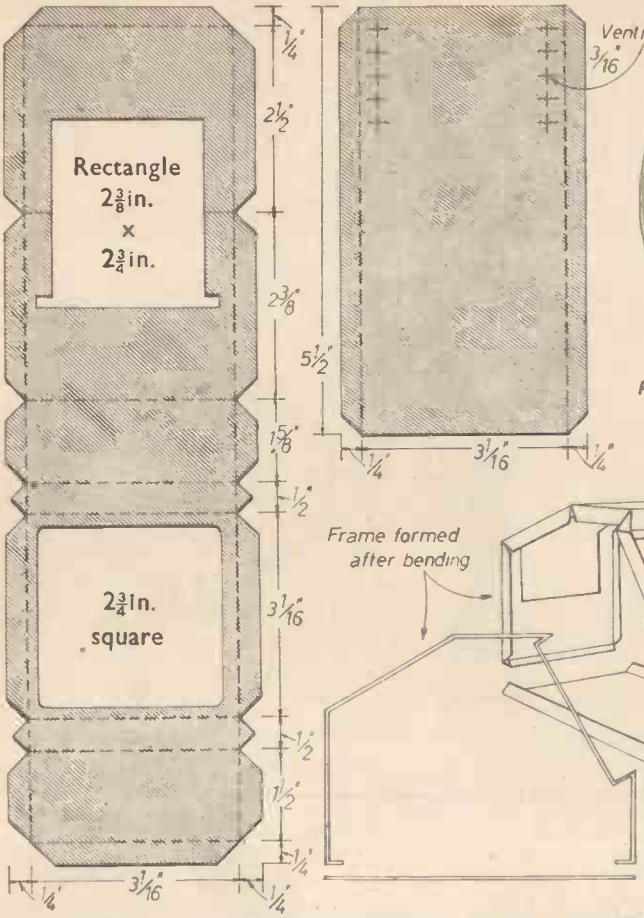


Fig. 4.—How to mark out and assemble the frame and base sections and form the finger recesses.

finger recesses are omitted. Tin all edges of frame and sides, and solder together.

The Lampholder and Switch Plate

Form the plate as shown in Fig. 5 and cut holes for toggle switch, bush and securing screws. An important point is to solder on a 4 BA brass nut for attaching the earthing wire of the 3-core lead. The top cap of the cord grip S.B.C. lampholder is cut off, leaving the screwed portion. This allows room for the wiring to enter from behind. Fig. 5 shows the completed switch plate.

Two 4 BA brass nuts are fixed to the inside of the frame to take the securing screws of the lamp and switch holder.

Lens Securing Frame

To hold the lens in position and to enable removal for cleaning, a wood frame is prepared, shaped at the back edge to the lens contour and rebated sufficiently to cover the thickness of the edge of the body. (Figs. 1 and 5). The frame is held in position by four small wood screws, two at each side.

Cut a piece of opal glass to the size required and slide into position. Hold this in place by nipping down the ends of the cranked pieces.

Ventilation

Drill in the base under the lamp position, a number of 3/16in. holes, also some 1/8in. holes in the top side of frame as shown in Fig. 3 this will provide sufficient ventilation to the lamphouse.

A piece of white card in the base curving up to the lower edge of lamphouse opening is sufficient to improve and diffuse the light.

Screw on, or attach with suitable adhesive, round rubber feet, at each corner of base. The whole box can be painted with synthetic enamel with the wood lens frame in a contrasting colour.

Finally, a length of three-core, braided or plastic covered lead, is connected with a soldering tag attached to the earth wire and screwed to earthing point provided. A 5A, three-pin plug (fused at 2A) is suitable for plugging to a standard socket outlet.

MATERIALS REQUIRED

- 26 gauge sheet Brass, about 14in. square.
- 1 S.B.C. Brass lampholder.
- 1 3A, 250V one-way toggle switch.
- 1 square flashed opal glass.
- 1 3in. × 3in. × 7in. focus, plano-convex lens, obtainable from The British Optical Lens Co., Victoria Works, 315 Summer Lane, Birmingham, 19.
- 1 10W film viewing lamp. (Philips Electrical Co.).
- 1 3-pin plug 5A (fused at 2A).

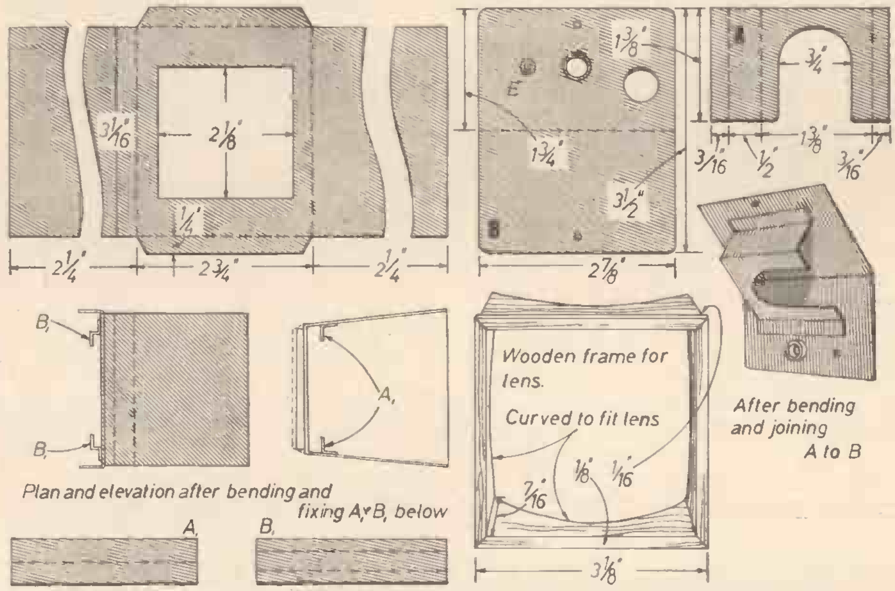


Fig. 5.—Slide and diffuser holder, lampholder and switch plate and lens securing frame.

COMMERCIAL TIME SWITCHES (Automatic House)

(*Continued from page 430*)

or if electric (synchronous) and not self-starting a device will be fitted to flick the mechanism over.

The "on" lever must now be moved to the exact time at which the circuit is to be made. To do this the lever lock must be released, in Fig. 40 the large central locking nut or ring is loosened while in Fig. 41, the small lever in the middle of the dial is lifted. Note that the *longest* or trailing edge of the lever is set to the time otherwise there may be an error of over an hour. Setting within ten minutes is quite easily done. The "off" lever is now set in the same way. Verify that in setting one the other has not been moved and lock the levers in position with the small lever or locking ring.

The switch requires no more attention except to wind it (if clockwork) every 14 days (etc.) or to reset the on/off times. A solar dial can be fitted by the makers and the times of on/off will alter automatically with sunrise and sunset, i.e., if you set the lights to come on 30 minutes before sunset in winter, it will still do the same in summer. The author prefers to leave all time clocks showing G.M.T. and to check them every three months with the radio time signal.

Availability of Time Switches

All the time switches shown with this article are available from stock and can be ordered from electrical suppliers, poultry equipment dealers or at retail prices from the makers or their representatives.

Since a solar dial switch is not suitable for immersion heater switching the truly automatic home may have three or more time switches situated by the appliance controlled, or better still in a small "control room." The switches being labelled and fitted with small neon lamps to show when the circuit in question is on. An artist's impression of this is shown in the heading sketch.

new maps for old

modern techniques described by G. Reynolds

ACCURATE, up-to-date maps are essential. The old and time-honoured orthodox ground survey by triangulation is time-consuming without a veritable army of surveyors and costs are high. Fortunately wartime experiences in aerial photography of enemy-held country have been turned to peaceful purposes.

A new profession, part science part art, has sprung into being since the cessation of hostilities. Profiting from new techniques the aerial photogrammetrist has come to lighten the burden of the cartographer and surveyor.

Basically his job entails the provision of new maps and the revision of old ones by aerial survey methods, but the technique is powerful and can be turned to mineral and oil prospecting, to agricultural and geological surveys, even to archeological research.

Method Used

The camera used is mounted in the aircraft's fuselage pointing vertically downwards. The film is exposed automatically at regular intervals as the plane flies across the area to be surveyed on level parallel courses. Successive photographs overlap each other by 60 per cent. of their area and each strip overlaps the previous run by 30 per cent. In this way at

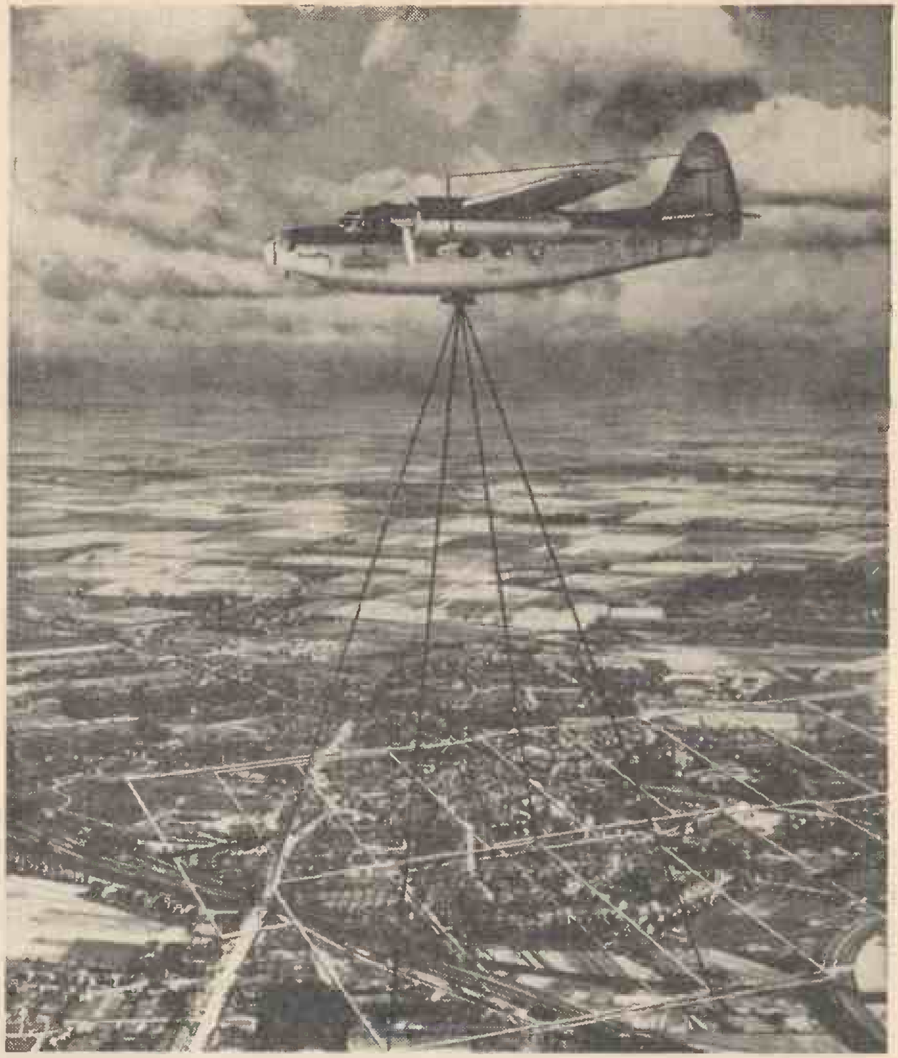


Fig. 1.—Method of survey photography. The aircraft is a Percival Prince.

Fig. 2.—Wild A.5 stereo-spotting machines in use.

Fig. 3.—The plotting pencil of a Wild A.5 stereo-plotter at work on a large-scale map of railway sidings.

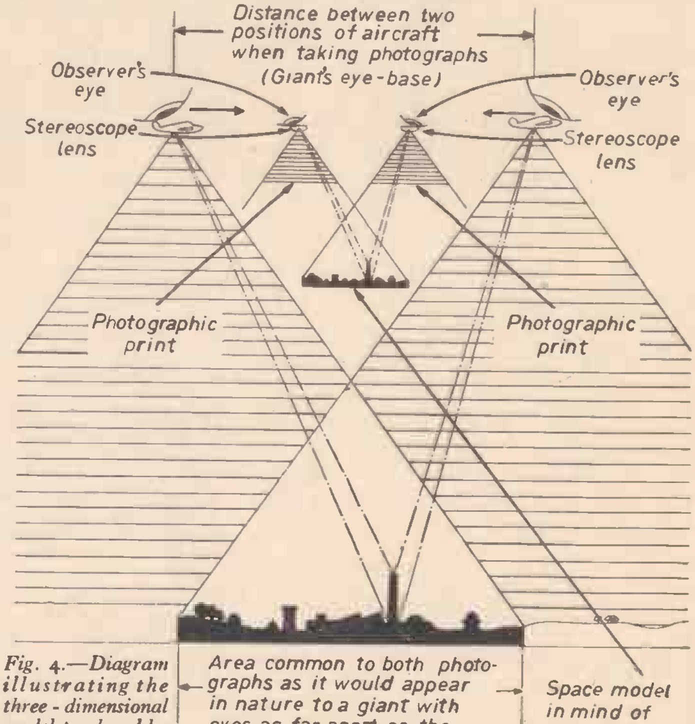


Fig. 4.—Diagram illustrating the three-dimensional model produced by examination of a pair of air photographs with a stereoscope.

Fig. 5.—The varying rock strata can be clearly seen from this aerial photograph.

least two pictures are taken of every part of the district under survey (see Fig. 1).

From contact prints a mosaic, a vertical panorama, of the entire area is built up. The mosaic, being more easily interpreted by the layman than a largely symbolic map, is often sufficient for the purpose in hand. Detailed maps, including relief contours, can easily be drawn from the prints by stereoscopic plotting instruments when required.

The Cameras

Aerial cameras are usually equipped with lenses of 5 to 6in. focal length taking a 7 to 9in. square negative. The definition of modern lenses is really remarkable, an object 3in. wide being clearly distinguishable in a negative taken from 2,000ft.

Many types of aircraft have been used for these surveys including D.H. Rapides, Oxfords and Bristol Freighters. This last machine is particularly suitable for work far from the home base of the surveying company for, in addition to its survey duties, it can transport all the equipment required by the expedition. The Percival Prince aircraft was specially developed for aerial photography (see Fig. 1).

Once the area to be mapped has been photographed the stereo-plotter is brought into service. Fig. 2 shows Wild A.5 stereo-plotting machines in use. Each pair of adjacent prints is projected on to a drawing table and viewed through special binoculars which permit each eye to see only one picture and thus give a three-dimensional view of a small area of terrain in exaggerated relief. (see Fig. 4). At this stage any distortion caused by the aircraft not having flown on an absolutely level cause can be corrected.

The operator also sees a white dot in his field of view and manual controls are provided with which he can steer this dot along any ground feature or trace out contours with it. A pencil coupled to the control draws appropriate lines on the map (see Fig. 3). Contours can be plotted with sufficient accuracy in open country to justify a 2ft. interval. In forests and densely-vegetated country the plotter can only follow the height of the tree tops and accurate ground contouring becomes impossible.

Oil Prospecting

Aerial photogrammetry has been used in Africa and the Middle East to prospect for oil and to investigate mining resources of both tin and gold. Exposures taken with different light filters enable geologists to identify rock types and a stereoscopic examination of the photographs will determine details of outcrops, faults and dip slopes. The tone and texture of vegetation assist in the identification of the underlying rock type. Oblique air photographs often show geological details not seen on verticals (see Fig. 5). Fig. 6 shows a dam under construction.

In forestry surveys volumetric estimations of timber stands can be made from photographs while the use of infra-red film or filters enable a separation of the species. Fig. 7 shows a forestry survey and some of the volumetric estimates of timber stands are: (8) Tree height 50ft., 88 trees to the acre; upper hill slope; 60 per cent. hard woods, 40 per cent. soft woods. (14) Tree height 45ft.; 108 trees to the acre on lower slopes; 40 per cent. birch and poplar; 60 per cent. soft woods. (17) Tree height 45ft., 104 trees to the acre; wet flat ground; 10 per cent. birch and poplar; 90 per cent. spruce. The height may be determined from stereoscopic views showing both base and tops of trees.

Aerial map making is more rapid than orthodox surveying (in jungle, ground survey may be virtually impossible), less expensive and in recent years its accuracy has become as good as that obtained by normal methods.

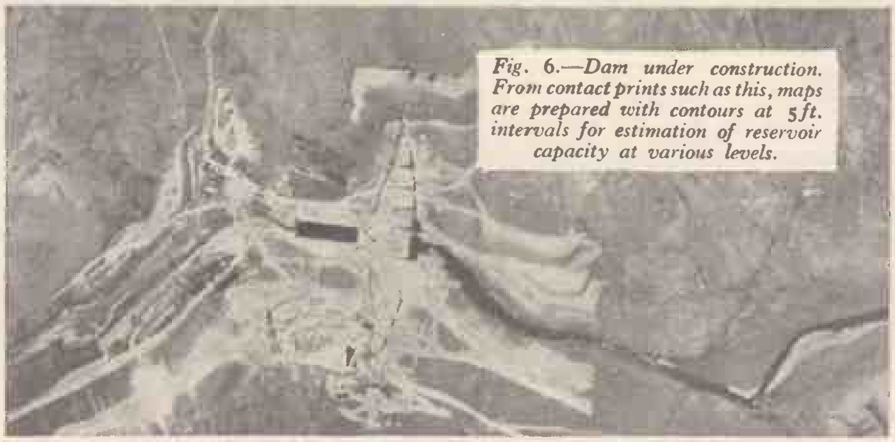


Fig. 6.—Dam under construction. From contact prints such as this, maps are prepared with contours at 5ft. intervals for estimation of reservoir capacity at various levels.

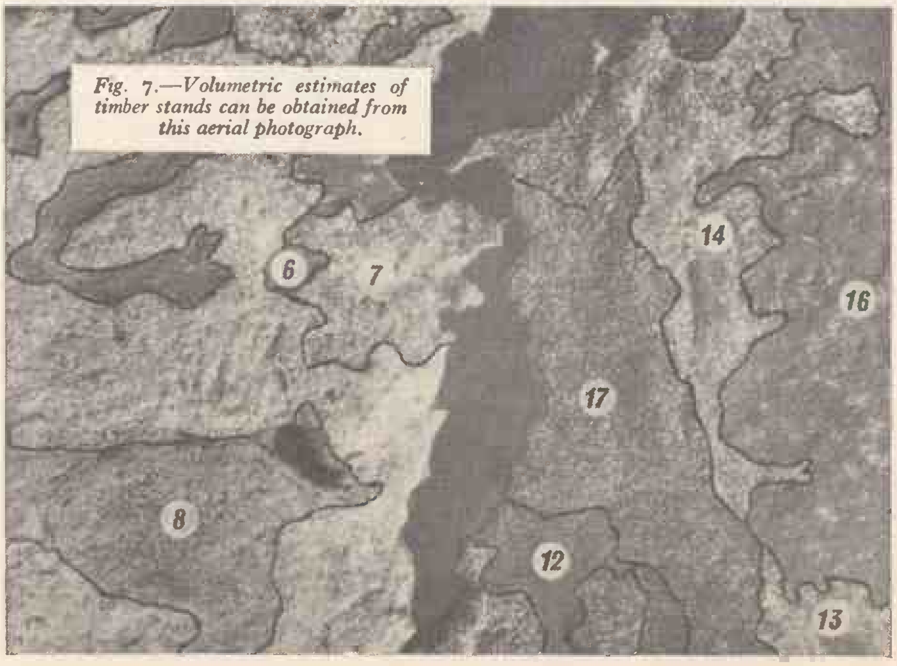


Fig. 7.—Volumetric estimates of timber stands can be obtained from this aerial photograph.

Continuing Floorboard Details

THE height of the supports must be lined up so that the floorboards do not rock, and this might be tested with a straight-edge of one of the floorboards. Note the outside board on each side will have to be shaped to fit the curvature of the hull.

Access is often wanted to the bottom of the boat, so that it is advisable to make the centre three boards joined together with an odd piece of batten at each end and in the centre. The outer boards can be screwed down with some 1½in. brass screws. Do not cramp up the boards tightly against one another. Instead, leave a gap which can be gauged the same for each board by using a spacer cardboard when screwing down.

Before finally screwing down the floorboards it is advisable to paint the undersides of the boards and the bottom or bilges of the boat. For the latter surfaces which are almost always wet or damp a bitumastic paint might be thought more suitable than the customary oil paint. This should be applied up to the chine batten; above this point oil paint should be used. Be sure to clean out the bottom of the boat before painting, a vacuum cleaner will be most useful in removing sawdust from crevices.

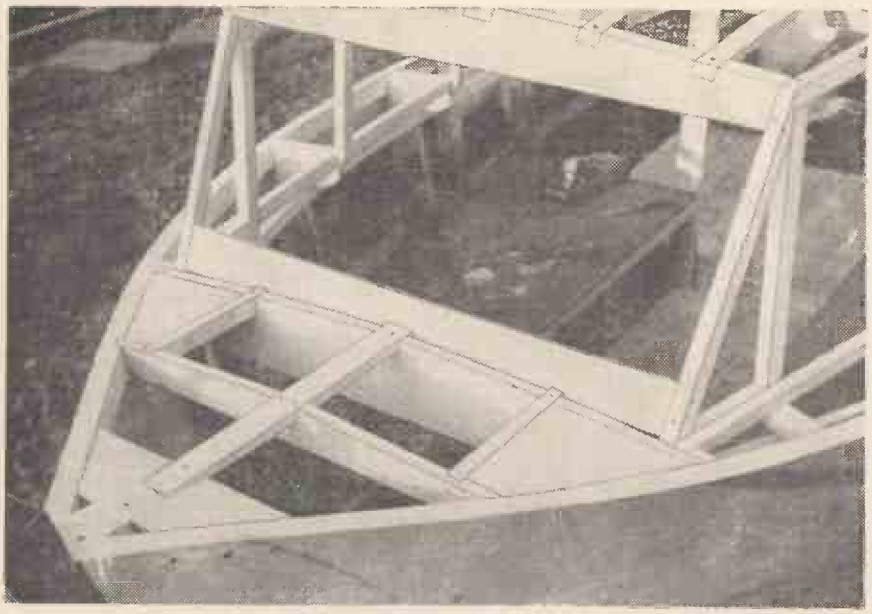


Fig. 23.—The fore deck framing.

The P.M. 2-Berth Cabin Cruiser

Part 3.—Concluding floor details and framing for the fore deck and cockpit coamings

The Cabin Floor

This floor is composed of four pieces of 1in. × 6in. flooring. As it need be only a little over 20in. wide it can be fitted directly upon the 20in. frame stretcher. Thus, the floor level will be lower than that of the cockpit. This is helpful in providing more cabin head room. In order to accommodate the full width of the floor it may be necessary to cut small notches in frames 2 and 3 (Fig. 19). At frame 1 the two outside boards will have to be tapered in to about half their width at their extreme forward ends. The two outer planks can be screwed down in position after painting, but the two centre planks should be battened together and made to lift out to give access to the bilges, as with the cockpit boards.

Side Deck Carlins

The carlins for the side decks are next to be considered and these are supported by knees secured to the top ends of the frame members. It is now necessary to consider the removal of the stretchers across the ends of the frame members as these should have been left in place during the work on the floor. In order that there may be no likelihood of the gunwale losing its shape during the fitting of the carlins temporary stretchers may now be bolted across the frame members about 6in. below the gunwales which will not be so much in the way as those at the extreme ends of the frame members. Thus, remove one stretcher at a time and shorten as necessary and bolt on lower down.

Refer to Fig. 20 and note that the knees are 3½in. wide and are sawn from the ends of the side members of the frames when the stretchers have been removed.

The knees slope upwards towards the centre of the boat and this slope should correspond with the slope on the top edges of the transom, i.e. there is a rise of 3in. on the centre line. It is advisable to start with frame 6 and check the slope with a straight-edge as well as sighting from the transom line. Thereafter, the slopes at the other frames may be all done by sighting from the stern, securing with one nut and bolt and tapping up or down as required to get the correct slope and then drilling the other bolt hole and securing. No knees are required for frame 1.

Cutting the Knees to Length

Before attending to this operation be sure that the boat is level across its width by placing a straight-edge across from gunwale to gunwale and resting a spirit level on it. Wedge up the chines until dead level is indicated.

From points 8in. from the outside edge of

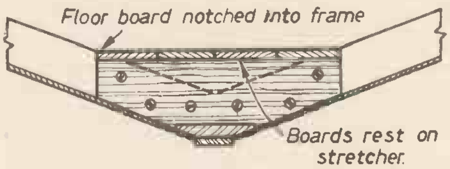


Fig. 19 (Left).—Section of the cabin floor.

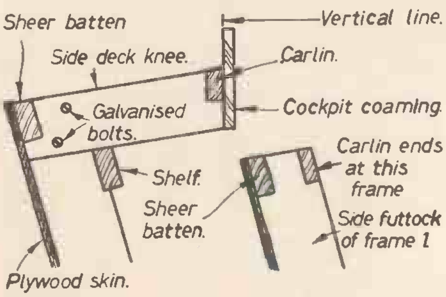
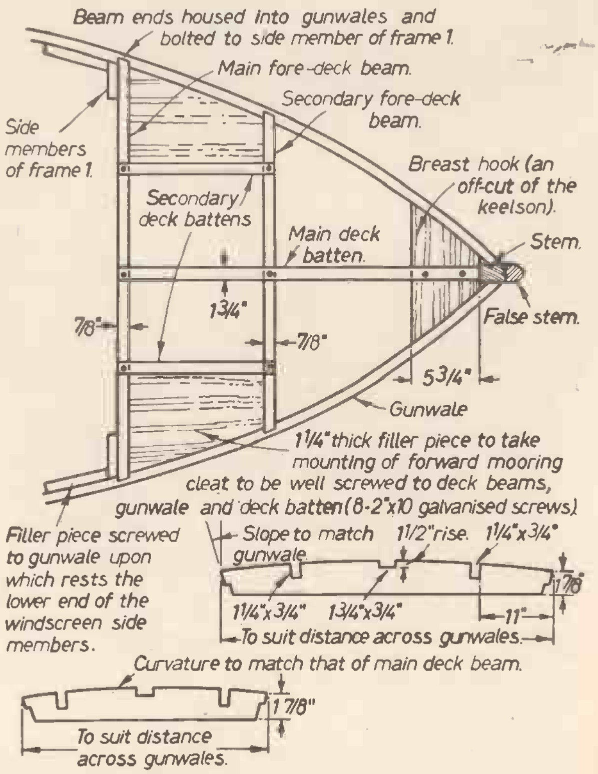


Fig. 20 (Left).—Longitudinal members attached to side deck knees, and Fig. 21.—Carlin ends at frame 1.

Fig. 22 (Right).—Details of the fore deck.



the gunwale a vertical line is drawn to indicate the end of the knee (Fig. 20). A variation is to be found at frames 1 and 2. At frame 1 there is no knee but a notch is sawn and chiselled in the vertical frame member to take the end of the carlin (Fig. 21). The length inwards at frame 2 will be about 5½in. but is best checked by springing the carlin into position and securing on the top of the knees with G-cramps and scribing the lines for the recess to be cut in each for the carlin. It should be noted that the line at which the cut is made will not be square except at frame 4 and the carlin in position will help to get the correct angle easily.

Two housings will have to be sawn in the transom for the extreme ends of the carlins. These will need to be about ⅜in. in depth. The carlins can now be screwed into place with brass screws.

The Shelf

Two similar members to the carlins are fitted underneath the knees to the side members of the frames (Fig. 20). The object of the shelf is to give support to the knees as well as to generally stiffen up the gunwales of the boat. Remember that the side decks have to take the weight of the crew scrambling alongside, and, of course, the knees take the weight of the cabin as well as any passenger who might be reclining on the roof.

These members are notched into the frame for ¼in., and are then securely screwed in position with 1½in. × No. 8 brass screws.

The Fore Deck

The fore deck is supported by two deck beams and the breast hook, details of which are given in Figs. 22 and 23. As these beams are called upon to bear a fair amount of weight they may be notched into the sheer battens. They are then screwed into position from outside the boat with some 2in. × No. 10 galvanised screws well countersunk in the plywood skin. The top curvatures of these members should be the same.

The central deck batten is housed into the main deck beam and the secondary beam. A small housing may be necessary in the breast hook to take this batten. Two smaller deck battens are also fixed across the two deck beams.

At this stage one must bear in mind the requirements of a strong point at which to fix the mooring cleats at a later time, and it is better to do this before the deck covering is fixed. These filler pieces are shown in Figs. 22 and 23, and should be of some 1¼in. or 1½in. thick Parana pine or oak. They should be carefully fitted to all four members to which they are attached.

Finally, the filler pieces are glued and screwed in position. Any slight protrusions above the level of the beams can be removed with a smoothing plane.

This completes the fore deck except for covering which operation (Fig. 24) is better left for the time being whilst attention is now given to the construction of the cabin framework.

Cockpit Coamings

The cockpit is lined on the inside of the carlins by the coamings (Figs. 20 and 24). These members are made from timber 5¾in. × ¾in. If they are to be painted at a later stage, they can well be made of Parana pine. On the other hand mahogany coamings look very fine and are best left natural colour and varnished. This arrangement would look well with a natural mahogany transom. The coamings are screwed to the ends of the knees and the carlin. They reach from the transom, into which they are housed, about ½in. and end at frame 4.

It is of interest to note in passing that at this stage the boat could very rapidly be completed for use as an open run-about. The fore deck and side decks could be finished and a coaming run the full length from frame 1 to the transom. Some cross seats could be improvised and the boat is ready for painting. It is possible for the constructor to use the boat like this and to convert it later to the full cabin cruiser design with very little trouble.

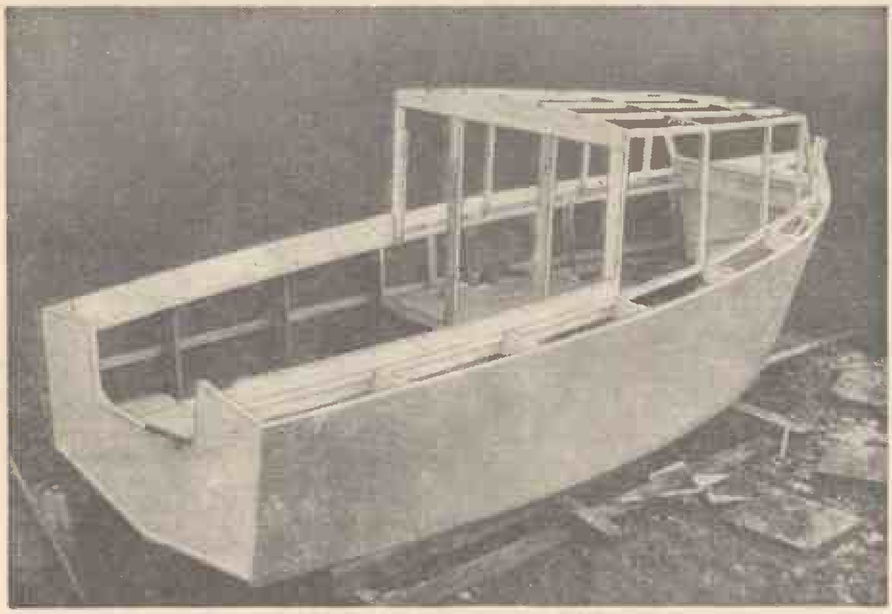


Fig. 24.—This stage shows the cabin framing and the cockpit coamings.

MATERIALS REQUIRED FOR THE CABIN

At Frame 4
- 2 door uprights 4ft. 9in. × 1¾in. × ¾in.
- 2 cabin side supports 2ft. 6in. × 1¾in. × ¾in.
- 1 roof beam 4ft. 6in. × 1in. × 6in.
- 2 middle rails 1ft. 7in. × 1¾in. × ¾in.

At Frame 3
- 1 roof beam 4ft. 6in. × 1in. × 4¾in.
- 2 cabin side supports 2ft. 6in. × 1¾in. × ¾in.

At Frame 2
- 1 roof beam 4ft. × 1in. × 4¾in.
- 2 cabin side supports 2ft. 6in. × 1¾in. × ¾in.

At Windscreen
- 1 roof beam 3ft. 6in. × 1in. × 4¾in.
- 2 cabin side supports 2ft. 6in. × 1¾in. × ¾in.
- 2 windscreen side supports 2ft. 1in. × 1¾in. × ¾in.
- 1 windscreen bottom rail 3ft. 6in. × 2½in. × ¾in.
- 2 filler pieces 9in. × 1¼in. × ¾in.
- 2 ties from carlin to sheer batten 9 in. × 1¼in. × ¾in.

Roof of Cabin
- 2 cabin carlins 6ft. × 1¼in. × ¾in.
- 1 centre roof batten 6ft. × 1¾in. × ¾in.
- 4 side roof battens 6ft. × 1¾in. × ¾in.

Plywood
- 2 cabin side panels 6ft. 3in. × 2 ft. 6in. × ¼in.
- 1 windscreen panel 3ft. 2in. × 2ft. × ¼in.
- 2 roof panels 5ft. 6in. × 2ft. 6in. × ¼in.
- 2 bulkhead panels 4ft. 6in. × 2ft. 6in. × ¼in.

Side Decks
- 2 pieces 8ft. × 1ft. (approx.) × ¼in.
- 2 pieces 4ft. 6in. × 1ft. (approx.) × ¼in.

Foredeck
- 2 pieces 2ft. 6in. × 1ft. 10in. (approx.) × ¼in.

The plywood covering for the cabin and decks can be cut from: 2 sheets 8ft. × 4ft. × ¼in.
2 sheets 6ft. × 4ft. × ¼in.

Cabin Door
- 4 verticals 4ft. 6in. × 1¾in. × ¾in.
- 6 rails 10in. × 1¾in. × ¾in.
- 2 plywood panels 4ft. 6in. × 10in. × ¼in.

Materials for Fore Deck
- Breast hook 1 piece 1ft. 6in. × 1¼in. × 5¾in.
- Beam 1 piece 3ft. 6in. × ¾in. × 3½in.
- Beam 1 piece 2ft. × ¾in. × 3½in.
- Main batten 1 piece 2ft. 6in. × ¾in. × 1¾in.
- Side battens 2 pieces 1ft. 6in. × ¾in. × ¾in.

Next Month

In the next instalment full constructional details of the cabin will be given. Its general appearance can be seen in Fig. 24 and as a preliminary to commencing construction we have included above the list of materials required.

OUR READERS ASK

1.—The caption to Fig. 1 mentions that frame 1 is shown set up first. Is this correct?

No. The caption should read: "Frame 7 braced in position on the building form." Frame 7, i.e. the transom, is of course actually shown in the photograph.

2.—Under frame 1 in the Materials List, you mention "Bottom futtocks, 1 piece 2ft. 6in. × ¾in. × 3½in., but on the drawing of the frames the width is not 3½in. but 9in. Which is correct?

The drawing is correct. The Materials List should read: "2ft. 6in. × ¾in. × 9in.

3.—In the Materials List the floor support width is 5in. but on the frame drawings it is 4in. Which is correct?

Neither is incorrect. The 5in. width is ordered to allow for waste in fitting.

4.—The notches for stringers and battens in frame 7 are marked 1⅞in. × ⅞in. and yet the Materials List indicates sizes of 1¾in. × ¾in. Which is correct, please?

The drawing is correct and the dimensions in the Materials List should be 1⅞in. × ⅞in.

5.—Should 2in. bolts be used at all the points shown in the frame assembly drawings or would brass screws be as good?

Bolts are to be preferred, although 1½in. × No. 10 brass screws could be substituted.

6.—The Materials List shows only two pieces of wood for the stem. No mention is made of the size of the piece to which the hog is fastened.

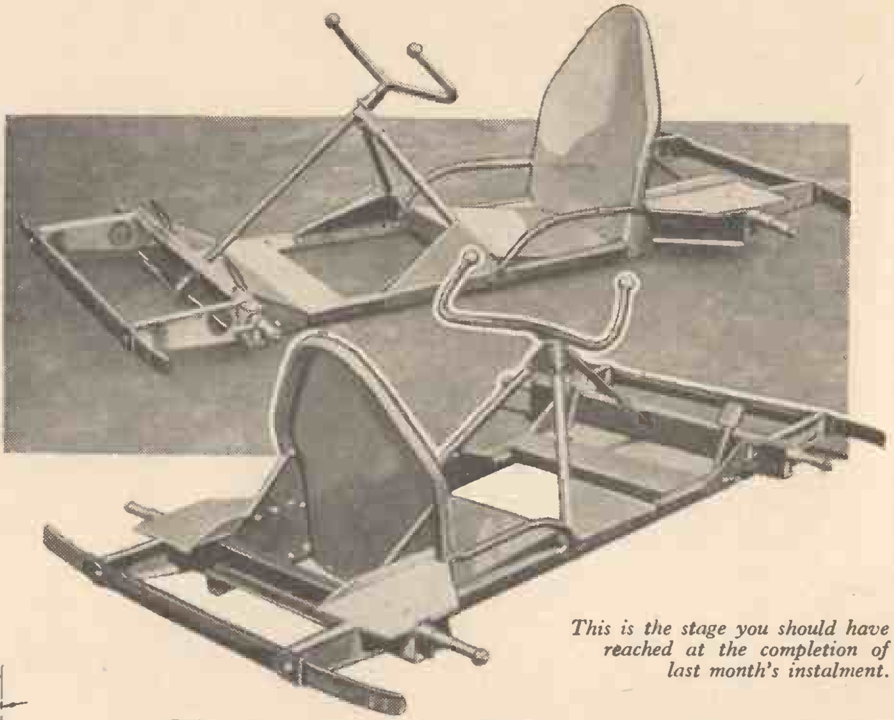
In Fig. 2 the lower piece and the piece rising to the left are cut from the length of 2½in. × 3½in. timber (see also Fig. 4). The web piece shown 5in. across is cut from the 2ft. × 2½in. × 6in. piece specified in the Materials List.

THE MECHANIKART

PART 3

Final assembly details and notes on karting

By Arthur W. J. G. Ord-Hume



This is the stage you should have reached at the completion of last month's instalment.

Assembling the Drive Wheels

THE next stage in the construction is to assemble and fit the rear drive wheels and sprockets complete with brake assemblies.

The rear wheels are supplied with extension spools to which are bolted the 72-tooth

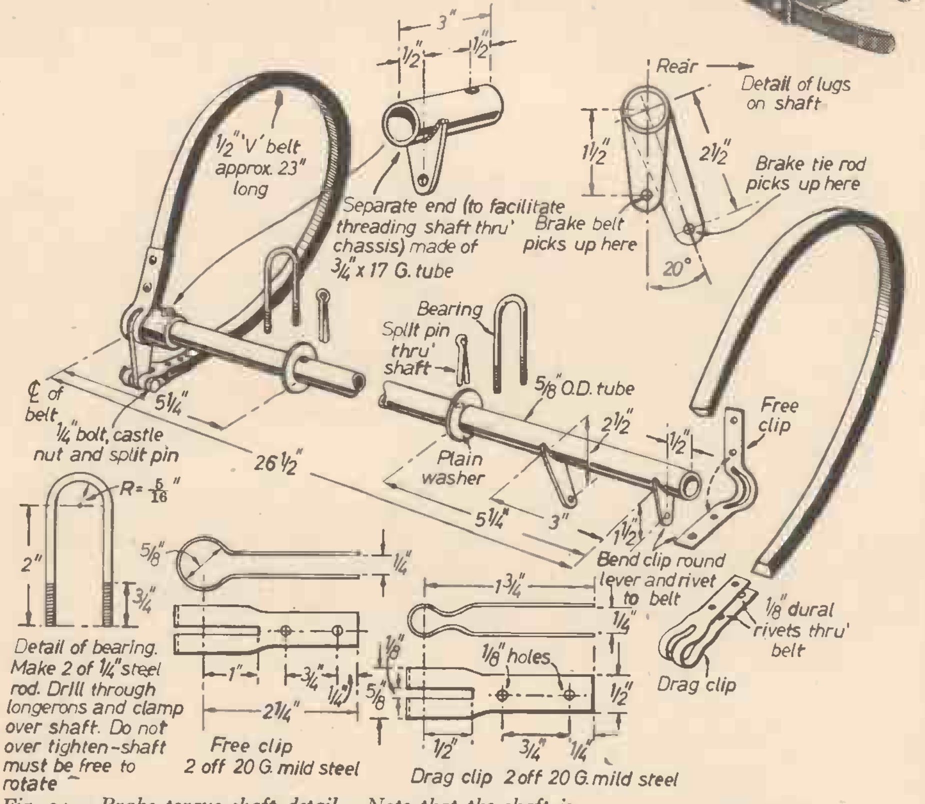
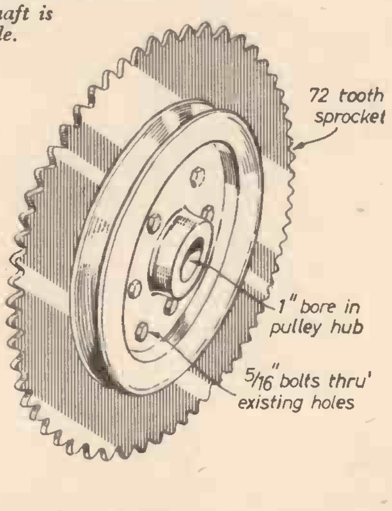


Fig. 24.—Brake torque shaft detail. Note that the shaft is inserted through the chassis holes from the left-hand side. On the right is shown the assembly of the brake pulley to the 72-tooth drive sprocket; concave side of pulley facing in towards chassis centre-line.

drive sprockets. The actual " drum " of the brake is a 7in. dia. " V " groove pulley. Two are required and they are obtainable from any large tool store or hardware factor. The pulley is bolted through the holes provided to the drive sprocket. Note that the flat side of the pulley (not the hollow face) should be against the sprocket.

The brake torque shaft is of ⅝in. o.d. mild steel tube of about 16 gauge and it is located in plain " U " bearings on the longerons. This is shown in Fig. 24.

Now make up the two foot pedals. These are both the same but handed and may be made either of steel tube or channel, as detailed in Fig. 25.



The brake tie-rod is made of ¼in. dia. mild steel and the assembly of the brake is detailed in Fig. 26.

The brake is self-energising and is made from two lengths of " V " belting. These are connected up as shown. It is most important that the assembly should be fitted as drawn, as, if the direction of the " V " belt is reversed, the brake will lock on.

Engine

The engine may be either the J.A.P. S.80 or the Clinton A.490. It is mounted on the left-hand engine table and the drive is transmitted through a ⅜in. Renold chain. The length of the chain is approximately 72 links.

First of all, fit the 12-tooth sprocket in the engine drive shaft. This is attached with a grub screw and a key. Place the engine on the mounting table and see that the drive sprocket which is attached to the drive shaft is in line with the sprocket attached to the wheel. For best all-round performance, the drive shaft sprocket should have 12 teeth, giving a **6 : 1** reduction.

Clutch

Karting enthusiasts seem divided as to the need for a clutch, but, should Mechanikart builders desire to fit one, Messrs. H. A. Wills Ltd. can supply a special centrifugal clutch to fit both the J.A.P. and the Clinton engine. It is affixed to the engine drive shaft with a key and a grub screw. The 12-tooth drive sprocket is then fitted to the square extension shaft of the clutch and locked with a nut.

When the clutch is incorporated, the engine must be moved further inboard towards the centre-line of the chassis in order to keep the sprockets in line.

With a clutch, it is possible to start the engine with the recoil starter. The clutch is set to transmit at about two thousand r.p.m. and power take-up is very quick. The advantage of the clutch is that, if the kart should skid off the track, the engine will not stop. Also it is possible to start the kart single-handed with ease.

Chain Guard

The chain guard is made of strip steel, preferably about ⅛in. thick so that there is little possibility of its being inadvertently bent to foul the chain. The provision of a chain guard is a mandatory requirement (Fig. 28).

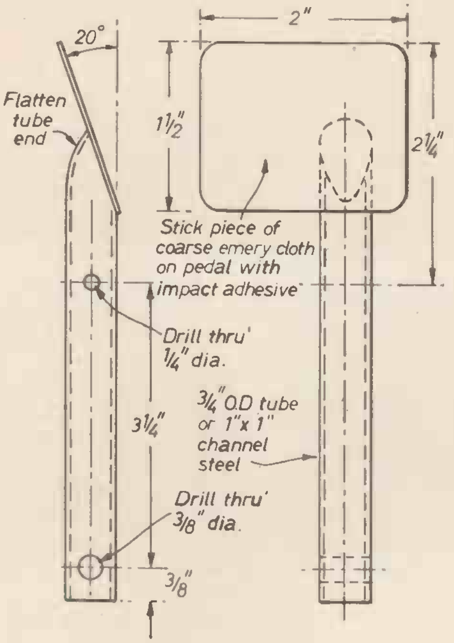


Fig. 25.—Detail of the foot pedals. Two are required, handed.

Throttle Control

Details of the throttle control are shown in Fig. 29. If two engines are to be used, the cable clip on the chassis is modified as shown to take the two cables which are supplied with the engines. The second engine, incidentally, must be of counter-clockwise rotation and is fitted in the same manner as the first motor.

Ignition Cut-out

It should be possible for the driver to stop the engine in an emergency from the driving position. With efficient brakes, it will be found in practice that the kart will stop in a very short distance. The normal earthing tag on the sparking plug is satisfactory, failing which the plug lead should have a spade clip end to enable the lead to be pulled off.

On later engines of the Clinton type, provision is made for the earthing of the ignition and a connection is embodied on the flywheel magneto casing to which an earthing switch may be fitted. The switch (one will cater for two engines) is mounted in a convenient place on the steering column. One lead is taken from the earthing connection on the engine into the switch. The other switch connection is to the chassis. The wire end can be looped round a Parker-Kalon screw and screwed into the chassis.

Finishing Off

With the steering handlebars central, check that the front wheels are in the correct alignment, adjustment being effected by the adjustable ends of the tie-rods.

The seat-back may be upholstered if required, failing which a customed seat-back and squab is available from H. A. Wills Ltd.

Check all nuts and bolts for security.

Fuel

The correct fuel for the J.A.P. S.80 is a two-stroke mixture made up of 18 parts petrol to one part of oil. It is advisable to use ordinary commercial petrol.

With the Clinton, it is recommended that it should be run in for the first two tank-fulls of fuel with a mixture of ¾ pint to 1 gallon of regular fuel. Once run in, the mixture should be 1 pint of oil to 2 gallons of petrol. The oil and petrol must be mixed in a separate container and preferably strained before filling the tank, as is normal two-stroke practice.

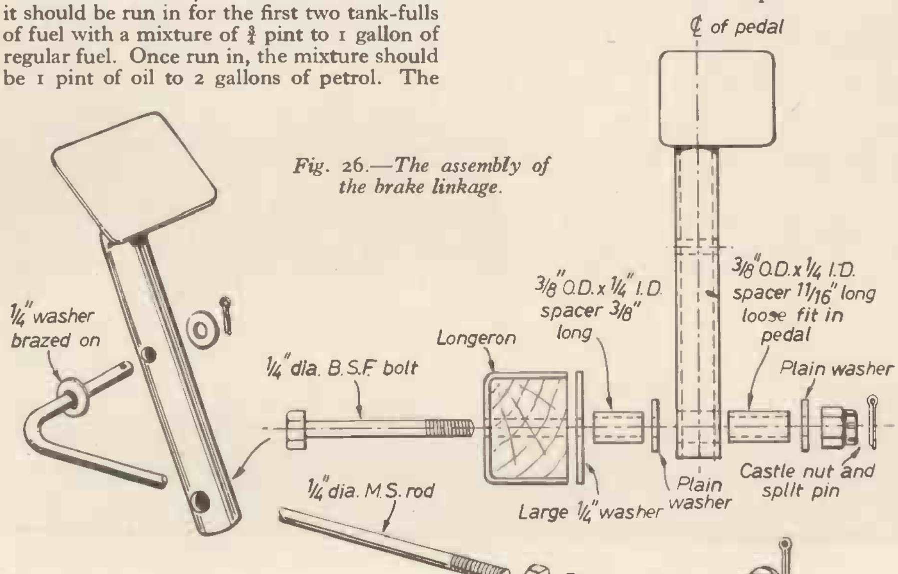


Fig. 26.—The assembly of the brake linkage.

Note: If engine vibration is excessive, drill two 1in. wide strips of ⅛in. thick M.S. to sandwich under each pair of bolt heads and the mounting table.

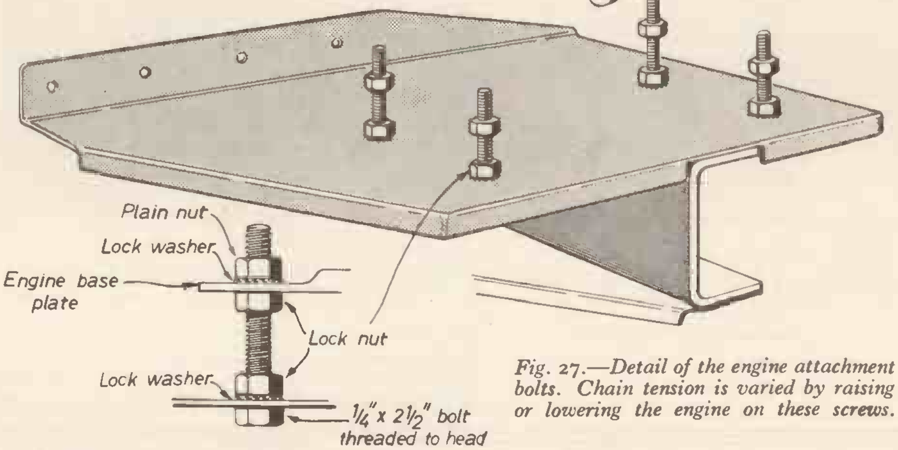


Fig. 27.—Detail of the engine attachment bolts. Chain tension is varied by raising or lowering the engine on these screws.

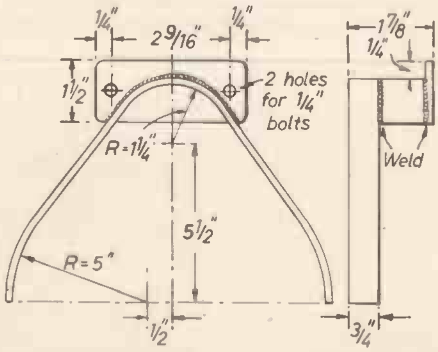


Fig. 28.—Chain guard detail for Clinton engine. Make from ⅛in. thick or 10 gauge M/S plate. The chain guard for the J.A.P. engine is similar.

Karting

The R.A.C. Regulations state that all kart drivers must wear crash helmets, goggles (or a visor) and thick gloves. The driver is also advised to wear thick clothing to minimise possible abrasions.

With the driver in place, turn on the fuel and depress the accelerator about an inch. Have an assistant push the kart whereupon the engine will start.

If the clutch is fitted, the motor may be started by using the recoil starter. As the clutch is fully automatic, there is no additional control required.

The steering is very positive, and until the karter gains the "feel" of the machine he should be cautious. It is only necessary to turn the handlebars a few degrees to obtain full lock on the steering.

Under normal conditions it is almost impossible to turn the Mechanikart over. On corners it will help balance the kart if the karter leans into the corner. The brakes should only be used for stopping as the throttle can be used for slowing down if necessary at very sharp corners during a race. With practice it will be found that it is possible to drive "flat out" all the time as the low centre of gravity keeps the Mechanikart on an even keel irrespective of the sharpness of a bend or chicane in the track.

On a wet surface, the Mechanikart can be made to skid in a spectacular manner in absolute safety and it is a sound scheme to encourage such skids in order that one may cultivate one's reactions to such an occurrence. In this manner also may be taught skid-control in ordinary motoring by actual skid practice.

Several different types of tyre are also available for the Mechanikart including the smooth, broad-faced racing "slick" which has almost no tread.

What of kart tracks? Avoid using the Mechanikart on a sandy beach unless the sand is damp. Dry sand will blow into the sprocket chain and accelerate wear; wet sand will stick to and corrode the chassis. Smooth grass is suitable, although one can skid very easily on damp or wet grass. A loose cinder track tends to wear tyres rather more quickly but makes for a spectacular show with plenty of skids on corners. Concrete or tarmac makes an ideal surface for karting and the many disused airfields throughout the country are already being given a new lease of life by the many new kart clubs which perform on them.

Licences

No driving licence is needed to operate a kart, nor is there any age limit. If, however, it is the intention of the karter to enter for races, the driver must hold an R.A.C. Competition Licence which costs 5s. per annum. For racing, if the competitor does not hold an ordinary driving licence, he will have to undergo observation prior to competing in a kart event. This observation is made whilst the driver covers the circuit at "competitive speed" for 10 minutes.

Karts on the Highway

It is not permissible to drive an ordinary kart on any part of the public highway without embodying extensive and costly modifications to comply with the Road Traffic Act. If the constructor wants to build a miniature car, he is well advised to construct one of the many different types of successful car designs which are available rather than undertake a kart conversion. Karting is an inexpensive sport—and it should remain that way.

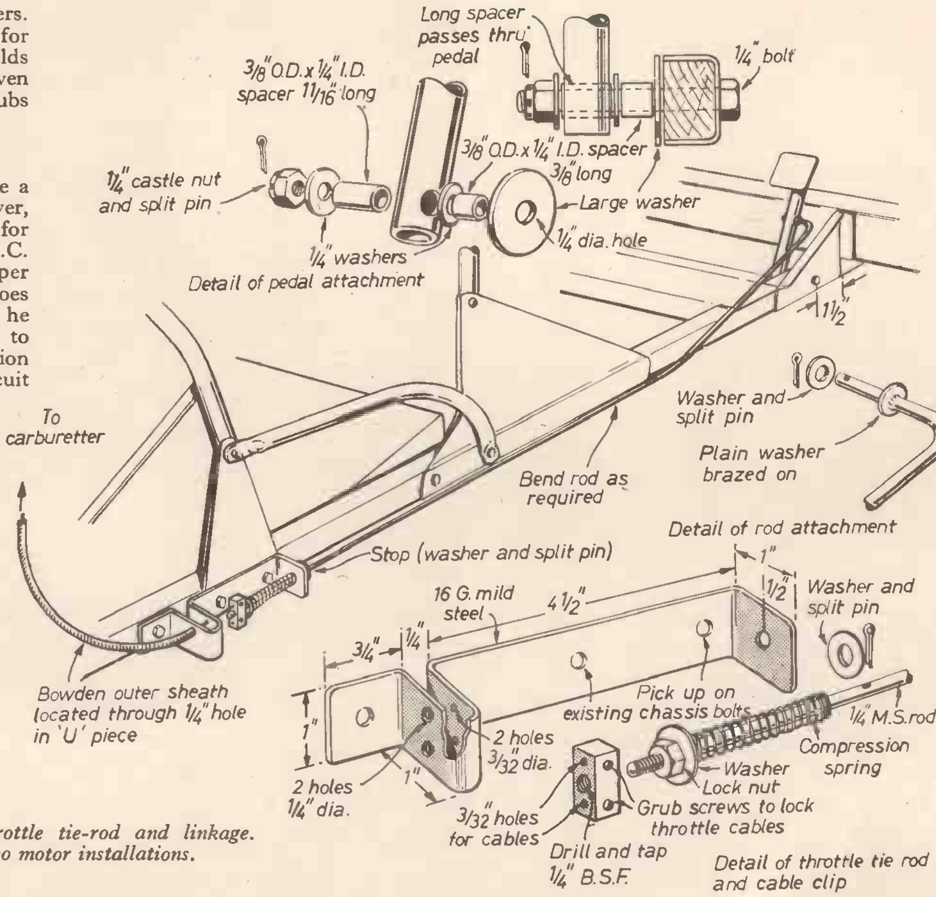
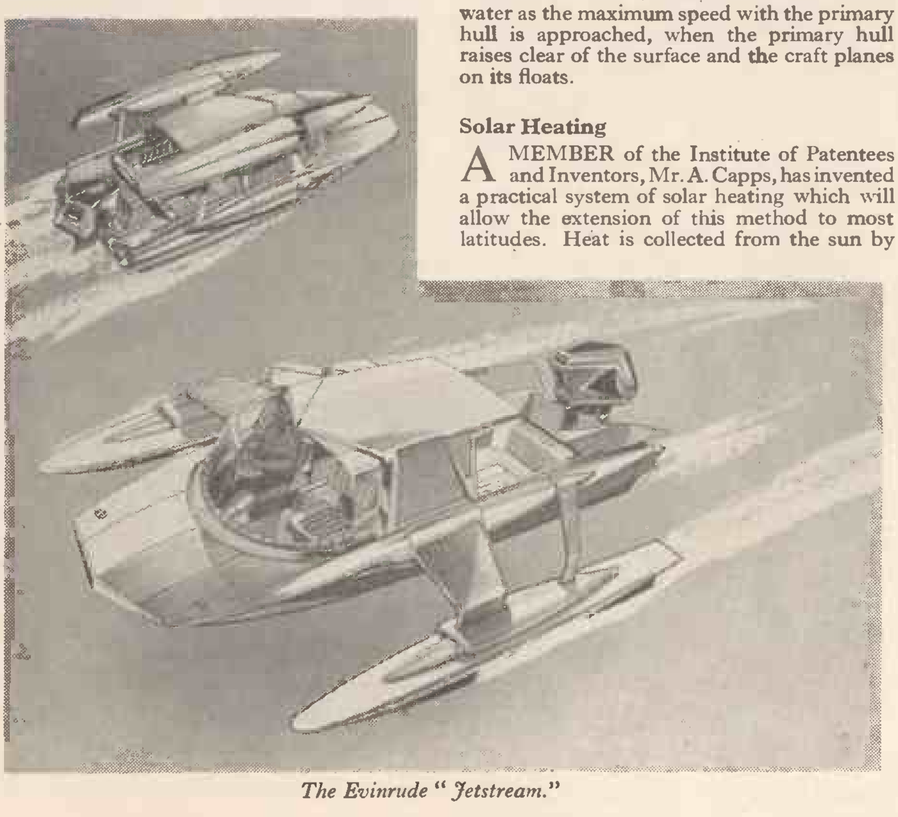


Fig. 29.—The assembly of the throttle tie-rod and linkage. This may be used for one or two motor installations.

SCIENCE notes

Unique American Runabout

THE latest American outboard craft, the Evinrude "Jetstream," combines the advantages of an ordinary hull at low speeds with those of the hydrofoil concept at high speeds. As can be seen from the photograph, two 13ft. pontoons are mounted to the hull on folded arms. These are lowered into the water as the maximum speed with the primary hull is approached, when the primary hull raises clear of the surface and the craft planes on its floats.



The Evinrude "Jetstream."

Solar Heating

A MEMBER of the Institute of Patentees and Inventors, Mr. A. Capps, has invented a practical system of solar heating which will allow the extension of this method to most latitudes. Heat is collected from the sun by parabolic reflectors which lie longitudinally on the roof of the inventor's bungalow. These are made of aluminised Terylene film and are adjusted automatically. The sun's rays are thus focused to heat boiler pipes lying along the focal centre of the mirrors and the resulting steam used, on the principle of the heat pump, to keep the house cool in the summer.

To overcome the lack of sunshine during the winter, the ground under the concrete raft on which the bungalow is built is used as a heat store. Between the bungalow and its foundation is a thick layer of sawdust contained in a water-tight envelope and it is this which keeps the heat in the ground.

Infra-red Detector

NEW apparatus incorporating infra-red devices may when perfected replace some forms of defence radar. This new system will show on a screen the actual objects which it sees instead of the "blip" of light produced by conventional radar. It cannot be jammed, needs no transmitter and its equipment is simpler, cheaper, smaller and lighter.

Driverless Trolleys

VISITORS to the recent Mechanical Handling Exhibition at Earls Court, London, were shown a demonstration of E.M.I. Electronics Ltd. Robotug driverless trolleys. These operate by following a wire through which a low-frequency A.C. current is passed. Sensing coils on the front of the trolleys are used for this purpose. As a safeguard to avoid collisions the control unit of each Robotug energises the section in front of it and de-energises the section behind, ensuring that there is always one dead section between two vehicles. Instructions can be fed into the control unit so that the Robotug will call automatically at 75 or more loading or unloading points and then return to the starting place.

SPACE COMMUNICATIONS

Using "Talking" Satellites

By D. S. Fraser

THE American National Aeronautical and Space Administration are experimenting with station-to-station radio signals reflected from man-made "radio mirrors" in outer space.

If the experiment should prove this sort of communication to be technically and economically feasible, it could point the way to a network of terminals for sending telephone calls and live television to distant parts of the world by way of fixed satellites. By the same token, "orbital post offices" would be a possibility. (See Fig. 2.) Letters would be converted to radio signals and flashed instantaneously across the oceans of the world by a satellite relay station. While such a service would employ standard letter forms, it would be cheaper and faster than present mails.

The name "fixed" has been given to these satellites because they orbit around the earth at the same speed the earth rotates on its axis. As a result, they always maintain the same position over a given point on the earth.

The A.N.A.S.A. satellite will be used as a "radio mirror" for transmission experiments between the Bell Telephone Laboratories, in New Jersey, and the Jet Propulsion Laboratory, at Gladstone, California.

The first station-to-station radio signal to be reflected from a man-made "radio mirror" in outer space was transmitted last January, by a research group at the Bell Laboratories. At that time, a signal was beamed to a 100ft. aluminised balloon far above the earth, after a series of tests, designed to perfect the technique of ejecting and inflating a folded plastic sphere at high altitudes, had been made. The folded sphere was ejected at a high altitude; inflated in space by the air and chemicals contained inside, and rose to a maximum altitude of over 250 miles. As it settled back into the earth's atmosphere, wind carried it far over the Atlantic Ocean. Air pressure at the lower alititudes caused it to deflate and fall.

The Ground Station

The experimental ground station for sending and receiving telephone messages by way of man-made satellites is taking shape on a hilltop at Holmdel, New Jersey.

The station, under construction by Bell Telephone Laboratories on Crawford Hill, will "bounce" radio signals off the "sky mirror" satellite. It will have control buildings and two large antennas for communication experiments with objects in outer space. (See Fig. 3.)

Fig. 1.—A model of a large horn antenna, to be 50ft. in length and the aperture 20ft. × 20ft.

One of the uses of the installation will be to take part in communication projects sponsored by the A.N.A.S.A.

Although single telephone channels will be used in the experiment, the objective is to determine whether television "broadband signals" (the equivalent of about 900 telephone channels) could also be transmitted.

Such broadband signals cannot now be carried over present submarine cables, and cannot be transmitted directly by radio between widely separated points because the signals are blocked by the earth's curvature.

The microwave radio signals to be used in the experiment will be analysed to obtain information about transmission effects. The data will be studied to discover the reflection characteristics of satellites in orbit.

The satellite experiments probably will be preceded by test transmissions of signals using the moon as the reflector. The signals will be received and transmitted between A.N.A.S.A's. Jet Propulsion Laboratory tracking station in California and Holmdel.

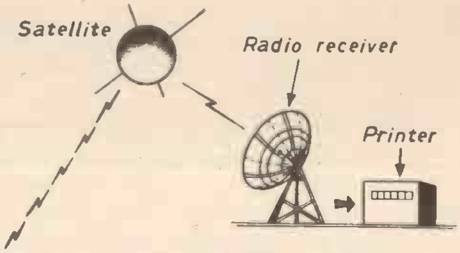
The Antennas

Heart of these communication experiments will be the antennas and the transmission techniques. The Holmdel installation will include a dish-shaped commercially available antenna to transmit signals and a horn-shaped antenna will be the receiver. The latter antenna was designed by Holmdel engineers and is a large version, adapted for tracking of the horn-reflector antenna which was originated some years ago at Holmdel for radio relay use in the Bell System. (See Fig. 1.)

The horn-reflector design permits the antenna to receive radio energy from essentially one direction, and less than one-millionth as much from other directions. The result is greater concentration on the wanted signal and less pickup of "noise" from other directions, especially the radiation from the ground, than for conventional antennas.

In conjunction with the horn, a highly sensitive receiver is required. The receiver will utilise extremely low-noise amplifiers, either a pair of "parametric amplifiers" or "masers," or a combination of one each. The central element of a parametric amplifier is a semi-conductor. Maser is short for "microwave amplification by stimulated emission of radiation." The central element is a ruby crystal contained in a liquid helium "refrigerator" at a temperature approaching absolute zero—about 460 deg. below zero (F.).

One of the initial and crucial problems in these experiments will be tracking speeding satellites precisely, and for this purpose Bell Laboratories will devise its own special equipment. Data predicting the "passes" of satellites will arrive in coded form and the new equipment will rapidly convert the information into a form suitable for controlling the antennas.



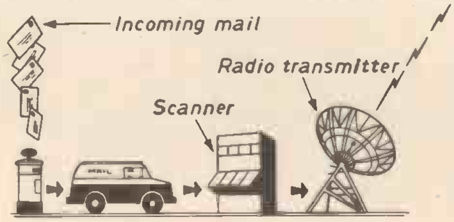


Fig. 2.—How an "orbital post office" would work.

Transoceanic Communications

It would appear that these experiments will ultimately lead to the use of satellites for transoceanic communications in the future.

Large ground installations would be required to provide a television channel across the ocean. It would need 100 kilowatts of 2,000 megacycles microwave power. It would require 150ft. antennas. But these things, or parts of them, are already being done by the Bell Telephone Company for other reasons.

While such installations would be expensive, the equipment is all on the ground where it can be installed and repaired, and changed, if necessary. Aloft, would be merely a number of 100ft. spheres or balloons in orbit. Attempts to put a balloon into orbit are being made at present.

Fig. 3.—The base for a low-noise horn antenna under construction at the satellite communication station site at Holmdel, N.J.

Evolution of the FUEL CELL

The revolutionary hydrogen/oxygen fuel cell put into perspective by F. Colin Sutton

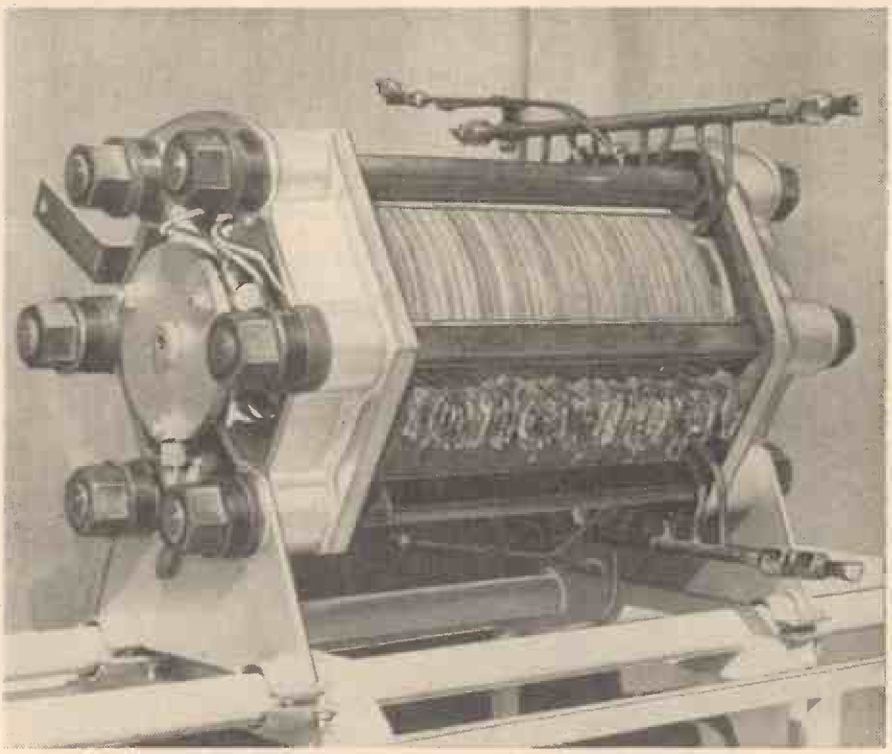
BEFORE we describe the various types of voltaic or electrolytic cell it would be as well to establish the fundamental principles underlying the electro-chemical processes involved.

Principle of Electrolysis

When a current of electricity passes through a solution of a salt or an acid some of the dissolved substance is carried to the points where the current enters and leaves the solution. The vessel in which this reaction takes place is called the electrolytic cell and the solution is known as the electrolyte. This electrochemical reaction is known as electrolysis and the conductor by which the current enters the cell is called the anode and that by which the current leaves the cell is known as the cathode.

As an illustration of the basic principles governing electrolysis, consider the experiment shown in Fig. 1. The three cells are connected in series with a battery and the contents of each cell are as named. The anodes are marked positive and the cathodes negative and the current travels from positive to negative in each cell.

When the current passes through the first cell it is found that a certain quantity of copper is deposited on the cathode and the same quantity of copper goes into solution from the anode. When the current passes through the second cell, a certain quantity of silver is deposited upon the cathode (negative electrode) and exactly the same quantity of silver goes into solution from the anode, or positive electrode. Finally, when the current passes to the third cell, oxygen is evolved at the anode and hydrogen at the cathode. Moreover, if the respective gas bubbles are caught over inverted tubes placed over the two platinum electrodes, it will be found that the volume of hydrogen collected from the cathode is exactly twice the volume of oxygen that has been trapped in the tube suspended above the anode. In other words, the quantities of copper and silver deposited and the quantities of oxygen and hydrogen evolved are proportional to the quantity of electricity that passes and are independent of the size and shape of the cells and electrodes or of the concentration of the solutions.



A 3kW. power unit utilising 40 hydrogen/oxygen cells linked in series.

From these facts Faraday formulated two fundamental laws:

1. The mass of any substance liberated is proportional to the amount of electricity that passes.
2. The mass of any substance liberated by a given quantity of electricity is proportional to the chemical equivalent of that substance.

Before proceeding to a description of different types of cell let us consider for a moment a very elementary type and show why such a cell would not fulfil industrial requirements.

Consider the reactions arising from the simple case of a copper plate and a zinc plate immersed in a dilute solution of sulphuric acid contained in a glass vessel. The two plates will be at different potential and if this difference were measured it would be found to be 1·8V., the copper plate being at the higher potential. Provided that the surfaces of both plates were of perfectly pure metal, no bubbles would be found on either plate.

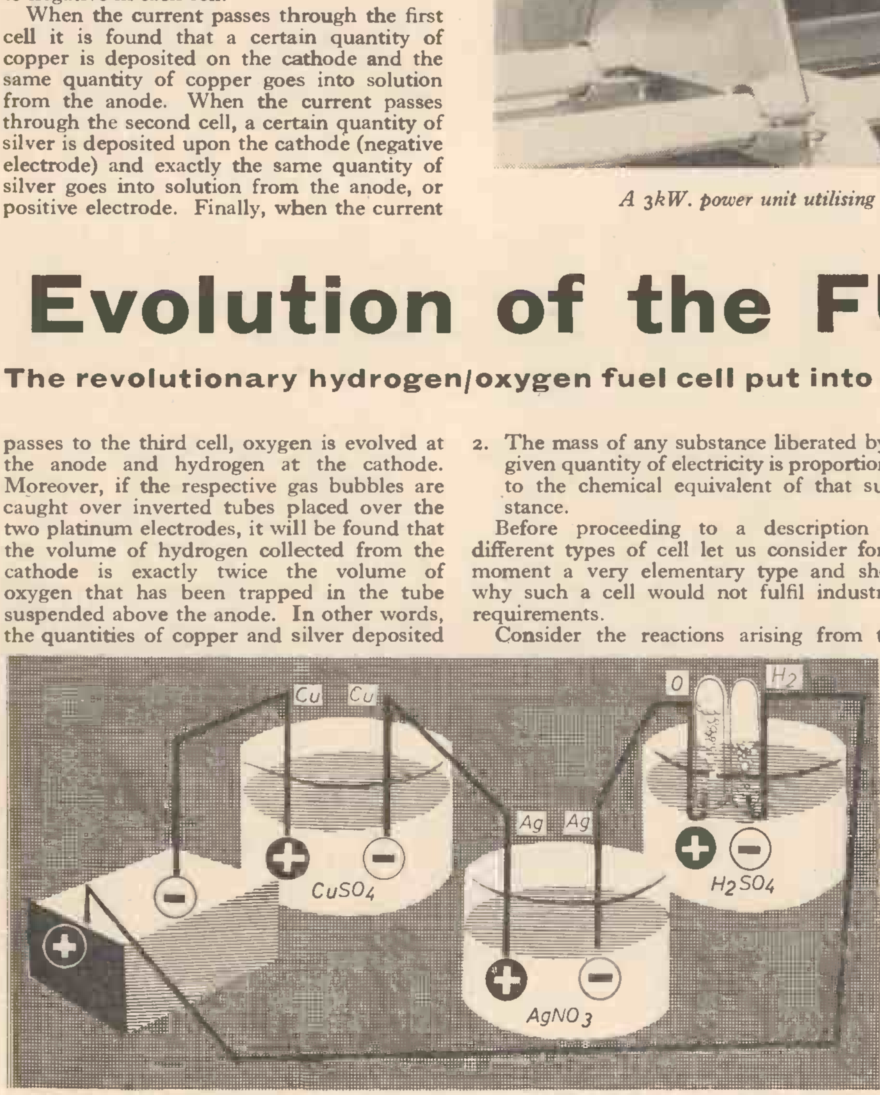


Fig. 1.—The basic principles of electrolysis.

If, however, the copper plate and the zinc plate were connected electrically by a wire, then a current would flow from the copper plate through the wire to the zinc plate and a mass of bubbles would emanate from the copper plate and the zinc plate. This arrangement then becomes a cell and from it a current of electricity can be obtained.

$$H_2SO_4 \rightarrow SO_4 + H_2$$

$$ZN + H_2 + SO_4 \rightarrow ZnSO_4 + H_2$$

The H_2SO_4 molecules dissociate (in dilute solution) to SO_4 and hydrogen ions, the SO_4 attacks the zinc, forming zinc sulphate, and the hydrogen ions are evolved as gas on the copper plate.

It is the energy given out by this chemical reaction that maintains the output of current.

However, there is a limit to the duration of the vigour of this reaction, for gradually the copper plate becomes coated with hydrogen bubbles. This has a double effect. It increases the resistance of the cell by virtue of an increasing area of copper becoming coated with hydrogen bubbles and thus diminishing the effective area of copper, and it also lowers the E.M.F. (voltage) of the cell. The cell is then said to polarise. If some means is taken to remove the bubbles from the surface of the copper, as for instance by agitation, then the cell becomes depolarised and the reaction starts again with renewed vigour.

It follows, therefore, that an effective cell must possess within itself the power of depolarisation.

The Leclanché Cell

This well-known cell is illustrated in Fig. 2. Here depolarisation takes place through the agency of manganese dioxide. The carbon electrode in the centre is encased in a conglomerate of manganese dioxide and powdered carbon. This unit stands within a porous pot. The interspace between the porous pot and the glass sides of the cell contains ammonium chloride as the electrolyte. A zinc electrode dips into the electrolyte. When the chlorine ion attacks the zinc electrode, forming zinc chloride, the ammonia ion (from the ammonium chloride), which is liberated at the carbon plate, dissociates into ammonia, which dissolves in the solution, and hydrogen which reacts with the manganese dioxide to form water and manganous oxide.

In spite of this the cell polarises rather quickly, but after a rest it recovers. It possesses the advantage that the current does

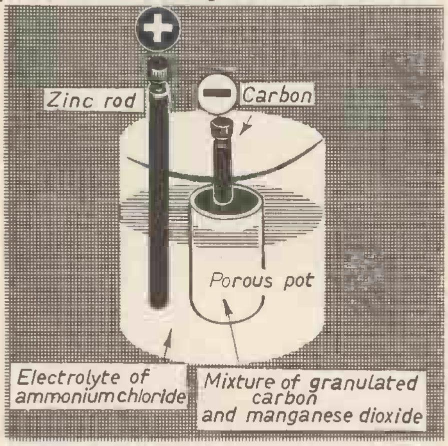


Fig. 2.—The Leclanché cell.

not attack the zinc when no current is passing. It is, therefore, a cell that is used for intermittent duty, such as electric bells, telephones, etc.

The Daniell Cell

This is an example of a cell where depolarisation is much more effective and a very constant E.M.F. is given, but the chemical reactions do not stop when the circuit is broken and it has to be dismantled when not in use.

It consists of a zinc rod as the negative plate and this dips into a porous pot containing a solution of sulphuric acid. This pot is placed within a wider copper vessel which contains copper sulphate. The porous pot prevents the two fluids from mingling. The copper vessel is itself the positive plate of the cell.

The sulphuric acid is decomposed into hydrogen and SO_4 ions. When a current passes the SO_4 ions attack the zinc, forming zinc sulphate, and the hydrogen ions pass into the copper sulphate forming sulphuric acid and liberating copper ions. These are deposited upon the copper plate and there is no polarisation. Had hydrogen bubbles been deposited upon the copper cell, then polarisation would have taken place. The E.M.F. of the Daniell cell is 1·08V.

Bichromate Cell

In the bichromate cell the positive pole consists of two carbon plates linked together electrically and between which is the negative zinc plate. The resistance of this cell is low because the plates are placed close to one another. The electrolyte is a mixture of potassium bichromate and sulphuric acid. The sulphuric acid attacks the zinc, liberating hydrogen. The hydrogen ions travel to the carbon plates, give up their charge, and are oxidised by the bichromate to form water, the bichromate thus acts as a depolarising medium. The zinc electrodes are lifted up out of the liquid when not in use. The E.M.F. of this cell is about 2V.

The Cadmium cell is used as a standard reference cell and is not used to give current productively. Its E.M.F. is very constant at 1·018V. and remains so for years. The cell consists of various substances contained in an H-shaped glass vessel with platinum electrodes sealed through the glass (Fig. 3).

The Storage Cell or Battery

A variation of the electrolytic cell is the storage cell or battery, as used in motor cars. This is used to store a charge of electricity and when this charge is nearly exhausted, it is re-energised up to strength again from an outside power source.

In the storage cell lead grids replace plates and the electrolyte consists of 10 parts of water to one part of sulphuric acid, and the interstices in the grids are filled with lead sulphate before charging, and after charging the interstices in the positive grid are filled with lead peroxide, while the negative grid is filled with a porous spongy lead. In the charging process the SO_4 ions travel to the anode and form lead peroxide as shown in the following equation:

$$PbSO_4 + 2H_2O + SO_4 = PbO_2 + 2H_2SO_4$$

The E.M.F. of a freshly charged storage cell of this type is 2·1V. and it yields 75 to 80 per cent. of the energy spent in charging it. The test for knowing when to stop charging an accumulator is to note when all the lead sulphate on the negative grid is converted into lead; for at this point hydrogen gas starts being given off and the cell ceases to work reversibly.

The basic difference between the primary voltaic cell, the secondary cell and the electrolytic cell is that in the first of them the

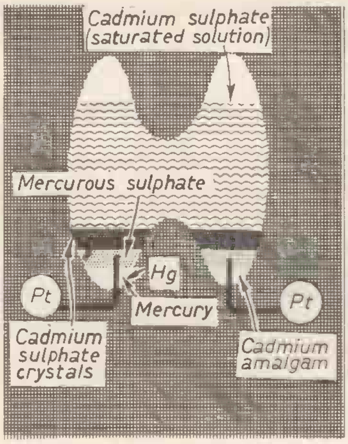


Fig. 3.—The cadmium cell.

chemical change is autogenous, in the second the current sets up the chemical reaction change during charging and the chemical reaction continues when the cell discharges; while in the case of the electrolytic cell the conditions are neutral in relation to chemical change.

The capacity of a cell is measured in ampère-hours or in milliampère-hours (Fig.4).

In recent years there has been considerable development in the manufacture of dry cells. Some have an E.M.F. of 1·7V. and give 112 A.h., a current of 1A., and have a negligible resistance. In addition, high-tension batteries can be obtained with E.M.F.s as high as 150V., this high current being obtained through linkage of a lot of small cells in series.

Hydrogen-Oxygen Fuel Cell

We now come to consider the latest development of generating electrical energy by non-mechanical means. This unit is known as the hydrogen-oxygen fuel cell. In principle it is simple; for it depends upon the opposite effect to that of the electrolysis of water. It is the invention of Mr. F. T. Bacon, of Cambridge, and possesses several very ingenious features.

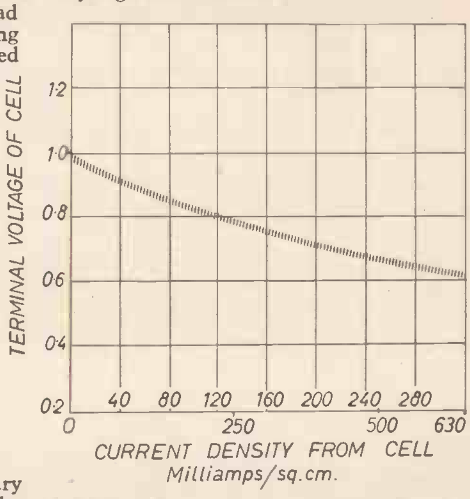


Fig. 5.—The characteristics of a single fuel cell.

The cell contains the conventional two electrodes, one of which is supplied with hydrogen and the other with oxygen. An ingenious method of ensuring as large as possible effective surface area has been achieved by fashioning the electrodes from porous metal.

If it can be imagined, by way of illustration, that each electrode is of an infinitely small honeycomb structure it can be understood how the effective surface area is multiplied many times by the number of interfaces on to which the hydrogen and oxygen gases can be adsorbed. The use, therefore, of porous metal for the electrodes is a step towards the honeycomb conception.

Between these two electrodes is a solution of potassium hydroxide. This serves the normal function of an electrolyte; it has very low resistance and allows the separation of the molecular forms of the two gases and facilitates the passage of the ions from one electrode to the other and carries an electric charge with them.

At the oxygen electrode some of the gas which has been absorbed on to the surface of the electrode reacts with water according to the following reaction:

$$\underset{\text{water}}{H.OH} + \underset{\text{oxygen}}{O^{2-}} \longrightarrow \underset{\text{hydroxyl ions}}{OH^-OH^-}$$

The two hydroxyl ions migrate to the other electrode where they combine with the hydrogen adsorbed on its surface:

$$\underset{\text{hydroxyl ion}}{OH^-} + \underset{\text{hydrogen}}{H^+} \longrightarrow \underset{\text{water}}{H.OH}$$

Thus, electrons, negatively charged, are accumulated on the hydrogen electrode and are lost from the oxygen one.

If the cell is left in this condition the hydrogen electrode becomes negatively charged with respect to the oxygen electrode

(Concluded on page 462)

Battery Type	Pos.	Neg.	Electrolyte	Cell Potential Open	Cell Potential Discharge
Lead-acid	PbO_2	Pb	H_2SO_4	2·14	2·1 to 1·46
Nickel-iron	NiO_2	Fe	KOH	1·34	1·3 0·75
Nickel-cadmium	NiO_2	Cd	KOH	1·34	1·3 0·75
Silver-zinc	AgO	Zn	KOH	1·86	1·55 1·1
Silver-cadmium	AgO	Cd	KOH	1·34	1·3 0·8

Fig. 4.—This table gives the characteristics of five common battery types, and is reproduced by kind permission of the Editor of "Product Engineering."

MAMBA Control-line Racer

By David Beavor

Full Plans & Details

Eligible for class A racing and conforming to F.A.I. specification

THIS model is designed for the control-line enthusiast and anyone else associated with model aircraft flying clubs, where the advice of experienced control-line flyers can be obtained. Although simple to build, this is not a beginner's model. The prototype already has one Concours d'Elegance to its credit in a competition which covered the whole of Surrey A.T.C. As an illustration of its flying capabilities, it has already reached 90 m.p.h.

Construction

Start by cutting out the wing, which is in two pieces; one full span 34½in. × ⅜in. and the other 25in. × 1½in., at the widest point ¼in. thick. Glue the two pieces together and allow to dry, then taper the section of the wing from ⅜in. at the root to ¼in. at the tip. Use a small plane and cut from the underside only. Cut templates from the sections shown on the plan and shape the wing to the correct contour, finishing with fine glasspaper.

The fuselage during construction.

A slot is cut in the centre section of the wing to accommodate a piece of hardwood ⅜in. × ¼in. × 2in. and another in the port wing for a piece of ⅛in. plywood (lead-out guide). Drill the hardwood 6 BA for the bellcrank pivot bolt and also drill the plywood lead-out guide as shown on the plan. Glue both pieces in position. Insert a ½oz. weight into the starboard wingtip and glue a small silk or nylon patch on to hold it in place.

Cover the whole wing with lightweight tissue (rag) doped in position and allowed to dry. Apply a coat of sanding sealer and rub down with flour paper.

The Fuselage

Cut out the fuselage sides, formers, cowl, block, crutch and plywood insert, which are all marked on the plan. F1 is ⅛in. plywood and must be drilled 6 BA for J-bolts as shown. Assemble F2, F3 and F4 to the crutch and allow to dry: check that the formers are square with the crutch. Glue on the fuselage sides, holding them in place with rubber bands while the glue dries.

Bend the undercarriage to shape, as shown in the plan (bottom right), and make the J-bolts. Bolt the undercarriage to F1 and glue into the fuselage. A small plywood insert, tapered to fit, is glued between the fuselage sides, rubber bands holding it while it dries.

Cut out the nose block and glue in place. Cut out the trough fairings (handed) and underside of cowl, then glue the trough in place, followed by the cowl bottom and finally the trough fairings.

As shown in the plan, glue a small piece of plywood to the rear of the fuselage where the rear anchor bolt comes through and a piece of ⅛in. plywood to reinforce the tailskid. Sand down smooth and cover with lightweight tissue, doped on. Give one coat of sanding sealer and rub down with flour paper. A small blob of solder on the nuts on the J-bolts will stop them undoing.

The Fuselage Top

This consists of a block of balsa, two engine bearers ½in. × ⅜in. and two pieces of ¼in. × ¼in. balsa which are fitted together with the engine bearers and the wings, which are already shaped. Cut the block to shape first and then hollow it out where the wings pass through to the exact contour required. Then hollow out as shown fore and aft of the wings. Cut a small slot (shown dotted in the plan) into the rear of the block for the 1/16in. plywood fin.

The engine bearers are cut and shaped to fit the underside wing contour (see plan). The port engine bearer has two slots cut in the underside for the lead-out wires; the starboard bearer has its inside radiused for bellcrank clearance. Both bearers are drilled 6 BA for engine mounting bolts, although bolt holes will vary according to the engine used (see plan). Cut the two strips of ¼in. × ¼in. balsa, and shape the end so that the strip follows the plan outline and meets at the tail with a mitre joint.

Underside view.

Assembly of Fuselage Top

Insert one 6 BA bolt for bellcrank pivot in the centre section and glue the wing in place. Make sure that the wing is horizontal and allow to dry. Two 6 BA bolts will be needed for each engine bearer. Cut a small piece of 22 s.w.g. wire to fit across the bolt heads, and solder it into the slots in the heads. The fuselage block will need hollowing out carefully where the bolts meet the block. Glue the engine bearers in place and allow to dry. Then drill through both the block and engine bearers 1/16in. dia. and glue the dowel rod in place. Glue the ¼in. × ¼in. balsa strip in place, holding it with pins to the correct contour, and allow to dry. Sand the top to its final shape, dope the tissue on and allow to dry. Then give one coat of sanding sealer, allow to dry, and rub down with flour paper.

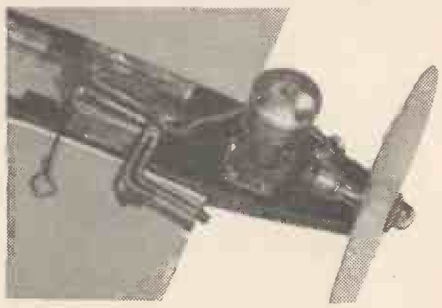
The Fin

Cut the fin from 1/16in. plywood and sand to shape on the port side only. Glue the fin in place in the slot provided (see plan). Cover with the lightweight tissue, doped on, and allow to dry. Give one coat of sanding sealer then rub down with flour paper.

Cut a 1/16in. plywood spinner disc (see plan). Cut out the centre of the disc, then cut it in half. Glue one half to the fuselage top and the other half to the underpan.

Tailplane and Elevator

This unit is cut from one piece of ⅛in. obechi 4in. × 17½in. Shape the tailplane and sand to the correct contour. Cut away the elevator and drill 6 BA where shown. Cut the tape hinges in pairs and glue one set to the upper side of the tailplane, the others to the upper side of the elevator. Mount the elevator in place and glue upper tailplane hinges to lower elevator side and upper elevator hinges to underside of tailplane.



Close-up view of the engine.

Controls

From a piece of 16 s.w.g. duralumin, cut out the bellcrank and elevator horn. Drill the places marked on the plan. Bend the elevator horn as shown and fix to the elevator with a 6 BA bolt. The push-rod is of 16 s.w.g. spring steel wire and should be bent as shown. The lead-out wires are from 22 s.w.g. spring steel wire and should be passed

SPECIFICATION

ENGINE = 2·5 c.c. MAX.	TANK = 10 c.c. MAX.	WING AND TAIL AREA = 186 sq. in.
WHEEL DIA. = 1·5 in.	LINE LENGTH = 52 ft. 3 in.	MAX. WEIGHT = 24·69 oz.
COCKPIT DEPTH = 3·94 in.	COCKPIT WIDTH = 1·97 in.	PILOT'S HEAD = ⅞ in. MIN.

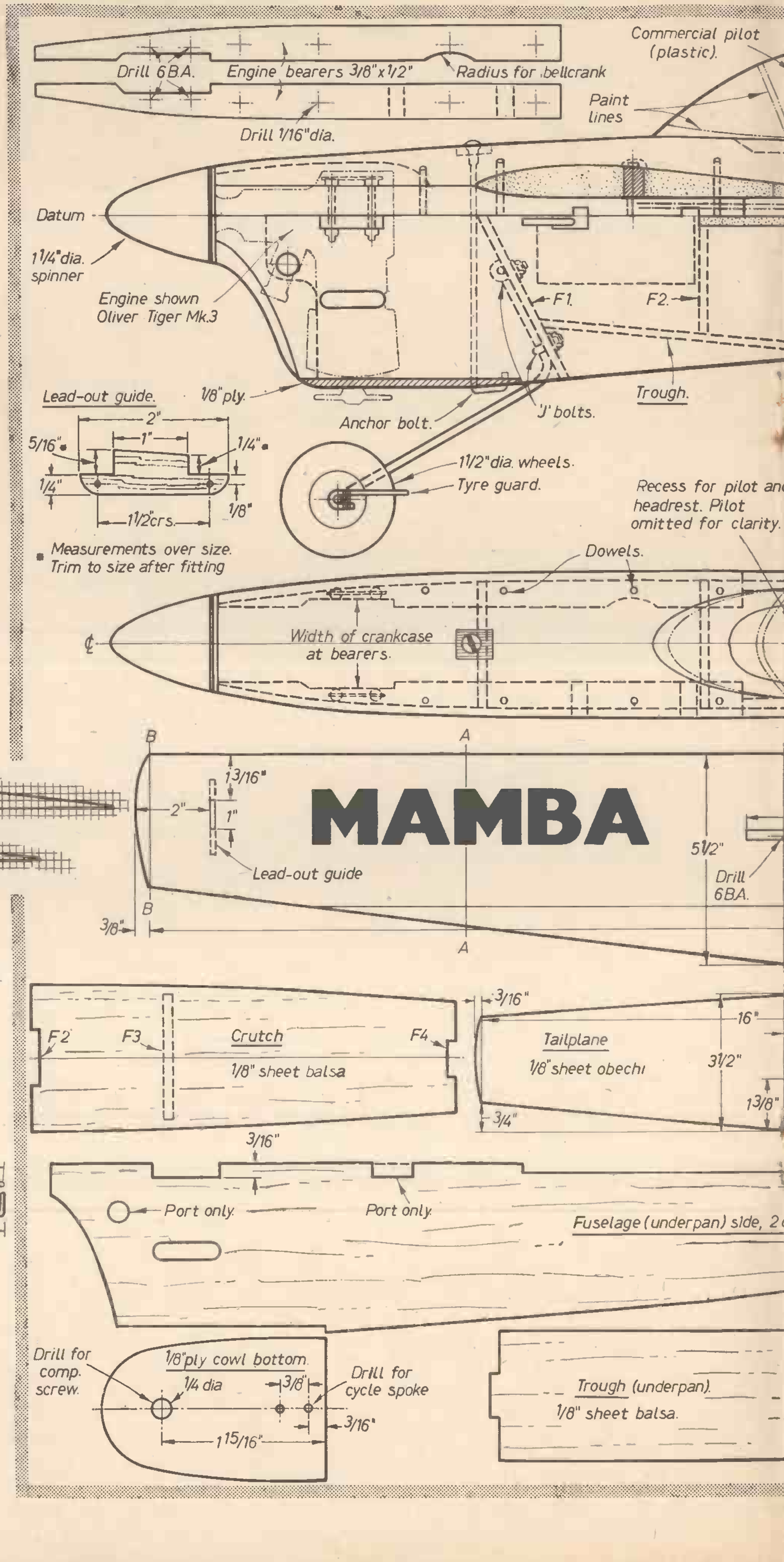
This spec. is for F.A.I. and S.M.A.E. " A " Racers known as the international class.
All measurements are minimum and should not be under this on the aircraft when built, unless otherwise stated

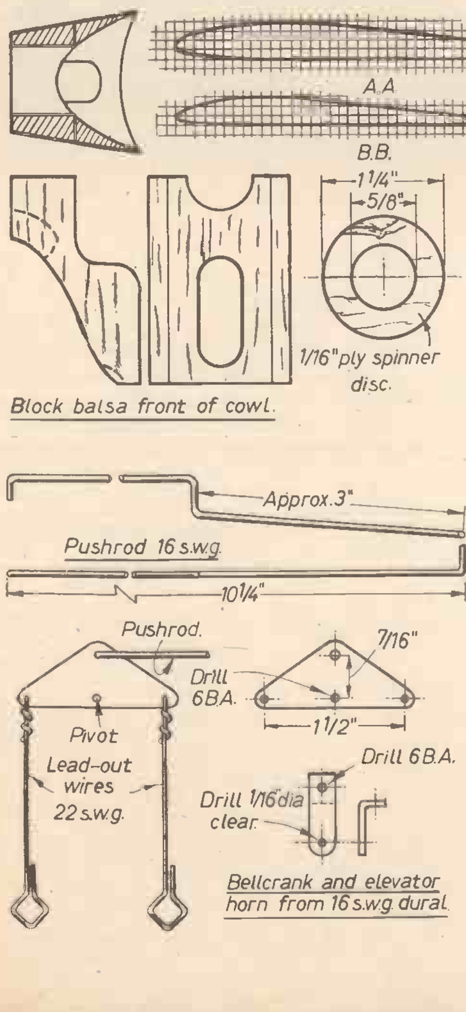
through the points indicated (see plan) and twisted to secure. The outside ends should be bent to a diamond with about ¼in. running parallel to the wire (see plan). Before bending a small piece of plastic tubing should be passed onto the wire. This is to bind the main shank to the ¼in. end. Insert the push-rod from the top of the bellcrank and solder a washer in place to stop it coming free. Insert the end into the hole in the elevator horn, fit a washer and solder. Bolt the elevator horn to the elevator with a 6 BA bolt. Mark the position of the tailplane on the fuselage top block, then screw it in place with four ½in. woodscrews. Fit the bellcrank to the pivot bolt, attach the nut and put a small blob of solder on the nut to stop it coming free. There is a nut on either side of the bellcrank, one to lock the bolt and the other to lock the bellcrank; both should be soldered. Check the controls for equal movement and if there is any variation a small adjustment at the bend of the push-rod can be made. A slight error in the bending will give you unequal movement.

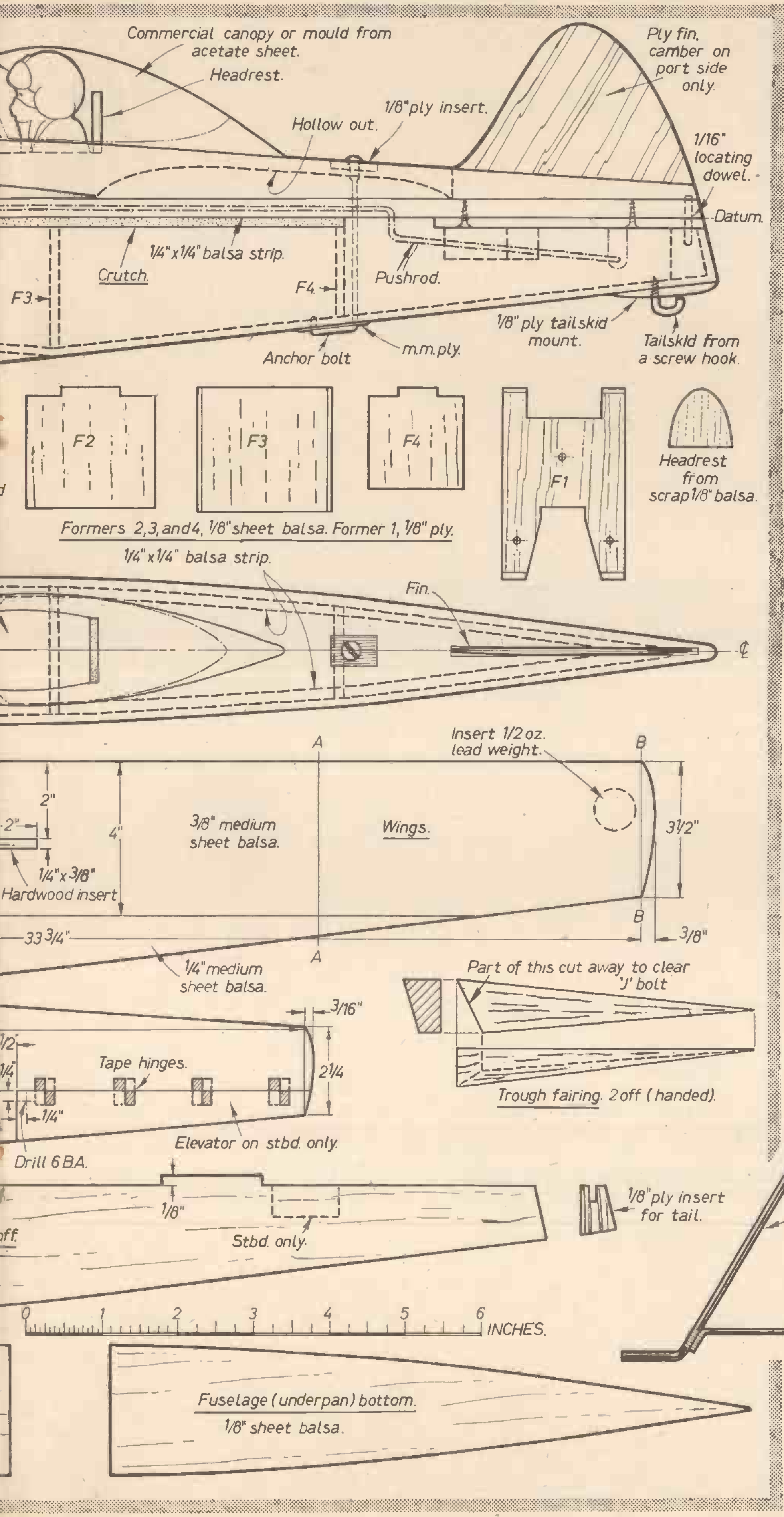
The Tank

This is a 10c.c. tank and must not exceed the measurements given. There are two vents which are soldered to the outside and a right-angle feed pipe which goes to within ¼in. of the rear wall of the tank. The feed pipe must not be less than 1/16in. from the side wall and the bottom of the tank.

The tank is formed from shim brass or tinplate and all joints must be well soldered. It is made in two pieces, a wrap round piece which forms the sides and top of the tank, and another piece which forms the back, bottom and front of the tank. These pieces are shown on the right of the plan. A small piece of shim brass or tinplate should be cut and two slots cut in the ends, large enough to take two ¼in. woodscrews, for mounting the tank to the fuselage. This is soldered to







the top of the tank. It will need bending slightly to clear the bellcrank pivot bolt. The idea of the tank being adjustable is so that the feed to the engine may be modified. Mount the tank centrally in the fuselage.

Checking the Assembly

A small piece of $\frac{1}{16}$ in. dowel rod should be glued into the top half of the fuselage and should locate in the slot in the plywood insert described earlier (see plan). Fit the two halves of the fuselage together, check for alignment, then drill two holes in the top of the fuselage for the two anchor bolts (see plan). These holes should first be reinforced with ply- or hard-wood scrap. The anchor bolts are made from cut down cycle spokes and should be bent and fitted as shown in the plan through the underpan bottom and through the fuselage top. Keep the spoke just short of the top.

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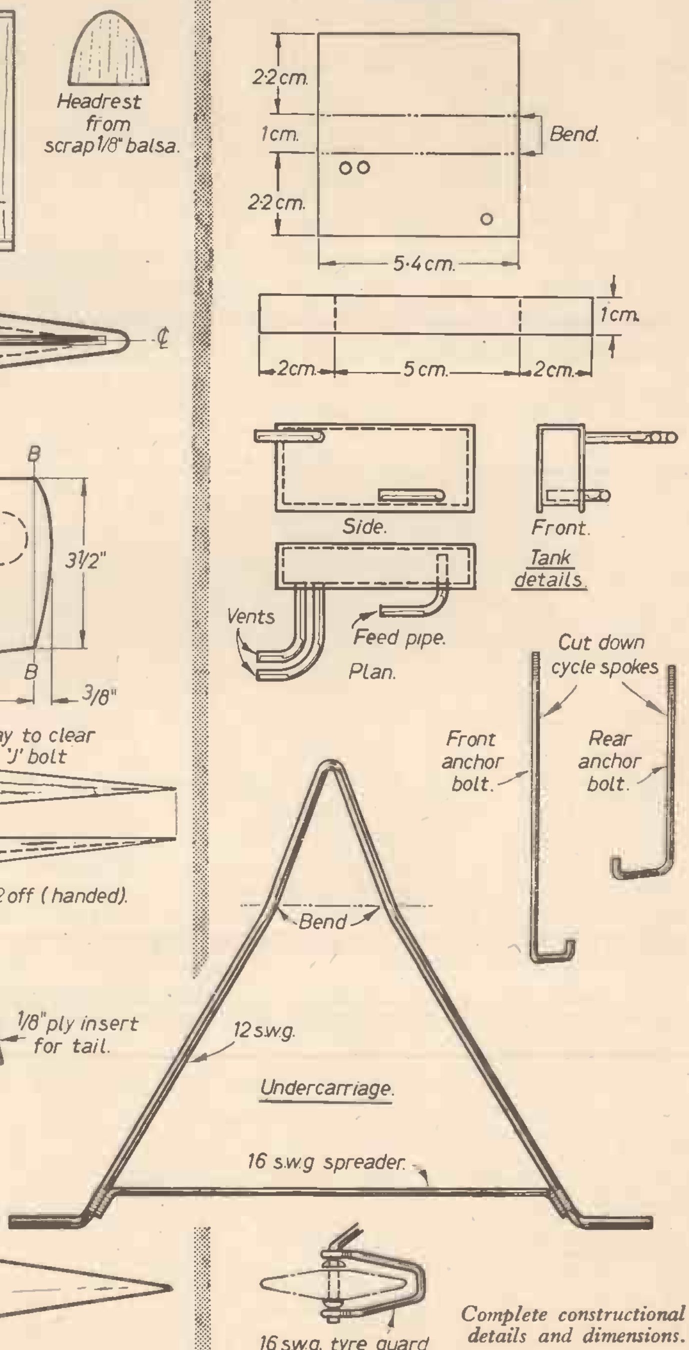


Complete constructional details and dimensions.

Water on VENUS

and planetary spectroscopy discussed by

V. A. Firsoff, M.A., F.R.A.S.

IN March the Johns Hopkins University of Baltimore, U.S.A., issued a dramatic announcement of the discovery of water vapour in the atmosphere of Venus. This announcement is *dramatic* not only by reason of its far-reaching consequences for our ideas about the conditions on our nearest planetary neighbour and possibility of life there; but also because it throws a sharp light on the unreliability of our ideas about planetary atmospheres in general.

Spectroscopy Difficulties

The difficulty of detecting gases which are abundant in our air in the atmospheres of other planets has long been realised. In passing through an atmosphere sunlight suffers differential absorption by its component gases, so that the spectrum of the light reflected from an atmosphered body shows dark gaps in addition to the so-called Fraunhofer lines appearing in the solar spectrum and due to absorption by the Sun's own atmosphere. If a gas in the atmosphere of the observed planet is scarce in or absent from both the solar and the terrestrial atmosphere, there is no trouble—the lines or molecular bands caused by it in absorbing the appropriate wavelengths of light will stand out clearly and unmistakably. This is the case with methane and ammonia on the giant planets. Neither gas is present on the Sun and they occur only as negligible traces in our air.

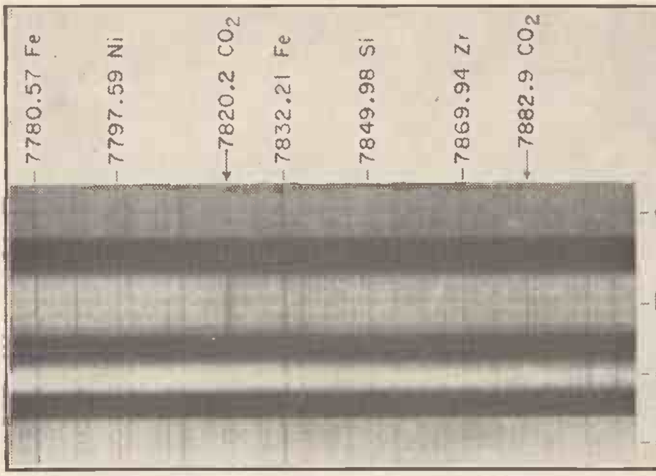
Carbon dioxide is also absent from the solar spectrum, but it does produce absorptions, especially in the infra-red, in our air. These telluric absorptions, however, are comparatively weak owing to the scarcity of carbon dioxide, which forms only about 0·03 per cent. of our atmospheric mixture. On Venus carbon dioxide is very abundant; less so on Mars, where its amount in the line of sight is twice that in our air similarly computed. As a result the telluric lines due to carbon dioxide are considerably strengthened and CO_2 could be detected in the spectra of both planets without any special difficulty.

When, however, it comes to water vapour and oxygen, or ozone, things become really tricky, for these gases produce very strong telluric absorptions, whilst nitrogen which composes the bulk of our air has no absorptions in the accessible part of the spectrum and is totally undetectable by this method.

If the absorptions in question were very strong in a planetary spectrum they still *ought to* produce a noticeable broadening and darkening of the corresponding telluric absorptions. Practice, however, does not always tally with theory and any such darkening or broadening is extremely difficult to determine. Dr. Kuiper did find water vapour above the polar caps of Mars, but otherwise this method has proved wholly barren.

Two Solutions

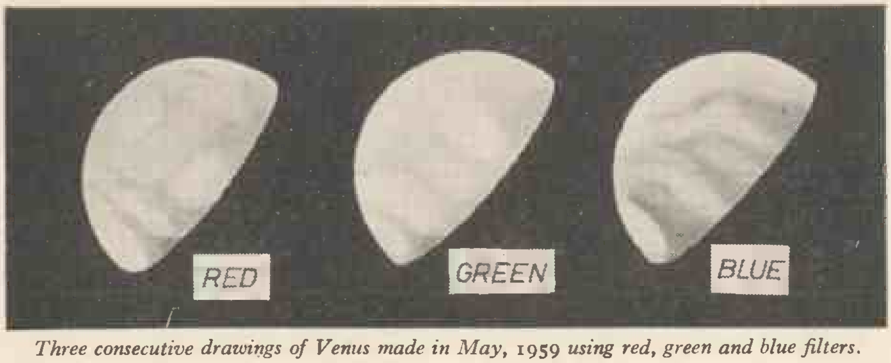
There are two ruses by which one can get round the obstacle. The one consists in photographing the spectra of, say, Mars and the Moon when both are at the same altitude above the horizon. The Moon is assumed to be airless, or at any rate to cause no detectable absorptions. If, therefore, the spectrum of Mars shows anything in excess of the lunar spectrum, one can be sure that the difference is wholly due to the presence of some gas on Mars. Thus, for instance, Dr. Kuiper obtained an infra-red spectrum of Mars and the Moon. The spectrum of the Moon showed a little *more* water vapour than Mars. Therefore, there was *no* detectable water vapour in the atmosphere of Mars, presumably because the polar cap was unfavourably placed for observation.



Spectra of Mars, Venus and the Moon. The carbon dioxide lines at 7820·2 and 7882·9 appear in the spectrum of Venus but not in that of Mars or the Moon. (a) *Mars* (b) *Venus* (c) *Moon. These spectra were obtained before the observations mentioned in this article were made.*

The other ruse is obtaining the spectrum of a planet at the moment of its maximum approach or recession in the line of sight, which causes a Doppler shift in the positions of the absorption lines. Again this is very simple in theory, but in practice the relative movement in the line of sight between the Earth and the planet is never sufficiently rapid (the maximum for Mars is 3·1 m.p.s.) to cause a shift sufficient to separate the lines altogether. The best one can hope for is perceptible broadening. Here, however, neither the eye nor the camera are wholly reliable.

The accuracy of the two methods has been estimated from theory and claims have been made that if, say, there had been this or that much water vapour or oxygen on Mars or Venus these would have been detected and, therefore, the actual atmospheric abundance of these gases must be less.



Three consecutive drawings of Venus made in May, 1959 *using red, green and blue filters.*

Mars showed some doubtful traces of oxygen and a little water vapour was found on Mars, none of either on Venus.

Venusian Cloud Composition

This gave rise to a crop of various hypotheses as to the possible composition of the clouds veiling the surface of Venus. Rupert Wildt suggested polymerised formaldehyde, Fred Hoyle oil droplets, G. P. Kuiper carbon suboxide (C_3O_2), Dauvillier ammonium nitrate (NH_4NO_2), Ernst Öpik finely ground sand raised from the desert surface by fierce winds. . . .

A few astronomers demurred and favoured water droplets and/or crystals, after all, as the most likely substance for Venusian clouds.

Our stratosphere is very cold (about —60 deg. C. on the average), so that any water vapour penetrating there is almost completely frozen out. Consequently, if planetary spectrograms could be obtained from above the troposphere, to which water vapour is largely confined, any *traces* of water vapour on other planets might be discovered.

Balloon Study

In November 1959 in the U.S.A., Commander Ross as pilot and C. B. Moore as scientific observer made an ascent in a stratospheric balloon to study Venus. They had some trouble with the gondola, but succeeded in securing three observations of Venus, which all showed a strong positive reaction for the 13,000 Å water band in the infra-red.

The amount of water vapour over the clouds of Venus was found to be substantially the same as above the high clouds on the Earth. This leaves no reasonable doubt that the clouds of Venus have similar composition and that Venus has a hydrosphere comparable to our oceans.

This comes as something of a shock to the adherents of the views advocated by Dr. Öpik and some others, and it has various consequences. Thus it has been known for some time that if the atmosphere of Venus contained water vapour in anything like the terrestrial amount the temperature of the surface could not be very high. For, although Venus receives about twice as much heat and light from the Sun as does the Earth, it also reflects more and absorbs less of this increased amount, namely about 25 per cent. as against 65 per cent. absorbed by the Earth.

A dark body depending for its heat supply on the Sun can radiate neither more nor less heat than it receives, or else the state of

(*Concluded on page* 462)

SHIPS' STABILISERS

What they achieve and how, described by David A. Watt

MANY attempts to overcome rolling have been made in the past, but it is only in recent years that a really effective method has been found.

The Action of Rolling

Let us consider what happens when a ship rolls. Fig. 1(a) shows diagrammatically a section through a ship's hull when it is in a stable condition in still water. The weight (W) of the ship acts vertically downwards through the centre of gravity (G) and is resisted by the upthrust due to the water displaced by the ship which is equal to the weight of the ship and acts vertically upwards through the centre of buoyancy (B). Fig. 1(b) shows the same ship listed to starboard. (M) is a point on the vertical line through the centre of gravity in the initial position known as the metacentre or " measuring centre." In geometrical terms it is defined as the intersection of a vertical line through the centre of buoyancy in the initial position with a vertical line through the centre of buoyancy in a slightly inclined position. The position of (M) is very important when designing a ship as it is the point above which the centre of gravity must not be raised if the ship is to remain in stable equilibrium.

In Fig. 1(b) the ship is no longer in equilibrium and the forces due to the weight of the ship acting downwards at (G) and the buoyancy acting upwards at (B) produce an anti-clockwise turning moment tending to return the ship to the original position of 1(a). Similarly, Fig. 1(c) shows the effect of listing the ship to port. It follows that, in order to make the ship list either one way or the other, a turning moment must be applied. This is in effect just what the action of a wave does to a ship.

Figs. 2(a) and 2(b) show how a wave travelling at right angles to the path of a ship causes the centre of buoyancy to move relative to the centre of gravity. As we saw earlier, this creates the condition required to make the ship roll. Obviously, the degree of rolling and frequency depend upon the distance between the wave crests the height of the crests and the distance between the ship's centre of gravity and centre of buoyancy.

Anti-Rolling Devices

Having considered how the rolling is caused, the obvious solution is to provide a turning moment of equal magnitude and opposite direction to that caused by the wave.

The first attempt to do this was by arranging two tanks one on each side of the ship and connected together by a narrow channel as shown by Fig. 3. These tanks were half filled with water so that when the ship rolled the turning moment was reduced due to the movement of the water in the tanks. The effect of this arrangement was not nearly as great as expected, and as these water tanks caused a serious reduction in cargo carrying capacity for a very small improvement the idea fell out of favour.

Another unsuccessful idea was to install a very large gyroscope in the centre of the ship which was set in motion when the ship started rolling.

When a ship is rolling, the water is moving in relation to the hull as shown in Fig. 4(a). It was discovered that a plate fitted on each side of the ship's hull, as shown in Fig. 4(b), had the effect of retarding this flow of water and acted as a damper to reduce the rolling to a certain extent. These plates are known as bilge keels and are most effective located as shown, running most of the length of the ship. Bilge keels have been fitted to ships for many years as standard practice and until very recently provided the only protection against rolling.

For an anti-rolling device to be effective it must be able automatically to detect a roll and produce a correcting moment of the right value at the right time.

Electro-hydraulic Stabiliser

The first really effective stabiliser was developed during the second world war, and is the " Denny-Brown Electro-hydraulic Stabiliser." This stabiliser can be considered as two major components, the stabilising gear and the controlling mechanism.

The stabilising gear is essentially two fins of aerofoil section

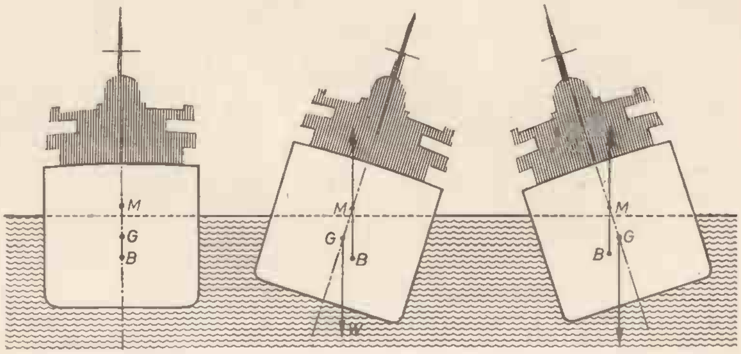


Fig. 1.—(a) Ship in stable condition. (b) Listing to starboard. (c) Listing to port.

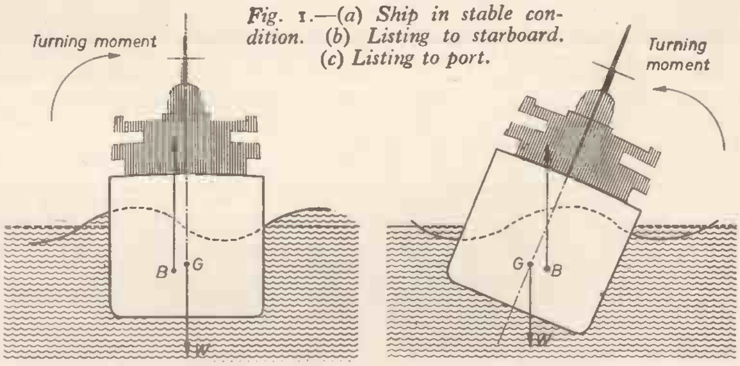


Fig. 2.—Effect of a wave travelling at right angles.

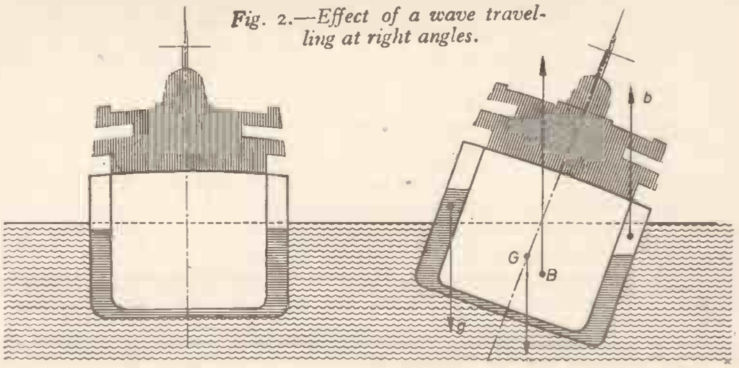


Fig. 3.—Water tank anti-rolling device.

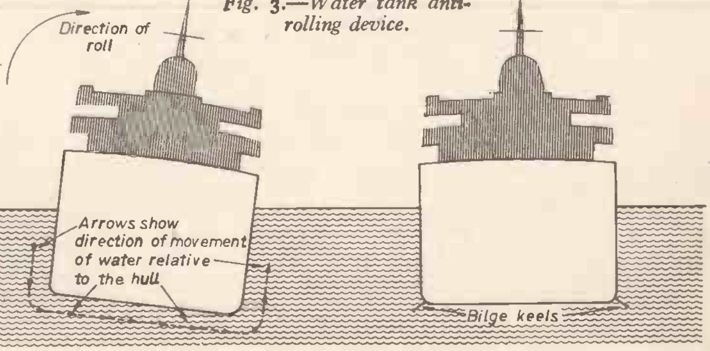


Fig. 4.—The effect of bilge keels.

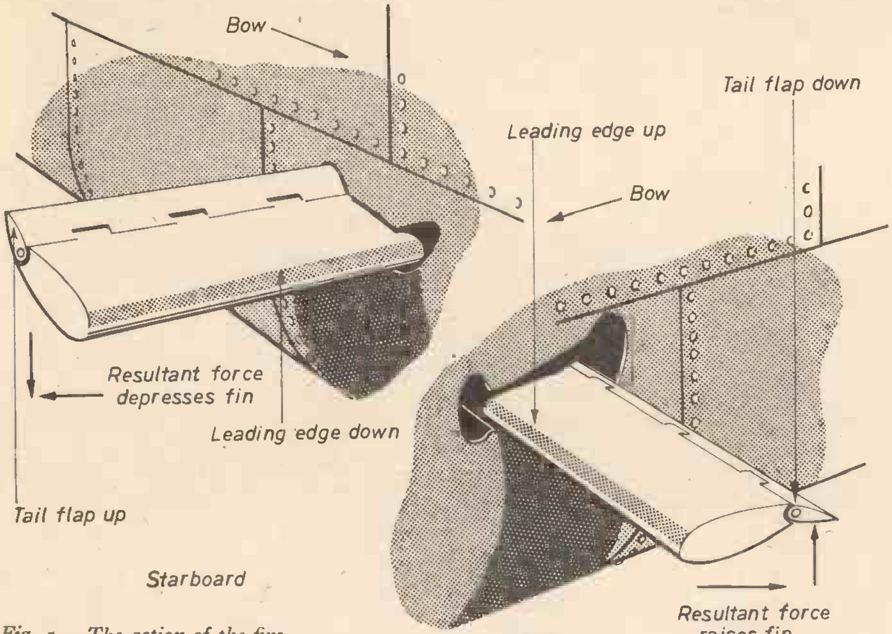


Fig. 5.—The action of the fins.

which, by hydraulic means, can be extended one on each side of the ship and tilted to create a turning moment to right the ship.

The Fins

The action of the fins is shown in Fig. 5, from which it can be seen that if the fins are tilted in opposite directions a turning force is exerted on the ship. In order to minimise the loss of buoyancy caused by the fin box, which is full of water when the fin is extended, a fin of special design was developed. This comprises a fin in two parts, the main fin attached to the fin shaft, and a tail flap hinged to the main fin and connected to the fin box by linkage. This is arranged so that the angular movement of the flap is considerably greater than that of the main fin but in the same direction. Thus, when the fin moves through 10 deg. the tail flap moves through 15 deg. relative to the main fin, giving a total tail flap angular movement of 25 deg. This results in the total deflection of the slipstream of 25 deg.

The photographs, Figs. 6(a) and 6(b) (reproduced by the courtesy of Messrs. Brown Bros., Ltd.), show a typical stabiliser fin and fin box; Fig. 7 shows how the stabilisers are located in the ship.

Actuating Mechanism

Each fin is mounted on a shaft which is bored out to act as a cylinder and fits over a ram or piston anchored at its inboard end to the ship's structure. When it is required to extend the fins, oil from the pumps (A) is admitted to these cylinders and the cylinders move outwards and extend the fins.

Tilting of the fins is achieved by means of oil flow from the variable delivery pumps (A) to the appropriate cylinders (B) in the same manner as a variable speed pump is used to move the rams in an electro-hydraulic steering gear.

When it is required to use the stabilisers the motors for the servo unit (C), the variable delivery pumps (A) and gyro unit (D) are started. The valves (E) which control extending or housing of the fins are operated to extend the fins. When they are fully extended the officer on the bridge closes the circuit from gyro unit (D) to hydraulic relay (F). This operates the control valve behind (C) to cause the variable delivery pumps (A) to deliver oil under pressure to the tilting cylinders (B). Movement of the tilting cylinders is transmitted to the fins via tilting levers (G) and the finshaft. When the angle of tilt predetermined by the gyroscope is reached the cut-off gear (H) stops delivery of oil from the pumps.

Control Mechanism

Once the switch closing the circuit from the gyro unit to the hydraulic relay has been closed, control of the stabiliser is achieved by signals from the gyro unit which are amplified by the hydraulic relay into movements of a lever connected to the valve of the servo unit (D). This control system was originated by Mr. John Bell, M.Sc., M.I.E.E., M.I.N.A., of Muirhead & Co. Ltd.

The gyro unit and hydraulic relay are sometimes referred to as the "brain" and the "heart" of the stabiliser. The gyro unit is in effect an electro-mechanical computer which continuously senses the ship's movement and produces control functions or signals. It combines five functions into one signal to operate the stabilising fins.

These five functions are:

(1) *Roll Angle*—signal to erect vessel; (2) *Roll Velocity*—signal to reduce movement (damping); (3) *Roll Acceleration*—signal to prevent movement building up; (4) *Fin Feedback*—signal to combine with Roll Acceleration to make it more effective; (5) *Natural List*—signal, for economy of power, to stabilise about the mean rolling or listed position if the ship has a list. It can be switched off if stabilisation to vertical is required.

Fig. 8 is a schematic diagram of the control and hydraulic system. Two gyroscopes provide signals proportional to roll angle (vertical keeping gyroscope) and roll velocity (velocity gyroscope). These, together with the natural list and acceleration assemblies, are housed in the gyro unit while the fin feedback signal is derived from a transmitter unit on the finshaft. The photograph, Fig. 9 (reproduced by courtesy Messrs. Muirhead & Co., Ltd.) shows a stabiliser control unit.

The Roll Angle Signal

This is derived from the "vertical keeping gyroscope" which serves in effect as a long pendulum tending to remain vertical as the ship rolls away from the vertical. Use is made of the relative movement of a point on the gyroscope casing and an adjacent point on the moving ship to provide the signal. To do this a magslip is mechanically coupled to the gymbal ring of the gyroscope and provides an electrical output proportional to the angle of the roll.

The Roll Velocity Signal

This is obtained from the "velocity gyroscope." The axis of this gyroscope is horizontal and athwartship, and the plane of the wheel vertical in a fore-and-aft direction. Rolling of the ship causes the wheel and the casing to precess horizontally, the faster the roll the greater the precession. Controlled damping is applied to the precessing casing by paddles in a dashpot, and two spiral springs attached to the casing and pulling in opposite directions centralise its movement. Again the signal is transmitted from the

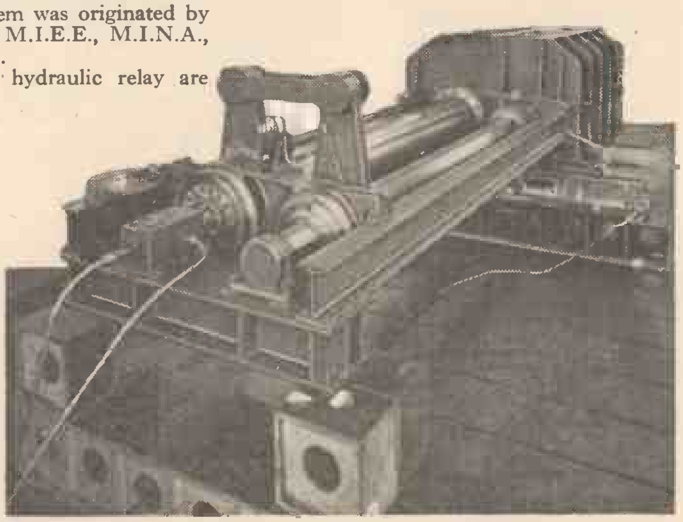


Fig. 6A.—A typical stabiliser, actually in the "Southern Cross."

Fig. 6B.—Stabiliser fin.

gyroscope to the hydraulic relay by means of a magslip.

Roll Acceleration Signal

Roll acceleration provides an early signal from the ship's motion and prevents a roll building up. A mechanical differentiating device receives from the "velocity gyroscope" a movement proportional to the roll velocity and produces a motion proportional to the rate of change of this velocity, i.e. acceleration. This motion is used to operate another magslip.

Fin Feedback Signal

This is derived from a magslip coupled to the finshaft and provides an electrical output which always corresponds to the fin angle. This signal makes the roll acceleration signal more effective and the control generally more sensitive.

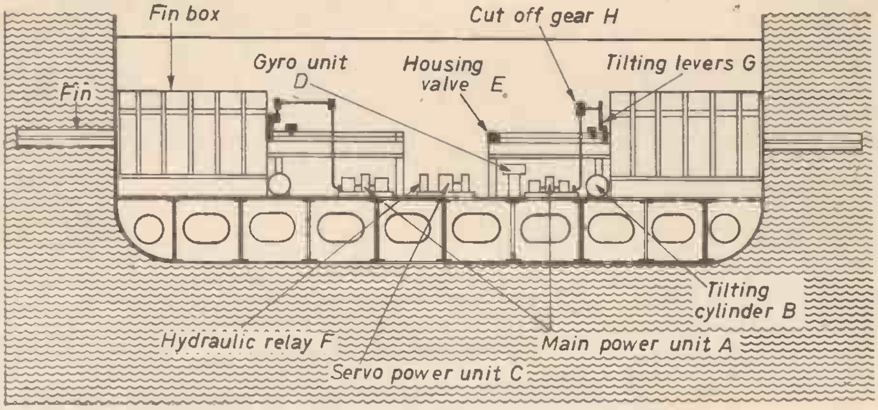


Fig. 7.—How the stabilisers are located in the ship.

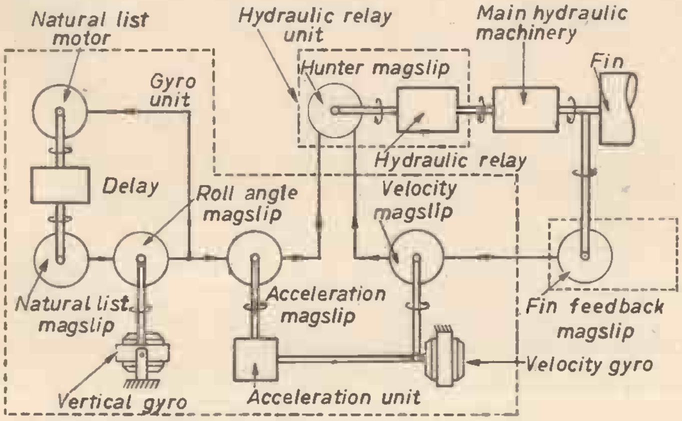


Fig. 8.—Schematic diagram of the control and hydraulic system.

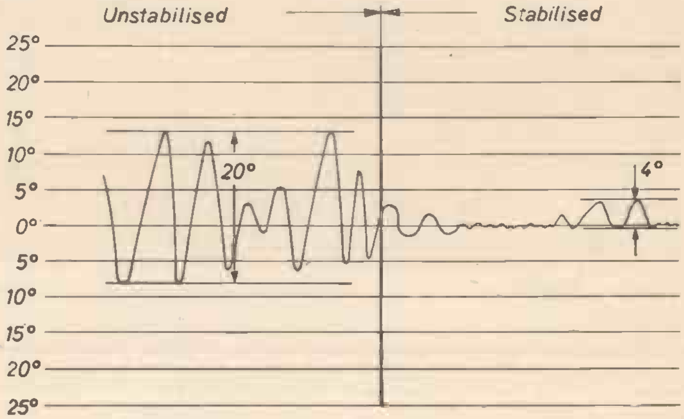


Fig. 10.—Reduction in rolling when using stabilisers.

Natural List Signal

The natural list unit is controlled by a portion of the roll angle signal. This unit comprises a magslip driven by an electric motor through reduction gearing. The motor rotates when the ship lists from the vertical position, and if the list persists the magslip motor assumes a position corresponding to the angle of list. The output of the magslip is transmitted to the roll angle magslip where it introduces a new datum about which the control will operate.

The signal from each of these magslips is transmitted to a "receiver" magslip which combines these signals and produces mechanical movement of the pilot valve of the hydraulic relay. This relay magnifies the movement of the magslip and operates the control valve on the servo unit.

The magslip units used, whether "transmitters" or "receivers" are basically similar. They consist of a stator having three coils at 120 deg. to each other interconnected phase for phase electrically, and a rotor consisting of a single wound H armature connected across an A.C. supply. While the rotor coil of transmitter and receiver are at the same angle to the stator coils respectively there is no voltage difference between the stator coils of the transmitter and receiver, and no current flows between them. If the transmitter rotor is moved a voltage difference is established and a current flows in the circuit causing a magnetic field to react on the stator fields. Since the transmitter rotor is held and the receiver rotor is free to move it does so until equilibrium is established.

The ability of a magslip to reproduce faithfully a very small signal, and the hydraulic relay to translate this signal into control movement means that small gyroscopes can be used and the whole control unit is small and compact.

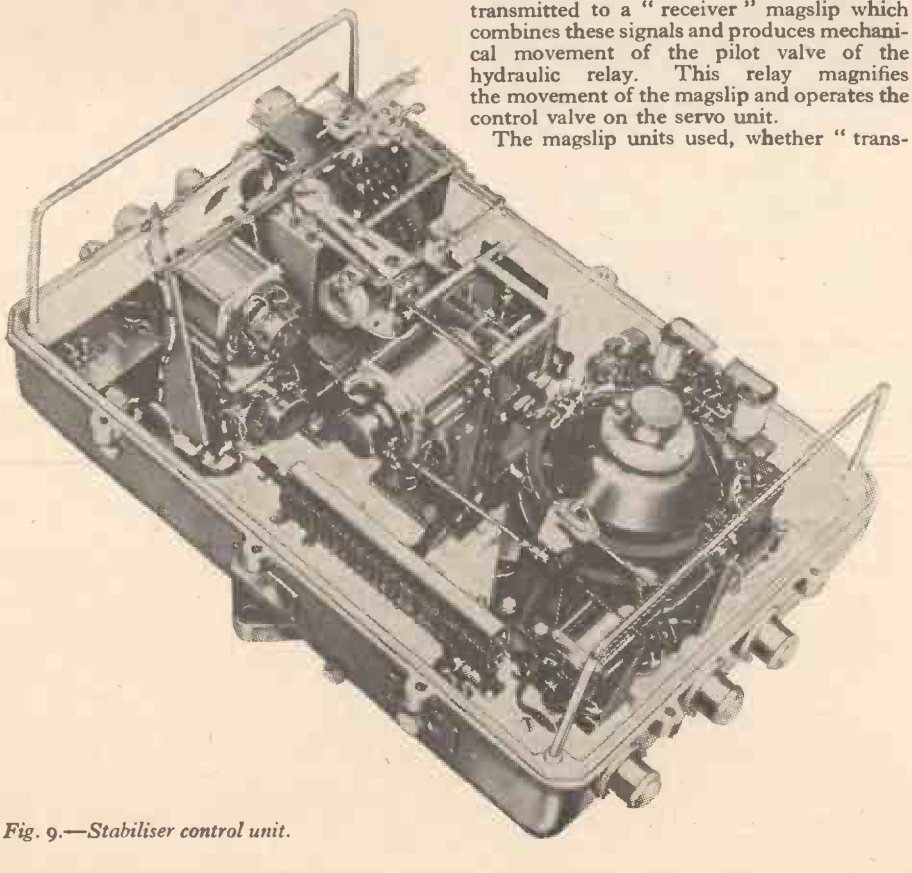


Fig. 9.—Stabiliser control unit.

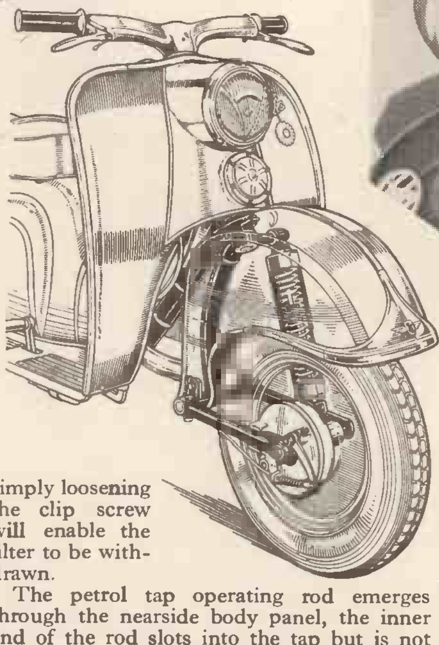
Effects of Drag

The drag imposed by the fins has to be overcome by the propulsive effort of the ship's engines. At the position of maximum tilt the drag imposed can consume as much as 20 per cent. of the propulsive power, however, even in very rough seas the average power consumed in this way is less than 10 per cent. The ship's speed in practice, is little reduced when using the stabilisers, as the resistance to movement is much greater when a ship is rolling; the gain and loss practically cancel out.

Recently, stabilisers have been fitted to small craft and yachts and have proved to be equally as effective as when applied to large ocean going liners. Fig. 10, shows the reduction in rolling achieved by using stabilisers actually recorded by a ship at sea. Although the stabiliser cannot completely prevent rolling it can reduce it to tolerable proportions.

DECARBONISING THE BELLA R203

By B. C. Macdonald



THE Zundapp Bella Scooter has a two stroke engine of 197c.c. capacity and is one of the more powerful scooters on the British market. The similarity between this scooter and other models of the same make is considerable, and the information will be useful to all Bella owners. The article deals primarily with decarbonisation, but technical data and some maintenance notes are included.

It is well known that all two stroke engines require to be decarbonised fairly frequently, every 2,500-3,000 miles or so. The experienced rider will know by feel when decarbonisation is required. Unnecessary dismantling should always be avoided.

Removing the Body

Access to the engine of the Bella is obtained by removal of the body, which is held in position by only four hexagon headed screws (14mm. spanner). Two of the screws are at the rear of the body and are covered by the dual seat; the two forward screws are not so covered and have chromium plated heads (Fig. 1.) On some models the air cleaner must be removed before the body can be taken off. This may be checked visually by opening the right hand body flap (Fig. 2); if the cleaner is facing the viewer it must be removed first. The filter is secured by a clip, which is also bolted to the engine, it is not necessary to remove the clip completely, simply loosening the clip screw will enable the filter to be withdrawn.

The petrol tap operating rod emerges through the nearside body panel, the inner end of the rod slots into the tap but is not fixed to it, the rod may therefore be disconnected simply by pushing it outwards through the rubber bush in the body panel. It need be pushed only by ½in. or so (Fig. 3). With the rod disconnected from the tap, the four body fixing screws removed, the air filter detached from the carburetter (if of the side facing type), the stop/tail lead connector parted, and the side flaps open, the body may be lifted clear of the machine revealing the engine as shown in Fig. 4.

The petrol tank lies beneath the body, cradled between the frame tubes, and is retained in position by a corrugated steel strip, hooked on to frame bolts at either side. Rubber strips are placed between the strip and the tank. A tommy bar or screwdriver is placed through one of the holes in the end of the strip and by pressing this downward the end of the strip may be pulled clear of the bolt. Next, the petrol pipe must be disconnected from the carburetter by unscrewing the banjo union (14mm. spanner). Make sure that the tap is in the "off" position before unscrewing the bolt, and take care that the two fibre washers are not lost.

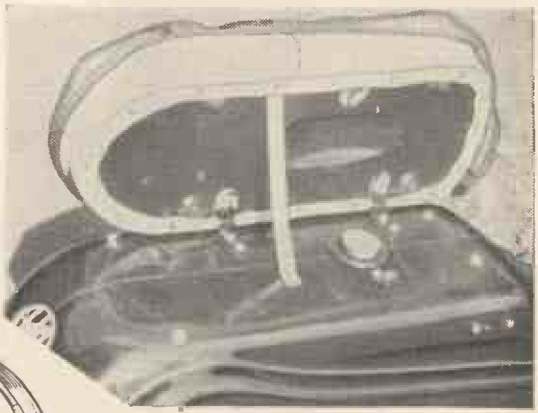


Fig. 1.—The four hexagon headed bolts that hold the body in position.

Fig. 2.—Checking the air cleaner.

Fig. 3.—The petrol tap rod must be pushed outward through the body.

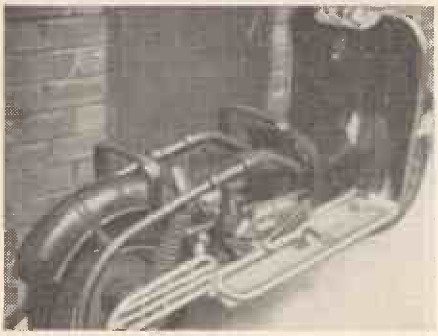


Fig. 4.—The Bella with the body, fuel tank and cylinder head removed.

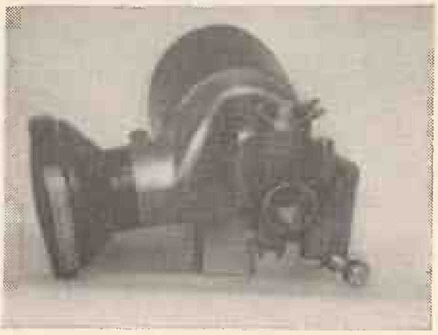


Fig. 5.—The carburetter and air cleaner unit.

The Cylinder Head

The cylinder head may now be removed. It is held in position by four bolts with 12mm. square heads, and a suitable box spanner is normally supplied in the tool kit. Before attempting to remove the bolts, first pull off the sparking plug terminal cover and take out the plug. If the cylinder head bolts are extra tight extend the tommy bar at each end by means of lengths of tubing, in order to obtain sufficient leverage to undo the bolts. Box spanners will serve the same purpose. With the four bolts out, the head will lift off quite easily. An aluminium gasket is used to make the joint between the cylinder and cylinder head and this must be placed in a safe place where it will not be damaged. Even slight damage such as might be caused by placing or dropping tools upon it, will render it useless.

The Carburetter

In the particular model being dealt with there is a chamber between the filter and carburetter fixed to the latter by means of a cotter (Fig. 5), releasing the wing nut on the cotter will enable the chamber to be pulled off. The carburetter itself is fixed to the cylinder stub by a clip, and slackening the clip screw (10mm. spanner) will enable the carburetter to be withdrawn, but it must first be twisted through 90 deg. to enable the float chamber to clear the crank case. Now unscrew the top cap and the nut at the entry of the cable to the starting carburetter (¼ B.S.F. spanner). Hang the cables, with the carburetter parts still attached, safely out of the way. At this point it would be well to pour some paraffin or penetrating oil over the ribbed nut holding the exhaust pipe to the cylinder, to make its removal easier later on.

The cylinder is held to the crankcase by 4 14mm. nuts, which should now be removed. Lift the cylinder upwards (see Fig. 6), and when it is some way clear of the crankcase, place hand underneath and hold the connecting rod so that it will not fall sideways as the piston emerges, with the risk of damage to the latter.

Removing the Piston

The piston is attached to the connecting rod

Fig. 6.—Removing the cylinder.

by the gudgeon pin, and this pin is located in the piston by a circlip at either end, these clips must be taken out before the piston can be removed. To extract the clips a pair of circlip pliers are needed. These pliers have small projections on the end which fit into the small holes in the ends of the clips, and by means of the pliers the clips may be contracted and withdrawn. It may be possible to push the gudgeon pin out with the fingers, but if it is tight, a gudgeon pin extractor should be used. The piston crown is marked with an arrow and the piston must be fitted so that the arrow points forward—that is towards the exhaust port.

It should be remembered that piston rings have a very long life and the fitting of new ones should not be undertaken unless necessary. The surface of the rings which bears on the cylinder wall should be polished in appearance, and any that show a marked surface should be replaced. The ring gaps must not be less than 0·006in. or greater than 0·015in. The gaps may be checked if the rings are inserted in the bore of the cylinder, one at a time near the top, a feeler gauge being used to measure the gap. The rings must be " square " with the bore. If new rings are to be fitted, the ends of the rings must be filed as required to make the gap 0·006in. when the ring is inserted in the cylinder, this time *near the bottom*. The rings are brittle and easily broken, but with a little care can be eased out of their grooves and off the piston. The very old, but quite sound method, of using three, or more metal strips may be used. The strips are inserted beneath the ring and slipped round until so positioned that the ring is held clear of the groove and can thus be pulled off the piston.

The Silencer

This is located under the nearside footboard, and is held in position by two 10mm. screws (Fig. 8). The screws are covered by the rubber foot mats which are held on to the footboard by five nipple-like projections which are pushed through holes in the boards. The mats may be pulled off without difficulty, but care is needed to avoid damage to the nipples. Note that four screw heads are visible when the mats are removed, and it is the screws

Fig. 7.—The silencer with the end removed and baffle withdrawn.

nearest the ends of the footboards that hold the silencer. The silencer is also fixed to the exhaust pipe by a clip, but this joint need not be disconnected yet since it is easier to remove silencer and pipe together and to split

Bella R 203 Data
Ignition timing: 3mm. (0·115in.)
Sparking plugs: Bosch 240 P 11S. Lodge HN.
Plug points gap: 0·7mm. (0·027in.).
Batteries: 11 amp. hr. each.
Piston ring gap: 6-15 thou.
Carburetter make: Bing.
Main jet: 110 (100 if air filter faces R. hand side body flap.)
Needle position: 3rd notch from top of needle.
Needle jet: 1508.
Air regulator screw: 1 1/2 turns from fully closed position.
Starter jet: 85.
Throttle slide: 18.
Chain: ½ × 5/16in. 98 links. Tension, 2cm. (0·79in.)
Tyres: Front, 17 p.s.i. solo and pillion. Rear 21 p.s.i. solo, 27 p.s.i. pillion.
Fuel: oil mixture: 1:25 (⅓ pint oil to the gall. of petrol.)
Recommended oil: any first grade S.A.E. 30·40 oil. Mobil mix or Castrol Two stroke 1:16 (½ pint to the gall.)
Gearbox: S.A.E. 30 oil.
Telescopic fork: S.A.E. 30 oil.
Rear fork: S.A.E. 140 oil.
Rear chain: medium grease.
Clutch cable slack: 1mm.
There are 9 grease gun lubrication points. Grease should be injected every 600 miles.

them afterwards. To do this, unscrew the exhaust pipe nut from the cylinder stub. This nut may be tight but the earlier application of oil will help to make removal easier. Naturally the possession of special tools renders the work easier, but as these are not likely to be available to the average owner, he must make do the best he can. The nut has a normal right hand thread and is ribbed and

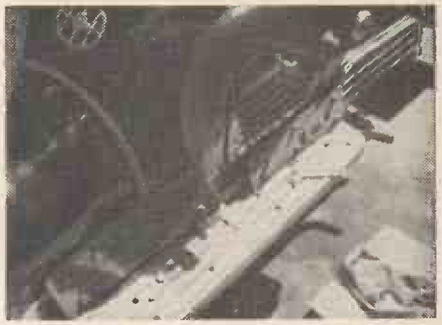


Fig. 8.—The near side footboard. The two most widely separated screws hold the silencer.

may be jarred off, using an old screwdriver and a wooden mallet. If a hammer and drift are used very great care will be required since otherwise the cylinder could easily be broken. Note that a gasket is used to make a gas tight joint, and this washer will drop out when the pipe is removed.

Disconnect the pipe from the silencer, and proceed to dismantle the latter. First remove the 14mm. nut near the base of the tail pipe, this will enable the tail pipe portion of the silencer to be pulled off, though it is likely to be tight. When this has been done the end of the interior baffle will be exposed. This baffle will be tight, due to carbon formation, but tapping it with a mallet, alternately on different sides will help to free it (Fig. 7). Paraffin oil will also help to free this part if liberally applied at the joint. The author used a hook to remove the baffle; the hook was inserted in the baffle, the opposite end being secured in a vice. Pulling on the silencer then removed the baffle. It is recommended that the carbon should be removed by burning and not by the use of a solution of caustic soda.

Decarbonising

Dismantling is now completed, and the next step is the thorough removal of carbon from all the parts. The cylinder head is most easy to deal with, and an old, blunt screwdriver may be used as a scraper to remove the carbon (Fig. 9). The carbon must also be removed from the cylinder ports and associated passages. Partial closure of the ports will probably have taken place and the carbon will be extremely hard. The piston requires similar treatment, and again, a sharp tool should not be used because of risk of damage to the soft alloy. Remove all carbon from the underside. It is also necessary to clear the ring grooves. A certain amount of carbon is deposited round the gudgeon pin bosses, but this must not be removed.

Fig. 9.—Removing carbon from the cylinder head with a screwdriver.

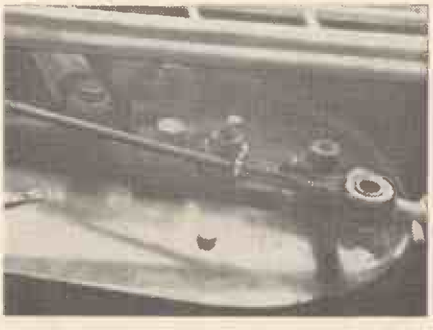


Fig. 10.—The lower portion of the chain guard.

Fig. 11.—The carburetter, showing the air adjusting screw, above the right hand slotted hexagon and the throttle stop, between the two slotted hexagons.

Reassembly

The first step in reassembly is to fit the cylinder. The base joint is made air and oil tight by means of a paper washer, and while these can be made, it is far better to obtain a proper one from your Bella dealer. It is probable that the remains of the old washer will be adhering to the crankcase face and some may be found on the cylinder flange, and all must be completely cleaned away. Care should be taken during this process not to allow dirt or bits of washer to fall into the crankcase. No jointing compound should be applied to the new washer before it is placed in position, a little oil being all that is required. Some patience may be necessary to secure the entry of the piston into the cylinder. It is necessary to compress the rings, one at a time, and make sure that the peg is between the ring ends and not underneath the ring. When the first ring has entered the cylinder the same procedure is followed with the second and third. A piston ring compressor may be used, and this will compress all the rings at once. The help of a friend to hold the cylinder while the piston is being inserted makes the task less difficult. When the cylinder base nuts have been tightened pour about a teaspoonful of engine oil into the cylinder and rub it round the walls.

Place the aluminium washer in position on the cylinder and fit the cylinder head. Make sure that the spark plug opening faces forward. Screw in the cylinder head bolts until finger tight, then use the box spanner to tighten each bolt a little at a time, not in rotation but diagonally from corner to corner, until all the bolts are tight.

Fit the carburetter, and before tightening the clip ensure that it is vertical (Fig. 11). You are not recommended to dismantle the carburetter unless some fault is present, but after a considerable mileage solid material does tend to accumulate in the float chamber and should be removed. To do this disconnect the petrol pipe at the float chamber end and remove the bolt which holds the float chamber to the carburetter, taking care not to lose the two fibre washers. Using a screwdriver, take out the screw on the bottom of the chamber and then remove the cover on the top. The needle is clipped to the float and may be pushed downwards and then pulled out. The float may then be tipped out in the hand. Any sediment will be caked in the bottom of the float chamber and will need to be loosened by a screwdriver or similar tool, afterwards being thoroughly washed out with petrol. In refitting the float chamber beware of using excessive force in tightening the fixing bolt, otherwise there is danger in breaking the carburetter.

Assembling Silencing System

An easy way to assemble the silencing system is to first fit the exhaust pipe to the cylinder, making sure that the gasket washer is not forgotten. The retaining nut should not be screwed up more than fingertight. Now fit the silencer, by forcing it on to the end of the pipe, paraffin oil may be used as a lubricant to aid this process. Finally fix the silencer by means of the two footboard bolts, tighten the clip to hold the silencer on to the exhaust pipe, and tighten the nut which holds the exhaust pipe on to the cylinder.

Maintenance

The following important maintenance points are noted. Grease the chain every 300 miles. Lay the scooter over until it is resting on the right hand footboard, and it is best to remove the batteries before this is done. The lower portion of the chain guard is retained in position by two screws, one of these is shown in Fig. 10. and there is another to the left in a slotted lug. Removal of these two screws enables the lower part of the chain guard to be pulled clear. Apply grease liberally to the chain, turning the rear wheel to move the chain so that grease may be applied over its full length. The chain is adjusted by slackening the wheel spindle nuts and the two chainguard screws in the slotted lugs and tightening the chain adjuster rear nuts. The forward facing nuts on the chain adjusters are lock nuts, and must be slackened during adjustment and re-tightened afterwards. It is essential that wheel alignment should be maintained, and to check this a piece of wood with a straight edge should be placed alongside the wheels, and it must touch the tyres at two points on each wheel, or the wheels are not in alignment.

Gearbox

Check oil level every 500 miles and top up if required. The level plug is accessible through nearside flap. Oil must reach mark near the bottom of the dip stick, when the stick is pushed in as far as it will go, but not screwed in.

Greasing Points

There are nine greasing points on the Bella, and these are: front fork pivot, speedo drive, gear change pedal pivot, gear operating lever pivot (2), prop stand pivot, rear brake pedal, front brake cam lever, rear brake cam lever. These points should be greased by means of a grease gun every 300 miles. Very little grease should be injected at the nipples of the brake cam levers, or grease will enter the brakes.

Contact Breaker

Adjust the points every 3,000 miles. The points are accessible through the inspection plate on the flywheel cover. Three screws are visible. Slacken the middle screw, then turn the bottom screw until the gap is correct (0·012-0·016in.) Retighten the middle screw. Use a feeler gauge to check the gap. Before replacing the cover add a small amount of grease to the felt which lubricates the cam.

Batteries

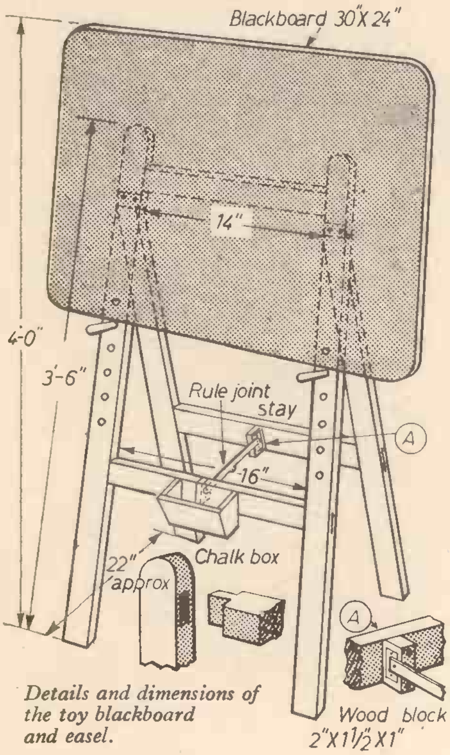
Check acid level every fortnight, and if required top up with distilled water until the level corresponds with the upper line on the battery case. In removing the batteries unscrew the earth connection first. If the scooter is not used for any length of time, the batteries will require a topping up charge about once a month in order to prevent deterioration.

Your children will love this

TOY BLACKBOARD AND EASEL

All the dimensions and information necessary to make it

By Jameson Errol



Details and dimensions of the toy blackboard and easel.

THIS toy is popular both with girls and boys and will help to pass many an hour not only out of doors in the summer but during the winter evenings too. It is simple to make and does not cost a great deal. The size shown is on the generous side but may be made smaller or larger if desired.

The Board

This is of ⅜in. plywood and has rounded corners. After glasspapering it should be painted both sides and edges with lamp black to which has been added a small quantity of gold size and some finely ground carborundum powder. Allow to dry for at least 24 hours, rub down, and give another coat.

The Easel

The framework of the easel is constructed of 2in. × ⅞in. deal, the joints being mortised and tenoned, glued, and pegged through with ⅜in. dowels. The two frames are connected at the top by a pair of 2in. butt hinges and are kept from opening too far by the use of a rule-joint stay; a cord or chain may be used instead but the stay makes a firmer job. As it may be difficult to obtain such a stay with an ear at each end, a method is shown at " A " for fastening the flat end. The chalk box should be quite shallow inside, otherwise it will be difficult for little fingers to get the chalk out.

The Pegs

Making these actually presents the biggest problem to anyone without a lathe, for they must be a good fit in the holes, without being too tight. If they are too loose they will wobble and might easily fall out and allow the board to fall. They should be made from ⅝in. or ¾in. dowels and be only slightly tapered. The holes should be bored a little smaller than the dowel used so that, when the latter is tapered, it will enter the frame for about half its length, which should be 2in. To the face of the dowel is fitted a round wooden washer or button 1½in. to 2in. dia. to prevent the board from slipping forward. The pegs may be fastened to the frame with short lengths of thin chain or string; this will prevent them being mislaid.

The frame may be left " in the white " or given two coats of good quality paint.

Building the 'Luton Minor'

Part 11 Deals with Stitching, Doping, Final Inspection and Flying

STITCHING consists of looping a continuous thread through the fabric on one side, round the rib inside, through the cloth the other side and back to the first side via the other side of the rib, a knot then being tied before leading the uncut thread to the next stitch.

The materials used are rot-proofed thread (spec. W.9), 1in. wide cotton webbing and a block of beeswax through which each piece of thread will be drawn and prepared for use.

The tools required comprise a pair of sharp nail-scissors, a 10in. or 12in. double-ended sail needle and, possibly, a small curved needle.

The best position for stitching is with the surface upright, and whilst on the wings two people will be needed, the tail surfaces may be tackled single-handed.

Fig. 77 illustrates the type of stitch, how it is made and the correct pitch of the knots. For a professional finish, the knots should all be arranged to come at the edge of the cap-strip along each rib and they should be arranged on alternate sides of the rudder ribs, i.e. the first rib will have the stitches on the port side, the next on the starboard, the third on the port again and so on. On the tailplane and wings, the stitches will all have their knots on the lower surfaces. Each knot must be tight and must not rely on the link to the next stitch for tension. If it is necessary to join the thread during stitching, arrange the join so that it can be pulled inside the surface to minimise irregularities on the external covering.

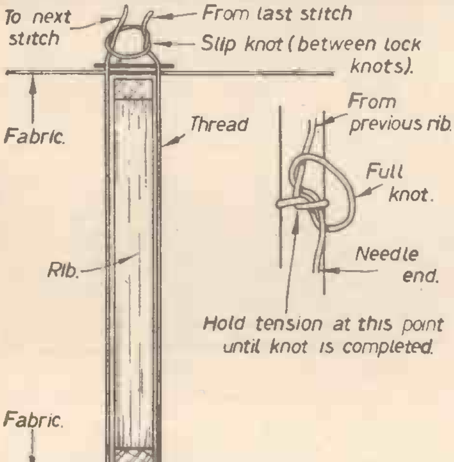


Fig. 77.—The rib stitch.

Doping

The first two coats of red dope at least *must* be brushed into the fabric by hand. This applies to fabric-covered plywood and to unsupported fabric (such as on the wings and tail unit). These first two coats should be as thick as possible without causing runs or blobs. Dope in a warm, draught-free atmosphere. Below about 50 deg. F. dope dries very slowly and develops a milky colour known as "blushing." Blushed dope will not serve its purpose.

Avoid doping in direct sunshine in hot weather as the dope will dry before it has had a chance to be brushed in, leaving a patchy covering. Similarly, do not overbrush—any apparent brush-marks will vanish with drying.

Do not dope or spray in a confined space without adequate ventilation. Some people are affected by the fumes of dope and, if much work is to be done, drink plenty of cold milk before and after each spell of work.

It is supposed that the first coat of dope has been applied to the wings and tail before stitching. The next operation is the application of the serrated tapes which cover the lines of stitches and also protect the leading edge, tips and trailing edges of the surfaces. The illustration (Fig. 78) shows typical taping applications. Note how the edge tapes are always put on last to cover the ends of rib tapes. The rib tapes on the wings at the main spar are trimmed to a narrow "V" with the pinking shears to prevent peeling in the slipstream. The chordwise seams in the wing fabric are covered with a continuous tape passing from the trailing edge forward, over the leading edge and back to the rear again.

When all the tapes have been affixed in this manner and are dry, give the complete surface one good coat of red dope and leave to dry for an hour or so.

Applying Madapolam to the Fuselage

First apply three good thick coats of red dope, allowing thorough drying between each coat. Cut the madapolam into strips running from nose to tail and, with the fuselage upside down, apply the bottom strip first. Begin at one end and, working a few feet at a time, apply red dope to the wood and stretch the madapolam over and on to the tacky surface. Rub the dope through with a thinners-soaked cloth pad, carefully excluding all air bubbles. Avoid over-saturating the cloth with thinners. When the full strip is applied and is dry, trim flush with the sides and then apply the fuselage side strips. The edges of these are also trimmed flush and a 2in. wide serrated-edge fabric tape is then doped along the edge. Note that the fabric decking is covered separately and that the decking fabric should overlap the fuselage sides by 2in. the edge being sealed with a 2in. tape as before.

If the fuselage is not required to be fabric-covered, still apply the three coats of red dope, rubbing down with abrasive paper between each coat.

On the wings and tail, *very lightly* scuff over the fabric with medium abrasive paper, used dry to remove any roughness. Do not exert any pressure and be ultra cautious on sharp corners, otherwise the fabric will be damaged.

"Pulling Over"

For a really professional, smooth finish on the wings and tail, take a cloth pad soaked in thinners and "pull" the fabric over to lay the fibres after the second coat of dope. Start at one side of the surface and work in one direction only. The pad should be wet enough to soften the dope surface, but must not be running. This preparation takes time, but later the very smooth surface which results will take a high-gloss finish really well.

The third coat of dope on the fabric-covered surfaces may be either brushed or sprayed, but at all events it should be thickly applied.

Allow this coat to dry and then examine the surface. The process of pulling over may be repeated, but it should not be necessary.

Spray on a fourth coat. Dilute this with about 30 per cent. thinners.

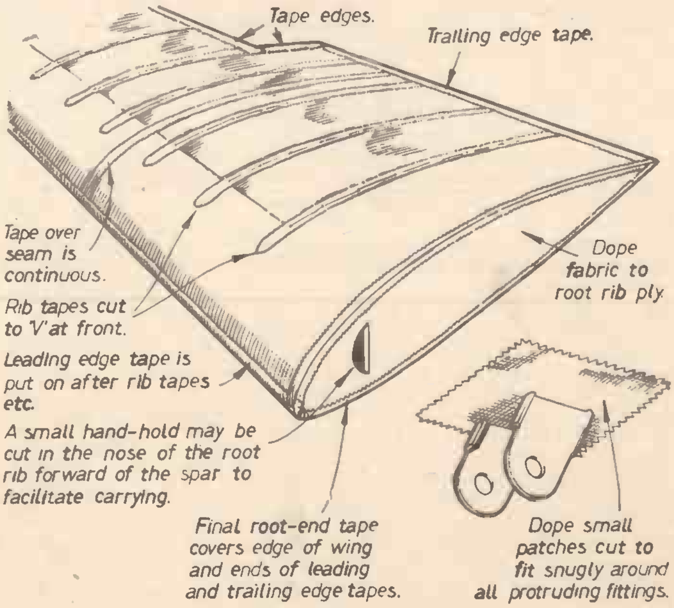
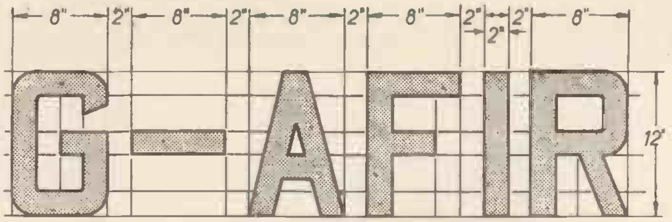


Fig. 78.—Taping operations.



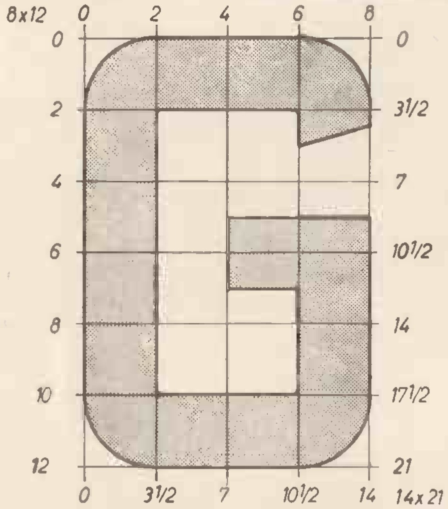


Fig. 79.—The thickness of the strokes in the letters is equal to the width of the spaces between the letters. The dash is made the full width of one letter as shown.

Although aluminium sealer is not vital, it is advisable to spray a general coat of this now as it will assist in the detection of any light spots or "holidays" in the finishing coats. Give this coat a good rub with medium-grade wet abrasive paper. The fuselage may be given one or more coats of filler, rubbing down between each, the final coat being rubbed with fine paper.

Colour Scheme

Scheme out the approximate paint scheme which will be used. Choose the first or main colour and the second colour which will be used for the registration letters and any flashes or trimming lines. It is this second colour which is applied first.

Assuming the colours to be silver (first) and blue (second), the blue areas are marked out first using white chalk (*not* pencil or wax crayon), allowing a good margin on all sides.

Spray these areas evenly in blue, but make no attempt to get a clearly defined edge to the areas, i.e. let the spray mist away at the sides. These finishing coats should contain nitro-varnish to provide a high gloss. These dopes take a little longer to dry, and about three to four hours should be allowed. Lightly scuff the misted areas with medium wet abrasive to remove the spray dust which has formed hard lumps on the surface of the undercoat. Avoid scuffing the areas of colour which will show. Spray a second coat on these areas and repeat the process.

When absolutely dry, mask in the registration letters, flashes and so forth, using 1in. wide paper masking tape. This tape is quite expensive at about 10s. per roll, but do not be tempted to use transparent or any other form of adhesive tape as these products strip off the underlying dope layers.

Edge round the letters with the tape, filling the centres with newspaper cut to shape. Make sure that the edges are well down and that there are no joins under which the spray may blow. Joins in the paper should be amply overlapped then sealed with an off-cut of masking tape. The illustration, Fig. 79, shows the correct sizes for registration letters, the larger size (14in. × 21in.) being used for the wings and the smaller (8in. × 12in.) for the fuselage.

Mask out also parts which are not required to be sprayed. On the fuselage, completely paper across the cockpit and across the engine mounting, etc.

The first main coat is now sprayed. Do not attempt full coverage with the first coat—it is better to apply two medium coats than to risk runs and blemishes from one thick application.

A few points are worth noting on cellulose spraying. The higher the spray pressure, the less the amount of thinners required in the mixture. Too low a thinners content, however, will produce an "orange-peel" finish. The lower the thinners content, the brighter and higher the gloss of the finish will be. Fifteen to 20 per cent. is the lowest thinners content which should be used.

Too much thinners produces a "wet" spray which contains little dope and which runs readily.

Finishing coats should be sprayed at a pressure between 45 and 65 p.s.i. Mix thinners with the dope in a clean can or jar—never in the pot of the spray gun. Keep the gun clean, flushing through by spraying a little clean thinners after use. Spray evenly, maintaining about 12in. between nozzle and surface and hold the gun at right-angles to the surface.

When absolutely dry, carefully peel off the masking tape and newspaper.

For final burnishing, special cellulose polishes are available. Wax polishes and car polishes may be used, but remember that if at any time it is necessary to touch up the paintwork all traces of the wax must first be removed with spirit or detergent.

Final Assembly

Refit the windscreen and then proceed with the erection of the complete aircraft as before. Connect all control cables and rig the controls as shown on the rigging diagram on Drawing No. 12.

Fit the engine and propeller, not forgetting to track it before locking the hub nuts with split pins.

With the aircraft in the rigging position, check the incidence of the wings and the dihedral, tighten the bracing wires and again check the incidence. Using a steel tape or a length of flexible wire, check the alignment of the aircraft by trammelling as detailed in Fig. 80.

Any necessary adjustments can be made on the bracing wires by slackening the forward one on one side and the rear one the other side. The opposite front one is then carefully tightened to the desired position.

When all is set, tension these wires equally until they produce a *low* drumming sound when twanged.

Wire lock the turnbuckles and wire-strainers on these and all the control cables. The correct method is shown in Fig. 81.

The gap between the two wings at the centre-section is covered with a strip of thin duralumin, tensioned underneath the wing by a wire-strainer.

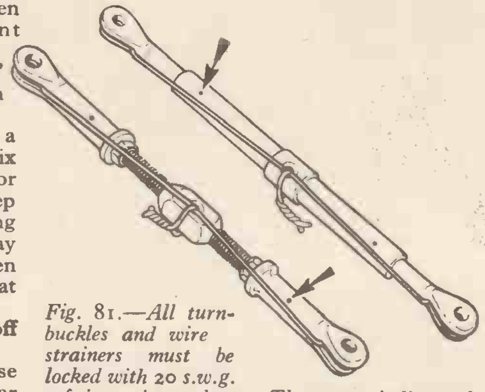


Fig. 81.—All turnbuckles and wire strainers must be locked with 20 s.w.g. soft iron wire as shown. The arrows indicate the "safety" holes. It must not be possible to insert a pin through these, otherwise insufficient length of thread is being subjected to the tension load.

Centre of Gravity

The centre of gravity of the aircraft must be within the limits shown in Fig. 82. If it is outside these limits, any attempt at flight might prove dangerous.

The exact position of the C.G. is computed by a simple calculation using three bathroom scales or two and a spring balance.

The aircraft must be in a complete state with all cowlings, seat cushions and fairings

(*Continued on page 457*)

RIGGING DATA

MAINPLANES	INCIDENCE	DIHEDRAL
(Port and Starboard)	3 deg. ± 0 deg. 10min. Measured across spars at root end and outboard of lift struts	0 deg. + 0 deg. 30min.—Zero Measured along front spar
TAILPLANE	0 deg. (NOMINAL)	ZERO

CONTROL SURFACE	RANGE OF MOVEMENT Measured at trailing edge of surface		RELATIVE TO
Aileron	6in. up (min.)	3¼in. down (min.)	wing trailing edge
Elevator	7in. up (min.)	5in. down (min.)	tailplane chord
Rudder	10in. port (min.)	10in. stbd (min.)	Fin chord

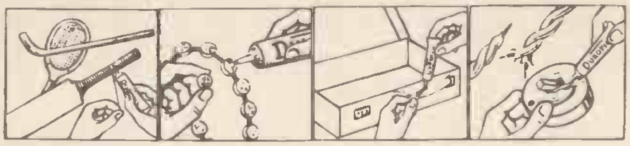
Angle of fin centre-line to horizontal = 90 deg. ± 0 deg. 15min.
Rigging Datum: Top Longerons at cockpit level fore and aft and across.
Cross Trammel Engine mounting top bolt to front lift strut top bolt port and starboard variation = ¼in.
" " Rudder centre hinge pin to rear lift strut top bolt port and starboard variation = ¼in.

Fig. 80.—Table giving details of the rigging.

RAWLPLUG Recommendations

DUROFIX

FOR MAKING AND MENDING ANYTHING



1/- PER HANDY TUBE

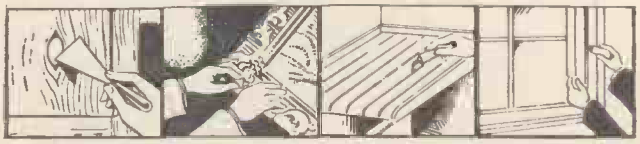
If it can be stuck Durofix will stick it because it is a universal adhesive which is heatproof, waterproof and being transparent makes almost invisible joins. Valuable ornaments and trinkets can be repaired. When dry and hard it will not become tacky in the hands so it is ideal for sports goods. Once 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.

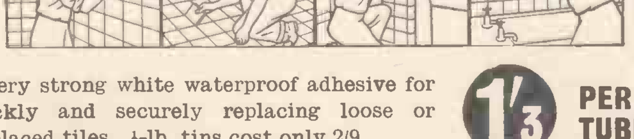
Plastic Wood Softening Fluid 1/6 per 2 oz. bottle.

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. ½-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.

METALIDE No. 8 FIXING KIT 6/6

Here is the modern "visual" pack with a No. 8 Metalide masonry drill in plastic wallet (with instructions for use) and in the crescent shaped bubble. 6 each No. 8 x ¾" and No. 8 x 1" Rawlplugs and 6 each No. 8 x 1" and No. 8 x 1½" countersunk steel screws. How to make firm fixings with Rawlplugs is printed on the back of the card. This is the ideal kit for the "Do-it-Yourself" enthusiast.

RAWLPLUGS AND SCREWS

IN ONE SHILLING PACKETS

Nos. 8, 10, 12 or 14 Rawlplugs in various lengths and with corresponding countersunk steel screws are just the answer for the handymans tool kit. Ask your dealer to show you these new polythene packets of Rawlplugs and Screws selling at 1/- each.

RAWLPLUGS WALL PLUGS — make light work of strong fixings

B666B

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

in place. Seat a person of normal weight in the cockpit (or place a weight of about 160 lb. 12in. forward of the seat back) and half fill the petrol tank with petrol (approximately 3 gallons) or place a weight of 24 lb. centrally on top of the tank. The engine sump should be filled with the correct amount of oil.

Stand the aeroplane on two sets of scales, one under each wheel, and trestle the tail so that the top longerons are horizontally level. Either stand the tail-wheel on a third set of scales or suspend it on a spring balance. Tie a safety wire loosely to the tail-wheel and anchor it to a weight in case the aircraft should tip up.

Suspend a plumb-bob on a cord over the wing adjacent to one side of the fuselage so that it just clears the ground. This is shown in Fig. 82.

Add the two weights registered on the scales under the main wheels. Measure accurately the distance between the main wheels and the tail-wheel at their respective points of contact with the scales. Fig. 83 refers.

Example Calculation:

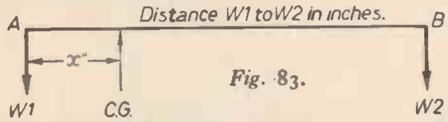


Fig. 83.

Let distance W_1 to W_2 be 174in.
Let $W_1 = 294{\cdot}5$ lb. $+ 294{\cdot}5$ lb. $= 589$ lb.
Let $W_2 = 46$ lb.
Taking moments:
$$W_1 \times x = W_2 (174 - x)$$
transposing:
$$589 \times x = 46 (174 - x)$$
$$635x = 8004$$
$x = 12{\cdot}6$in. aft of undercarriage
$12{\cdot}6 + 5$in. (check on aircraft) $= 17{\cdot}6$in. aft of wing leading edge. This is within limits.

If it is desired to move the C.G. forward, the pilot's seat may be shifted forward by 1in. To move the C.G. back, move the seat back by up to 2in.

In extreme cases where a motor heavier than the J.A.P. is used, it may be necessary to affix ballast to the stern-post as detailed in Fig. 84.

Fuel Flow Test

With the fuel tank half full, it must be proved that sufficient fuel is delivered to the carburetter, and this is checked by undoing the pipeline connection at the carburetter and draining fuel into a can or measure, timing delivery. This must be done at the carburetter end, this being the last link to the engine. The flow should be a minimum of three times the maximum consumption, giving a result of at least 8 gallons per hour.

Insurance

Before any aircraft flies, it must be covered by third-party insurance. Phoenix Aircraft Ltd. have been successful in obtaining a special coverage for their constructors with one of the most experienced Lloyd's aviation brokers. The third-party coverage for the Minor costs between £7 10s. and £10 per annum. Also available is full comprehensive cover at an annual premium of 7½ per cent. declared value should the Minor owner require it. Only third-party insurance is mandatory.

Pilot's Licence

No person may act as pilot of an aircraft without holding a valid licence. Whilst under instruction, the pupil pilot must hold a student's pilot licence. This costs 10s. and is granted on the satisfactory passing of a simple medical examination which may be conducted by any private doctor in accordance with a Ministry of Aviation form.

Normal flying training comprises 40 hours' flying, of which at least 15 must be as pilot in charge or "solo." At the discretion of the instructor, the student pilot may complete some of these 15 hours' solo flying in his own single-seater aircraft under the supervision of his instructor. The Minor lends itself admirably to use as a single-seat trainer due to its docile handling characteristics.

At all times until the successful passing of a simple written and oral examination followed by a flight test for the issue of the full private pilot's licence, the student pilot must fly under supervision and all his solo flights shall be authorised by a qualified instructor.

Once the private pilot's licence has been obtained, the amateur pilot may fly as and where he wishes within the simple limitations of the regulations and safety rules laid down to avoid airways, danger to the general public and danger to himself and his machine.

Full information regarding flying instruction is available upon request from the Popular Flying Association, Londonderry House, 19 Park Lane, London, W.1, together with lists of addresses of flying clubs.

The Permit to Fly

The Permit to Fly carries no drastic restrictions for the amateur pilot, excepting that special permission is required to fly the machine out of the British Isles. Should the amateur wish to fly to France, for example, he should inform the Popular Flying Association beforehand in order that the necessary permit may be arranged.

With the aircraft fully assembled and ready for flight, the final inspection will be carried out. This is a thorough check of the complete aircraft to ensure that everything is perfect. As soon as any snags have been rectified, the inspector will sign the aircraft logbooks (one engine and one airframe which are obtainable through H.M. Stationery Office) and recommend that the aircraft be granted permission to cover test flights. The Minor will have to complete 5 hours' trouble-free flying during which time it shall not be flown outside a radius of 5 miles from the airfield nor shall it land away from the airfield. As soon as this 5-hour period is up, the Minor will receive its full Permit to Fly, which costs 10s. per year. This document must at all times be carried in the aircraft.

Preparations for Flight

The first flight trials should be conducted at a licensed aerodrome. This is desirable from many aspects, the main being that experienced engineers and ground staff, fuel and oil, etc., are readily to hand. Where possible, it is suggested that, to minimise disruption to normal aerodrome routine, test flights (certainly the early ones) should be carried out during the week-days. Most flying clubs operate mainly at week-ends and the air is rather crowded for this type of flying.

The weather should be clear with at least 5 miles visibility and a cloud base of not less than 1,500ft. Surface wind should not be more than 10 m.p.h. and should be in such a direction that take-off and landing may be directly into wind without being hazardous due to obstructions.

At all times before flight from an aerodrome, notify the aerodrome control. The reasons for this should readily be apparent. For initial tests, the controller will arrange that the airfield is solely at your disposal and that no other aircraft may baulk your take-off or landing.

First Flight

Since test-flying must be conducted by a competent pilot and to a schedule which may be obtained on application from Phoenix Aircraft Ltd., only specific information will be given on this stage.

For the first flight, it is not necessary to fill the fuel tank and thereby increase the weight unnecessarily. Three gallons in the tank is a safe minimum for this test flight.

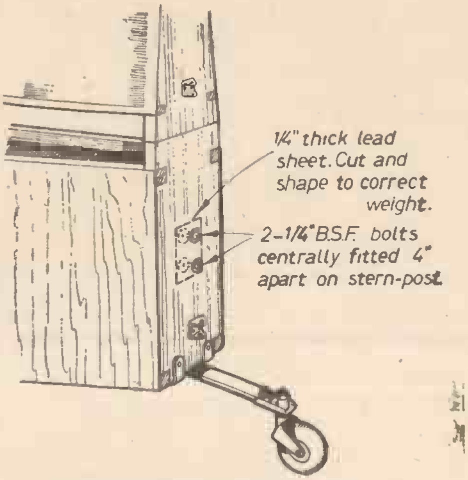


Fig. 84.—Fixing the lead ballast.

Warm up the engine for 5 minutes with the nose headed into wind.

The following cockpit check should be memorised—the easy way is to remember the initial letters and their order:

- **T—Throttle friction nut—TIGHT**
- **M—Mixture Choke control IN**
- **F—ON and sufficient for flight. Check that indicator reads correctly.**
- **G—Gauges—Altimeter set, oil pressure O.K.**
- **H—Harness—TIGHT.**

Slowly taxi the Minor into take-off position, having first run up the engine to maximum r.p.m. and also having checked the magnetos on the switches. Line up into wind and smoothly open the throttle.

The Minor displays little or no tendency to swing on take-off, although care should be exercised in cross winds to keep the nose straight. The tail will rise almost immediately as the aircraft rolls forward.

Do not attempt to haul the aircraft off the ground at too low an airspeed—this results in porpoising and can only serve to prolong the take-off distance. The true unstick speed is about 28 m.p.h. and it is good practice to hold the machine down to about 32 m.p.h. before breaking ground decisively with a slight backward pressure on the stick. Once clear of the ground, allow the speed to build up to about 40 m.p.h. before climbing away. Ease back on the throttle slightly to produce about 2,150 r.p.m. and climb steadily to 1,000ft.

The throttle is then set to cruising r.p.m. and the full effectiveness of the controls may be checked.

(To be continued.)

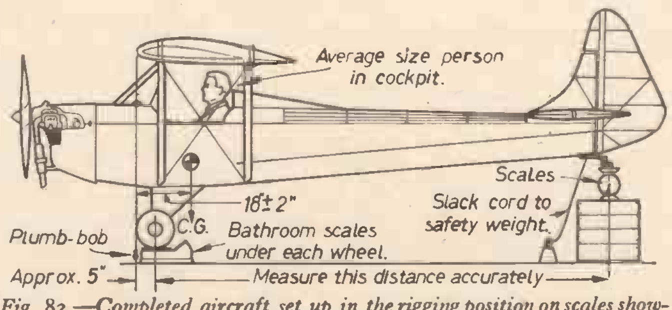
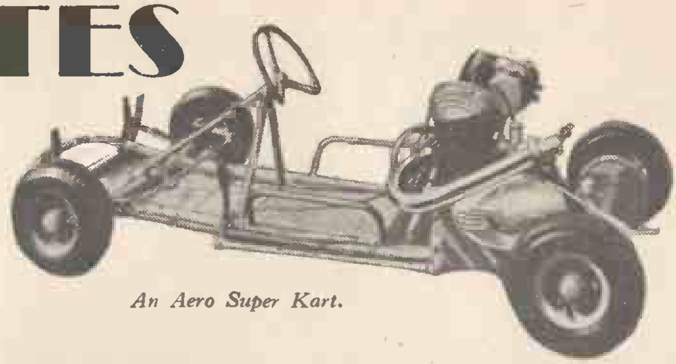


Fig. 82.—Completed aircraft set up in the rigging position on scales showing the position of the centre of gravity.

TRADE NOTES

A REVIEW OF NEW TOOLS, EQUIPMENT, ETC.



An Aero Super Kart.

SMOOTHING PLANES

TWO new Marples smoothing planes are now on the market. The No. 2690 smoothing plane which retails at £1 12s. 6d. and No. 2691 which costs £2. Made of beechwood, these planes have the screw-adjusting principle for fast and accurate setting. The manufacturers are Wm. Marples and Sons Ltd., of Hiberia Works, Westfield Terrace, Sheffield 1.

MIDGET HOIST

THE Haltrac Midget Hoist can be used for a wide variety of purposes. It occupies the minimum of space and weighs only 1lb., but is tested to lift 1,000lb. This well-finished hoist has self-lubricating pulley wheels and rust-proofed metal parts, complete with nylon cord over triple blocks with self-locking hooks. The price is £2 17s. 6d. and the manufacturers are Haltrac Ltd., of Bourne Works, Weimar Street, London, S.W.15.

(Left) The Haltrac Midget Hoist.

BURGESS SPRAYER

MADE to an American design the new Burgess sprayer weighs only 3lb. and retails at £3 19s. It will spray paint, varnish, enamel and insecticides, etc. The sprayer, which is simple to operate, is made in all standard 50-cycle voltages A.C. only. The manufacturers are Burgess Products Co. Ltd., P.O. Box 11, Hinckley, Leicestershire.

The new Burgess Spraygun.

INTERNAL MIX AIR CAP

THE Aerograph-DeVilbiss Co. Ltd., of 47 Holborn Viaduct, London, E.C.1, who recently introduced the Tuffy lightweight utility spraying outfit, now supply as standard with this unit their improved internal mix air cap. This allows a faster rate of paint spray application and it is particularly useful for general painting and decorating and for refinishing where higher speeds are needed and where materials used require pressure feed.

(Left) Improved Internal Mix Air Cap.

WALL CLOCK IN KIT FORM

FORMAPRODUCT Ltd., of 3 Deanery Street, Park Lane, London, W.1, supply a kit of parts for the wall clock shown in the photograph, at a cost of £5 10s. It works for a year on a small torch battery and has a jewelled automatic movement. Once the battery is in place the clock starts and automatically rewinds itself. This firm also supplies a seven-jewelled, eight-day movement for £5 7s. 6d. or a synchronous electric movement at £4 17s. 6d. (all plus 5s. postage). Warp-proof wood is used for the frame, the surround is a deep gold silk cord and the decorative fittings are of polished and lacquered brass. The overall diameter of the clock is 12in. and the dials are available in cream, red, black or pale blue.

AERO SUPER KARTS

AERO Controls Ltd., of Industrial Estate, Weedon Road, Northampton, recently announced the introduction of two new Karts. They are the Grand Prix Super Kart and the Clubman Super Kart. The first (a 197 c.c. model) will develop up to 13 h.p., and the second (a 98 c.c. model) over 4·5 h.p. when fitted with high compression engine. All component parts have been designed and manufactured to ensure ease of assembly for the home constructor. The Grand Prix Super Kart home constructor's kit costs £90 ex-works, approximately.

One of the new Marples Smoothing Planes.

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THIS new Holt product is of particular use in garages, etc., where there is a problem of greasy floors and the dangers arising therefrom. Floor cleansing involves a simple sprinkle on and wash-off routine. The manufacturers state that heavy incrustations of grease and oil-bound dirt are quickly removed; it is equally effective on concrete, rubber, composition, P.V.C., tile or steel and harmless to tyres. It costs 4s. 6d. for 2lb. and 9s. for 5lb. The manufacturers are Douglas Holt (Est. 1919) Ltd., of Vulcan Way, New Addington, Surrey.

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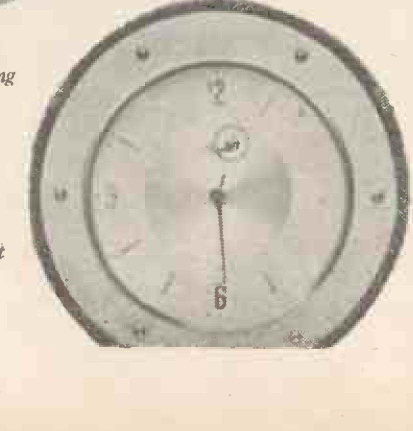

(Right) Wall Clock built up from a kit.

READERS' SALES AND WANTS

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

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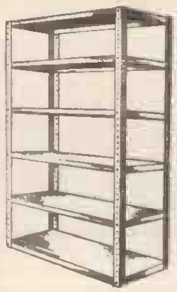

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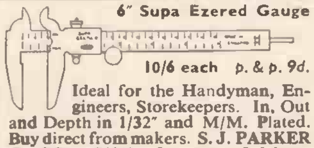

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LETTERS to the EDITOR

The Editor does not necessarily agree with the views of his Correspondents

Back issues of the "Cyclist"

SIR,—In 1937 my brother did a journey by cycle from South Africa to London. The story of this trip was written up in a series of articles which appeared in the old "Cyclist" in early 1938. My copies of these articles—the only record I have of the journey—were recently lost in a fire and I wonder if there are any old cycling enthusiasts who would have retained any of the very old issues of the original magazine. There were four articles and they appeared in more or less consecutive issues of January and February 1938. Should any readers be in possession of these issues I would be deeply grateful if they would contact me.—E. L. ATTWELL, P.O. Box 1128, Port Elizabeth, South Africa.

More Workshop Practice?

SIR,—I have been a regular reader of P.M. for many years and enjoy the wide variety of subject-matter that you manage to include in the magazine every month, such things as transparency viewers, telescopes, radio transmitters, etc., articles explaining glider flying, ships' steering gears, atomic engineering and of course "flying saucers" and space travel.

All this is very enjoyable, but could you, without upsetting the present balance of P.M., let us have more articles on good modern workshop practice, particularly articles on how to use modern tools such as those powered by an electric drill. Many thousands of readers must own these drill kit workshops and a series of articles on projects designed especially for the portable drill kit owner would be very welcome. What about a *modern* series on woodturning for the beginner, i.e. turned salad bowls instead of ornamental chair legs?

One final point, could you include more short features in every issue? Some of the long series, such as "Building the Luton Minor," are admirable, but not everyone has either the facilities or the finance for these large jobs.—A. L. SHORE (Swindon).

There is a lot in what reader Shore says, but we consider that some of our major projects such as the "MechaniKart" and the P.M. Cabin Cruiser, both of which are running in this issue, are well worth doing and there is no alternative to the long series. Perhaps other readers would care to add their comments.—Ed.

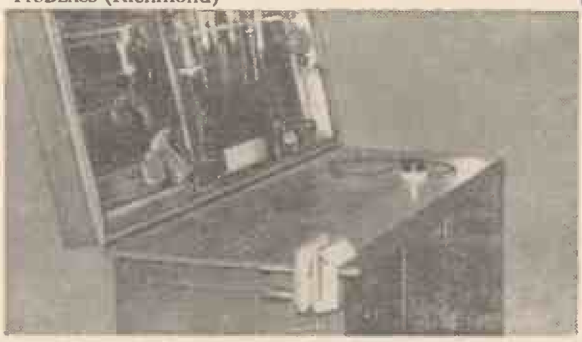
Model Theatre

SIR,—I read with interest an article in the March issue on a model theatre. This was excellent and will, I feel, fill a long-felt need in the amateur dramatic world. You did not, however, mention the enormous amount of enjoyment children of all ages can obtain from such a model. I made one for my own young family several years ago and they have had hours of enjoyment from it, eventually writing and producing many of their own plays. Incidentally, I am incorporating several of the features of your design into a rebuilt version of my theatre, which should widen its scope considerably.—L. S. CHANDLER (Blackpool.)

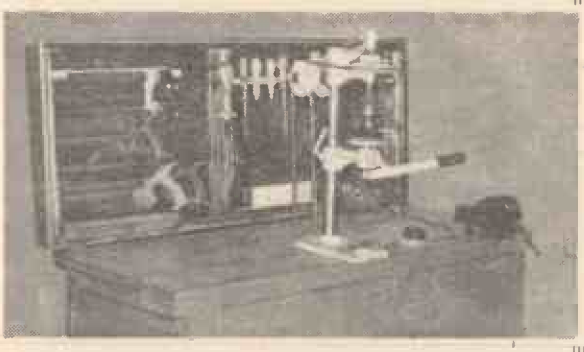
It's all in the BOX

SIR,—As a regular reader of PRACTICAL MECHANICS, I was interested in the article "A Foldaway Bench" which appeared in the March issue. Until recently, when I moved into a flat, I had a well-equipped workshop. After moving I missed my workshop so badly that I designed a power bench to enable me to carry out wood or metal work and also store all the tools and fittings out of sight in one combined cabinet. The bench (shown above) comprises a carpenter's bench with vice, power-driven circular saw, power-driven $\frac{3}{8}$in. vertical drill, power-driven metal-working lathe and mechanic's bench with vice. There is accommodation inside the cabinet for all the power and hand tools, bolts, screws, nails, etc., and a hand tool drawer is included. Incidentally, I am 86 years old!—F. W. HUDLASS (Richmond)

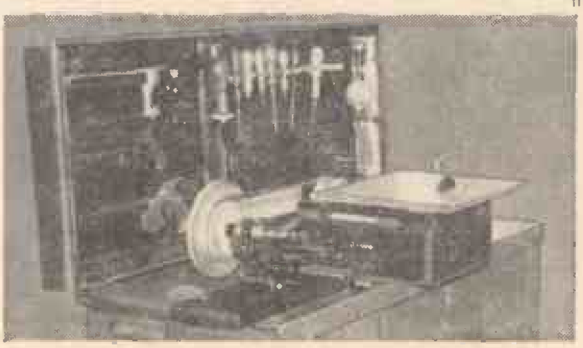
(Above) The cabinet closed and locked. Dimensions are 45in. × 17$\frac{1}{2}$in. × 36in.



(Left) The cabinet with top opened and prepared as a carpenter's bench with universal vice.



The cabinet fitted with power driven $\frac{3}{8}$in. high speed drill which has a simple one-bolt fixing. Also fitted is an engineer's vice which is easily detachable.



The cabinet fitted with a small metal-working lathe. The saw shaft is used as a counter-shaft.

Table-Top Photography

SIR,—The photographs shown below are examples of my table-top photography. These are some model cars which I have made from home construction kits and have set

These realistic shots are of model cars.

them up in realistic fashion in my home made racing circuit. I photographed them at just a few inches with a close-up lens. The blurring effect to show speed was achieved by agitating the background to and fro during a very slow exposure. Are many more of your readers interested in this subject?—H. T. Roberts (Lancs.).

Water on Venus

(*Concluded from page 446*).

thermal equilibrium would be upset. Venus has been found to radiate at an effective temperature of —39 deg. C. (Sinton and Strong), whence the amount of heat available at ground level can be calculated. This was done last year by the author of the present article on the assumption that water vapour was present. By using meteorological methods a mean annual ground temperature of + 17·5 deg. C. was obtained, which is only about 3 deg. C. above the corresponding figure for the Earth.

Despite the negative spectroscopic evidence, a long period of axial rotation of Venus appears unlikely, so that the surface conditions there may not differ greatly from those on the Earth.

Now, however, important as this result may be, it does not exhaust the interest of the Johns Hopkins announcement. For if superabundant water vapour on Venus has eluded the spectroscope for so long, what reliance can be put on any negative estimates of the upper limits to either water vapour or oxygen on other worlds as obtained by spectroscopic observation from the surface of the Earth?

This does not prove that there is oxygen on Mars, but it makes it probable that at least water vapour is there in a far greater quantity than at present supposed, for some has actually been found. The lesson of Venus can be over-emphasised, but the fact remains that the present ideas about the atmospheres of other planets and even of the Moon will require revision. Nothing definite can be said on this subject until air-free spectrograms obtained from Earth-satellites have become available, but they may not be long in coming.

Evolution of the Fuel Cell

(*Concluded from page 442*)

and the potential difference stabilises at just over 1V.

If, however, the electrodes are connected in an electrical circuit, the excess electrons from the hydrogen electrode can return through the circuit to the oxygen electrode, the E.M.F. between the electrodes will drop, but the flow of hydroxyl ions will be maintained.

It has been found that this type of cell works better at a temperature of 200 deg. C. and gas pressures of 400 to 600 p.s.i. than at atmospheric temperature and pressure. This entails special engineering considerations in the fabrication of the unit. Moreover, since the E.M.F. is low, i.e. 1V. to 0·6V. according to how much current is taken out of it, it follows that a considerable number of individual cells must be connected in series to give a worthwhile output.

The graph reproduced in Fig. 5 shows clearly the characteristics of a single fuel cell.

The electrodes are flat plates made of nickel or nickel-plated steel, through which a large number of holes are drilled. This plate supports a layer of porous nickel, which is made by sintering nickel powder mixed with ammonium hydrogen carbonate. A porous nickel layer of still finer grain is made on top of the coarser grained material. Fig. 6 illustrates this clearly.

The gas enters through the holes in the supporting plate and then penetrates into the porous nickel layers on the plates.

The hydrogen electrode is made more reactive by soaking it in nickel nitrate and then roasting. This converts the nitrate into nickel oxide, and this is then changed to metallic nickel by reduction in hydrogen at as low a temperature as possible.

The oxygen electrode is treated with a mixture of nickel and lithium nitrates and roasted in air, thus resulting in the formation of a double oxide of lithium and nickel being formed. This is not soluble in the electrolyte which it will be remembered is potassium hydroxide and which is a fairly good conductor of electricity.

Full justice cannot be done in an article of this length to the detailed research work that led up to the present form of the hydrogen-oxygen fuel cell or to the engineering ingenuity that has led to the present neat design as a 3kW. unit at 32V. by the linkage of 40 cells in series (See heading photograph).

The power unit referred to above has been used successfully to drive a fork-lift truck, and we have little doubt that before very long this ingenious invention will find many more applications.

The writer of this article is indebted to Mr. Bacon for the information that has enabled him to give this brief outline of the Bacon Fuel Cell.

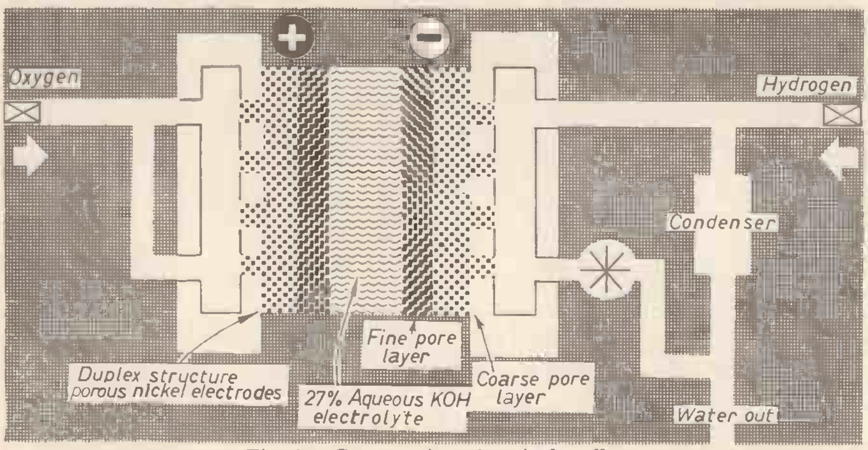


Fig. 6.—Cross section of a single cell.

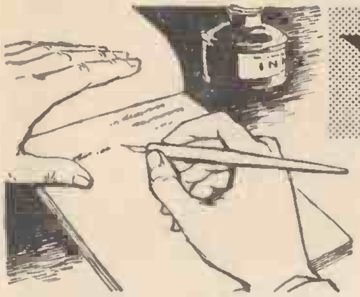
PUZZLE CORNER

Around the World

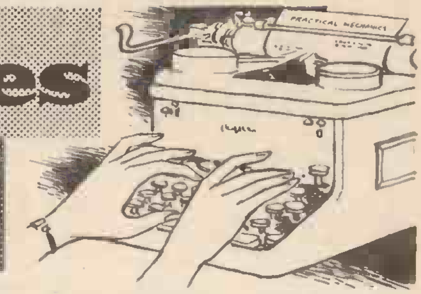
IF the earth was a perfectly smooth sphere and a wire was stretched round it at the equator and then the wire was cut and two yards added to its length, how far would the wire be from the earth, assuming it to be equidistant from the equator at all parts?

Answer

Very nearly a foot.



Your Queries Answered



Constructing a Siren

WOULD you describe how a "siren" is constructed? I wish to make up a geared unit, hand-operated, which will produce a high-pitched note. Would you explain how the note can be varied and what will be the approximate speed of the rotating disc or plate? I also want to construct a unit to produce a similar result as above, but without moving parts and working from an air pressure of approximately 10p.s.i.—S. Wild (Lancs.).

IN such units one plate is fixed, and a second is pivoted very near it. Openings in fixed and rotating plates match in such a way that they are alternately covered and together, when the pivoted plate or disc is turned. If the unit is driven by air pressure, projections on the edges of the holes of the rotating plate are given a slope, so that air pressure causes this disc to rotate. If the disc is gear-driven, these projections are formed into a fan or blower, which forces air through the openings when holes in fixed and rotating plates coincide. The note is directly proportional to the number of holes and r.p.m. Divide r.p.m. by 60 and multiply by number of holes, e.g. a 12-hole plate running at 6,000 r.p.m. would give 1,200 c.p.s. The note is most easily changed by altering the speed. A rotating cylinder, with open ends, inside a fixed cylinder, with matching holes, is also used, and in this variety a cylinder some 2in. long and 3in. in diameter would suffice for a reasonable sound output. Clearance between fixed and rotating members must be very small.

Cricket Practice Pitch

I WISH to make a concrete cricket pitch for use with batting nets. Could you please advise me on the length and breadth of such concrete wickets; thickness of concrete surface and what mix to use? I wish to cover the concrete wicket with matting; what is the best material to use for this purpose?—H. T. Sneeting (Cambridge).

THE normal cricket pitch is 22yd. long and we would suggest that for training at the nets you should have a concrete apron not less than half this length. The width would not be less than 3ft. Thus you will have an area of 12sq.yd. to cover at 4in. in thickness, or a total of 1½cu.yd. of mixed concrete. For this we would suggest approximately 1½cu.yd. of ballast, ½cu.yd. of sand and eight bags of cement. The mix should be one part cement, two parts sand and four parts aggregate, by volume.

No reinforcement should be necessary but it would be as well to lay about 4in. of hardcore. Coconut matting is the usual covering for concrete pitches and is obtainable through sports stores or flooring firms.

Maintenance of Roofing Tiles

I HAVE a bungalow with a red asbestos slate roof which is covered with a mossy growth. Some years ago I scrubbed it clean but did not put any dressing on afterwards. I am once again scraping it and it looks like new. Can you give me any advice on the treatment I could use to stop the moss growing again? Would it be advisable to use a plastic emulsion paint, if obtainable in red, as a final coat, thus keeping the colour?—F. Crump (Malpas).

WE never recommend painting roofing slates, asbestos tiles or clay tiles, due to the continual maintenance problem which arises. Often the weather takes command and the application will fail in a short time, leaving a very patchy appearance.

You state that on cleaning the surface looks like new and therefore we conclude that if the moss growth could be controlled you would be more or less satisfied. With this in mind we would suggest that you give the roof surface a dressing of either Cuprinol for Brickwork or Santobrite. The former is available in all areas and the latter may be obtained through John Line & Sons, of Tottenham Court Road, London, W.C.1; a 5 per cent. solution of the latter would be sufficient. These materials are water-sensitive and may be washed away eventually by rain, thus an application each spring might be required to control the moss growth.

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.

Etching on Aluminium

COULD you please tell me how I could etch or "frost" aluminium without using dangerous acids? I believe there are non-acid chemicals which will etch aluminium. Could you also tell me the best varnish to use for blocking out the design?—W. Smyth (N. Ireland).

USE melted paraffin wax for blocking out the design. The actual etching process is effected with a strong solution of caustic soda. Rubber gloves should be used when handling this material; but one would not regard this chemical as dangerous as the acids.

Igniting Fireworks Remotely

I WISH to make some elements ¼in. long if possible, ½in. being maximum length, to work from torch batteries. They will be worked in threes or singly and are required to ignite fireworks remotely. Will you also tell me the type of wire required for these?—G. Leabon (Northampton).

WE are rather doubtful whether a torch battery will be sufficiently powerful to ignite a firework, and would suggest that you use a small 2v. accumulator, if possible.

One method would be to use a small fuse consisting of a thin strip of magnesium, the size of which would have to be found by experiment. Alternatively you could try using about ¼in. of 32 s.w.g. Brightray resistance wire; such wire is made by Henry Wiggin & Co. Ltd., of Wiggin Street, Birmingham 16.

Current in an A.C. Circuit

IN a single-phase circuit does the neutral wire carry the same current as the live wire? Suppose a four-core cable (three-phase and neutral) is used to supply single-phase circuits, each taking 30A., what current is in the neutral wire? Is it the total of the three circuits, 90A.? An electrician told me that less current flows in the neutral wire, but what proportion, etc., he did not know. He pointed out how a group of houses are supplied from overhead mains, with various groups tapped off each phase, but all connected to the common neutral, which he said is quite often a smaller gauge wire. It would appear to me that a single-phase A.C. circuit is similar to a D.C. circuit, e.g., if 30A. flow in one wire, then 30A. flow in the other.—D. Brinkley (Suffolk).

THE current in an A.C. circuit is not constant but varies in time in accordance with a sine wave. An A.C. current of 30A. (effective value) will produce the same heating effect as a 30A. D.C. current. The A.C. periodically reaches a peak value of 1·414 times the effective value. The peak value of the 30 (effective) A.C. amps is therefore 1·414 × 30 = 42·42A. The currents in the three phases connected to a three-phase generator reach their peak values at different instants. At the instant when one phase of the generator and supply has its maximum (peak) current of 42·42 in a positive direction, the currents in the other two phases of the generator and supply have negative values of 21·21. Since the phases are connected together at the neutral there will, at that instant, be a current of 42·42A. flowing from one phase to neutral, and 21·21A. flowing from the neutral to each of the other two phases. Thus there will be no current flowing in the neutral. A similar state of affairs will exist (with different values of current) at other instants, so long as the three single-phase load circuits are alike, i.e. so long as the loads are balanced.

In practice the single-phase loads are very seldom exactly balanced and a small resultant (out-of-balance) current will then flow along the neutral cable between the generating plant and the consumers. The out-of-balance current is never as great as the full-line current, consequently the neutral cable can be of smaller cross-sectional area than the phase or line conductors.

A Photo-electric Exposure Meter

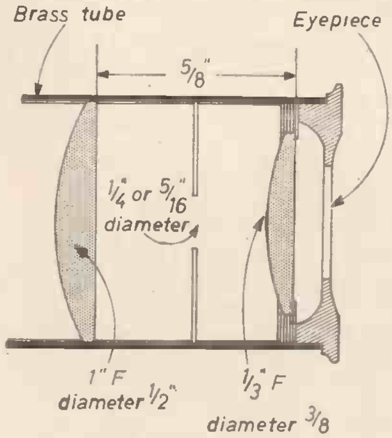
I WISH to make a photo-electric exposure meter, using an ex-Government meter, as I have been told that this is possible. I have an 0-5mA meter moving coil, made by G.E.C., and a Weston AE 0-3·5amp thermo-couple. Would either of these be suitable?—J. Nash (Herts).

A MICROAMMETER is needed for a photo-electric exposure meter. This is much the same as a milliammeter, but more sensitive. Photo-electric cells produce a very small current, so that a 100 microamp (0·1 milliamp) meter is usual. The 0-5mA meter would not do because the pointer would not move far enough to give any reading. It is not feasible to use a meter requiring more than ¼mA (250 microamps) for full-scale deflection with an average cell. The 3·5 amp thermo-couple meter would be a milliammeter, with internal thermo-couple. The " AE " signifies Aerial, as they are intended to read the current flowing into a transmitter aerial. If the thermo-couple is removed, leads being taken to the hair-springs, the instrument will operate as a milliammeter. The current required for full-scale reading cannot be stated, but could be found from Ohm's Law with a resistance and battery, or by testing with another meter. Most such meters were 1mA or 2mA types. If so, it is not sensitive enough for the purpose. You require a meter in which about 100mmA (0·1mA) will take the pointer to the full-scale position.

Astronomical Telescope

WOULD you please give me details of an eyepiece that would give the greatest magnification for an astronomical telescope (refractor) 2in. in dia. and having a focal length of 40in.—H. Roughley (Lancs).

YOU did not give any indication regarding the quality of the object glass of your telescope, whether it is a high-class achromatic or ordinary single-glass lens. Obviously the first would stand much the higher magnification. In any case, however, it usually happens that more details can be seen with low powers than with high and we recommend a magnifying power not greater than × 80, which will be the result of using a ½in. focus eyepiece. It is composed of two lenses 1in. focal length and ⅓in. (or ⅜in.) focal length arranged as shown in the illustration below in a



Mounting the lens.

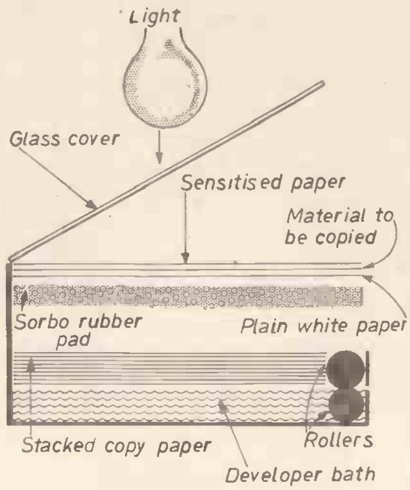
brass tube and held in place by rings of Bristol board. Midway between the lenses a stop must be placed, the hole through which can be about ¼in. or 5/16in. dia. The two lenses are both plano-convexed and these are mounted with the domed side towards the O.G., flat sides towards the observer's eye. They can be obtained from Broadhurst Clarkson and Co. Ltd., of 63 Farringdon Road, London, E.C.1.

Photo-copying Machine

I WISH to make a photo-copying machine similar to those advertised in P.M. I require it for copying drawings, etc. Could you please supply me with details?—L. Short (Sheffield).

THE machines marketed are elaborate and electrically controlled as to time of exposure, time of development and time of photographing and would therefore be very difficult to reproduce. However, the diagrammatic sketch attached illustrates the basic principle and we think you could manage to make a simplified hand-operated machine.

The material to be copied is laid upon the white paper covering the sorbo pad and the sensitised paper placed upon it and the whole clamped firmly by the glass cover. The glass cover is specially treated so as to have a slightly smoky colour in the middle, tailing out to plain glass on the outer edges. This is to ensure equal illumination over the whole area. The overhead light is switched on for a few seconds and then the sensitised paper is plunged into the developing portion of the



Layout of machine.

unit for a further number of seconds and is withdrawn through the squeegee rollers which pick up simultaneously a piece of plain copying paper from the rack. The passage of the two sandwiched pieces (the developed sensitised one and the plain one) are thus held momentarily in face-to-face contact as they pass as twins through the rollers. The reproduced material appears as a positive on the piece of copy paper. Times of exposure, development and temperature of the developer are critical for different types of material. The clearer the master copy the shorter is the exposure.

Mamba Control-Line Racer

(Concluded from page 445)

Give the whole aircraft one coat of sanding sealer after the two halves have been taken apart. Rub down with flour paper; if there is any grain showing give another coat of sanding sealer and rub down.

Painting

Use a good quality car cellulose. Putting it on in thin coats and rubbing down between each coat should give a finish to be proud of. With a team racer the finish is very important because of the extra speed that can be obtained. The prototype (see photo) had twelve coats of cellulose, all thin ones, which gave it a high gloss finish. Apply your light colour first in one thin coat. When this is dry rub down with wet-or-dry, then give another coat of paint and do the same as before.

After the light colour apply the dark colour or colours. These need a little extra care as they show irregular spots and also care must be taken where two colours meet. Masking tape will be most useful here. The final coats in both cases should be polished with metal polish and dusted off with a smooth duster. A small dummy pilot will be needed for the cockpit and can be obtained from your local model shop, either painted or unpainted.

The pilot is fitted in position (see plan) before fitting the canopy. Use a contact adhesive. The canopy can either be moulded or bought. The commercial canopies are slightly shorter than the one shown on the plan but it is the depth which is important. Glue the canopy in place with balsa cement, hold in place with rubber bands and allow to dry. Mark in the cockpit frame lines by masking, then painting the frames while the masking tape is in place, to obtain a clean line. When dry remove the tape. The position of the frame lines is marked on the plan.

Flying

The aircraft has a very quick take-off so do not be in too big a hurry to get it off the ground. Before flying, warm the engine up, so starting will be easy. Use an 8in. × 8in. propeller for this job, then change to a 7in. × 9in. propeller for racing.

The control lines are as stated, 52ft. 3in. The lines are made from 0·010in. high tensile steel wire, which can be obtained from your local model shop. Each wire is looped at either end for attachment to the aircraft and handle. These loops can be soldered to stop them slipping. The handle should be of regulation pattern, i.e. a plain steel harp type. These can also be obtained at a model shop. Two 20 s.w.g. wire clips made in the same way as the control lead-out wires should be fitted to the handle and secured in the same manner. The control apparatus (handle, line and bell crank) should conform to the minimum breaking strain of 10 times the weight of the model. Do not use thread or nylon lines on this aircraft. Make sure that when the lines are looped at each end they are both the same length. Do not try to loop this aircraft.

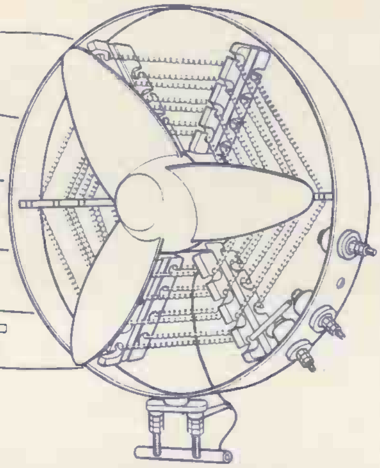
COLD AIR

TEMPERATE

WARM

HOT

VERY HOT



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