PRACTICAL MECHANICS AND SCIENCE

JUNE 1963

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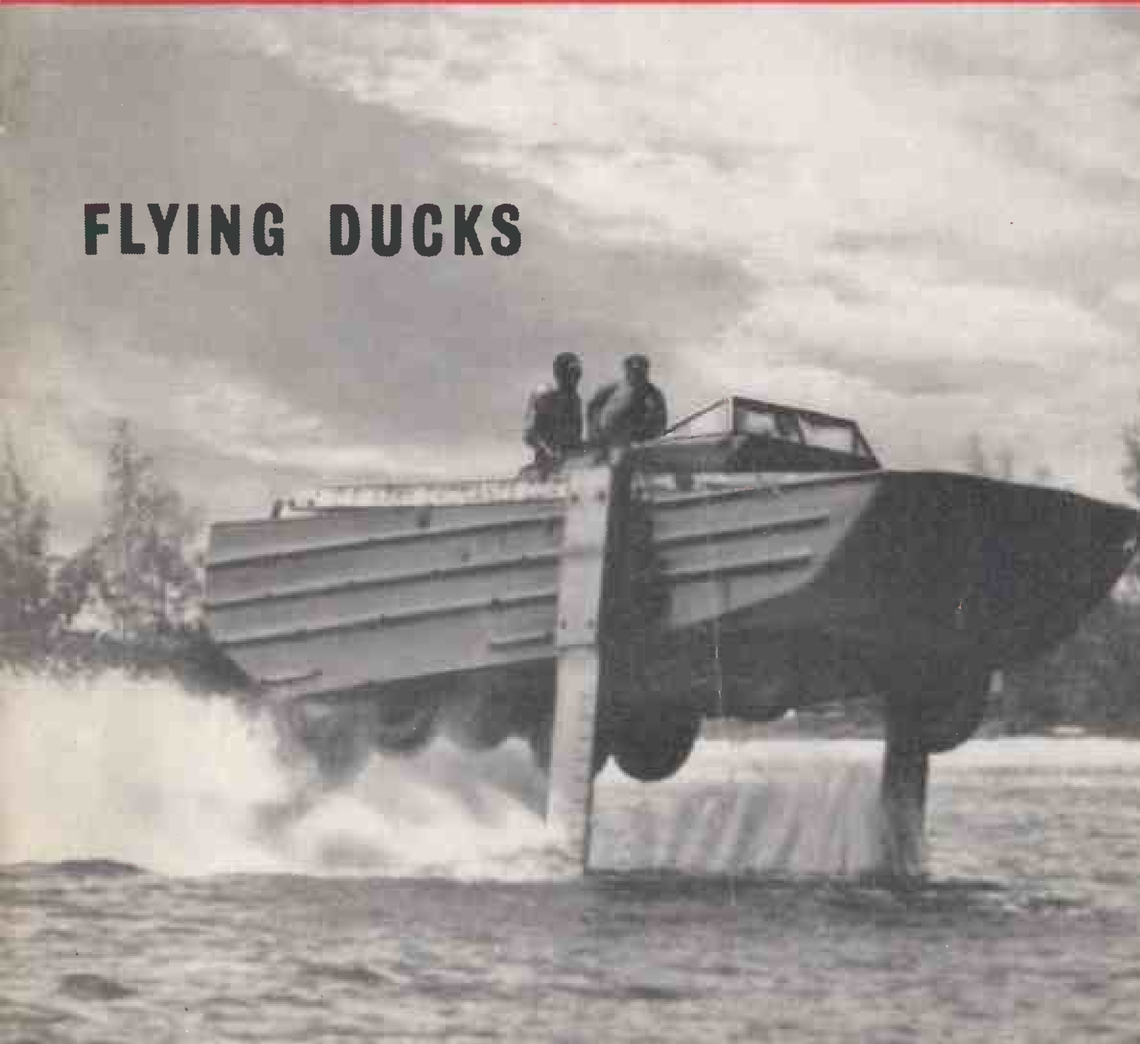

INSIDE THE EARTH

ROTATING ASTRONOMICAL OBSERVATORY

A COMBINATION SAFE

PRACTICAL MECHANICS AND SCIENCE

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TALKING POINT

Metals shaped by shock waves

A SUDDEN discharge of electricity, producing high-pressure shock waves in a liquid can now be used to form metal without using a press. Department of Scientific and Industrial Research's National Engineering Laboratory at East Kilbride has been working on this process, known as electrohydraulic forming and has constructed a prototype industrial unit. Experiments so far indicate that the method is suitable for producing small numbers of intricate components, including re-entrant shapes.

In this process electrical energy, built up at a comparatively slow rate in a bank of condensers, is suddenly discharged through a pair of electrodes immersed in a liquid, usually water. This produces a shock wave which is used to force a metal blank, in either sheet or tube form, against a die.

Because the energy involved can be precisely controlled and the duration of the pressure wave is of the order of micro-seconds only, the dies can be made of cheap, easily worked materials such as aluminium, wood or even plastics. This makes the process attractive for short runs or even one-off jobs since tooling costs will be comparatively low.

Shapes which have been made include tubes with bulged, conical or screwed ends and bellows couplings, and the process has been used for expanding tubes into a plain bush, a problem similar to that of fitting tubes to the tube plate of a condenser or heat exchanger. Coining and embossing are also possible with this system. The process should, however, lead to the opening of a new design field as its possibilities become known more widely.

Although similar in principle to explosive forming methods, electrohydraulic forming avoids the hazards attendant upon storing and handling explosive charges and the equipment can be installed on the shop floor alongside other plant.

Ball bearings with wire races

Ball bearings with wire races have been developed at the Institute of the Bearing Industry in Moscow. They consist of two pairs of wire rings of different diameters with balls in between.

The new bearing differs from the conventional ones not only in its wire races. It also has no massive retaining rims. The wire rings are put into grooves cut in the body of the machine and in the shaft. Balls are placed between them. The components of the mechanism themselves act as retaining rims. Owing to this arrangement great quantities of high alloy steels are saved and the dimensions of sub-assemblies are reduced.

The wire bearing is less susceptible to dirt than the commonly used one and does not require special lubrication. The worn parts, wire rings and balls, can be replaced without great difficulty.

Bearings with wire races are simple and cheap to manufacture. They are finding wide application in farming and road-building machines, turning devices, wood working machines and tools, and in optical and astronomical equipment—where small loads on shafts are needed.

Donald Campbell and Bluebird are again attempting the world land speed record —

with the whole

STRAPPED in the driver's seat of the new Bluebird, with the power of 4,250 horses, figuratively speaking, behind him, Donald Campbell will sometime about now be once again attempting to shatter the world land speed record. Coupled with the ingenuity of British engineering and craftsmanship his chances are excellent. We have done it before and we sincerely hope that Donald Campbell—holder of nine land speed records—will do it again.

Engineering skill alone will not be sufficient to break the land speed record, set up by the late John Cobb at Bonneville Salt Flats, Utah, in 1947. His speed was 394·19 m.p.h. It will take sheer nerve and professional competence on the part of the driver, and Donald Campbell certainly has these. He is already the holder of the water speed record, which he regained on Ullswater in Cumberland at a speed of 202·32 m.p.h. He went on to raise his own record on five occasions, finally to 260·35 m.p.h., where it stands today. That he is the survivor of the world's fastest crash, on the Bonneville Salt Flats in 1960, can be chiefly attributed to his dexterity as a driver. Like his father, he is a perfectionist. He has more or less lived with speed since he was 14 years old, and the severe test which he now faces will, we sincerely trust, prove to be another personal achievement.

His Proteus-powered Bluebird was designed by Norris Brothers Limited, of Burgess Hill, Sussex, and has been rebuilt since the crash, with a number of modifications, by Motor Panels Limited, of Coventry. Altogether, some 80 British firms have contributed to the task of producing the car which has cost in the neighbourhood of £1,500,000. In designing the Bluebird, Norris Brothers have kept in mind that it must establish a record which will be recognised by the International Automobile Association. This means that it must have at least four wheels, not in one line, always in contact with the ground, with at least two of the wheels steering and at least two driving. This distinguishes the land speed record for cars from the absolute land speed record which could be held by a motor cycle or a vehicle with jet propulsion.

The chief modification made to Bluebird is the addition of a 7ft 8½in. tail fin, which will give greater aerodynamic stability at high speed. It is constructed in sections, with a special aerofoil section, so that adjustments in the fin area can be made. This provides for a compromise between decreased stability or higher drag.

Instead of two fuel tanks, with a total capacity of 25 gallons, one tank has now been installed with a capacity of 16 gallons. This, with a consumption rate of one mile per gallon at top speed, is sufficient for a one-way run.

The centre of gravity has been moved towards the front end of the car by bringing the batteries, fuel tank, air bottles, valves, filters, gauges for the braking system and an 18-channel recorder for measurements taken at important points throughout the car when the run is being made, forward. With the exception of the fuel tank, it is now all mounted on fore and aft rails so that its position, can be altered if necessary, should the centre of gravity need to be adjusted during the working up trials.

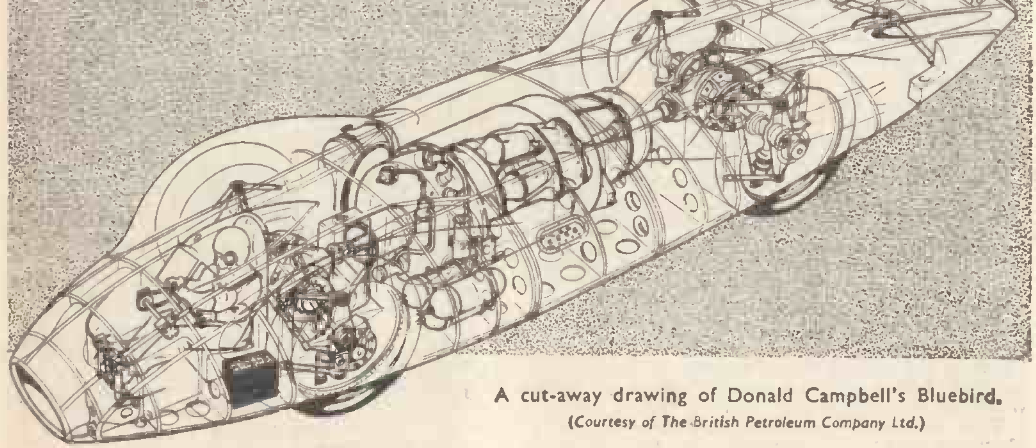
The new cockpit canopy is thicker and is made from glass fibre in place of Perspex. This will give greater protection to the driver's head, and is able to withstand a load of 50 tons. Two panels on either side of the driver's head are made of clear Perspex, and a safety glass screen is fitted. A Hussenot system has been installed so that Mr. Campbell can take the essential readings of speed and linear acceleration from figures reflected on the windscreen, instead of having to look at his instrument panel.

Power, which is one of the most important features of a car designed for speed, is provided by a Bristol-Siddeley Proteus gas-turbine engine. Seldom has one engine achieved such versatility as the Proteus. Originally it was introduced in the Britannia airliner; it then became the power behind 3,000kW turbo-generators; then the powerplant of high-peed patrol boats for five navies; the boost for a United States hydrofoil, and now the power behind Bluebird.

The Proteus gas-turbine engine has been modified to drive from both ends, and power is transmitted to the four wheels through two spiral bevel gearboxes with ratios of 3·6 to 1. The driver sits in the nose of the vehicle, forward of the front gearbox. The engine has a ring of air intakes around its centre section. These are fed from the air intake at the front of the car via twin ducts, passing each side of the driver, and a plenum chamber. The arrangement for exhaust gases consists of four ducts. The compressor consists of a twelve-stage axial type, followed by a single centrifugal stage. The rotor is built up from a series of discs with a high resistance to centrifugal stresses. There are eight combustion chambers with outer casings of stainless steel enclosing Nimonic nickel-chrome alloy flame tubes. In all, there are four turbine stages. The first two turbines drive the compressor, the other two, the power turbines, drive the output shafts and have no mechanical connection with the compressor. The engine burns a distillate diesel fuel similar to paraffin and averages approximately 1½ miles per gallon. The dimensions of the unit are; length, 105·75 in.; diameter, 39·0in.; weight, 3,000lb.; shp, 4,250.

The wheels are sharply dished steel discs, with detachable rims, carrying tyres of 52in.. diameter by 8·5in. section. The tyres consist of four layers of rayon cord, with a 0·02in. thick outer coating of natural rubber. The cover has to be kept very thin because of the high centrifugal forces which will be exerted at high speed. In the range of 470-500 m.p.h., the tread is subject to about 8,000 times the force of gravity. The tyres will be inflated with nitrogen at a pressure exceeding 100 psi. The inner tube is also of natural rubber, and tyre and tube combined weigh 50 pounds. The duties imposed on the tyres are extremely exacting, but endurance is not one of the worst since the duration of a run is only a little more than a minute. The wheels will be changed after each run, thereby bringing

world watching



A cut-away drawing of Donald Campbell's Bluebird.

(Courtesy of The British Petroleum Company Ltd.)

new tyres into use. This has the advantage that it avoids the necessity of inspections for accidental damage and in any case the tyres themselves will be too hot to handle immediately after a run. The turning circle of the car is 300ft, equivalent to a lock of only 5 degrees each way.

Lake Eyre, in South Australia, where the runs are to be made this summer, presents different problems from those encountered at the Bonneville Salt Flats. While a much longer run is possible, (20 miles at Lake Eyre against only 15 at Bonneville Salt Flats), the surface is composed of a mixture of salt crystals and dust, which is highly abrasive. The American salt flats have crystals of a much lower strength which wore away faster than the tyres, in Australia it is the exact opposite. In view of this, special tubeless tyres have also been made, and will in all probability be used.

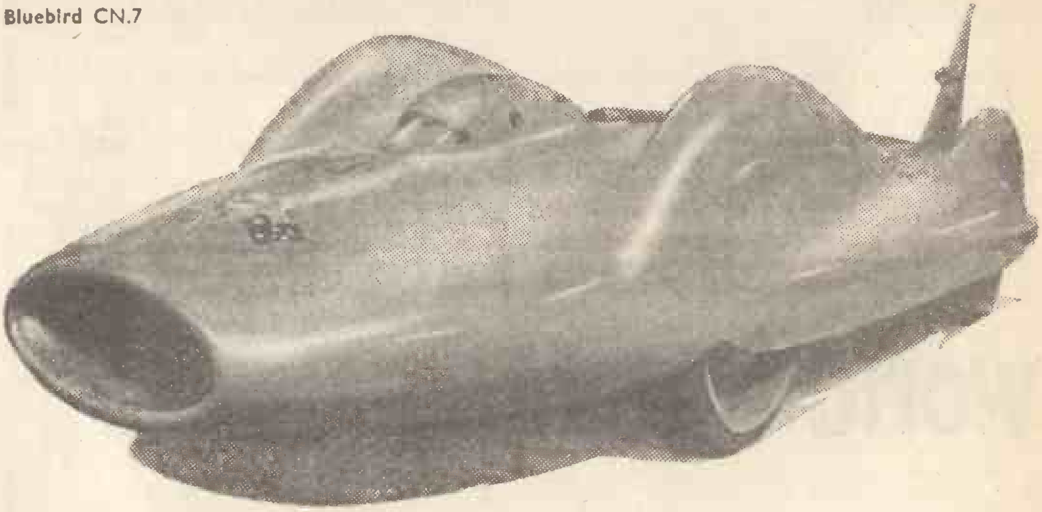
Under the regulations, two runs have to be made, one in each direction, the final time being the average. The measured mile, therefore, has to be in the centre of the straightway, thus leaving a distance of about seven miles in which the car has to be stopped. The brakes consist of two systems—air brakes to slow the car from its peak speed of about 400 m.p.h., and disc brakes inboard on either side of the reduction gears, to bring the car to a halt. The total amount of energy to be dissipated in the 60 seconds of braking is 75 million foot pounds.

Torque is smoothly transmitted to the wheels throughout the entire speed range without any clutch or gear change. The engine will be started and run up to a predetermined speed, with the car locked on the brakes. Then the brakes will be released and the car will accelerate at a rapid but controlled rate. It will not be possible to apply full torque until the car has reached 200 m.p.h. otherwise there would be a drastic wheel spin.

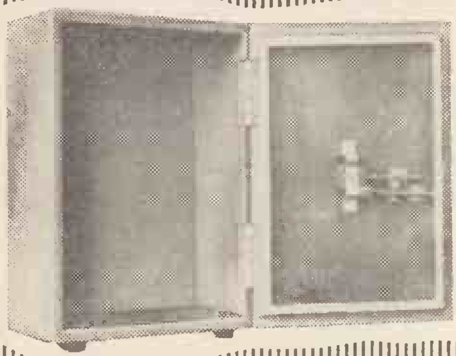
The frame of the 30ft car is of "egg box" construction. It is permanently assembled by riveting, which is reinforced with a special bonding. The main beams, auxiliary beams, engine covers, gearbox covers, pressure bulkheads and canopy frame consist of sandwich panels with aluminium alloy facing sheets and "Aeroweb" aluminium stabilising cores. Metal inserts are included in the core of the panels to take concentrated loads at various points where other components are attached. The adoption of "Aeroweb" honeycomb panels for several main components of the frame has resulted in very considerable saving in weight without loss of strength and stiffness. Savings in weight in such a car as this are, of course, of fundamental importance. They not only contribute to acceleration, but in this case were essential to lighten the duty on tyres. It must not be forgotten, however, that the evolution of a light and powerful gas turbine engine, such as the Proteus, has helped considerably.

And so, we wait and watch with the rest of the world, for his next attempt on the world land speed record—and wish him well!

Bluebird CN.7



Donald Campbell seated on Bluebird after a trial run at Goodwood.



A COMBINATION SAFE

BY J. E. TURNER

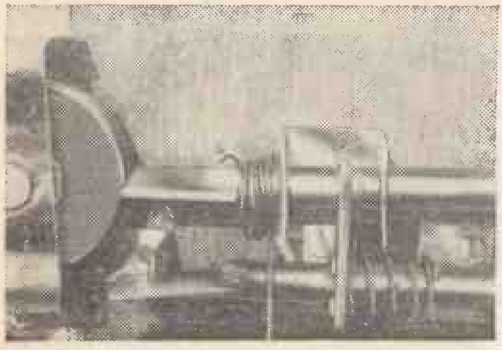
THE small safe described here is intended solely as a security box in which to keep private papers and small items safe from exploring children but there is no reason why the same arrangement cannot be employed using, say, $\frac{1}{4}$in. steel plate with a strongly constructed lock mechanism, to baffle the usual housebreaker. Especially if the safe can be built into a wall. This safe is constructed from $\frac{1}{2}$in. thick hardboard, 12in. high, 9in. wide and 5in. deep but the material and sizes are matters of choice. All angles and corners of the safe should be slightly rounded and the whole given a coat or two of paint, colour to choice, grey or green seeming most appropriate. Four rubber feet should be screwed to the bottom to prevent scratching polished surfaces. As is the case with some real safes the door, being relatively heavy, tips the safe forward when opened. In the small model described this is unimportant as it can easily be held steady or the safe can be made deeper from front to back. In a full size steel safe however, this tendency can be dangerous and the safe must be anchored down or solidly built in.

The lock mechanism which is the main feature of the safe is fairly simple to construct and operates as follows. The door is provided with the usual dial, complete with the letters of the alphabet set around the edge. The dial is secured to a shaft ($\frac{1}{4}$in. diameter silver steel rod) which passes through the door face in a suitable metal bush. The shaft, on the inside of the door, is fitted with four metal discs each having a radial slot and a pin or stud which projects a small distance from each face close to the edge as shown in the drawings.

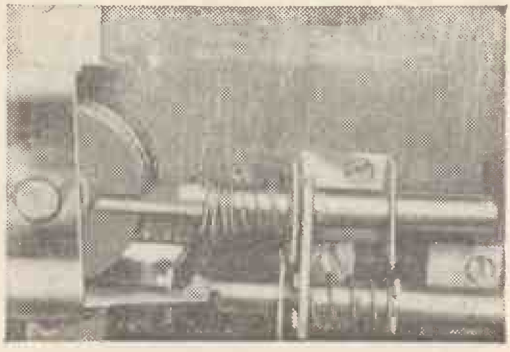
The disc closest to the inner face of the door is securely fastened to the shaft. It is essential that this first disc is really secure on the shaft, as should it work loose the safe cannot be opened without damage. Silver soldering or brazing is recommended. The remaining discs should be slipped on the shaft with a washer or two fitted between each disc, so that the pins are just clear of the faces of the adjoining discs. When any disc is rotated the pins will thus engage each other and turn the next disc. Each disc, apart from the first, must rotate freely on the shaft. The shaft and discs are held in position by a shaped bracket screwed to the back of the door.

As the dial is turned only the first disc will rotate until its pin meets the pin on the second disc

The mechanism in the locked condition, showing how the discs and keybolt hold the locking bolt in place.



With the combination applied correctly the slots in the discs align and the keybolt withdraws the locking bolt.



which will then also commence to rotate. The pin on the second disc will in its turn engage with the pin on disc number three until finally all four discs are rotating with the dial.

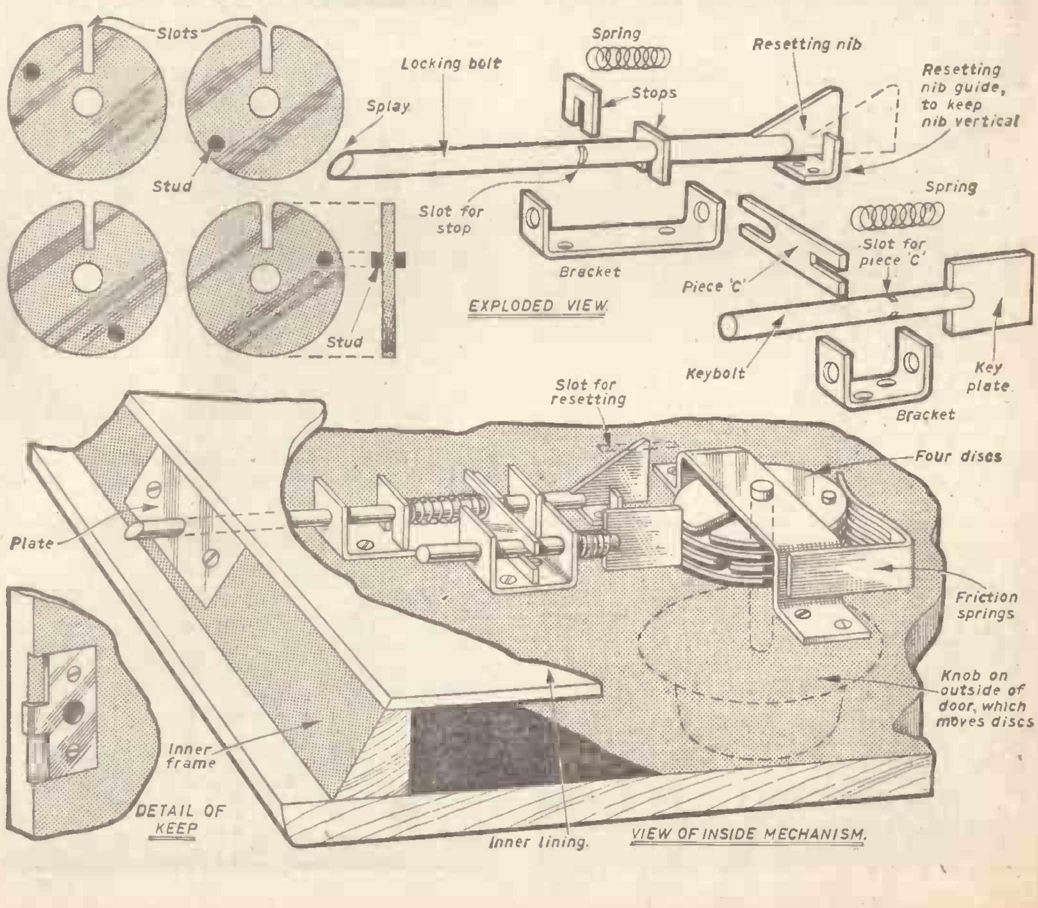
To open the lock all the slots in the discs must be aligned with a key plate, allowing it to enter the slots and withdraw the bolt. Having turned the dial sufficiently to be sure all the discs are turning together, the sequence is as follows. The dial is turned onwards until the slot in the fourth disc is correctly located with respect to the key plate (first letter of the combination). The dial is now rotated in the reverse direction, thus turning the first disc only. The second, third and fourth discs remain stationary until the pin on the first disc once again engages number two pin, on the other side this time. Continuing in the same direction this in turn meets and turns pin and disc number three. When the slot in number three disc is correctly positioned (second letter of the combination) the dial is again rotated in the reverse direction until the slot of disc number two is aligned (third letter.) A final change of direction brings the last slot into position at the last letter and the bolt springs back with a pleasant "clunk" allowing the door to be pulled open. To prevent the discs being moved out of position by the friction between the spacing washers, friction springs are necessary, made from springy brass cut and bent to the shape shown in the sketch and soldered to the large bracket. Additional discs can be added if required thus increasing the odds against opening the safe without the combination.

To allow the safe to be closed, the locking bolt has to be spring loaded as shown. It must be provided with a nib to project through the inner lining of the door to enable the lock to be reset. The lock has to be reset each time the safe is opened and this is done by moving the bolt forward, which in turn withdraws the key plate from the slots. The dial is then turned several times to displace all the slots and the door can then be slammed shut. It is important when resetting the lock, to turn the dial a sufficient number of times, otherwise it is possible for the safe to be opened with little trouble.

Dimensions have not been given for the mechanism as these can be varied to suit individual requirements. The discs can be cut from thick sheet metal but they must be very accurately made. A better method is to use pressed metal discs or washers having a true circular shape. The diameter of the discs is not important, between $1\frac{1}{4}$in. to 3in. is suitable but they must all be exactly the same.

(Continued on page 430)

The complete set of parts for the combination lock and their arrangement in the door thickness. The position of the studs on the discs determines the combination (see text).



NO-MOVING-PART MOTORS

By G. Haydock

DETAILS OF THE REVOLUTIONARY LINEAR INDUCTION MOTOR AND A TRY-IT-YOURSELF MODEL

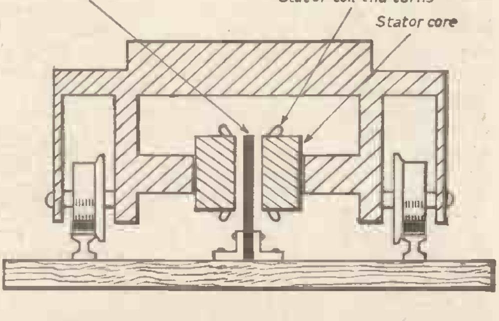
THE linear induction motor—a new form of propulsion which requires no moving parts—is being developed for British Railways by Dr. E. R. Laithwaite at Manchester University in association with Dr. F. T. Barwell of the British Railway Board's research organisation.

The new device is a motor with flat stator windings in place of the circular windings of an ordinary electric motor. Instead of the rotor a flat reaction strip of electrically conducting material is used, fixed throughout the length of track between the railway lines. The windings are positioned close to the metal strip and when the current is applied eddy currents are induced in the strip. Reaction between the two sets of currents produces a force which propels the windings along the track when fixed to a trolley. Braking and movement in the opposite direction are achieved bv reversing the flow of current through the windings.

At the Gorton locomotive works a public demonstration of the linear motor has been given. An experimental model of the motor, fitted to a rail trolley and working in conjunction with a continuous vertical metal strip fitted between the rails, exerted a tractive effort of 1,000lb and reached a speed of 30 m.p.h. in a distance of 65ft.

The linear motor has several advantages. Firstly, the machine is extremely simple and cheap compared with the rotary motors at present used for rail traction, particularly if their associated gearing is taken into account. Secondly, because the driving force arises electrically, propulsion and braking is no longer determined by adhesion limits between wheel and rail. Thirdly, the limitations on the power developed by a motor of given size arising from overheating are partially removed, because the vehicle moves continuously over a cool plate leaving the heated plate behind.

The linear principle has been known for some time, and although there have been proposals to adapt it to various uses including "firing" shells, no practical design has been evolved before. This is probably because in earlier experiments the winding was taken as the fixed part and what has become the continuous strip in the present model, was taken as the moving part. This meant that the winding had to be extended throughout the whole of the desired length of travel. In the rail application the position of these two intrinsic elements is reversed, thus producing an elegant design requiring only a comparatively short winding



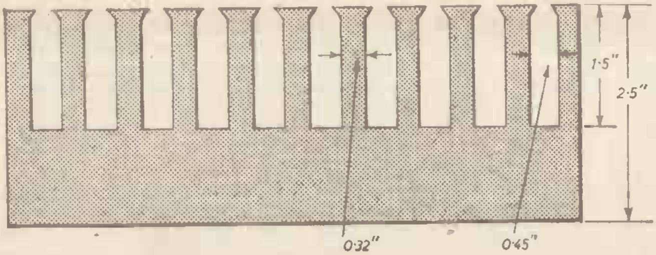


FIG 1

The linear motor can give a tractive effort which is independent of speed and, unlike ordinary motors, its maximum speed is not determined by centrifugal force. The faster the vehicle needs to be propelled the more attractive the linear motor becomes. Above a speed of about 120 m.p.h. the advantage over conventional motors becomes absolute. Should commercial considerations eventually dictate substantial increases in rail transport speeds the linear motor may well provide the ideal propulsion medium.

The present experiments being carried out are intended chiefly to elucidate certain technical performance factors to provide a basis for an economic appraisal. These are, the material and form of the centre plate, the minimum air gap required between the winding and the continuous

FIG 2

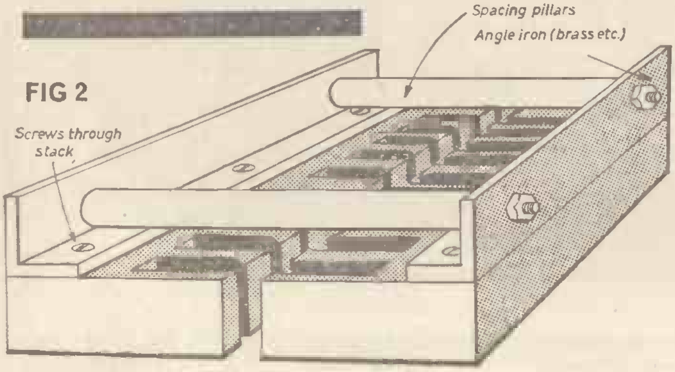
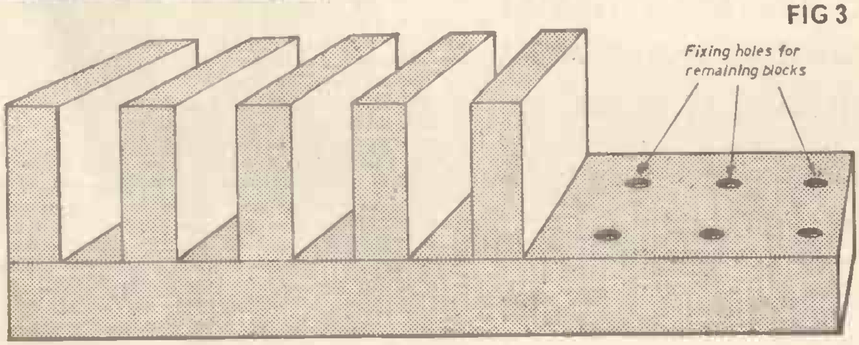


FIG 3



carried on the vehicle, and a continuous metal strip. The latter is entirely passive in the sense that no current is supplied to it. Power for the windings on the vehicle can be fed to it by means of conventional catenary and pantograph arrangements.

The extreme cheapness and simplicity of the device, particularly as there is a complete absence of moving and wearing parts, suggests that considerable economies may be realised. Moreover, there is a greater certainty of obtaining higher acceleration and better braking because there are no limitations due to lack of adhesion. A disadvantage is the cost of the plate on the track, which must extend throughout the length of route, and some difficulties are anticipated in finding sufficient room for mounting the plate without interference with other rolling stock. Clearance at points and crossings is another difficult problem to be overcome.

strip, the method of mechanical attachment of the motor the vehicle to allow for vertical and horizontal displacement, and power consumption.

While these experiments will establish the linear motor's potential more exactly, there is an immediate application for it in a modest way as a booster accelerator in moving heavy trains from rest or up starting inclines, or as a propulsion unit in marshalling yards in place of the conventional shunting locomotive. It is conceivable, provided that the cost of conversion could be justified by the expected results, that an entire route could be worked by linear-motored trains at speeds up to 200 m.p.h.

Construction of a model linear induction motor

So much interest in the linear induction motor as a form of high-speed railway propulsion has

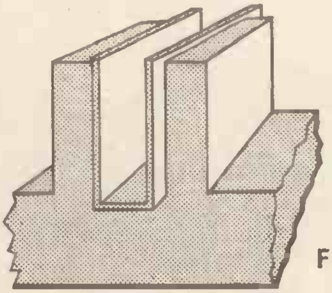


FIG 4

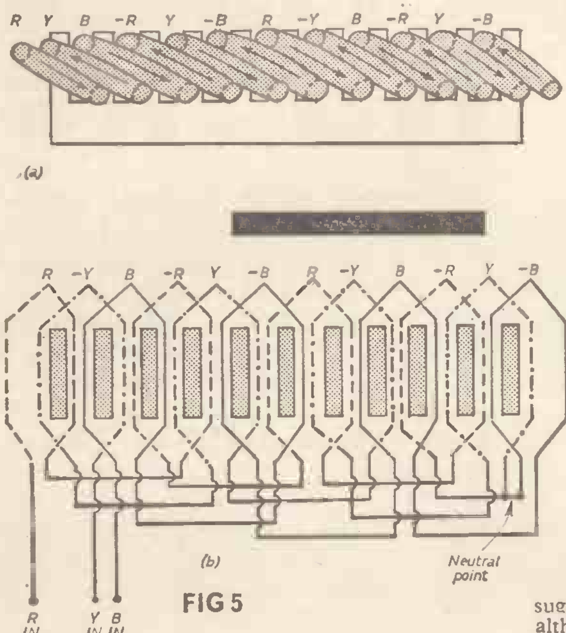


FIG 5

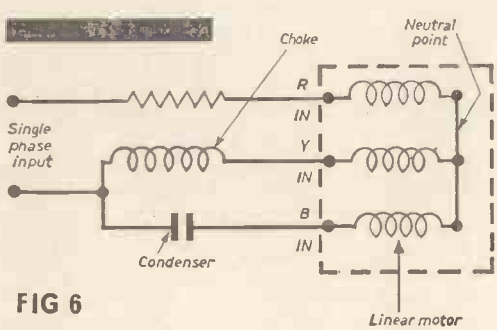


FIG 6

arisen that a book is being written on the subject. This book is to be called "Propulsion Without Wheels" and is likely to be on sale towards the end of 1963. At the end of each chapter there will be a section devoted to detailed instructions for making models for demonstration purposes. It is hoped that it may be possible to arrange for a firm to supply parts to enthusiasts.

Meantime Dr. Laithwaite has prepared the following detailed information about the motor, but emphasises that it describes one particular model only, and gives no indication of possible variations to suit local supplies, etc. To a large extent, he points out, the choice of number of turns of wire will be experimental and it may be necessary to rewind the motor after an initial test.

Ideally, the motor stator should be made up from steel stampings stacked together to form a laminated block. It is often convenient to use slots with a partially closed top as shown in Fig. 1, to prevent the windings from leaving the slots but this, like several other features, is not vital. If such stampings are available, so much the better, if not, plain stampings might be obtained (for example, offcuts of large transformer stampings) and rectangular slots milled out from a stack of these. This assumes that the model builder has the use of a milling machine. The stack should be drilled and bolted together between thick metal plates before milling. It is suggested that a stack 2in. thick would make a useful model since it could be divided to make a double-sided motor as shown in Fig. 2. If no such stampings are available, the stator core could be made from solid iron or mild steel. It could even be fabricated from rectangular blocks screwed on to a base block, as shown in Fig. 3.

When the stator blocks have been made they should be bolted together so as to leave about $\frac{3}{8}$in. between the faces, as shown in Fig. 2. Before finally bolting together, the windings should be fitted to each half. The slots should first be insulated with a layer of suitable material, as shown in Fig. 4. The material should project slightly at each end of the slot to protect the wire against the sharp corners.

Coils may now be wound on a former measuring perhaps $2\frac{1}{2}$in. x 2in. The wire suggested is Lewmex insulated, diameter 0·036in., although any varnished wire of that diameter will do. It should be possible to get coils of 75 turns in the slots, although adjustment of this number may be necessary after a first try. Arrange the coils in the slots as shown in Fig. 5, and connect coils in the same set in series, in the directions shown. Connect the same sets in the two blocks in series also, but make sure that red coil is opposite red coil and that both drive magnetic field across the gap in the same direction at any instant of time.

To terminals A, B and C (Fig. 5b) should be connected a 3 phase, 400 volt supply. The machine should take about 25 amps/phase. If you cannot obtain so much current, then use more turns of thinner wire (thus four times as many turns of 0.018in. diameter wire would cause the motor to take 25/16 amps instead of 25 amps, but the force produced by the motor would only be $\frac{1}{16}$ that of the original design and this may not be enough to move it). Use as much current as possible.

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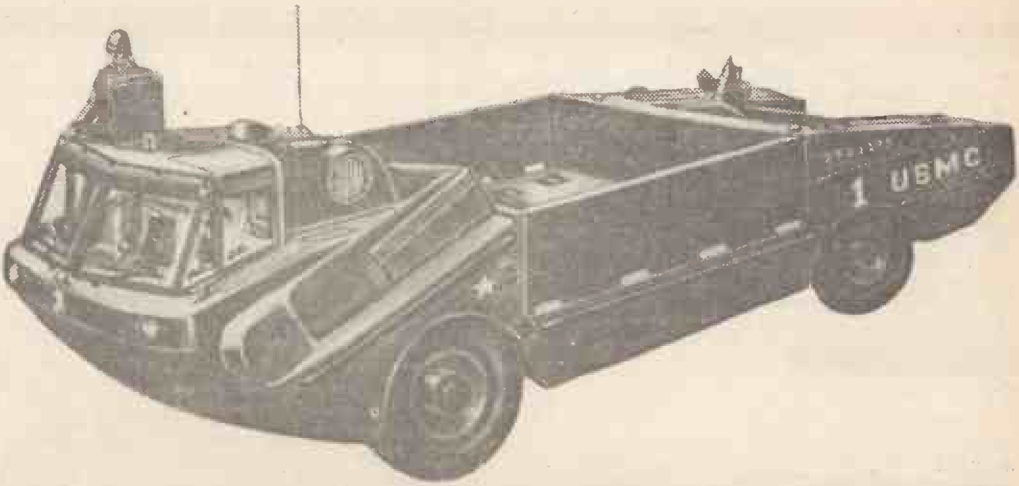
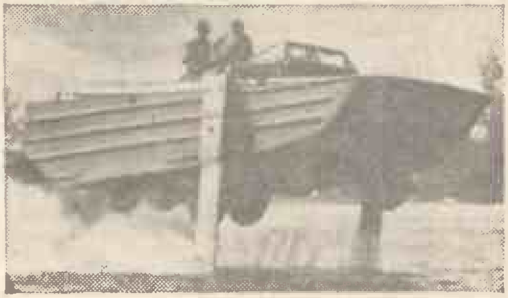


flying ducks



The "Flying Duck" designed and developed by Avco Corporation's Lycoming Division proved the principle of gas-turbine/hydrofoil marriages. The converted World War II amphibious DUKW (left) operated at speeds in excess of 35 m.p.h. as compared to its previous speed of 6 m.p.h. It first "flew" in 1959. Further developments are currently proceeding.

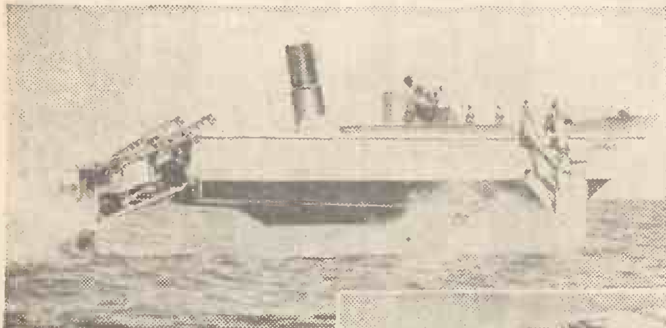
THE United States Bureau of Ships has always had a fondness for amphibious vehicles. A number of these " flying ducks ", as they have been affectionately called, have been produced by Avco Corporation's Lycoming Division, who have been engaged in amphibious vehicle and hydrofoil activitv for several years. They are, incidentally, the only American company to have conducted a successful programme for high-speed, rough water operation of a wheeled amphibious vehicle. This programme was the " Flying Duck " project conducted for the U.S. Government under contract with the U.S. Army Ordnance Corps. A "one only" research vehicle, the " Flying Duck " is a gas-turbine powered, hydrofoil version of the famed World War II, DUKW.

Combining an 860 horsepower Lycoming T53 engine with aerodynamically shaped hydrofoils, the craft proved its ability to " take off " and operate successfully in rough water at speeds in excess of 35 m.p.h. All tests of the " Flying Duck " proved highly successful.

A second test programme, of a more advanced nature, is currently underway under contract with the U.S. Marine Corps. The Marine Corps craft, now being designed and developed, is an amphibious landing craft—a gas-turbine powered hydrofoil craft with fully submerged foils capable of transporting several thousand pounds at speeds up to 45 knots through rough seas. Known as the LVH, or Landing Force Amphibious Support Vehicle, Hydrofoil, this new amphibious vehicle will be used by the Marines in a logistic role during landings. Specifically its mission is to transport cargo during the assault phase of an amphibious operation from widely scattered LST's, LSD's and LPD's.

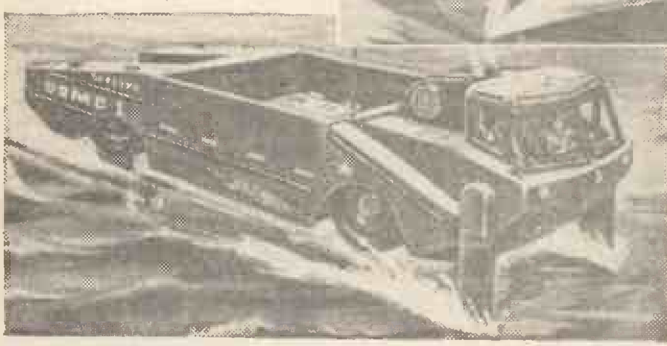
It must be capable of " flying " through rough water, boating through the surf zone and traversing difficult beaches, sand dunes and other rough terrain normally encountered in off-road operations, reach an unloading point and then return to ship. All dimensions must allow operations from virtually any U.S. Navy ship.

In order to meet all the design requirements stipulated by the Navy for the new vehicle, Lycoming engineers incorporated several unique features into the LVH. " Flying " speed in excess of 35 knots, boating speed of several knots, and overland speed of more than 25 miles an hour is made possible through the use of the new Lycoming TF-1430 marine gas-turbine engine which can operate on a variety of fuels.



"Halobates", a converted Navy LCVP and the world's first turbine-powered hydrofoil boat was built to test the feasibility of advanced hydrofoil designs. Powered by a Lycoming T53 gas turbine engine, the craft "flew" successfully at speeds in excess of 35 m.p.h. in sea trials starting early in 1959.

The U.S. Navy's newest amphibious landing craft, the gas-turbine powered LVH. For land operations, the hydrofoils are retracted completely within the hull. The LVH will be capable of "flying" at speeds up to 45 knots or travelling overland at speeds of more than 25 m.p.h.



Another impression of what the Marine Corps amphibious craft will look like when operating on hydrofoils. The hydrofoil legs retract completely into the body for normal boating or land operations. The heading picture to this article shows the vehicle on land with the hydrofoils folded up.

The hydrofoils, one forward and one aft, are of high aspect-ratio design and are completely submerged during all water operations. For land travel, they are retracted entirely within the confines of the hull. The foils are self cleaning and have been structurally designed to operate through floating debris without damage.

Separate propellers are included for boating and "flying" operations. The "flying" propeller is mounted on the forward portion of the bottom of the rear strut. The entire lower section of this strut, including the foil and propeller, is rotatable to provide dynamic steering. The boating propeller is separately mounted on a retractable drive beneath the hull.

The four huge 18:00 x 25:00, 12-ply tubeless, self-sealing tyres are mounted on fully retractable wheels for boating and "flying" operations. Power steering of the front wheels is provided. The tyres incorporate a Schrader inflation system which permits inflation or deflation from within the cab while under way.

Delivery of the first of the new Marine Corps craft was scheduled for early this year. Initial qualification tests will be performed in Long Island Sound off Stratford. Government tests and evaluations will be conducted at the Marines' Camp Pendleton in California.

Avco's Lycoming Division is also noted for the production of aircraft engines and missile components. Prior to their development of the "Flying Duck", mentioned earlier, they installed a Lycoming T53 engine in a Navy LCVP which was converted to a hydrofoil configuration. This vehicle, called "Halobates", was designed only to test the feasibility of some advanced hydrofoil designs. It was flown successfully, early in 1959, at a speed in excess of 35 m.p.h. In both "Halobates" and the "Flying Duck" the T53 engine ably demonstrated its ability to perform in a marine environment.

Lycoming's amphibious vehicle experience dates back to World War II, when it built for the military a then secret high-speed craft known as the "Salamander" or "X Craft". This vehicle was a track-laying amphibious tank design, capable of moving through water and on land at a speed up to 20 m.p.h. Production of this vehicle was never released due to the termination of hostilities or it might have played an important part in Pacific operations. Flying ducks are clearly here to stay, though never, we hope, to be shot at.

WEIGHT BELT FOR a Wet Diving Suit

By B. R. Pearce

Any reader who has made the wet diving suit described in the October 1962 issue will require a weight belt for use with his suit.

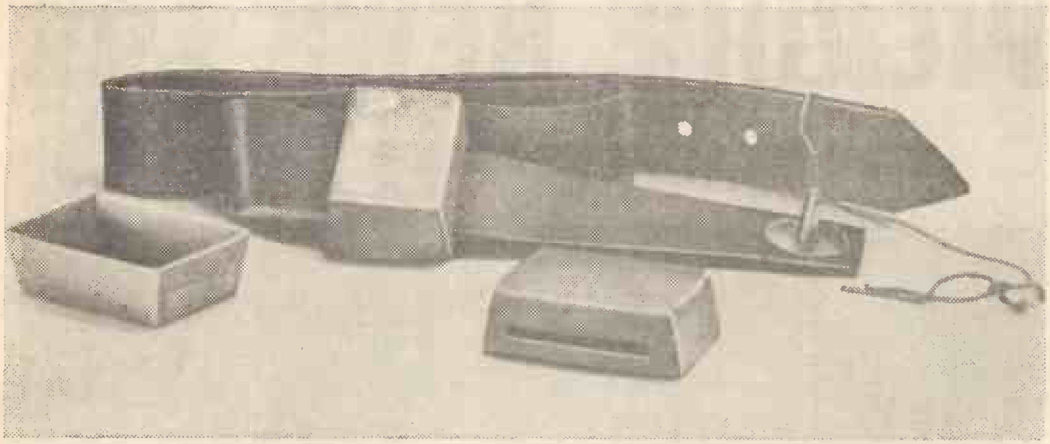
The amount of weight will vary from person to person and should be determined by trial. However, seven of the weights described should cater for the needs of most divers.

THE BELT

THIS is simply made from a length of rubberised webbing and a quick-release pillar fastener. These items were obtained from, Sub Aqua Products, 63 Twyford Road, Eastleigh, Hants., at a cost of 16s. 6d. Assembly is as follows: Punch a number of $\frac{3}{8}$in. diameter holes at the tapered end of the belt, to suit your own waist measurement. Punch one hole at the other end of the belt and assemble the pillar. The quick-release pin should be retained with a length of nylon cord.

THE WEIGHT MOULD

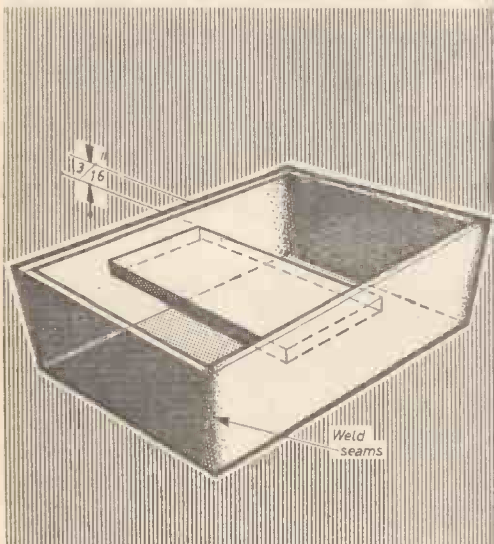
This can be made from either mild steel or aluminium of about 18 s.w.g. It should be cut as in Fig. 1 and folded into the shape shown. The seams should then be brazed, welded or otherwise sealed to prevent the molten lead escaping. A steel plate,

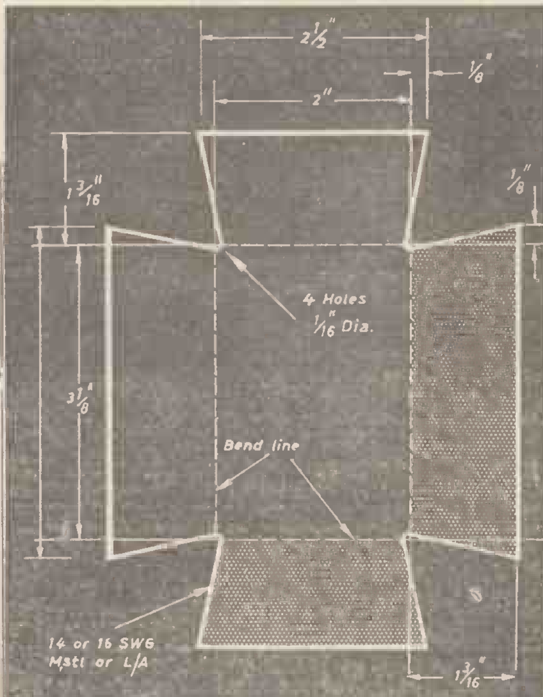


Above. The belt with one weight in place, a separate weight and the weight mould.

Right. Cutting the sheet to make the mould.

Below. The complete weight mould with plate.





the thickness and width of the belt should be cut and the sides shaped so that it sits in the mould as shown in Fig. 1.

CASTING THE WEIGHTS

Scrap lead should be melted in a suitable receptacle and the mould warmed to prevent "spluttering". With the plate in position pour in the lead to within about $\frac{1}{16}$in. of the mould top. When the lead is cool remove the casting from the mould and drive out the steel plate using a drift of wood or aluminium.

FINISHING TOUCHES

The weights should be threaded on the belt as in the photograph. This shows the completed belt with one weight in position, another finished weight and the mould. It is useful to know the total amount of weight on the belt so weigh and mark each weight for easy release.

PICTURE NEWS

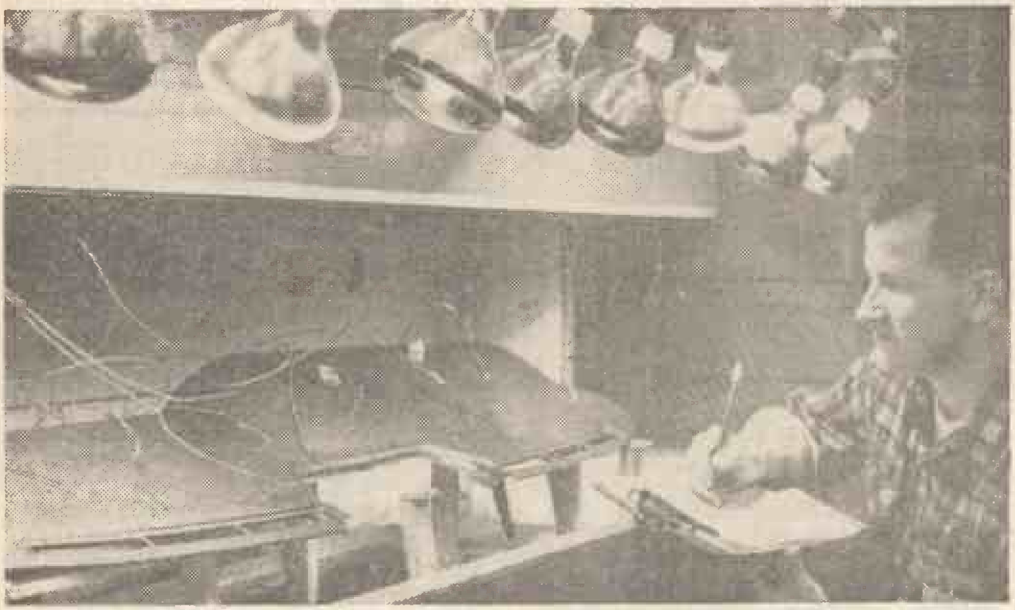
FROM THE WORLD OF SCIENCE

Tracer applications of nuclear radiation in industry

A TECHNICIAN at the Esso Research Centre uses an instrument equipped with a radiation detection device. He is checking the radiation level of radioactive piston rings used in a test car. The piston rings have been made radioactive. The speed with which they wear away is indicated by the radioactivity of the oil into which the worn-away bits are introduced. This method is widely used as a quick, accurate means of measuring the efficiency of lubricating oils.

Test for polyester film

A SLING made of Du Pont's new "Mylar" T polyester film only 0·005in. (500 gauge) thick and 14in. wide is more than strong enough to lift this 2,700lb Volkswagen van high in the air. The new film has such extraordinary tensile strength—40,000lb/sq in.—that except for the necessary safety precautions two such vans could have been supported in this demonstration. Use of the exceptional physical properties of this film is made in such applications as industrial strapping, pressure sensitive tape, sound recording tapes and conveyor belt reinforcing. Other types of the film are used as an insulation material for wire and cable, capacitors and electric motors; for the packaging of food and sharp-edged objects; for book jacket covers; for metallic yarns and other applications.



Safety tests for cars

THE motor-car of the future will be something of a travelling "padded cell" as well as a marvel of engineering. The trend toward foam padding for seats, instrument panels, arm rests and sun visors is continuing at a rapid pace. In the photograph a padded instrument panel is being tested by special equipment. Accident injuries in cars result from passengers being thrown against hard objects and padded instrument panels have been in use as safety devices since 1954.

Tracer uses of the atom

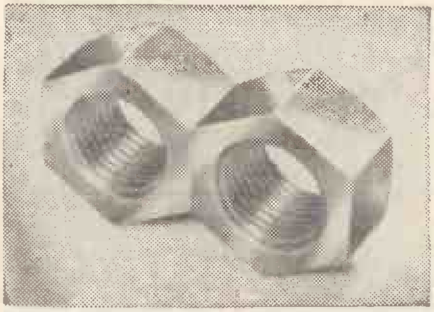
AUTOMATION of industrial chemical processing may result from investigations being carried out with this small-scale pilot plant at the Battelle Memorial Institute in Columbus, Ohio, U.S.A. In the illustration a scientist studies the radioactive isotopes of a chemical that is being processed. *(Bottom left.)*

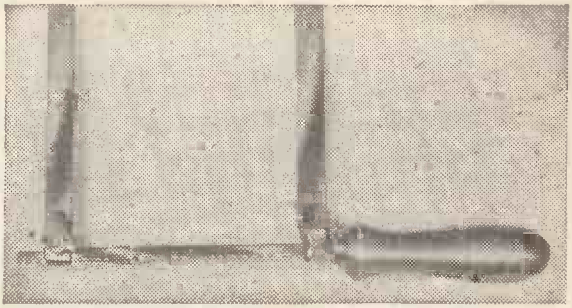
When is a tyre not a tyre?

TYRES in the United States of America are used for many other things than carrying air. The illustration shows water being drawn from the first "Rolli-Tanker" designed to carry portable liquids. The 55in. tall, 29in. wide Rolli-Tanker carries 200 gallons of water. This type of "tyre" has been used for many years by U.S. military forces to carry petrol and other fuels to remote areas. A special pumping system is attached to the 20in. rim to force air through one valve opening and the water out of another.

That's a good idea!

Useful hints passed on by our readers





Fabricated V-blocks

A USEFUL V-block can easily be made from two undamaged, bright steel hexagon nuts. The one shown was made from 1in. B.S.F. nuts. Thoroughly clean one flat on each nut and tin them, then sweat the two nuts together while lined up on a nicely flat surface. A soft solder joint will be found quite strong enough for a V-block used for light jobs such as marking out.

After sweating together, the joined pair can be sawn in two vertically to make a matched pair of narrow blocks if desired. If this is done they should be marked so that they are used in the same position relative to each other as when they were one, otherwise the matched effect can be lost.

Countersink for tight corners

NEXT time you accidentally break a drill of about $\frac{1}{4}$in. diameter don't regrind it for use as a normal drill but give it a 90° point. It will then prove most useful as a countersink for use in restricted places such as close to the vertical web of a piece of angle where a normal machine countersink cannot be used.

When regrinding the broken drill, first grind the broken end flat and square to the shank. Then produce a regular cone to the required angle, backing off the cutting edges as the last operation. Even a stub broken off near the run-out of the flutes, where the centre web is too thick for normal drilling, is still satisfactory as a countersink, as it only cuts the outside edge of an existing hole.

Large circle tip

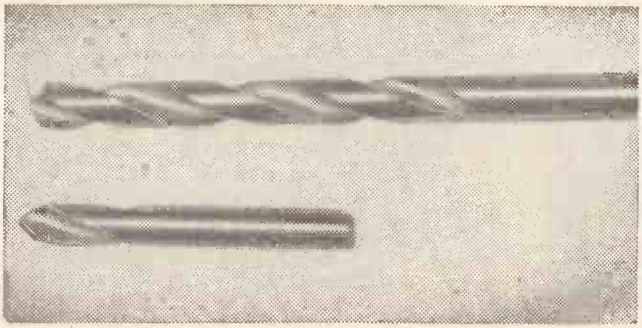
WHEN a circle of 6in. or so in diameter has to be cut from a sheet of metal the job can be made easy by using a junior hacksaw blade in a normal fretsaw frame. Depending on the design of fretsaw frame, you will probably have to remove the bottom pin from the saw blade. Lay the blade on the vice jaws, almost gripping the lower end of the pin. Gently tap the pin down flush with the blade. Enough length of pin will now be protruding underneath to be gripped by pliers, when you can twist the pin out.

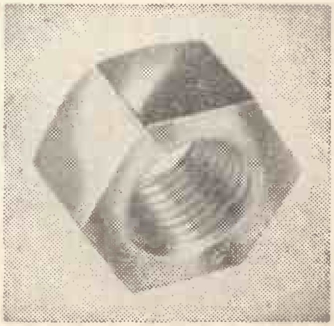
If the blade is narrowed down by grinding about a third of its width off the back much smaller circles can be cut.

Gripping threads

WHEN cutting a slot in a screw head or making a grubscrew from a piece of threaded rod the screw must be held by the thread. If this is gripped in the vice in the usual way there is considerable risk of bruising the threads, even if soft jaws are used. The safest grip is by using a split nut and a collection of these—one for each size of thread—will prove most useful, especially for the small B.A. sizes.

The important point is to saw the slot from one corner of the nut into the tapped hole as shown. In this way the vice jaws can bear on opposite flats of the nut with the slot midway between. This affords the maximum grip.





What is inside the earth?

By B. C. Macdonald

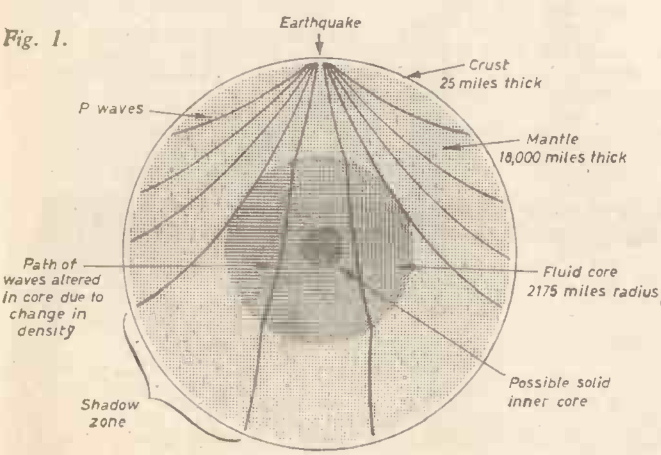
THERE has always been speculation on what is to be found in the centre of the earth. It has been suggested, even in quite recent times, that the earth is hollow. Some have insisted that there is another world inside the earth and the organisation concerned with the American " Mohole " project, the object of which is to make a very deep bore, have been urged to abandon the idea. The objectors think that the hole might release pressure from inside the earth and cause a collapse of immense magnitude. These, of course are all fanciful ideas, but what do we know about inside the earth and how do we know it? It is 4,000 miles to the centre of the earth, therefore any kind of probe in the form of a bore hole will never be possible. The deepest bore so far possible with modern technology is from 5 to 10 miles.

Is the earth hollow?

The earth is not hollow. The gravitational forces which the sun and the earth exert on each other are enormous and would distort the earth if it were not solid and therefore completely rigid. Further, shock waves due to earthquakes and nuclear explosions pass right through the earth. These waves could not pass through empty space. It is believed, for reasons which we shall explain, that the core of the earth is fluid and at a temperature of from 3,000°C to 10,000°C.

The weight of the earth is known to a high degree of accuracy, and it should be possible to calculate the weight from the volume and the average density of the surface rocks. Such calculations, however, give results that are far too low. This proves that the materials inside the earth must be much heavier than those at the surface. There are two reasons for this. The effect of gravitation is to pull the materials of the earth together, and this compacting effect of the weight of the outer layers on the inner ones is very great and must compress the inner parts very considerably. It has been calculated that the pressure at the centre of the earth is in the region of 12,000,000lb/sq.in. No matter how the earth originated—whether it was a " hot " or " cold " process, and we shall talk about this later, great heat was generated in the interior and it is reasonable to suppose that the heavier materials, such as iron, would be drawn to the centre.

Fig. 1.



In Fig. 1 we see the interior of the earth as it is thought to be. The crust is only about 25 miles thick, the second layer or mantle forming a large part of the material. If " Operation Mohole " is successful we shall obtain samples of the mantle for the first time. The core lies inside this. Some geologists believe that although most of the core is fluid there may be a small solid inner core. This is not certain.

Shock waves

Vibrations or waves, caused by earthquakes or nuclear explosions, radiate inwards from the point of the disturbance, some passing right through the earth. These waves are recorded by seismographs all over the earth's surface (Fig. 2) and the whole

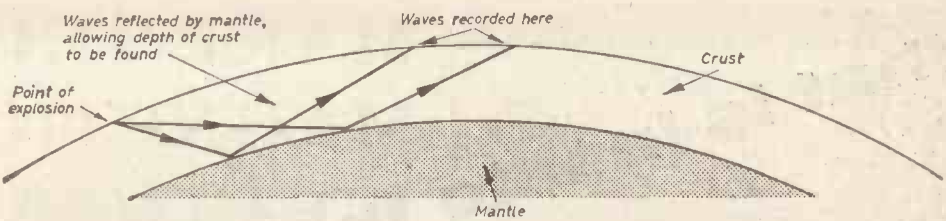


Fig. 2.

of the information collected is forwarded to Kew Observatory where it is analysed. The waves are of two kinds, Primary or P waves and Shake or S waves. The S waves cannot pass through fluids, and it is significant that these waves do not pass through the core. The P waves pass right through, and their velocity increases as they approach the centre, thus indicating a higher density there. The point of increase is about 25 miles below the surface, indicating a change of material at this depth, in fact the "Mohorovicic Discontinuity", the beginning of the mantle.

The aim of the American "Mohole" project, mentioned earlier, is to drill a hole in the bottom of the sea, through the crust, and so obtain samples of the mantle. The hole will be 5 or 6 miles deep, sufficient to pass through the crust which is only a few miles thick on the sea bed.

How the earth was born

There have been very many theories to explain how the earth was born and most of them have been discarded as too improbable. At present, opinions are divided between the "Hot Earth" theory and the "Cold Earth" theory. Neither of these ideas is entirely satisfactory, but they are the best so far achieved. It is assumed that the earth, and all the other planets, came from the Sun. In some way, the sun, an immense expanse of incandescent gas, bigger than it is now, gave off some of its material and either left it behind as the sun cooled down or threw it off in a manner unknown. This material, still partaking of the Sun's rotation, formed the planets which, according to the "Hot" theory, formed immediately into huge fiery spheres which slowly cooled down to their present condition. The "Cold" theory asserts that the material that came from the Sun did not coalesce at once into the planets, but into a vast number of small pieces, and that gravitation brought these together into the huge lumps of the planets. The planets grew more or less as a crystal grows, and it may be that each planet formed on a nucleus that was a little larger than the other material in the vicinity, attracting smaller pieces to itself by gravitation. As the size of the accumulation increased so would the compacting force of gravity and the heat generated by the crushing action would melt the core, the lighter elements being forced outwards and the heavier ones drawn in. This is a very bare outline of the two theories; each can explain some of the facts as we know them, but none can completely explain the earth as we know it now. Certainly when the earth was born there was no life upon it. How or when the first life originated is not known.

How old is the earth?

All we can say with any certainty is that it is extremely old according to our scale of time. This is obvious from the geological column, the accumulated debris of past ages that has built up on the earth's surface to a depth of 94½ miles. In the past 70 years geologists' estimates of the age of the earth have risen steadily from 40,000,000 years. This estimate was arrived at by Lord Kelvin, who calculated how long it would have taken the earth to cool to its present state since the time the water condensed out of the atmosphere, accepting a "Hot Earth" theory of the earth's origin. We now know that this estimate is too low because the earth contains a large quantity of radio-active elements which give off considerable heat. These radio-active elements themselves provide a means of estimating the age of the earth. The complex atoms of the element uranium are in a continual process of disintegration in which they change from uranium into lead and helium. The rate of change is very slow, is known accurately and does not alter. Therefore by determining the amounts of lead and helium in uranium-bearing rock the time needed for them to form can be calculated. But can we be sure that all of the lead and helium derived from the uranium is still present? Well, there are means of assessment that reduce doubt, and the age of the earth is now believed to be at least 3,000,000,000 years. That is a very long time by anybody's reckoning.

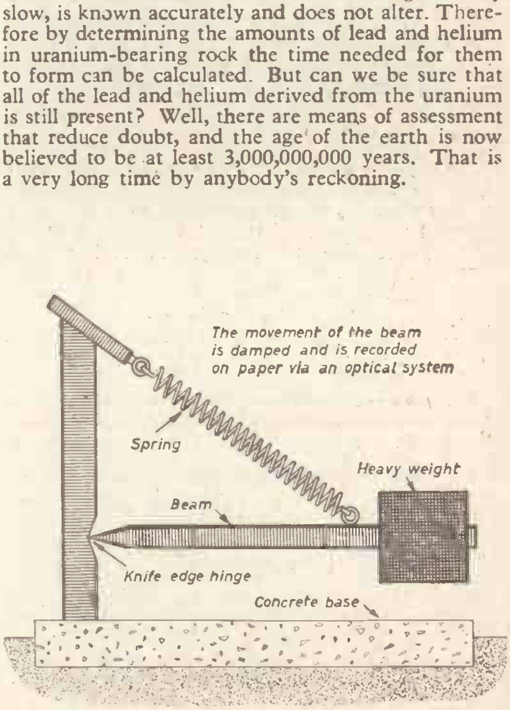


Fig. 3.—Simplified diagram of a Seismograph.

MAKE THIS MAGNETIC WEATHER CHART

By R. Cornick

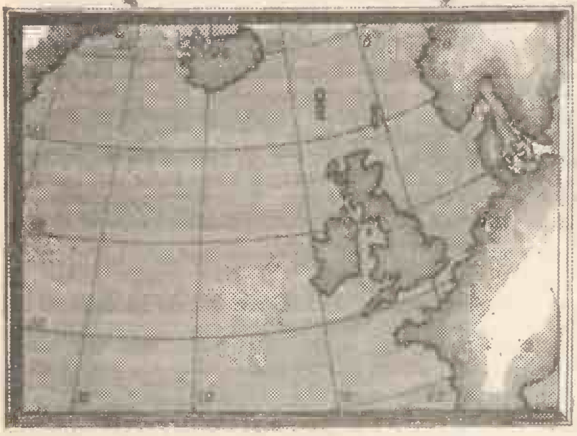


Fig. 1. The completed base map to which the magnetic weather symbols are attached.

FOR the amateur meteorologist, or for school classes studying elementary meteorology, some kind of weather map is essential. To obviate the work involved in plotting the changing weather systems daily on fresh background maps the idea here described will be found time saving and interesting. For our purpose the term "magnetic" really describes the method of placing movable magnet-loaded weather symbols wherever required on a specially prepared map of the appropriate land and sea areas around the British Isles.

The materials required are:

1 sheet of 24-gauge tinplate,
1 sheet of drawing cartridge or thin pasteboard,
Six ½in. diameter "Eclipse" button magnets,
1 sheet of 20 thou. P.V.C. or cellulose acetate.

A standard-sized sheet of tinplate (28in. x 20in.) should be obtainable from an ironmonger's or hardware store for about 5s., together with the button magnets—the latter for about 1s. 6d. each, or a size larger, if required, 2s. 3d. each.

The map

The idea is to provide a metallic backing to a map of the appropriate geographical area to which the magnetic symbols will adhere. The most convenient area of the northern hemisphere would be approximately from lat. 40° or 45° north to lat. 65° north (or the Arctic Circle) and from long. 40° west to long. 10° east. This gives a picture of most of the North Atlantic and Continental weather systems that are likely to affect the British Isles in the coming 24 or 36 hours. While it may be difficult to obtain a geographical map of suitable size including such a large portion of the Atlantic this can be cut out of a large geographical sheet if available. Otherwise it should not be too difficult to draw and paint a presentable map by following these suggestions. An enlargement of the area may be copied from an atlas by the "squaring up" method. A grid of, say, 1in. squares should be lightly ruled over the portion of the atlas map to be copied, covering the above-mentioned limits of latitude and longitude. On a sheet of pale blue cartridge paper or thin pasteboard (no more than postcard thickness) rule a grid of proportionately larger squares.

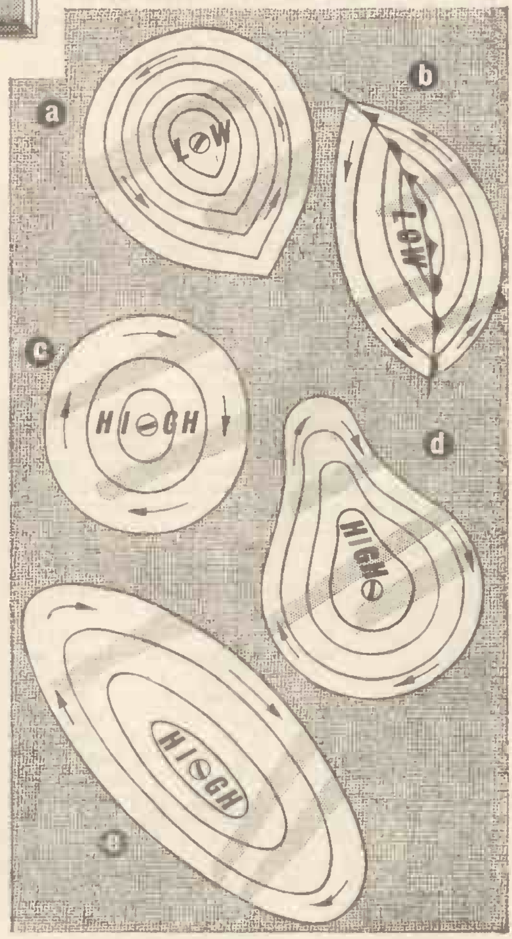


Fig. 2. Suggested weather symbols. (a) Depression. (b) Trough. (c) Small Anticyclone. (d) Anticyclone with ridge. (e) Elongated Anticyclone.

Thus, for example, 6in. squares give an enlargement of six times where the small original grid is in 1in. squares. Draw in pencil the outline of the small original on to the enlargement, using the appropriate grid lines for position and proportion until an outline map of the British Isles and adjacent Continent is complete. Suggested colouring, using waterproof poster colours on the pale blue "ocean" background, are: British Isles, red; other land areas, orange or pale green; all coastlines, black. The few lines of latitude and longitude required might be in red or white and numbered at their termination on the margins of the map.

When dry the map should be carefully mounted on the tinplate, using a reliable paste or gum. Leave the mounted map face downwards to dry on a clean, flat surface. Some weight placed on the tinplate backing will help to give even adhesion. A finishing touch can be added in the shape of a border of 1in. half-round beading. This should be mitre-cornered to frame the map and fixed by ½in. woodscrews through holes drilled in the tinplate. To hang the map on a wall, two small hooks should be screwed into the edge of the frame (Fig. 1).

Highs and lows

The principal weather symbols which will be used on the chart are anticyclones (high-pressure areas), depressions (low-pressure areas), warm fronts, cold fronts and occlusions (combined warm and cold fronts). Two or three of each will be needed of varying sizes. These should be drawn on shaped pieces of transparent p.v.c. or cellulose acetate, 20 thou. gauge, obtainable from most art supply or handicrafts shops. A piece about 2ft x 1ft is sufficient for a selection of symbols as shown in Fig. 2. If cut from the roll it may need to be slightly warmed and rolled in reverse until it lies quite flat. Use a thinned black enamel, or waterproof poster paint, to draw the systems of closed isobars, with average diameters of 300 to 500 miles or up to 1,000 miles for an elongated anticyclone, in accordance with the scale of your base map. If, due to greasy fingerprints, the enamel or paint fails to flow on the p.v.c., wipe over with a grease remover such as "Thawpit", dust with talcum powder or french chalk and wipe clean.

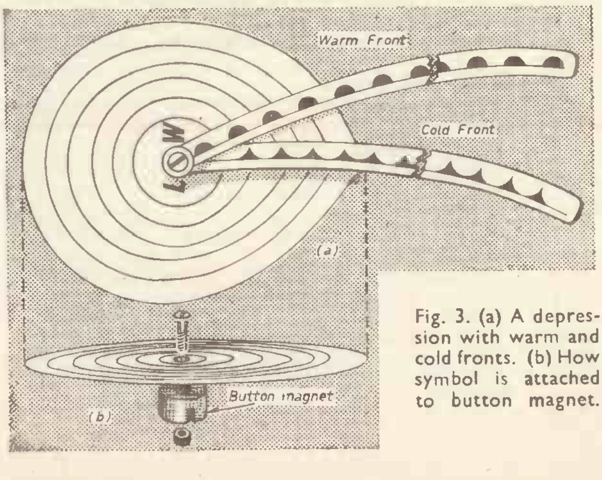


Fig. 3. (a) A depression with warm and cold fronts. (b) How symbol is attached to button magnet.

Wind direction arrows may be drawn on the highs and lows, remembering that the wind flows clockwise around the highs, counter-clockwise around the lows in the northern hemisphere. While the depressions should be drawn with the isobar lines close together, anticyclones should have fewer isobars, more widely spaced, as shown in Fig. 2. Draw individual warm and cold fronts on curved strips of p.v.c. as in Fig. 3, semi-circular "blobs" on a thick line indicating a warm front and pointed "spikes" a cold front. One or two occlusions—alternate blobs and spikes—should be made in the same way.

Fixing the magnets

Small brass bolts and nuts should be used to fix together each "low" symbol and its accompanying warm and cold fronts. The bolt should be pushed through a hole pierced or drilled at one end of each frontal strip, through the centre of the low, through the hole of the magnet and finally into the nut, which must be small enough to fit between the "legs" or poles of the magnet (Fig. 3). This method allows the fronts to be swivelled to indicate a wide or narrow warm sector, *i.e.* the area between the two fronts, or even, with careful arrangement of the "blobs" and "spikes", to show a partial occlusion near the centre of the depression. The anticyclones should be mounted in the same way but without any fronts. Several separate frontal strips should be mounted on magnets for use independently of a low-pressure area such as on the perimeter of a high.

Plotting the chart

Any of the weather symbols may now be magnetically attached at any position on the map and easily moved to new positions to follow, at least with fair approximation, changes in the weather situation from day to day, or even several times a day, as information becomes available, even though the individual systems are unconnected by the usual trans-hemispherical isobars. There are, of course, several sources of information from which the amateur may plot his chart. Weather charts are published in some daily newspapers; a general inference usually precedes the B.B.C. radio forecasts; a chart is shown daily at 6.20 p.m. on B.B.C. Television, remembering that the first chart referred to is for 6 a.m. that day, the second or forecast chart for noon the following day. Perhaps the best source of information, being more technical and therefore of greater interest, is the synoptic situation given in the shipping forecasts—B.B.C. Light Programme (1,500 metres only) each day at 6.45 a.m., 1.40 p.m. (11.55 a.m. on Sundays), 5.58 p.m. and 12.2 a.m. Sometimes the positions of several different systems are given by reference to latitude and longitude, or else as, for example, "A depression with central pressure 980 millibars 100 miles to the west of Scotland will move north-east towards Norway". Although this is not read at dictation speed one can soon develop a shorthand method of noting it down thus—980 100 W Scot ↗ Nor, the arrow showing the direction of movement. This is followed by the usual forecasts for seas around the British Isles and reports from coastal stations.

A ROTATING ASTRONOMICAL OBSERVATORY

By K. Gage

ANYONE who owns even a moderately sized telescope requires some sort of permanent cover for it. The rotating observatory described here was built for an equatorially mounted 8in. Newtonian Reflector with a focal length of 64in., but will house a larger instrument if necessary. Entrance is through a small door which is actually a continuation of the slot. Once inside the observatory, the main shutter is removed by first sliding the top shutter back a few inches to clear the upper rain-guard, turning the 6 latches, and then lifting the main shutter off. If it is required to have the telescope in a vertical position the top shutter can be slid right back. With the main shutter removed, it only remains to shut the door and rotate the observatory to face the part of the sky to be viewed.

Concrete base

The concrete base is 10ft in diameter and stands about 6in. above ground level. This allows plenty of clearance for the four centring wheels. The shuttering for the concrete can consist of hardboard sections held together with metal joining plates, see Fig. 2. A firm base of rubble should be laid down first of all and then a layer of gravel spread on top. Approximately four bags of Portland cement and 1 cubic yard of gravel will be required and should be mixed in a ratio of about 1 to 3. If an electrical supply is needed for lighting, or to drive the telescope, a ¾in. conduit tube should be embedded in the bottom of the foundation or in the soil below. A concrete rim with a radius of 4ft, and ¾in. high, should be added to the concrete base to stop rain forming puddles on the portion of the base jutting out at each side of the square structure of the observatory walls (Fig. 2).

Constructing the observatory

The four sides or walls of the observatory can be prefabricated to ease final assembly. The basic square structure consists of 2in. x 4in. deal and the uprights and octagonal structure 2in. x 2in. deal, all finish planed. See Fig. 1 and Fig. 3a for the dimensions. Three of the sides are identical but the remaining front section is provided with a small doorway (Figs. 3a, 3b, 3c). Oil-tempered hardboard ⅛in. thick should be used for the covering and can be marked out simply by laying the wooden structures on it and marking round them. It is best to saw the hardboard with the shiny side towards you, otherwise the saw tends to make a ragged edge along the cut. A space 1in. wide must be left at the top of each section, so that the hardboard sections of the dome may be screwed to the wooden structure.

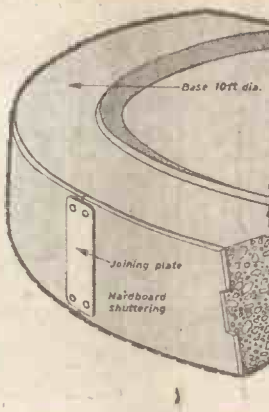
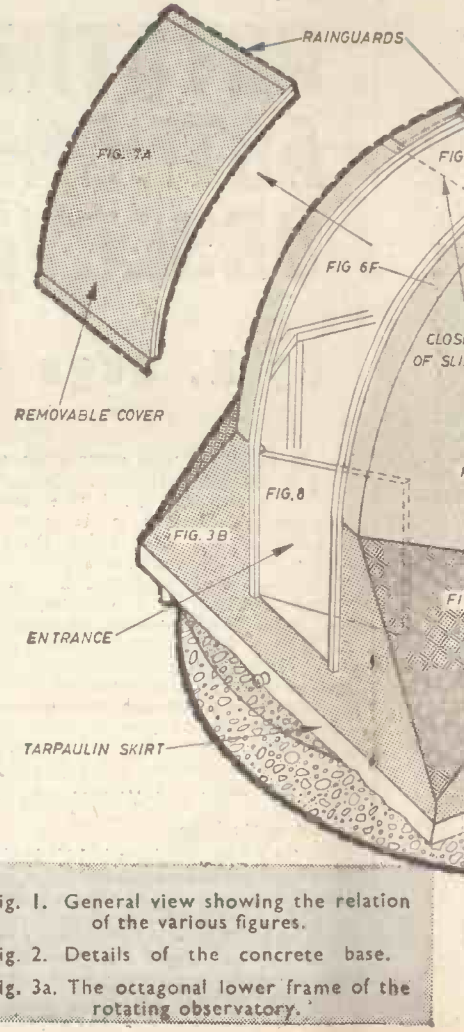


Fig. 2

A Rotating Astronom

by K. Gage



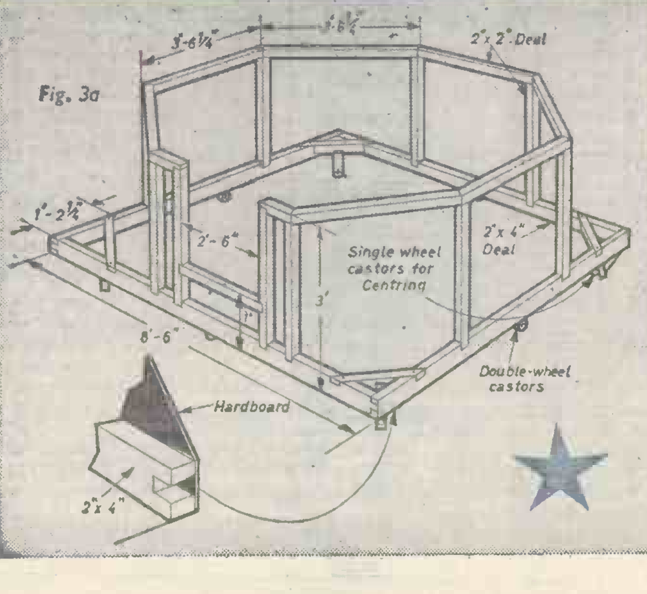
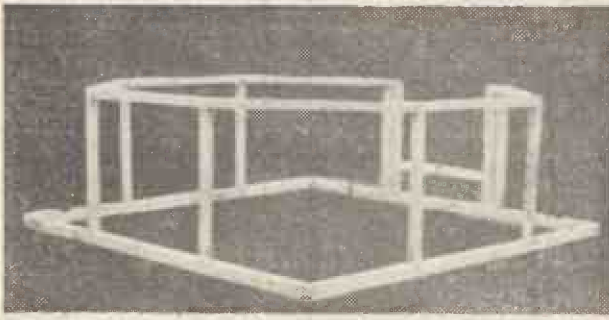


Fig. 3a

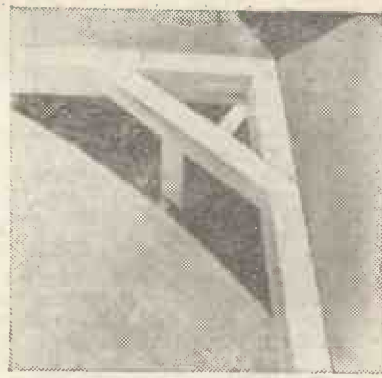
Fig. 1. General view showing the relation of the various figures.

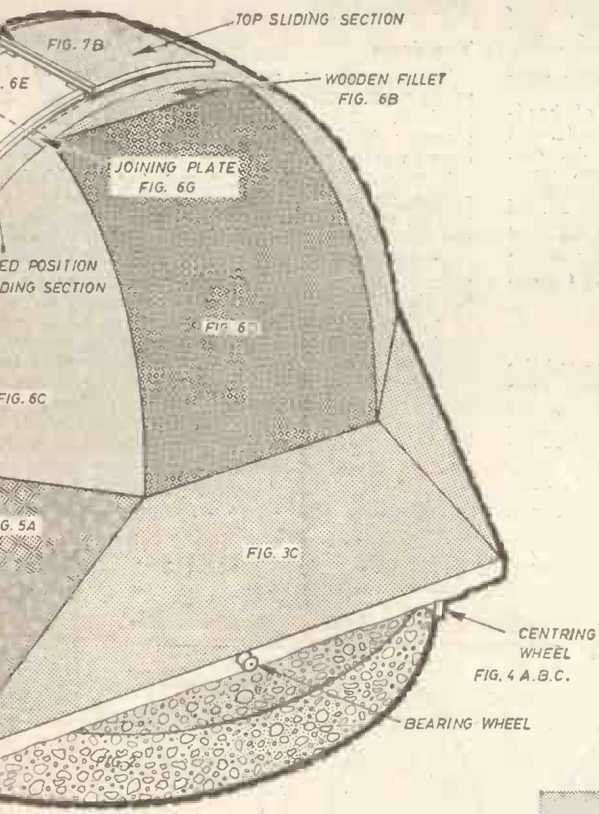
Fig. 2. Details of the concrete base.

Fig. 3a. The octagonal lower frame of the rotating observatory.

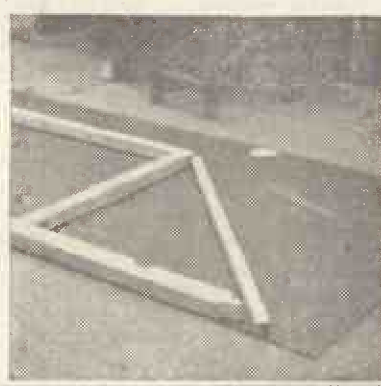


nical Observatory





General View
Fig. 1



Top. The octagonal base frame before covering with hardboard.

Centre. One of the centring castors.

Lower. Using the wooden frame to aid in marking out the hardboard.

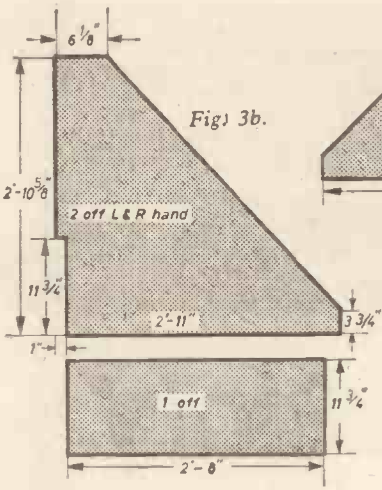


Fig. 3b.

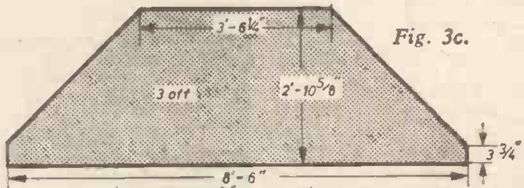


Fig. 3c.

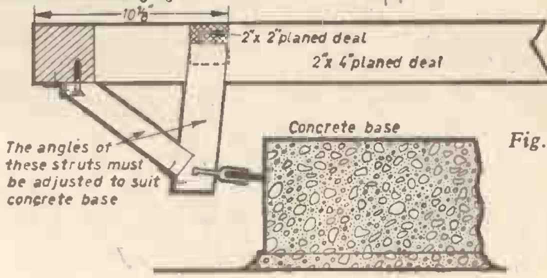


Fig. 4a.

When the hardboard sections have been screwed on, the four load bearing wheels can be fitted, and the sides assembled on the concrete base, completing the octagonal wooden structure. The bearing wheels employed should be rubber-tyred, 2in. double-wheeled castors, similar to those used on heavy furniture-transporting trolleys.

Before fitting the triangular sections of hardboard which cover the corners, the four horizontal centring wheels must be fitted (Figs. 4a, 4b). These wheels run on the side of the concrete and prevent the observatory rolling off the base. Ordinary castoring " coffee-trolley " wheels can be used if they are strengthened with mushroom-head rivets (Fig. 4c). These rivets stop the tyre of the wheel being pushed between the two plates around which the tyre is stretched.

The corners

Having fitted the centring wheels and tested the observatory to see that it rotates freely, the triangular sections can be fitted over the corners (do not forget to grease all the wheels). The brackets, which should be made from 20 or 22 gauge dural or aluminium, can be riveted to these sections before assembly (Fig. 5a). The sections should be fitted by placing them in position and, from the inside, drilling through the holes in the brackets, finally securing them with 6 B.A. or ⅛in. Whitworth bolts.

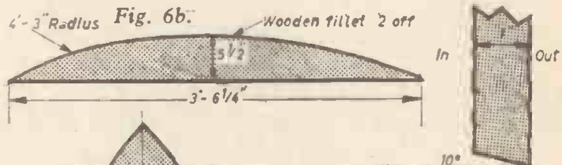
The dome

The dome is octagonal, consisting of four rectangular sections and four shield-shaped corner sections. All these sections should be joined together in the same manner as the triangular corners (Fig. 5b).

The method of laying out the shield-shaped corner pieces for the observatory described is shown in Fig. 6(c). For other sizes refer to Fig. 9. Set out the cross-section of the dome across opposite base corners (i) and the plan view of the corner piece (ii) in the relation shown, exactly to scale or full size. Draw DEF extended through ii and mark in a suitable point F. Draw baseline FA at right-angles, to the correct length. Set out any convenient angle on i as shown and draw in the arrowed lines, cutting DF at E on i and then parallel to the various construction lines. With a flexible rule measure FE and ED on i and set out these distances above the baseline FA in iii. Draw through E at right-angles to meet the arrowed line at B. Join AB and BD with straight lines and draw lines through their centres, at right-angles to them, to

Fig. 6a.

Fig. 6b.



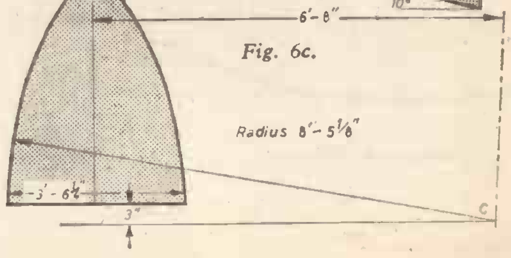


Fig. 6c.

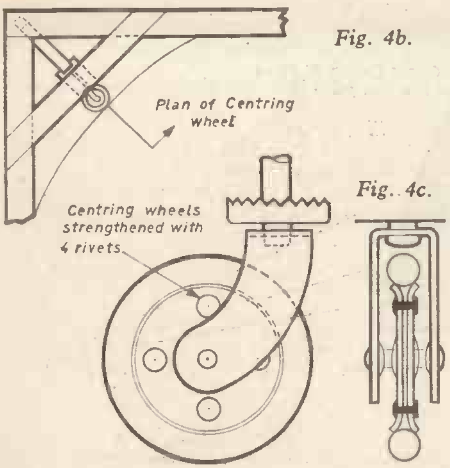


Fig. 4b.

Fig. 4c.

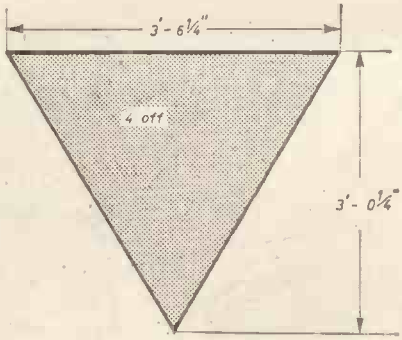


Fig. 5a.

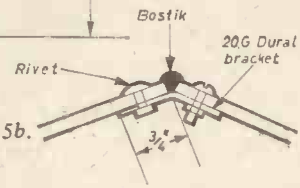


Fig. 5b.

meet at centre N. This is the centre of arc ABD, the radius of which can thus be measured. Also measure the vertical distance between baseline AF and centre N (3in. in Fig. 6).

Assembling the dome

The two sides of the dome should be assembled first. Each of the sections should first be screwed to the 1in. spaces left on the octagonal wooden structure. Then, with someone holding a corner together, the holes should be drilled from the inside and the sections bolted together as before, working from bottom to top. When the three sections of each side have been assembled, the wooden fillets (Fig. 6b) may be screwed in position ready to fit the large rectangular section which stretches over the top of the dome. This forms the back and uppermost sides of the slot (Fig. 6e). The two extensions on the upper end of the rectangle should be wrapped round and screwed to the wooden fillets.

It now only remains to fit the two strips for the front sides of the slot to complete the dome itself. A metal plate has been specified at the upper joint with the top of the dome to retain a smooth contour around the dome front (Fig. 6g).

It will be found that until the strips of ½in. x ¾in. planed deal are screwed around the edge of the slot, the two shield-shaped sections on each side of the front of the dome will tend to lift up and distort its shape. This is not important at this stage. These strips should be made pliable by pouring hot water over them, allowing them to soak well. While still hot, hold them between stakes in a radius of about 3ft 6in. (when they are taken out of the stakes, they will straighten out a small amount). The strips must be free from knots or twists in the grain, otherwise kinks will occur in the curvature. The distortion in the curvature of the dome should be corrected with temporary props while the strips are being screwed in position from the inside, again working from top to bottom.

Removable cover and sliding section

The two curved covers (Figs. 7a and 7b) are the most tricky jobs to tackle; the difficulty arising from the fact that one has to make them assume a permanent curve. This is done by using a double lamination of ¾in. x ½in. deal on each side of the panels, set into a curve. First the sections of hardboard should be bent into somewhat more

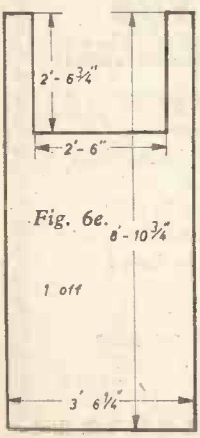


Fig. 6e.

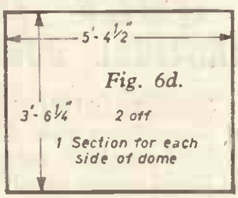


Fig. 6d.

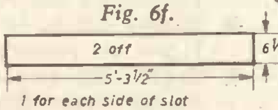


Fig. 6f.

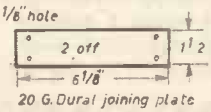


Fig. 6g.

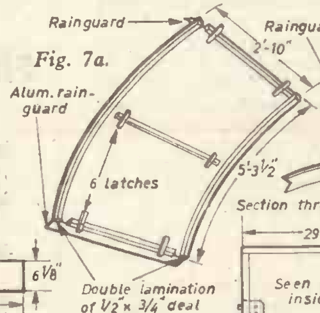


Fig. 7a.

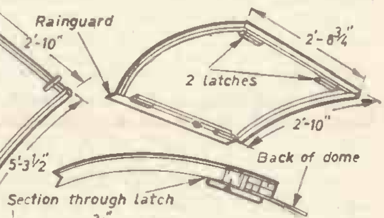


Fig. 7b

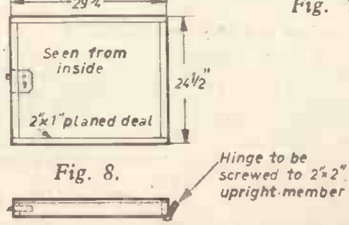
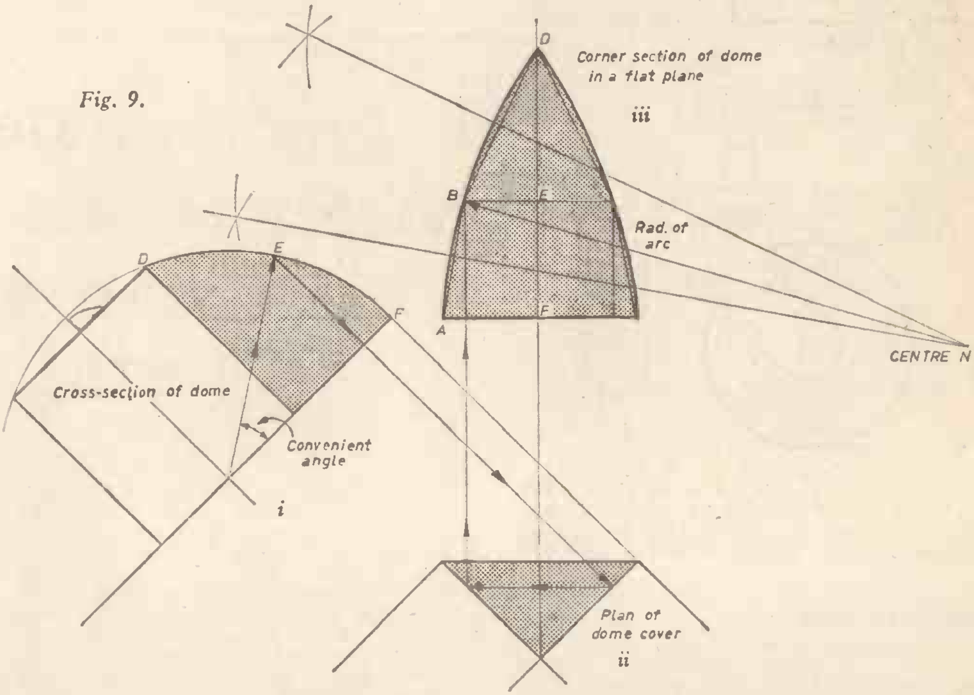


Fig. 8.

Fig. 9.



than the required curve and held in this shape with wire. The wooden strips should then be glued on and screwed in position, one lamination at a time on each side. After a few hours the wire can be removed.

The smaller section at the top (Fig. 7b) has to be unlatched at the back and lifted over the coaming before it can be slid back. A single rainguard should be fitted to the front edge of this sliding section while two should be fitted to the large removable section which should also have six latches for retaining purposes.

The door

The slot in the dome is continued down the front wall of the observatory to form the small doorway. The door, which opens inwards, should be flush with the front of the observatory wall and consists of a panel of hardboard on a frame of 2in. x 1in. planed deal (Fig. 8). It hangs on two hinges and should be fitted with an ordinary mortise lock acting on a striker-plate screwed to the 2in. x 2in. upright of the structure.

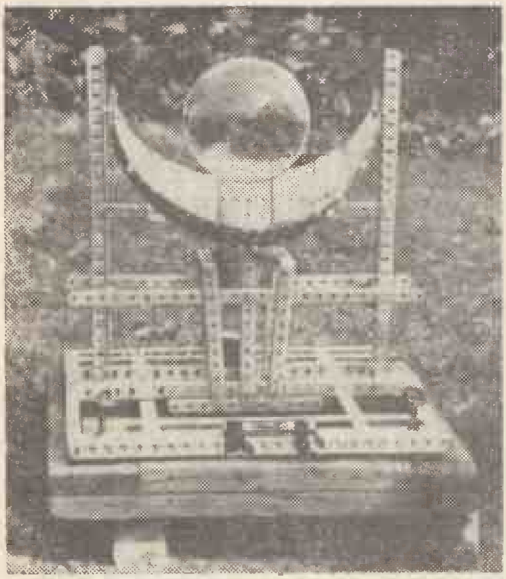
Though it is not a necessity, the rigidity of the structure can be improved by carrying the 2in. x 2in. octagon right across the doorway.

Keeping out the weather

All joints between hardboard sections should be sealed with "Bostik Sealing Compound". Although this compound remains flexible for a considerable time, after long exposure to the weather and with the slight movements in the structure which are bound to occur, it does crack and will need renewing at intervals.

The hardboard itself should preferably be painted before assembly, first with a coat of flat white plastic emulsion paint and then with a liberal coat of aluminium finishing paint. This finish has proven extremely resistant to wind and rain. To stop rain and wind blowing underneath the superstructure, a tarpaulin skirt, about 4in. wide should be tacked around the base of the walls.

As far as wind resistance is concerned, the observatory has shown no signs whatever of being pushed off its base, even in the strongest gales of the last 4½ years.



A home-made SUNSHINE RECORDER

BY P. G. HOOKEY

A METEOROLOGICAL Office pattern sunshine-recorder is an expensive instrument, and amateur observers may be interested to hear of a cheap and acceptably accurate instrument which I have made for my own use. This article was first published in "Weather", November 1962 and is reprinted by their permission. It will be seen that the construction of this instrument entails little cost and no special skill.

The framework of the instrument is built of Meccano parts, but wood or other materials could be used. The burner is an inverted 700 ml long-necked spherical glass flask filled with water. A dilute solution of glycol in water, which has a refractive index little different to that of water, will have to be used when temperatures below freezing point are to be expected. The flask costs six shillings. Three-point levelling is employed, and this is obtained by building into the base three screws from an old tennis racket press, together with two cheap spirit-levels.

The base of the instrument consists of four 12½in. angle irons forming a square. Cross members were added as shown to carry the superstructure and give additional rigidity. Exactly in the centre of the square an open-ended cylinder is fixed at a suitable height and of a diameter just large enough to accommodate the neck of the flask. This is supported by the upper rim of the cylinder. The distance from the centre of the flask to the brightest focus having been ascertained (R cm), two upright angle irons, at least as high as the centre of the globe, were erected, each R cm horizontally from the centre of the cylinder. The uprights and the centre of the globe are in a straight line (Fig. 1). Two semicircular paper holders, each πR cm long, in my case constructed of 2½in. wide Meccano plates bolted together, are attached to the inner sides of the uprights at the height of the centre of the globe (Fig. 2). The uprights need to be stressed to

(Continued on page 430)

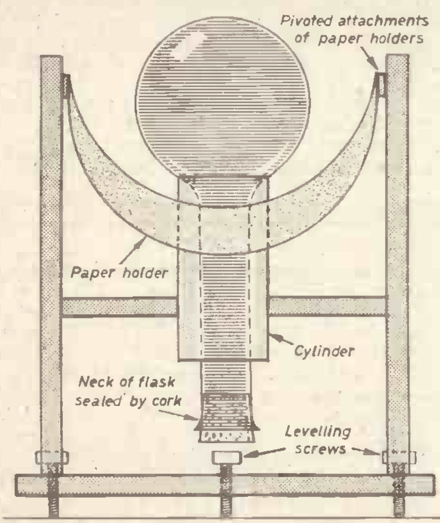


Fig. 2.

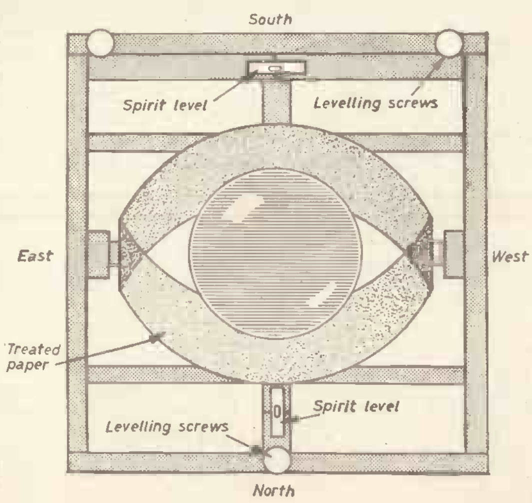
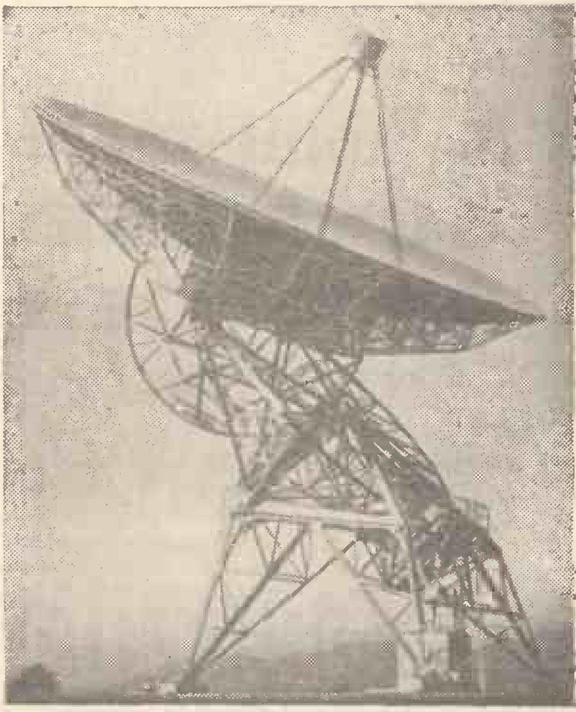


Fig. 1



LISTENING FOR LIFE ON OTHER WORLDS

BY E. ASHPOLE

The U.S. National Radio Astronomy Observatory's 85-foot telescope at Green Bank, West Virginia, was used by Dr. Frank Drake and Dr. T. K. Menon to search for messages from planets circling neighbouring stars.

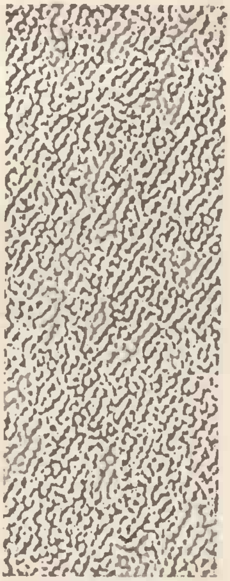
AT the beginning of July 1959, Sir Bernard Lovell, director of the world's largest steerable radio-telescope at Jodrell Bank, received a letter containing a startling request. The letter came from a distinguished American scientist, Professor Cocconi, who was then working at the European Organisation for Nuclear Research at Geneva in Switzerland. He urged Sir Bernard Lovell to use the giant radio-telescope to search for messages that highly advanced civilizations may be transmitting in our direction from planets circling other stars similar to the Sun.

Sir Bernard was enthusiastic for such an attempt to contact intelligence on other worlds, but he was unable to spare time on the Jodrell Bank instrument for such a scientific long-shot, although success would answer many fundamental questions that have been tantalising men's minds for generations. Are there other intelligent beings in the universe? In what form has intelligent life emerged on other worlds? Are systems of planets formed automatically by a natural process? Given Earth-like conditions, is life bound to evolve? These are some of the foremost questions that might be answered.

"We believe", says Sir Bernard, "that the solar system, far from being the sole example of its kind in the cosmos, is probably paralleled by planetary systems around stars which are of extremely frequent occurrence in space". The Milky Way, the swarm of stars of which our Sun is a very ordinary member, consists of 100,000 million stars. At a conservative estimate, astronomers consider that at least 100 million of these stars possess encircling planets that could support life. Some may be the homes of intelligent beings, not only less but perhaps far more advanced than ourselves.

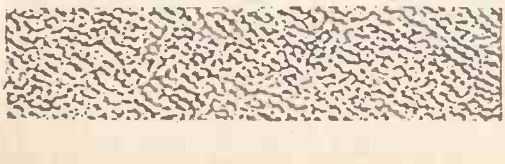
Unfortunately, we cannot expect to find intelligent life nearby—on our neighbouring planets Venus and Mars. From what we know of the conditions on these planets, higher forms of life are not possible, although primitive forms of life may exist. The nearest stars similar to the Sun, and therefore likely to possess families of planets, are about a dozen light years away. In other words, travelling at the speed of light, which is 186,000 miles a second, it would take a dozen years to reach them. We can judge how enormously distant these stellar neighbours of our Sun are by considering that the Moon is about 1¼ light *seconds* away, while Venus and Mars are but a few light *minutes* distant.

Many other internationally respected scientists in addition to Sir Bernard Lovell, accept the new and exciting ideas about intelligent life in the universe. Professor Malvin Calvin, 1961 Nobel Prize winner for Chemistry, contemplates them just as enthusiastically. Talking to the American Association for the Advancement of Science recently he said, "We are even beginning to discuss seriously and make a few small attempts at communications with extraterrestrial organisms who might have not only our power of understanding but even powers far beyond those which we know." And Professor Edward Teller, a pioneer in the final research that unleashed the enormous energy of the atom, says this on the



Outstanding American scientist Dr. Melvin Calvin, awarded 1961 Nobel Prize in chemistry for his research in the field of photosynthesis, supports the idea of intelligent life on planets outside the solar system.

Dr. Edward Teller, an associate director of the University of California's Lawrence Radiation Laboratory: "I am sure that the universe is full of life . . ." In this photograph Dr. Teller is receiving the 1962 Enrico Fermi Award from President Kennedy.



same subject. "I am sure that the universe is full of life, is teeming with life . . . If the universe is indeed as old as it's said to be—almost 10,000 million years—and human life spans only the last million or so years, there must be others who arrived earlier".

Current scientific thinking, then, clearly favours the idea of an abundance of intelligent life in the universe. Therefore, there may already exist a complex system of communications among highly advanced civilisations living in the Milky Way. To join this communication network would mark a new stage in the history of mankind. So far, the only scientists to embark on this challenging search are Dr. Frank Drake and Dr. T. K. Menon of the U.S. National Radio Astronomy Observatory. With this observatory's 85ft radio-telescope they have listened for intelligent radio signals from two neighbouring stars similar to the Sun, Tau Ceti and Epsilon Eridani. The telescope was tuned to pick up radio waves of 21 centimetres. This wavelength is continuously being transmitted by the endless clouds of hydrogen gas which exists between the stars. It is the fundamental radio wavelength of the universe. Intelligent beings would know this and would choose it as the obvious wavelength on which to send their messages. Success would come in the form of added bumps to the wiggly line that results from the natural background of radio waves that are continuously coming in from space.

Success, of course, did not come. But only two of the many likely neighbouring stars were scanned, and then for a few days only. Further attempts will soon be made. And if our current conclusions about the formation of planets and the evolution of life are not hopelessly wrong, some fortunate radio astronomer will one day receive the thrill of his life when that message from another world finally arrives on his recording equipment.

LATHE GADGETS

Part 18

BALL TURNING TOOL 2

By L. C. MASON

THE feed screw handle can be of any preferred type, the one shown being quite convenient. The cross bar can be shaped up in the four-jaw in the same way as the bar for the feed screw nut, tapped at the ends 4B.A. for the two handles and filed up to shape. Tap the centre hole ¼in. Whit. to match the feed screw, and lock it in position with a thinned-down ¼in. Whit. nut. For neatness' sake, the nut actually used was 2B.A. tapped out to ¼in. Whit.

The shape and size for the operating lever is equally to choice, the drawings showing the one actually fitted and shaped up from ¾in. x ⅛in. strip. Drill the end hole first, then make the bends so that the lever makes a good flat fit at both screw positions. Attach it to the slide with the end screw while the position for the other screw hole is spotted through the corner hole in the assembled base, from underneath. Both holes in the lever should be counter-sunk. The length of the lever shown should be looked on as the minimum giving reasonable tool handling; if room is available, a much longer lever gives easier and smoother control and a much slower and finer cut.

The tee bolt for the pivot bush and the bush itself both need to be nicely fitted for precise location and smooth operation. The bolt should be turned up from ¾in. round bar, turning the ⅜in. diameter a snug fit in the tee slots of the cross slide. Before threading the 5/16in. diameter portion, centre-pop the end and drill and ream a true ⅛in. hole into the end of the bolt for ½in. Part off to leave a ¾in. diameter head, a bare ⅛in. thick, and file the two flats to a nice fit in the tee slot.

The bush should be a good fit, both on the bolt and in the hole for it in the corner of the base. This should also be made from a stub of ¾in. rod, and should be turned and bored at the one setting. Turn the ½in. body a trifle long at first, facing back the small end a fraction at a time till, when in position in the base, the end protrudes no more than a few thousandths of an inch.

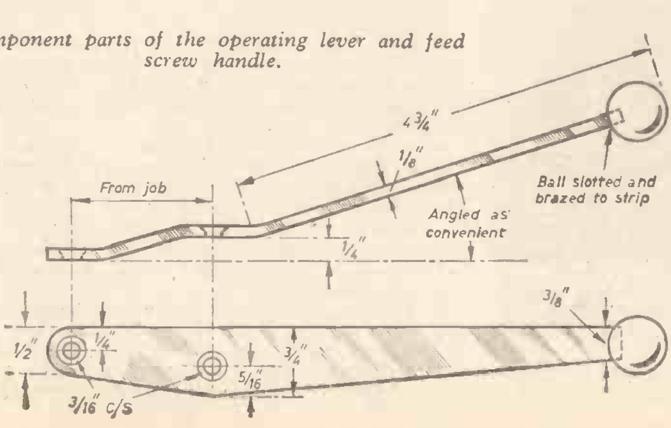
Lastly, a positioning pin is required. This is just a short length of true ⅛in. silver steel rod. Slip the bush over the tee bolt and screw the nut down lightly to secure it in the end of a cross-slide tee slot. Fit either the head or the tail centre and peg the pin upright into the hole in the bolt. Adjust the saddle and cross-slide positions till the pin is just touching the centre point. Cut the pin just there, so that whenever it is fitted into the bolt its top is exactly at centre height. Chuck the pin and turn a conical point on one end, without reducing its length.

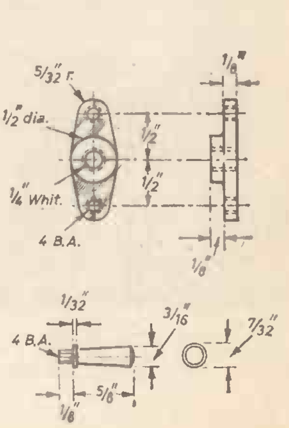
The tool for use with this gadget is pretty much like a L.H. knife tool, with a keen point well raked back in each direction. The tip can usefully be rounded very slightly with a stone. It will probably be found that it cuts quite freely in either direction of travel. With a cut from left to right the cut is more of a paring action, a wider shaving coming off the straight line of the cutting edge compared with that produced by the point.

To set up the tool for use, take off the topslide, clean all chips and swarf off the cross-slide and bolt the complete assembly in position at the end of an appropriate tee slot. Fit the positioning pin and mount the tool. Feed the tool forward in its slide and adjust its height and the amount by which it projects, so that the tool point coincides with the pin point. Clamp the tool down in its holder and run the slider well back. Fit the tail centre and bring up the cross-slide so that the pin point just touches the centre point. Carefully note the cross-slide dial reading. Now run the cross-slide back a fixed number of complete turns, say 5, or something appropriate to the size of the job.

With the ball blank already turned to cylindrical shape in the chuck, mark the halfway point along the blank where the centre of the ball will come.

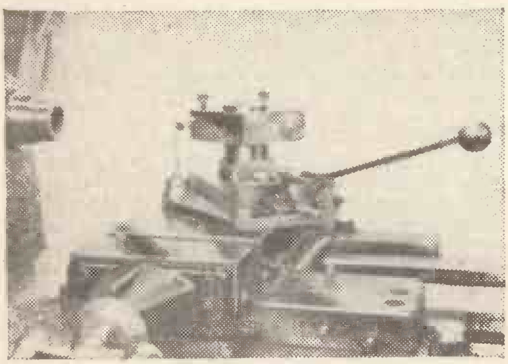
Component parts of the operating lever and feed screw handle.



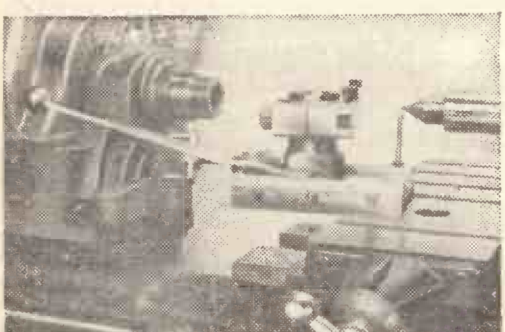


Bring the tool along by the saddle, on the nearside of the job, and adjust its position by the cross-slide till the point of the pin comes against the halfway mark. Remove the pin and feed the cross-slide forward under the blank for the rest of the 5 turns by which it was brought back, setting it to exactly the same dial reading as when it coincided with the tail centre. The tool's pivot point is now exactly under the centre of the ball-to-be. From here on, neither the saddle nor the cross-slide feeds must be touched at all. All the tool feed is done by the tool's own slide. If possible, lock both saddle and cross-slide as it is almost instinctive to put on the cut by the cross-slide. If you do, you will have to re-set to centre again! While the setting up takes quite a space to describe in detail, it is an operation quite quickly carried out once the purpose of it all is seen.

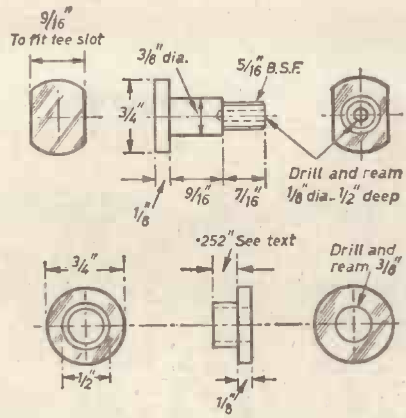
Lubricate the top of the cross-slide where the tool base will swing over it and make a trial swing with the tool to see that the tool clears the job all round. On starting to take a cut, the tool will cut first on the corners of the ball blank, so take light skims off both corners of the blank, keeping both ends the same. If the ball blank was turned down to slightly over ball diameter for a start, by the



Setting the cutter point to centre height with the aid of the gauge pin.



Setting the tool pivot point to come under the centre of the ball blank.



Details of the pivot bolt and pivot bush.

time the tool is cutting all round the ball will be nearly to size.

During turning, keep the cross-slide surface clear of chips and swarf, especially at the edge of the tee slots and the hole for the topslide spigot. Turnings trapped here by the leading edge of the tool base interrupt the smooth swing of the tool travel, which will show up in the work finish.

NO-MOVING-PART MOTORS

(Continued from page 395)

If only single phase is available, then a phase splitting circuit should be made up as shown in Fig. 6. The choke X should have an inductance of about 0.05 henry and a resistance of 5 ohms. If you do not have such an article, you can make one up by wrapping 0.036in. wire on to a bundle of iron wires until the right value is obtained. Test the values in this way. Connect low voltage a.c. to your choke. Measure the voltage applied (V), the current taken (I), and the power consumed (W) by means of a wattmeter. Then

$$Z = \frac{V}{I} \qquad R = \frac{W}{I^2} \qquad X = \sqrt{(Z^2 - R^2)}.$$

R should be 5 and X should be about 16. If R is too small, it can always be made up with an ordinary slide resistor in series, but remember that on 230 volt supply the final machine may take 10 amperes or more.

When the final connections have been made the machine may be tested. If it is found to produce too small a force on a $\frac{1}{4}$in. thick aluminium plate placed between the poles to move it, rewind with fewer turns of ticker wire and be prepared to take more current from the mains. If on the other hand the machine takes too much current, rewind with more turns.

The machine may be fitted with wheels on the bolts joining the two halves and used to fire aluminium plates from between the stators. Alternatively it may be inverted and run along the top of a fixed rail, supplied from a trailing cable.

Sheet metal fittings
Bending and flanging
Fuselage construction

Sheet metal fittings

WHEN bending sheet metal fittings use a vice with smooth jaws or cover the jaws with aluminium or light alloy caps, as on no account should fittings disclose vice marks. Use "Spectrablue" or similar blueing spirit on the sheet metal face for marking out and carefully avoid scribe marks in the metal surface, as they are liable to initiate cracks. Finished fittings are best cadmium plated but a good zinc chromate primer is quite satisfactory.

Fittings may be cut roughly to shape with shears or, failing this, by means of a cold chisel or hacksaw with the part clamped in a vice. Leave a margin of about $\frac{1}{16}$in. and file to the correct contour, finishing with a drawing action to prevent incipient cracks. Bending should be done in the cold condition, but bend uniformly along the length of the portion to be flanged by hammering on a wood block held in contact with the metal. If the part to be flanged is too long or of too heavy a gauge to allow of simultaneous bending this should be done in a succession of operations, in each of which a length of flange is turned through a few degrees only, perhaps 5° or 10°, working from one end to the other. In such cases it is almost impossible to prevent a slight amount of curling of the finished part.

Bending of aluminium sheet for such items as small fairings can be done by clamping, or fixing, two lengths of timber parallel and a short distance apart, across which the plate may be placed, and pressed down with a length of stiff tubing (Fig. 14).

Bending and flanging

The calculation of lengths allowing for bending over the radii of curvature sometimes presents a problem, but there should be no difficulty if the centre-line of the metal plate is considered to remain of constant length; the outer face of the metal extending and the inner part contracting under the force of bending.

Consider an angle fitting having lugs with *inside* dimensions A and B (Fig. 15). The length of its centre line is:

Fig. 14.

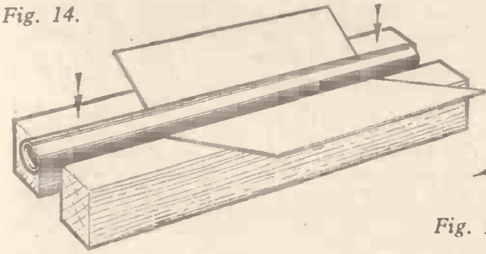


Fig. 16.

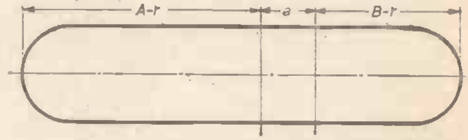


Fig. 18.

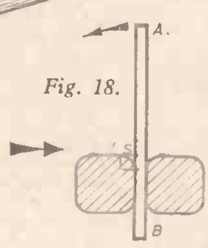


Fig. 14.—Bending thin aluminium sheets for small fairings.
Fig. 15.—The angle fitting described in the text.
Fig. 16.—Marking out to include the bending allowance.
Fig. 17.—Marking a sighting line to assist bending.

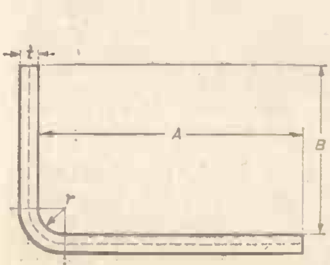


Fig. 15.

Fig. 17.

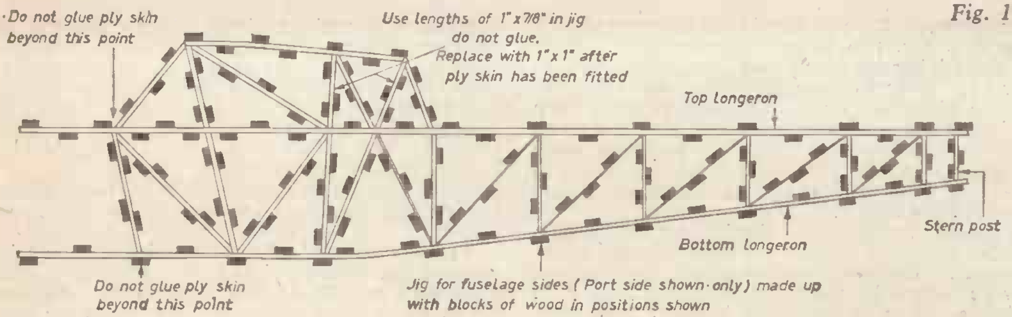


Fig. 19.

$$L = A + B - 2r + \frac{\pi}{2}\left(r + \frac{t}{2}\right)$$

If π is taken as 3·0 (correct to within 5%)

$$L = A + B - \frac{r}{2} + \frac{3t}{4}$$

It is not uncommon to make the radius of bend equal to $1\frac{1}{2}t$, in which case $L = A + B$, *i.e.* the total length is equal to the sum of the two *inside* dimensions.

The plate may be marked out (Fig. 16) by lines defining the two straight parts of the lugs, *viz.*: $A-r$ and $B-r$, together with the part to form the bend (sometimes referred to as the bending allowance), of length

$$a = \frac{\pi}{2}\left(r + \frac{t}{2}\right)$$

or if $r = 1\frac{1}{2}t$ and π is given the value of 3·0, $a = 3t$.

To form the bend, the length of plate should be held between bending bars (or equivalent) in the vice so that one of the bend defining lines coincides with the lower edge of the radius on the bending bar. As this cannot be seen, a sighting line s should be scribed, distant r above the lower defining line (Fig. 18). As drawn, lug A is then turned down through 90°. Again, if $r = 1\frac{1}{2}t$ the sighting line is halfway between the bend defining lines, which means that all that is required is to make the plate of length $A + B$ (inside dimensions), scribe the sighting line so as to divide the plate into parts A and B and complete the bend by the aid of the sighting line (Fig. 17).

Note that the method as described above is correct for any relationship between r and t, but where r may be made equal to $1\frac{1}{2}t$ the work becomes greatly simplified. This method may be used for channel and all other shapes where the bend angle is 90° but for angles (α) other than 90° the bend centre line length is

$$\frac{\alpha \times 2\pi}{360}\left(r + \frac{t}{2}\right)$$

Fuselage construction

The two sides may be made in one jig, but this means removing one of the frames prior to attaching the plywood and therefore care must be exercised to avoid distortion during and after removal. The procedure is to build the first side in the jig, complete with ply skinning, and lift out. Then complete the second frame, tack 6in. strips of plywood along the top and bottom (not necessarily in one length and any scrap or commercial plywood of uniform thickness will do). Few tacks or staples

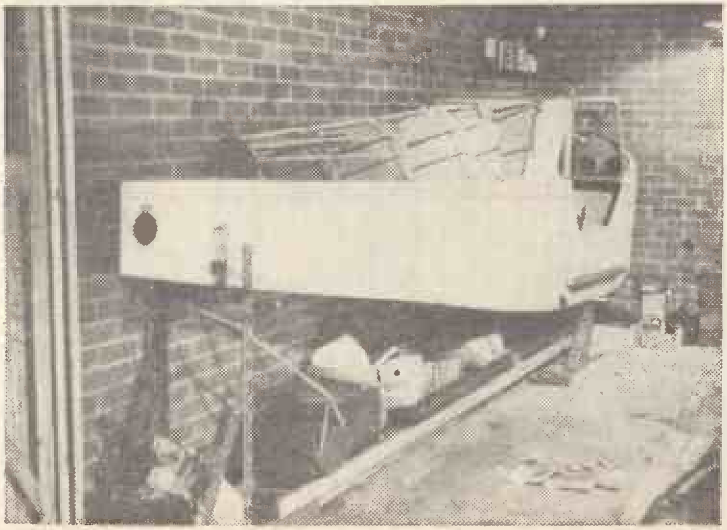


Fig. 20.—A nearly complete fuselage by Mr. W. G. Cooper, of Weybridge. Restricted space need not necessarily deter the builder, as this picture of Mr. Cooper's garage shows.

are necessary—three or four in the longeron at each joint and, say, two in each cross-member. After the glued joints have set remove the frame and turn over so as to rest on the ply strips. Before applying the plywood skin it is as well to place some additional plywood strips beneath the frame and between the two edge strips in order to avoid springiness in the cross-members. These strips may also be lightly tacked to the frame before removal from the jig.

To make the jig, set out the fuselage outline on a wooden floor and draw in the longerons and cross-members. The straight lines of the top longeron may be formed by the string and chalk method in which a string is stretched between two nails, chalked, held away from the floor and twanged like the string of a bow. Headless nails, $1\frac{1}{2}$in. long, may be driven in with $\frac{1}{2}$in. to $\frac{3}{4}$in. exposed, just externally to the lines, to hold the spruce members lightly in position, thus allowing for easy removal of the finished frame. Use at least two pairs to each cross-member and insert pairs every 2ft or 3ft along the longerons but closer over the curved portions. Alternatively, wood blocks may be used in place of the nails, though this is not really necessary for the construction of one fuselage; however, some wood blocks may be used to advantage where careful shaping is required, such as the bend in the lower longeron. Also perhaps along the length of the top longeron, since this forms the main datum line for the whole aircraft.

Place pieces of waxed paper at each joint position to prevent glue from sticking to the floor. The waxed paper may be fixed with adhesive tape. Set both longerons in position and carefully cut all the cross-members to length and place in position, together with packing blocks. The curving-in of the forward part of the four longerons can be facilitated by steaming prior to making up the fuselage sides, but some slitting of the longerons will be found beneficial. It is suggested that the top longerons be slit vertically over the forward 20in. (Fig. 22). This is best done on a small circular saw before commencing assembly of the sides. Cut $\frac{7}{8}$in. strips of 1mm or $\frac{1}{16}$in. plywood to fill the saw cuts but do not glue until the fuselage nose is being shaped.

The double bend of the lower longeron can be arranged for by vertical and horizontal slitting, *i.e.* quartering, or with a single diagonal slit. Alternatively, the upward curvature may be obtained by steaming prior to setting in the fuselage side jig, relying on vertical slitting for the inward bend.

It will be noted that members "g" and "h" are 1in. x 1in. section, as against $\frac{7}{8}$in. square for all the others, and would therefore stand proud of the jig, thus preventing fixing of the ply skin. This difference may be overcome by omitting these two members temporarily and inserting instead short pieces of 1in. x $\frac{7}{8}$in. timber (*not* to be glued!). Do not glue forward of the $1\frac{7}{8}$in. undercarriage member at this stage, as this makes for difficulty in pulling in the sides to the nose curvature. Now remove each cross-member in turn, apply glue where required, reset in position and leave to harden.

The $\frac{1}{16}$in. plywood covering should preferably be scarfed up with the grain vertical over the forward portion to the rear of the cabin, the remainder being horizontal. This should be cut roughly to shape for ease of handling but leaving a margin all round to be removed after gluing. Make leading marks on the inside of the ply for location of the frame.

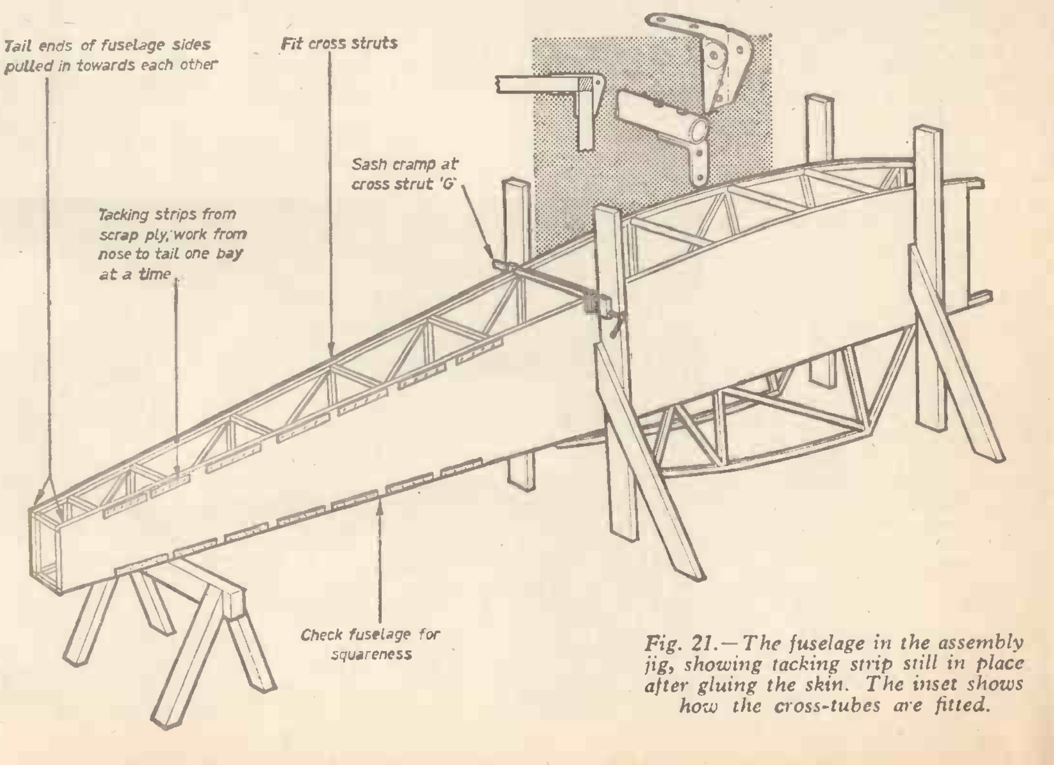


Fig. 21.—The fuselage in the assembly jig, showing tacking strip still in place after gluing the skin. The inset shows how the cross-tubes are fitted.

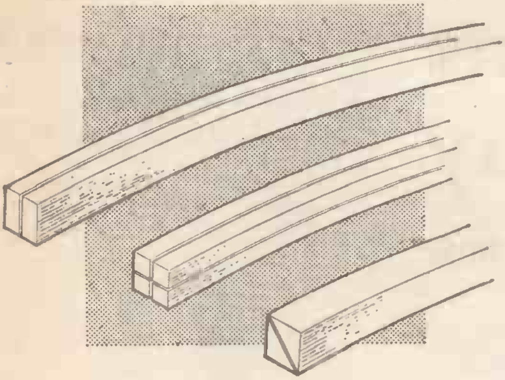


Fig. 22.—Three methods of assisting the bending of longerons. Top, vertical slitting; centre, quartering; bottom, diagonal slitting. The slits should be filled with 1mm ply strips glued in place after bending.

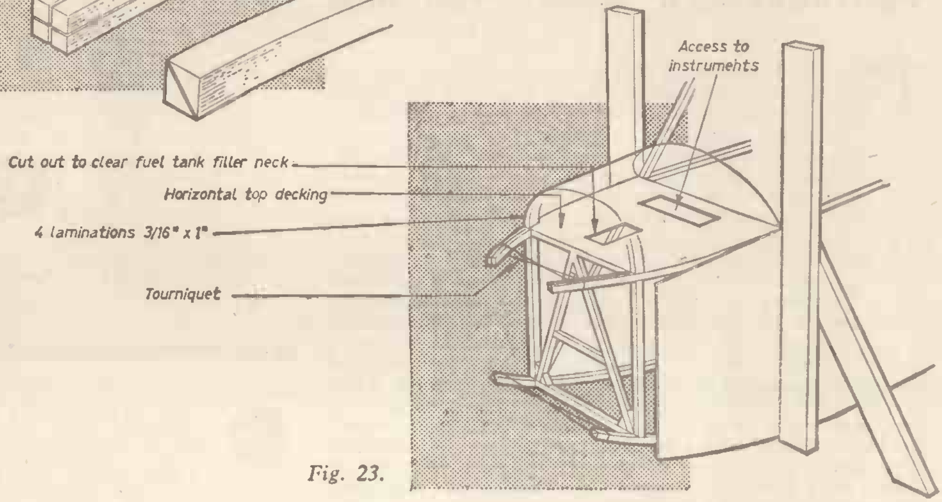


Fig. 23.

Gluing can be done in one operation from member "c" to the tail end, but it may also be done in sections, especially in hot, drying climates. In either case an assistant is almost essential for this operation. Contact of the two surfaces should not be delayed for more than 10 minutes after application of glue, although if allowed to stand for 5-10 minutes a stronger joint is obtained with Aerodux 185. This should give sufficient time to complete the gluing in one operation, especially with two operators. A further period of about one hour is allowable before tacking need be completed. Apply the glue liberally over the upper faces of all members, working along the length of the fuselage, and lift the completed skin into position, temporarily fixing by means of a few brads. Then, starting from the end that first received glue, lay on strips of plywood about 1in. wide (any offcuts will suffice) along the line of the longerons and cross-struts and tack in position with 20s.w.g. brass brads or ½in. wire staples every 1in. or 2in., again working along the length of the fuselage. Note: If Aerolite glue is used the glue component should be painted on the spruce members and the acid on the ply.

If piecemeal gluing is adopted, apply glue over the rearmost 4ft or 6ft of the frame, say to member "k". Carefully lay on the ply skin, fix with half a dozen brads where glued and affix tacking strips over the glued length. Carefully roll back the ply skin from the nose—a roll diameter of 2ft or 3ft will suffice—taking care not to disturb the glued portion nor to damage the plywood at the last glued point. Repeat the gluing process over the next 4ft (to member "g") and finally to "c". It is possible to build up the sides without the use of a jig by first scarfing up the plywood skin, marking out the positions of all spruce members and then gluing up, commencing with the two longerons and then adding the cross-members, but if this method is employed it is probably best to cramp the longerons in position, after gluing, allow the glue to set and then add the remaining members, fixing temporarily with gussets on the inside, then turning the slab over for stapling from the outside.

After removal from the jig, members "g" and "h" should be fitted. When the glue has hardened carefully remove all tacking strips, cut off the surplus plywood and sand the edges. The jig may now be completed for the other side by making the small changes required for the doors.

The next operation is the building of the fuselage base, for which purpose the two sides must be set up, inverted in parallel and made rigid. There are several ways of accomplishing this but perhaps the best method is to erect two pairs of 5ft-high vertical posts, spaced exactly 26⅛in. apart, the two pairs being distant 6ft 1½in. The sides should be firmly clamped to the supports (this is not shown in Fig. 21) with the tail ends resting on a trestle. Small blocks may be nailed to the inside of the supports at the same height as the trestle for the longerons to sit upon. It will be seen that the cabin upper extensions hang between each pair of vertical supports, clear of the floor, and some temporary battens should be tacked on to hold them in position. Check very carefully that the fuselage sides are vertical, 26⅛in. apart (measuring from the outer faces of both plywood skins), that both sides are accurately aligned one with the other and that the straight longerons are truly horizontal.

Develop Films This Way

'PHOTOGRAPHER' SHOWS YOU HOW

THE growth of interest in photography is such that it is now authoritatively considered to be one of the world's leading hobbies. For the pictorialist, it provides a means of artistic expression, without the necessity for any skill with pencil or paintbrush. For the scientifically minded, there are innumerable technical byways to be explored. However, exposing films and then sending them to a chemist or photographic dealer for processing, can rob you of a great deal of the interest value of your hobby.

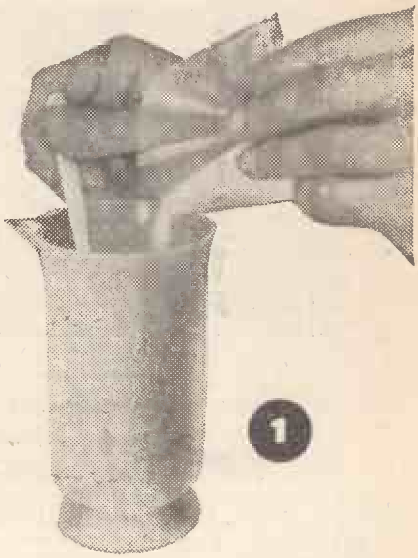
If you follow the simple directions given here, you should have no difficulty in processing your films to the very highest standard of quality. In addition, apart from the initial cost of the equipment required, your photography will in fact cost you less. Chemicals to develop a full-length 35mm or roll film can be bought for between sixpence and ninepence depending upon the type of developer in use. From this, it can be seen that the equipment will have paid for itself over a year or two if a fair number of films is exposed and processed. Although speed is, perhaps, not so important, it is always interesting to see the resulting negatives so shortly after removing the film from the camera. Excluding the final washing, the negatives can be viewed in the light within half an hour of starting the developing sequence.

The old-fashioned method of gripping a film at either end and then see-sawing through an open dish of solution is now gone, instructive and interesting though it was. Excellent plastic developing tanks, which may be used in full daylight or artificial light, cost from a pound to thirty shillings. Some types will take every gauge of film in modern use. Basically, a tank consists of a lightproof plastic body, a lid of similar material which can be screwed or bayoneted into place, and two spirally grooved discs which clip together at the required separation for your film. All tanks also have a rod which is inserted down the core of the tank to agitate the spiral in the solution or, if designed particularly for inversion agitation, a cap to fit over the outlet of the tank to seal it.

The tank must be loaded in a totally dark place, but this does not need to be a proper darkroom. A cupboard or wardrobe without any light leaks will serve very well. When checking a cupboard to see if it is light-proof stand inside for several minutes to let your eyes become adjusted to darkness. Alternatively, the film may be loaded into the tank with your hands deeply under the bedclothes and the curtains drawn. It is also possible to buy for thirty shillings or so a so called changing bag. The tank, film, etc. are placed inside and the hands inserted through elasticated sleeves.

When loading a rollfilm, split the seal with a fingernail, and unwind the backing, holding your thumbnail against the roll until the film is reached. Hold the film by its edges and thread it into the start of the spiral, continuing to wind in until the adhesive strip joining the film to the backing is reached. Tear off and discard the backing and then put the spiral into the tank and clamp on the lid tightly before taking it out into the light. Thirty-five millimetre film, which has no backing paper and is enclosed in a metal or plastic cassette, can be fed straight in.

Most people use fine-grain developers for all types of film these days, and these can be bought either in liquid or



1 Mix the solutions in a graduated measure. Plastic, glass, stainless steel and unchipped enamel vessels are suitable for mixing and storing solutions. Never use aluminium, copper, galvanized or unglazed earthenware vessels.

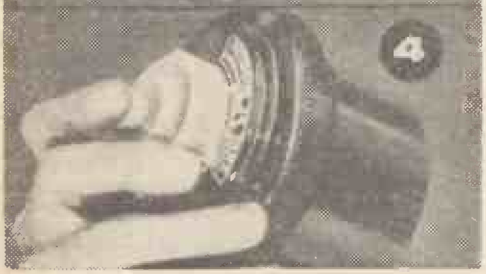
2 Agitate the developer as soon as it has been poured into the tank. This is to ensure that the film is wetted all over and removes any air bubbles adhering to the film.

3 Straight away take the temperature of the developer. Reference to the instructions supplied by the manufacturer of the developer will then give the correct developing time for the particular film.

4 Agitation should be carried out for ten seconds every minute. This picture shows a tank fitted with a watertight cap to allow agitation to be carried out by inverting the tank.

5 The film can be removed from the holder by bowing it and pulling it away from the spirals. Handle the film only by the edges or the clear end portion.

6 After removing the film from the tank hang it up to dry in a warm dust-free place. With 35 mm film, stainless wire hooks can be used in the perforations.



powder form. The individual packages give the dilutions required and the directions for mixing should be followed exactly. Use a graduated measure to obtain the correct strength, and stir in the concentrated developer with a plastic spoon. This must be washed before use in the next solution.

Having the processing solutions at the correct temperature is a vital factor of good film development. For this you need a photographic thermometer. A spirit-filled one at five shillings or so will suffice. Before you pour the solutions into the tank, check that they are at the correct temperature. If, as is most likely, they are too cold, they should be warmed by standing the measure or bottle in warm water for a while. Pour the developer into the tank, holding the latter at an angle as you do so to avoid trapping air inside. Without delay, insert the agitator rod in the centre of the tank or fit the cap if inversion agitation is used. Give the rod a few sharp turns in either direction (Fig. 2) or invert the tank a couple of times. Remove the rod or cap, insert the thermometer and check the temperature of the developer (Fig. 3).

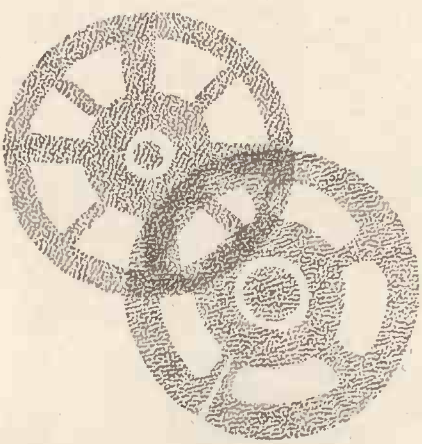
The degree of development is dependent on the time of development and the temperature of the developing solution, so it will be necessary to look up the required development period against the appropriate temperature given in the instruction sheet. Every minute during the development period, spin the agitator rod a few times in each direction for a total of about ten seconds. If your tank is of the type which can be given inversion agitation, a most efficient method, place the cap over the tank outlet and turn the tank completely over several times for ten seconds at one minute intervals (Fig. 4).

At the end of the development period, pour out the developer, into a storage bottle if it is to be used again, and refill the tank with clean water at approximately the same temperature as the developer. Agitate briskly for a minute and then empty the tank again. Immediately pour in a hardening fixer solution, which again should be at roughly the same temperature. Agitate for at least two minutes and then leave the film to fix

for about a quarter of an hour. Use a hardening fixer rather than plain hypo as the emulsion will be much more scratchproof then when dry.

At the end of the fixing period, pour the solution back into the bottle for further use, and fill the tank with water, again at the same temperature, and agitate vigorously. Pour this away and refill the tank with water about 5°F cooler. Continue doing this until the water is at about the same temperature as that from the tap. Two changes of water should suffice except in winter time. From then on, washing may take place under the running tap for a further half an hour. Empty the tank and refill with water to which a *few* drops of photographic wetting agent, or even household *liquid* detergent, have

(Continued on page 430)



ACCESSORIES FOR THE TAPE RECORDER

By A. E. BENSUSAN

ALTHOUGH tape recorders are now so popular in many homes, particularly with technically minded people, the various manufacturers have apparently not realised that there is a considerable market for small accessories. This being the case, anyone needing special facilities must, very largely, supply them himself by making the various items concerned. The accessories described here are almost universal in that they can be used with a wide range of different makes and types although they might need slight modification of details and dimensions from one make to another. Constructional costs are negligible in all cases as the materials can mostly be found in the junk box.

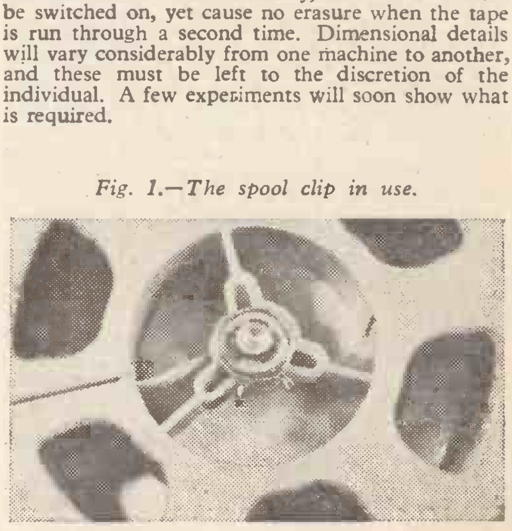
A few recorders have special flip-over retaining clips on the spool spindles, but the majority of makes do not have this feature. Thus, when the machine is stood on end to be carried (or in the instance of a battery-powered portable recorder, to be operated while slung from the shoulder), the spools can slip off the driving lugs. Provided that at least $\frac{1}{16}$in. of spindle protrudes from the spool core, a quickly and simply made clip can be fitted to obviate this nuisance. Use thin spring-steel wire (piano wire) and bend it around a pencil or other cylindrical object, rather smaller than the spindle diameter since the loop will tend to spring out when the tension is released. The wire will need to be clinched around the cylinder with pliers. Having formed a loop with cross-over ends, form each end into a small fingergrip and cut off the surplus. A greatly enlarged view of the completed clip is shown in Fig. 1. As can be seen, it is only necessary to press the fingergrips together while sliding the clip onto the spindle hard against the spool face, and then release the grips, to cause the clip to hold the spool firmly in place. Five minutes easy work should produce a pair of these patience-preserving accessories.

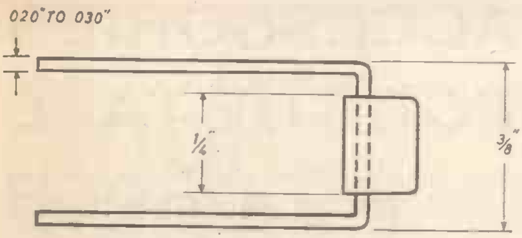
Another handy device for use in conjunction with the spools of tape is a tape retainer. This prevents the tape from spilling out all over the floor whenever a full spool is laid down. A few odds and ends of thin plastic, fibre or *non-ferrous* metal say 0·020—0·030in. thick, of any reasonably springy kind, are all that are required. If a plastic which can be moulded when heated in warm water is used, the retainer may be folded up from one or two pieces; otherwise, it may need to be fabricated from separate scraps of material and the joints made with a suitable cement. Appropriate dimensions are given in Fig. 2 while, as can be seen from Fig. 3, the two small lugs enable the retainer to be easily grasped between the fingertips and removed from the spool.

The ability to superimpose one recorded track over another greatly extends the scope of a machine, but professional type sound-mixers are expensive and seldom justify the outlay for purely amateur use. There is, however, a method of carrying out simple superimposition on any standard recorder. Normally, when the tape is run through the machine a second time with the controls set to "record" after having recorded a track, the erase head or permanent magnet which is located just before the recording head, wipes off the original sound as the new track is added. By shielding the first recording on the tape from this erasing head or magnet, a second track can be added on top without doing more than reduce the volume of the original sound by approximately one-half.

The superimposition shield may be made of any of the materials suggested for the tape retainer. Smoothly rounded edges avoid damaging the tape, and the shield should fit over the erase head or magnet so that the pressure of the tape holds it in place (Fig. 4). The strength of the magnetic field created by the erasing device will determine the thickness of material necessary, for the head must be switched on, yet cause no erasure when the tape is run through a second time. Dimensional details will vary considerably from one machine to another, and these must be left to the discretion of the individual. A few experiments will soon show what is required.

Fig. 1.—The spool clip in use.





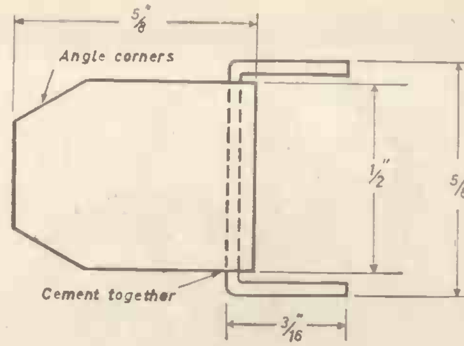


Fig. 2.—Details of tape retainer.

Fig. 3.—The tape retainer fits into the spool.

Fig. 4.—Superimposition shield partly in place.

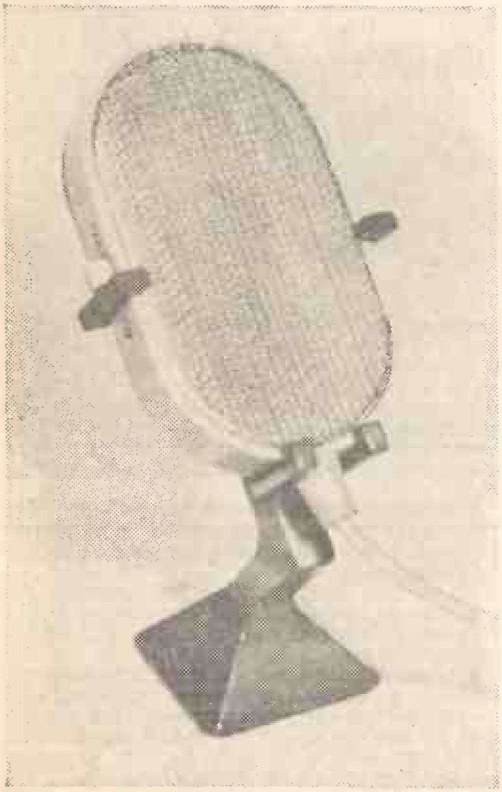


Fig. 5.—How the microphone fits into the stand.

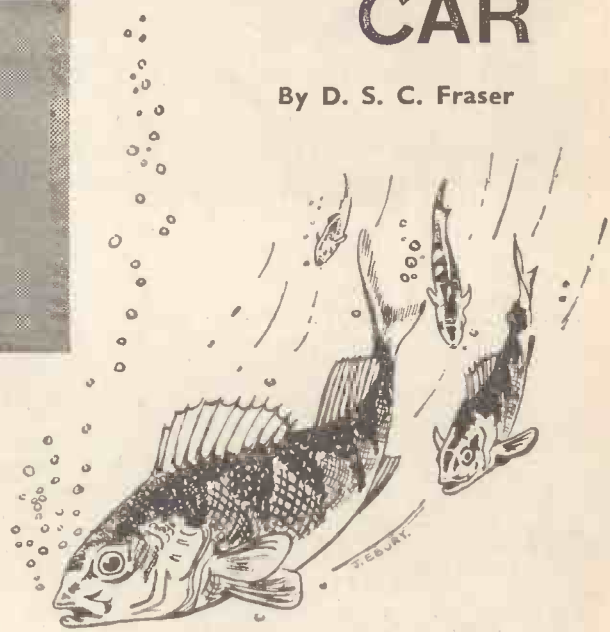
Much recording noise is caused by hand-holding a microphone when it could, just as comfortably, be placed on a table or other support. True, few of the less expensive crystal microphones have built-in stands, but the ideal is to have a stand into which the microphone can be slid when required. At other times, when the microphone must be mobile, it can be removed from the stand and held in the hand in the normal manner.

A suitable design for all fairly flat patterns of microphone is shown in Fig. 5; the exact dimensions and profile will depend upon the casing of the microphone. It is essential for the stand to be reasonably heavy, to prevent it being dragged by the screened lead, and for the weight to be evenly distributed to avoid the risk of falling over. The stand is shown fitted with a microphone, which slides in from above. The base and stem of the stand illustrated were moulded in one piece from Hermetal (this process was described on pages 231 and 232 of the February issue), with an offcut of brass rod embedded in the base during moulding to improve stability. The microphone supports were cut from aluminium alloy and fixed in place with Araldite. If preferred, the base and stem could also be fabricated from brass or aluminium alloy.

The angle of the microphone was calculated to suit a particular height of table, and mouth to microphone distance. As can be seen, the microphone is situated over the centre of gravity of the stand. The microphone supports were lined with leathercloth to produce a snug fit, while a square of leather was glued to the underside of the base, with its rough side outwards, to increase the grip on the table surface. The stand was finished with two coats of gloss enamel.

SEA SHORE CASTING CAR

By D. S. C. Fraser



Bill Wilson of Ohio, U.S.A. built this novel powered fishing trolley to aid his battle of wits with the channel bass our artist has sketched for us here.

A "do-it-yourself" mind conceived the idea for the shore casting outfit shown in the illustration. A three-wheeled, unique-looking job, it is home-designed and consists of easily acquired bits and pieces. Its function is to cover a great deal of beach when surf-casting for channel bass, a pastime much favoured in some parts of North America. Apparently, to locate these elusive fish an angler must drive miles along lonely stretches of beachline to just the right spot where they happen to be biting. And the right spot from all accounts may be here, there or anywhere. Hence the necessity for some rapid transportation.

Mr. Bill Wilson, of Munroe Falls, Ohio, thought up the idea for this low-powered means of conveyance. For the past six years, much of his fishing holiday has been wasted chasing these fish along the beach at Cape Hatteras, North Carolina.

Repeated bad luck and breakdowns with rented beach vehicles, prompted him to build this compact little run-about. It can be dismantled and carried in the back of a station wagon, and is capable of manoeuvring along sand dunes and even into shallow water like a sand crab.

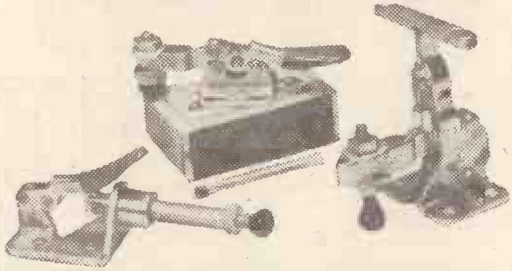
He built an all-aluminium body and mounted a motor and transmission from an ordinary lawn mower on it. The finished car is 56in. wide, 58in. long and clears the sand by 11in. The six-horse-power (American) motor moves it along at speeds up to 35 m.p.h. The vehicle's simplicity and design eliminate any need for a trailer. Removing four bolts releases the two rear wheels and power plant from the body. Another bolt holds the single front wheel and steering device, and the two seats snap out.

Two additional sections can be attached behind the seats for fishing. Two trays hold equipment, or the catch, and four vertical pipes serve as holders for casting rods.

Mr. Wilson is reluctant to say just what this experimental model cost him. However, he will go as far as to estimate that he could build slightly smaller ones for less than $200.

For tyres, Mr. Wilson decided on three Goodyear Terra-Tyres, the fat, low-pressure tyres much used on golf carts, swamp buggies and other vehicles used on soft footing in the United States. They are almost as wide as they are tall. Engineers estimate that if the total weight of the vehicle and driver could be kept to under 300 pounds, these tyres would float the vehicle and driver right into the fish's front door.

TRADE NEWS



Miniature toggle clamps

A RANGE of 19 miniature toggle clamps are being introduced by Destaco to reduce non-productive times in the manufacture of light components.

These tiny clamps, many of which are little larger than a matchbox, provide instant and positive pressure which may be preset to avoid damage to delicate work.

They can be readily adapted to a wide variety of applications from simple holding of parts during drilling, tapping, gluing and soldering to the positioning and clamping of units in bench-assembly work.

The smallest model has a maximum holding pressure of 42lb and yet weighs only 1oz. The lightness and ease of operation of these clamps are important factors in reducing operator fatigue.

Included in the range are several types of miniature toggle action pliers which can be adjusted for varying thicknesses of work. They are self-locking but instantly removable by light finger pressure and are intended for awkward jobs where fixed clamps are impracticable.

All models are plated to prevent rust and are supplied with neoprene-tipped adjustment spindles which prevent damage to work.

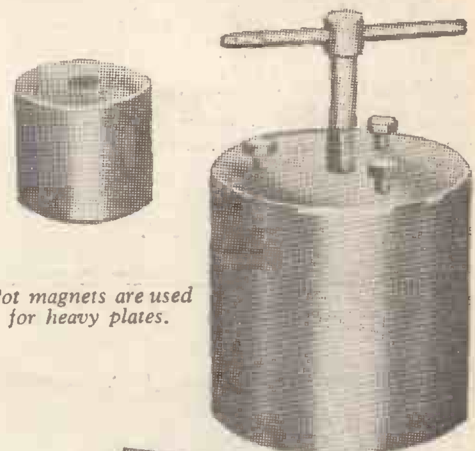
Details about these clamps can be obtained from: Insley Industrial Ltd., Insley House, 5 Windmill Street, London, W.1. Telephone Langham 5426.

Magnetic welding clamps

DARWINS Permanent Magnets are renowned for their long-lasting magnetic force and holding power. In the form of welding clamps their gripping capacity can easily be applied for holding rigidly in place all kinds of work pieces, particularly those of irregular shapes and sizes and in awkward positions.

For setting-up work pieces of iron and steel for welding the use of permanent-magnet holding devices is the quickest and most economical method known.

A few typical examples of their application are illustrated on the opposite page. They are made by Darwins Ltd., Fitzwilliam Works, Sheffield.



Pot magnets are used for heavy plates.

V magnets for holding work at right-angles.

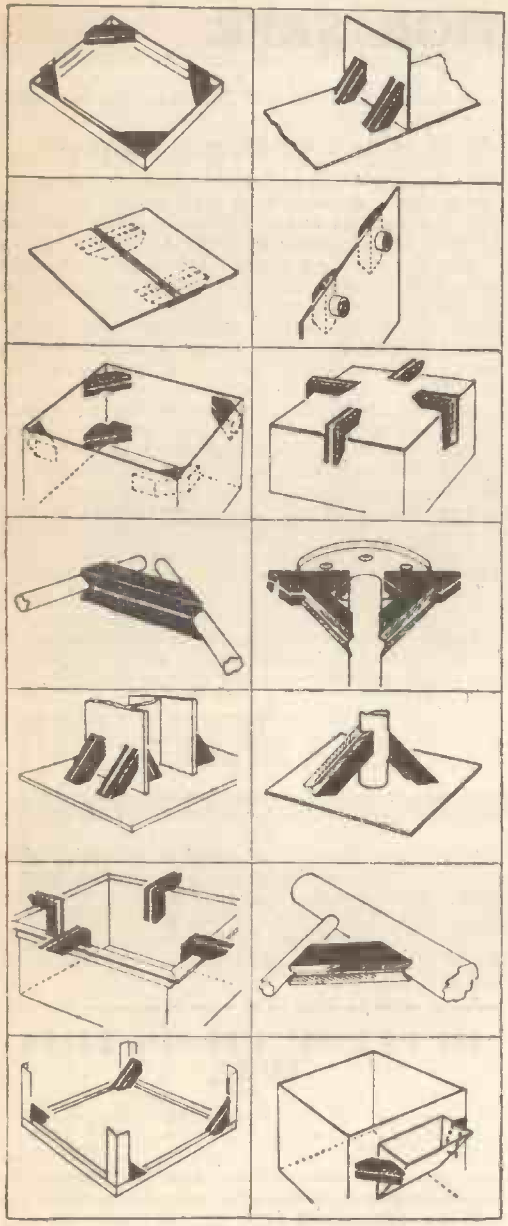
Pop rivet kit

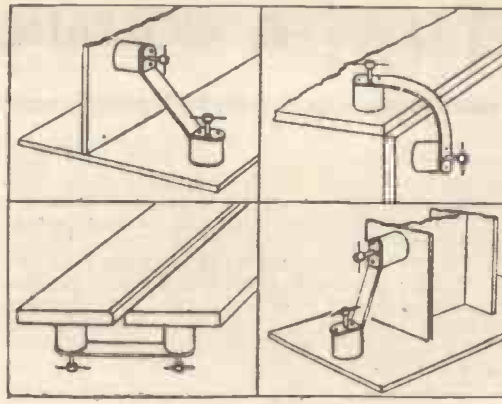
"POP" riveting is now available to the home handyman in the form of a kit. It provides a quick and cheap method of joining metal sheets or sections of tube in one operation and from one side of a structure by simply drilling a hole, inserting the rivet and operating the tool.

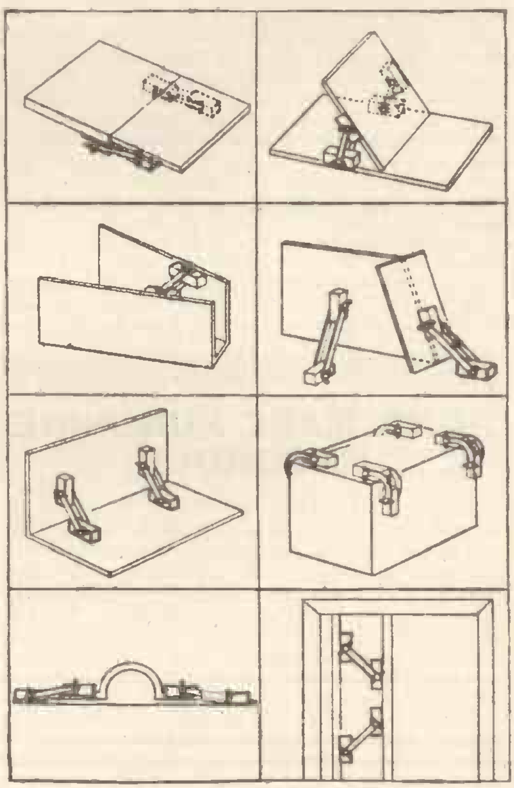
As well as joining all types of metalwork it can also be used for asbestos sheeting. This kit is invaluable both to the amateur and the professional engineer.

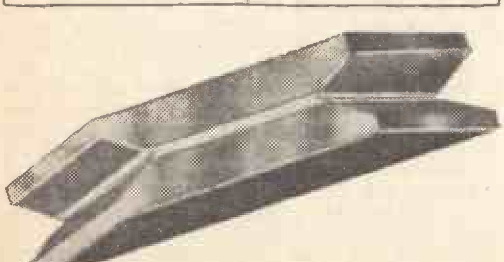
Retail price £5 18s.

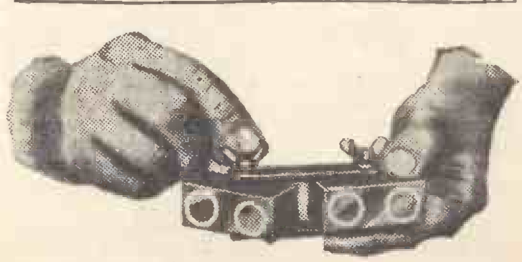
Made by George Tucker Eyelet Co. Ltd., Walsall Road, Birmingham 22b.











Two more magnetic clamps and, top, using these and other types.

A COMBINATION SAFE

(Continued from page 392)

The hole for the shaft must be truly central and must fit the shaft closely but be free to revolve. The slots must be radial and slightly wider than the thickness of the metal plate used as the key. They should be rounded slightly at the edge of the discs as shown, to prevent any slight irregularity causing clicks which would give a clue to the combination, or even jam the mechanism.

The pins can be fitted by drilling the discs and setting in a short rod, securely soldered in position and filed down to give the necessary projection on each side. A small nut and bolt would probably serve equally well. All the pins must be set at the same distance from the centre to ensure that they engage with each other. The slots and pins should be located in varying positions as shown as this enables the combination to be changed when required, by interchanging the discs.

The bolts can be $\frac{1}{4}$in. diameter silver steel rod cut to length and slotted to take stops as shown. The lock bolt must be cut on a slope at the end to allow it to ride over the keep when closing the door. The U-shaped stops and the brackets can be cut from $\frac{1}{16}$in. brass bent to shape and drilled for bolts and screws as shown. Spring A keeps the bolt forward in the locked position but allows it to push in when the door is closed and spring out again into the keep. Spring B pushes the key plate up against the edges of the discs until the slots are aligned when the key plate is forced in by the spring which also withdraws the bolt from the keep.

It is necessary for the door to overlap the sides of the safe to prevent the bolt from being forced back with a knife blade. The door has an inner frame and lining which gives the safe the appearance of the genuine article and also encloses the locking mechanism. The inner panel of the door has a small slot through which the re-setting nib projects. A small metal plate drilled to suit the bolt and screwed to the door edge allows the bolt to move more easily and makes a stronger job.

The dial can be a plastic knob as used on radio sets, with an additional circular plate fixed to it having the alphabet around the rim. In this case a mark is required on the door, most conveniently placed directly above the knob. A small panel pin driven in or a spot of paint will serve this purpose. Alternatively the alphabet can be marked on the door, with a pointer or mark on the knob to enable the letters to be selected. The shaft projecting through the door should have a flat filed on or a hole drilled to locate the set screw in the knob so that it can be replaced in the same position.

The door of the safe illustrated is hung on a pair of $2\frac{1}{2}$in. steel hinges. For other sizes they should be of a size and strength to suit the safe. With a small safe the door can be opened by simply pulling lightly on the dial once the lock has opened. With a heavier door a pull handle may be necessary.

It must be remarked that the combination should be determined by inspecting the action of discs as the dial is turned *before the door is closed for the first time.*

Another point is that two combinations will open the safe, depending on the direction in which the dial is turned in the first instance.

HOME MADE SUNSHINE RECORDER

(Continued from page 413)

counterbalance any outward thrust due to the stiffness of the paper holders. Newspaper cut to a suitable shape is attached with paperclips to the upper surfaces of the two paper holders, and bright sunshine is recorded by burns on the paper. Impregnating the paper with a very dilute solution of potassium nitrate (saltpetre) may be necessary to give sufficient winter sensitivity. However, too strong a solution will give a ragged inaccurate trace.

The instrument should be orientated so that the line through the two uprights runs east and west in order to give a symmetrical trace which will indicate the approximate times at which the burning takes place. The paper holders are attached to the uprights in such a way that they can be pivoted. Their settings, and also the shape of the newspaper, require adjustment to suit the path of the sun at various times of the year. Ideally the paper holders should be spherical sections, but as mine are only circular the best results are obtained when the setting is adjusted so that the burning is as near as possible along the centre line of the northern paper. The second (southern) paper holder is fitted so that the approximately spherical shape of the paper can be extended at the ends, beyond the east-west line. This is necessary in summer when the sun rises and sets northwards of due east and west.

The paper should be changed each evening after sunset and the trace measured with a pliable plastic ruler. The instrument can be calibrated by noting the length of burn for a given period of time.

[We apologise to Mr. Hookey for misspelling his name in the article on a Rainfall Recorder last month.—Ed.]

DEVELOP FILMS THIS WAY

(Continued from page 423)

been added. Allow the film to soak for between three and five minutes; then remove the spiral from the tank body and draw the film out carefully as shown in Fig. 5, handling it only by its edges.

While drying, the film must be hung up in a dust-free place. For rollfilms, special clips can be bought although plastic clothes pegs are quite suitable. When clipping up 35mm films, use may be made of the perforations along the edges. Stainless wire, bent as shown in Fig. 6, can be engaged in the end perforations and suspended by a clip. The lower ends of all films should be lightly weighed to prevent them from curling up.

Immediately the film is dry, it should be taken down and cut into lengths according to individual filing requirements. Negatives $2\frac{1}{4}$in. square and larger may be filed individually in translucent pockets, while 35mm negatives are best filed in strips of six.

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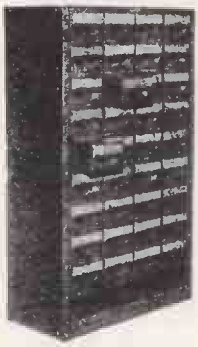

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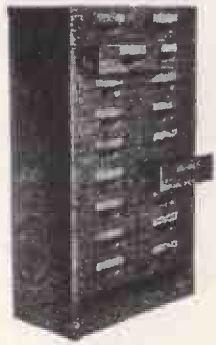

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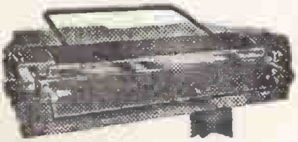

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