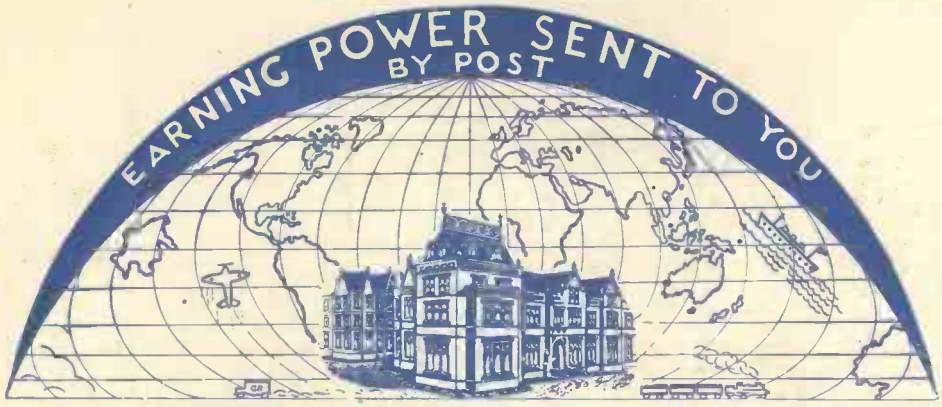
The PICK-A-BACK TRANSATLANTIC MAIL PLANE!

NEWNES

PRACTICAL MECHANICS

FEBRUARY

6D.



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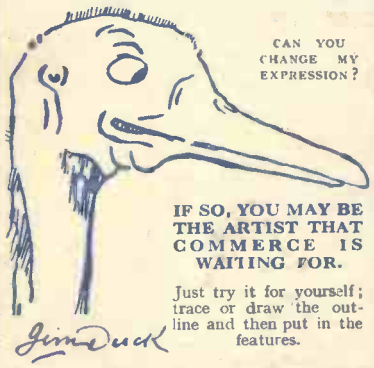

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Notes, News, and Views

A Remarkable Steel-forging Feat

THE largest gear wheel rims—14 ft. 3 in. in diameter—ever forged in England, have been produced at Sheffield by the English Steel Corporation Ltd. for a turbine being made for the Ellerman Line. They were made in a 7,000-ton forging press recently built.

Warships in Miniature

THE first of ten 600-ton escort boats, built at the Germania works at Kiel, is now in commission.

Record Long-distance Flight

TWO French airmen, Genin and Robert, have flown the 6,214 miles from Paris to Antananarivo, Madagascar, in 2 days 9 hours and 32 minutes, beating the previous record by nearly 28 hours.

A £6,000,000 Scheme

QUETTA, the great garrison city of North-west India, which was destroyed by an earthquake last May, with a loss of 30,000 lives, is to be rebuilt on the original site. The cost of rebuilding has been estimated in the reconstruction committee's report at £6,000,000.

Optically-perfect Crystals

PROFESSOR D. C. STOCKBURGER, of America, recently succeeded in making a 3-in. crystal of lithium fluoride, in a thin platinum crucible, placed inside a special electric furnace and heated to a temperature of 1,200° C. Lithium, a soft silver-white metallic element of the alkali group, and fluoride are melted, and after the slow process of cooling has begun, a tiny seed crystal forms in the conical bottom of the crucible, continuing to grow until the material has entirely crystallised. This discovery promises to extend the horizon of spectroscopic investigation, particularly in atomic research on liquids and some gases.

The Norris Dam

THE Norris Dam, over which the waters of the Church River, Tennessee, flow, is rapidly nearing completion. It will impound a lake containing 3,600,000 acre-feet of water.

A Formidable Fighter

THE new Gloucester "Gladiator," which recently made a test flight, is considered one of the most formidable fighters in the R.A.F. It has a high-speed performance, and is fitted with four machine guns, two being in the streamlined casings under the lower wings.

The World Speeding Up

ASTRONOMERS have now found that the world is going round in four-thousandths of a second less than 24 hours, a difference of less than one and a half seconds a year.

A New Aircraft Carrier

THE new Japanese aircraft carrier, "Soryu," of 10,050 tons, with turbines of 60,000 h.p. and a speed of 30 knots, was recently launched at Kure.

Bomb-proof Warships

BOMB-PROOF defence for magazines, machinery spaces, inflammable stores, and all vital control stations will, it is stated, be a feature of the new British battleships which, according to present plans, are to be laid down twelve months hence.

China Clippers

"CHINA Clipper" type planes are probably to be used this year in the experimental flights over the North Atlantic route from America to England.

A Valuable Find

IT is reported that a Russian labourer working in the Ural Mountains, has just found a nugget of gold weighing 443¼ fine ounces and valued at £3,123. This is the fourth largest nugget ever found in any part of the world—it is 15 in. in length—and the labourer is now probably wishing that he lived in a capitalist country !

The Deepest Hole in the World

IT is reported from Texas that the deepest oil well ever sunk has just been drilled, the final depth being nearly 13,000 ft. The bore is just under 7 in. in diameter and the earth temperature at the bottom was found to be 182° F. At 10,000 ft. the temperature was 150° F.

Conferences by Wireless

LARGE companies with many overseas branches can now hold meetings at which the distant staffs can participate by radio-telephone. A meeting has just been held by The International Combustion Company Ltd., at which the speeches were transmitted simultaneously to New Zealand, Australia, India, and South Africa, and reports were made by the various branches in turn. Such a scheme is perhaps expensive, but much cheaper than the cost of bringing the delegates to England.

Coal Petrol

PETROL made from British coal can now be bought at a petrol station in Kensington, price 1*s.* 6*d.* per gallon.

The Boulder Dam

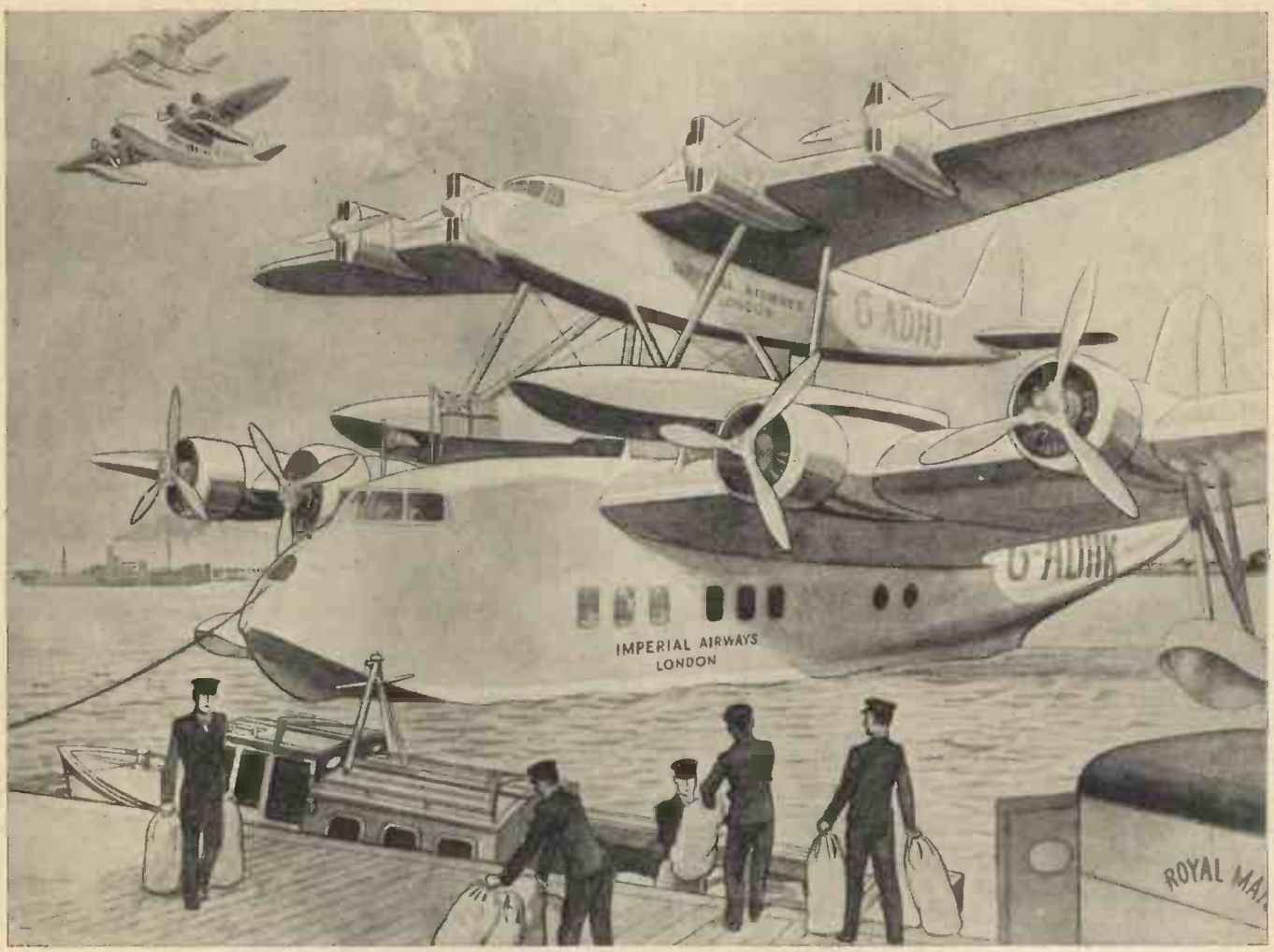
AS the task of impounding water in the huge lake being created behind the Boulder Dam proceeds, the engineers are anxiously watching for possible disasters. The dam is certainly strong enough, but never before has man applied such a concentrated weight of water on one spot of the earth's crust. It is calculated that the weight of the lake alone will be over 40 billion tons, and some adjustments of the earth's crust are almost inevitable. It is to be hoped that nothing serious happens, for the lake will contain enough water to flood the whole State to a depth of 10 ft.

Records by Railcars

RAILCARS are rapidly becoming a popular form of travel on the French railways, and a record has just been made by M. Jean Bugatti, the son of the motor manufacturer, who has driven a railcar the 313 miles from Strasbourg to Paris at the speed of 88 miles per hour. At present, there are no less than seventy-five railcars in use and not a single breakdown has yet occurred. Their ability to negotiate sharp bends at high speeds enable economical and high-speed running to be achieved without danger.

A New Use for Old Aeroplanes

WE all know that sharp ground frosts can occur when the temperature, a few feet higher, is well above freezing point. Fruit growers in California have often found that their orange groves are sometimes badly damaged by ground frosts, and in order to prevent the settling of the cold air, they are now fitting up old aeroplane engines on small towers to keep up a continual movement of the air. It is found that a 450 h.p. engine driving an 8 ft. propeller can keep an area of 40–50 acres free from frosts.



An artist's impression of the composite aircraft, which is now under construction for Imperial Airways.

THE PICK-A-BACK TRANSATLANTIC AIR-MAIL

Imperial Airways have Recently Designed a Composite Aircraft for Crossing the Atlantic, which is a Combination of two Machines—a Large Aircraft Ascending with a Smaller Machine Mounted upon the Upper Surface of its Wing; the Latter being Launched in Mid-Air for Ocean Flight

DURING recent years, one of the most formidable problems confronting commercial aviation, has been the operation of a regular Atlantic air-mail between Canada and the United States and England. Flying pioneers have, of course, blazed individual air trails across the North Atlantic; while regular services have come into operation on the route over the South Atlantic to South America. But the establishment of a regular commercial air-mail between England and Canada presents problems of a nature such as are encountered on no other air route in the world.

The Weight of the Fuel

On the South Atlantic, flying operations are generally simplified by favourable weather conditions; while although the North Atlantic has already been conquered in occasional flights—made when the forecasts have indicated suitable weather—there is all the difference in the world between such occasional flights and the institution of an all-weather service which is called upon to adhere to a pre-arranged time-schedule. There is also the following point to be remembered.

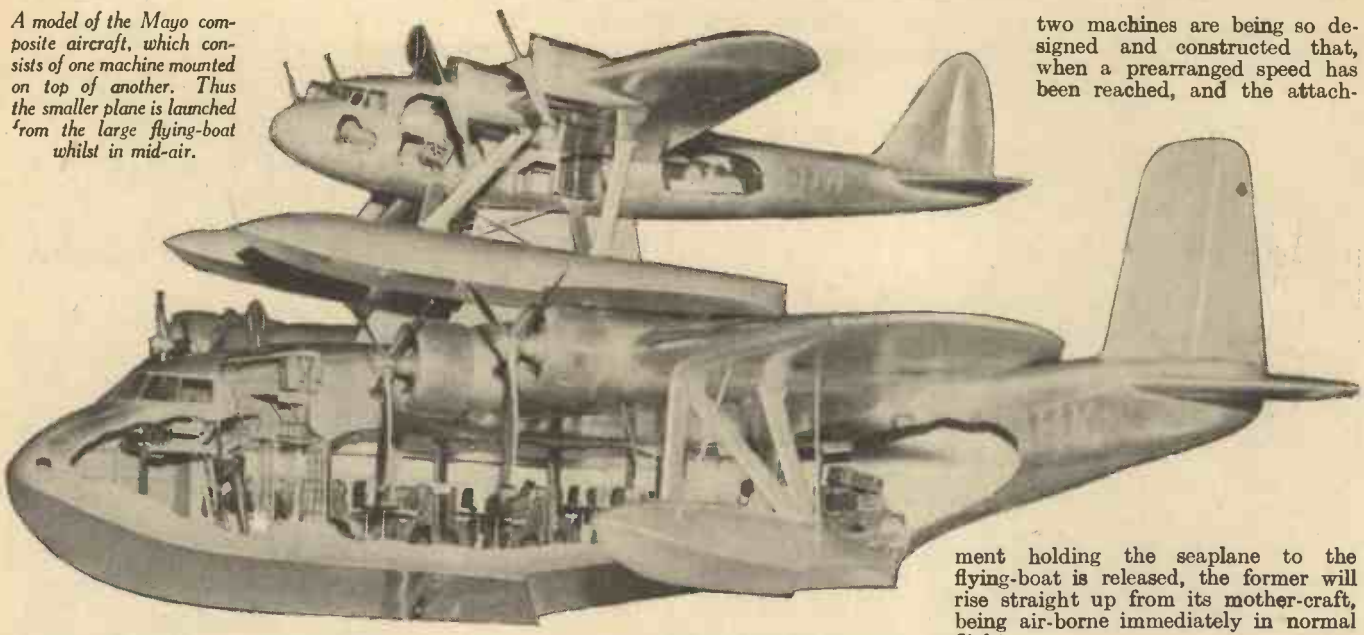
In the making of solo Atlantic flights, aerial record-breakers have had to burden themselves with such an immense weight of fuel that their machines have been unable to carry anything in the nature of a paying-load. And that, of course, is a vital point. It is not sufficient just to fly the Atlantic; or even to be able to do so regularly. It is essential, if a service is to be established on a normal business footing, that machines should carry an adequate paying load, over and above the weight of fuel and crew.

For a considerable time past the experts of Imperial Airways have been studying this North Atlantic air problem from a specifically commercial aspect. One point that emerged at an early date was that in any first experimental stage of flying on this route, it would be advisable to carry mails only—passenger traffic being catered for at a later date.

Another fact which emerged from the investigation was that one of the chief technical difficulties, in operating the Atlantic route with heavily-loaded aircraft was in getting these machines "unstuck" from the surface of land or water when they were carrying their maximum load at the beginning of a flight. Once at their operating height, and in horizontal flight, the problems arising were greatly simplified.

Solving the Atlantic Air Mail Problem

A careful examination of the position in this respect, led Imperial Airways to place an order for an ingenious "composite" type of aircraft which aims to solve this Atlantic air-mail problem in a manner never before attempted. Built to the designs of Major R. H. Mayo, technical consultant of Imperial Airways, this aircraft is now in construction for Imperial Airways by Messrs. Short Brothers, and it is expected that it will be completed in their Rochester factory in time for pre-



A model of the Mayo composite aircraft, which consists of one machine mounted on top of another. Thus the smaller plane is launched from the large flying-boat whilst in mid-air.

liminary trials to be carried out this year.

The main feature of this novel craft is that it really comprises two aircraft in one. The larger of these two machines is a powerful multi-engined flying-boat, driven by four 900 h.p. " Pegasus " engines, and on the wing of this flying boat is carried a small machine which takes the form of a long-range high-speed seaplane, driven by four Napier-" Rapier " 350-h.p. engines.

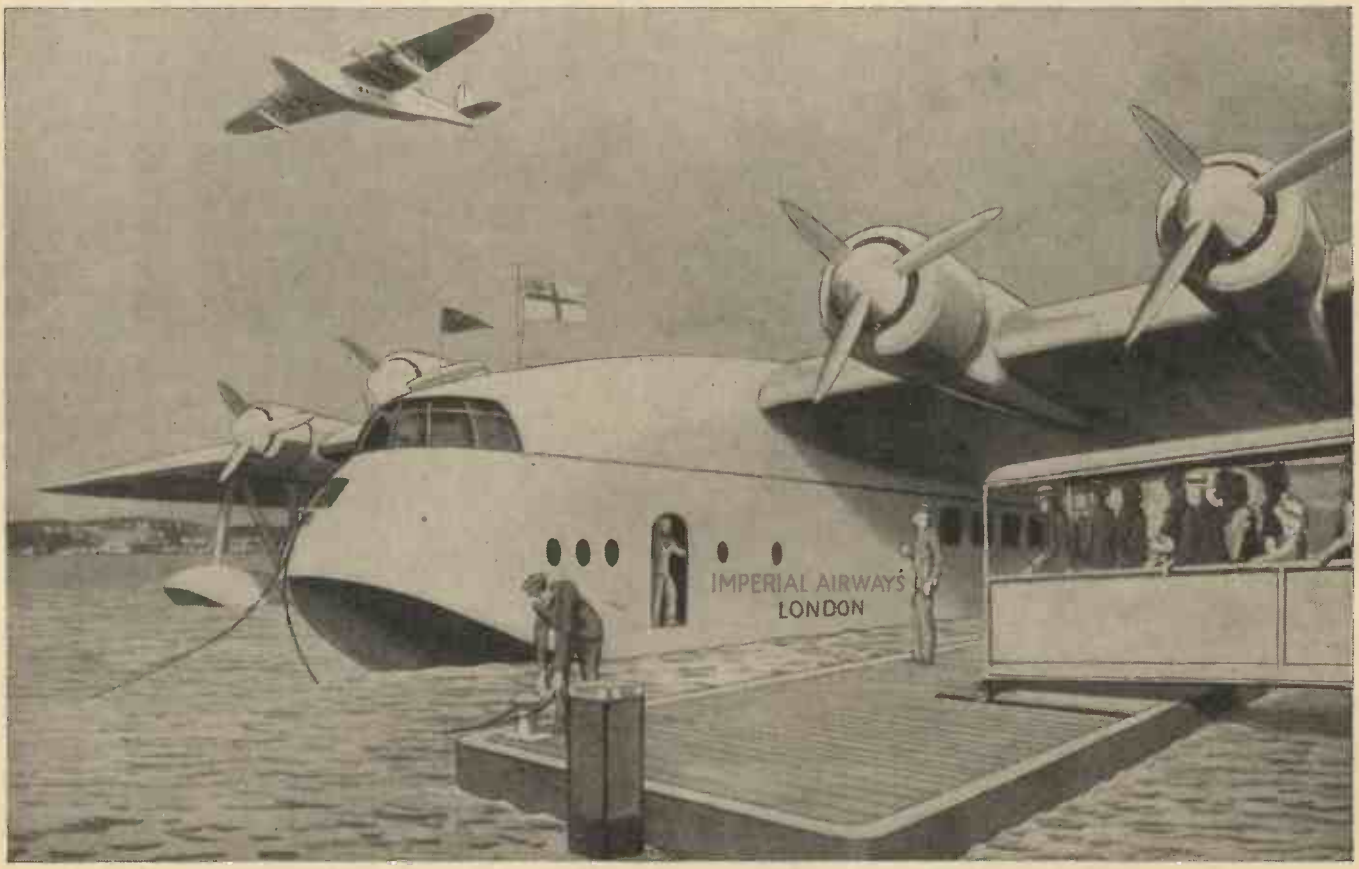
The Machines in Flight

The method of operation, with this " composite " aircraft, will be as follows. When the two machines are ready for flight, the seaplane mounted on the wing of its mother craft, the engines of both machines will be set in motion, and under their combined pull the " composite " aircraft will " taxi " across the water and take to the air as one machine. Still linked together, and operating as one machine under the combined pull of the eight engines, they will climb steadily until some suitable operating height has been attained—say, approximately, 10,000 ft. Then the pilot of the upper or seaplane part of the apparatus will, by the operation of a lever, be able to detach his machine from the lower flying-boat portion. Actually the seaplane will not glide forward when released from its mother-craft. The wing-sections of the two machines are being so designed and constructed that, when a prearranged speed has been reached, and the attachment holding the seaplane to the flying-boat is released, the former will rise straight up from its mother-craft, being air-borne immediately in normal flight.

Mid-air Launching

The advantage of this method of mid-air launching is that the seaplane thus launched at its operating height, ready to proceed immediately on a long-distance flight, will be able to carry a heavier load for a longer distance at a higher speed, and with a lower expenditure of power, than would be the case with any machine which has to ascend from the surface of land or sea.

After it has been completed, and is ready for flying, a number of technical trials will be carried out with this " composite " apparatus before it is scheduled for any experimental flights on the Atlantic route.



Another impression of the new Empire flying-boat, now under construction for Imperial Airways by Short Bros.

Synchronised Photo Flash-Bulbs

A Useful Device for Amateur Press Photographers

Fig. 1.—Showing the finished apparatus.

FLASHLIGHT photography has been greatly simplified by the introduction of the flash-bulb, a device which is fired electrically from an ordinary pocket torch. There is no smoke or noise; just a brilliant flash inside the glass bulb.

Normally the bulb would be fired in the hand with the camera on a tripod, but there are times—particularly in amateur press work—when a tripod cannot be used. In these circumstances, it is very difficult to hold the camera in one hand and to operate the shutter and torch button with the other, but the gadget described below will enable the operator to use his camera at eye-level and to synchronise the flash with the exposure. It can be adapted to any type of folding camera.

Constructional Details

The diagram shows the main constructional details, but measurements are not given as they will vary with every different make of camera. It will be seen that the device consists of two main parts: an electric torch mounted on a brass angle-piece (Fig. 1), the brass being bent so that it can be clamped to the side of the camera by a screw in one of the tripod bushes. To give rigidity, a small cross-piece *A* is soldered under the end near the torch. Above this is mounted a terminal strip of fibre, with two terminals. The long shank of one terminal is tapped into the brass cross-piece so that in effect it makes electrical contact with the metal case of the torch: the shank of the second terminal is cut off short, but the terminal itself is connected by a piece of insulated wire to the bulb holder at the top of the torch *C*. These connections are such that if the terminals are shorted, the torch bulb will light.

The Wire Release

The second part of the device consists of an ordinary wire release with the top of the plunger cut off and replaced by a small ebonite block (Fig. 2). To do this, it will be necessary to lengthen the plunger by soldering on about ½ in. of thick wire (16 or 18 S.W.G.). Under the block is fixed a metal contact strip made from a wireless double-ended solder tag, which is bent round the block as shown at *A*. The plunger passes through the hole in the tag, but must not touch it. The two flex wires are soldered, one to the collar *B*, and one to the contact strip at *C*. It will be seen that if the free ends of these wires are connected to the terminals on the first unit, and the plunger fully depressed, the short-circuit will light the torch bulb or fire the flash.

Synchronising

First of all try this experiment. Take your camera (with wire release), set the shutter and slowly press the plunger. At a certain point the shutter will fire. Mark this point on the plunger by means of a scratch, level with the collar, and repeat the operation. You will find that the shutter fires at the same point each time. You will also find that the plunger can be depressed about $\frac{3}{16}$ in. or more beyond the firing point. It is this extra movement that is used when synchronising the flash, as follows:

Assemble the complete device on the camera and put an ordinary torch bulb in the holder. Check the mark on the plunger showing the firing point, and adjust the ebonite block so that the contact strip is about ⅛ in above the mark. Place the camera on the edge of a table with the lens pointing towards you, and then depress the release as far as it will go with a steady, even pressure. You will find that the torch bulb lights a fraction of a second after the shutter has opened. (Use a slow speed of ½ or ¼ second, or a bulb if your shutter is without slow speeds).

Exposure

It must be remembered that when a between-lens shutter is fired, there is an appreciable fraction of time before it opens to maximum aperture. Therefore to make full use of the flash, photographically, it must be timed so as to lag, slightly behind the shutter in order to give the latter time to open. That is why the contact strip on the plunger is set about ⅛ in. above the mark where the shutter fires: the extra travel before contact is made gives time for the shutter to open fully.

It can be argued, quite rightly, that if the plunger is pressed very slowly, the shutter will open and close before the flash takes place. But if a slow speed of ½ or ¼ second is used and a steady even pressure applied to the release, this will not occur. If the shutter is without slow speeds, use the bulb and release the pressure immediately after the flash.

(*Continued on page 325*)

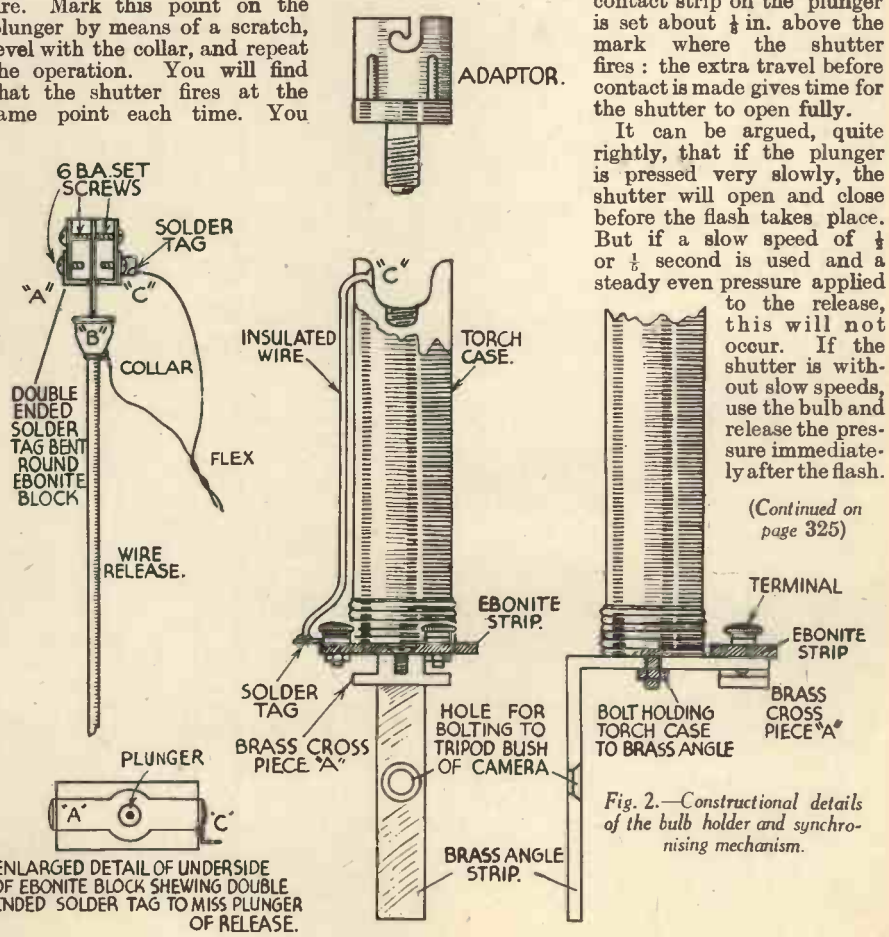
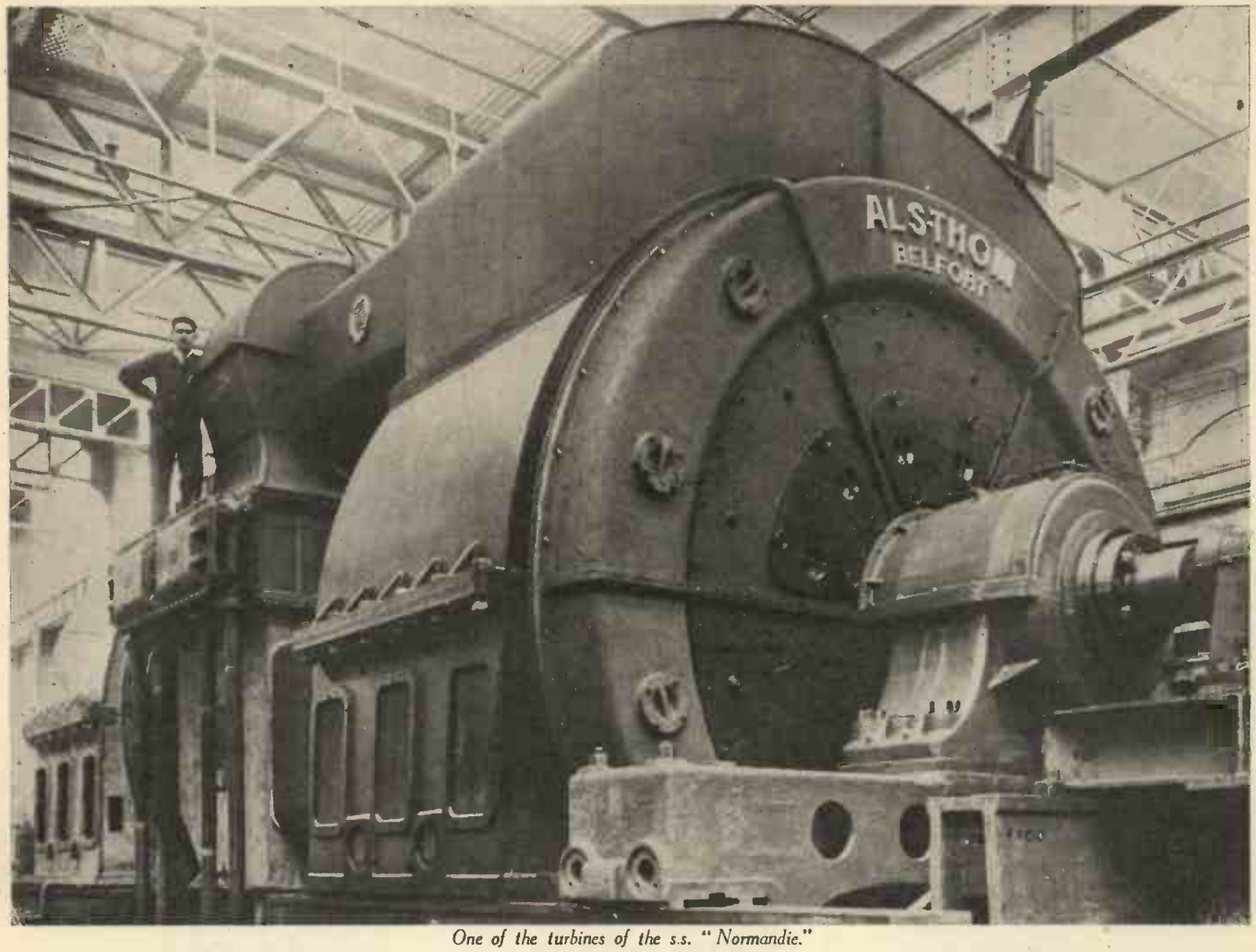


Fig. 2.—Constructional details of the bulb holder and synchronising mechanism.



One of the turbines of the s.s. "Normandie."

STEAM TURBINES

The Steam Turbine Appeared as a Serious Competitor to the Reciprocating Engine About the Beginning of the Present Century, for Although the Turbine was in use for Nearly Twenty Years before this, the Earlier Types were Wasteful of Steam

THERE are two main types of turbine, the impulse and the reaction. In the former, steam is expanded in a carefully designed nozzle so that the pressure energy becomes converted into kinetic energy; and because the energy in the live steam is high compared with the density, the steam issues from the nozzle at a very high velocity, somewhere in the region of 4,000 ft. per second. The jet of steam from the nozzle is directed on to a kind of "Pelton Wheel" as used for water motors. The principle of operation is identical, for both absorb the kinetic energy of a stream of fluid, but the steam turbine presents entirely different problems.

Now, theoretically, to absorb all the kinetic energy from the steam, the latter should escape from the turbine blades with no velocity at all, and this result should be achieved when the peripheral velocity of the turbine blades is half that of the steam entering the blades. Assuming the steam velocity to be 4,000 ft. per sec., a 12 in. diameter wheel should revolve at over 36,000 r.p.m. to obtain best efficiency, but, for various reasons the blade velocity of the impulse turbine is usually about one-third of the steam velocity, so that the speed would be about 24,000 r.p.m.

A De Laval Turbine

In any case, the speed of the impulse, on a De Laval type of turbine is always too high for all ordinary uses, and a reduction gear becomes necessary. The centrifugal forces at such high speeds are usually so high, that the loading nearly reaches the safe stress on the metal.

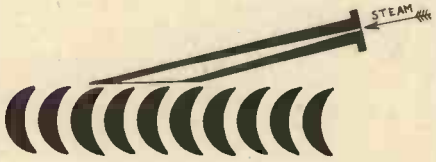


Fig. 1.—The principle of the De Laval turbine.

There are usually several steam nozzles on a De Laval turbine, the number in operation being varied according to the load. Fig. 1 shows the principle of this type of turbine.

In the reaction, or Parsons type of turbine, the steam, instead of flowing into the blades tangentially, flows parallel to the shaft, and instead of expending its energy on a single row of blades, there are many rows; the blades becoming larger and the diameter greater as the steam expands on its passage through the turbine. In addition to the rotating blades, there are stationary blades arranged in alternate rows to the rotating blades, as shown in Fig. 2. When the steam passes through the moving blades it is deflected back in the direction opposite to the moving blades, and it is the duty of the fixed blades to direct the steam on to the next set of moving blades.

Blades Similar to an Aeroplane Wing

On glancing at Fig. 2, the reader may notice that the blades have a section

somewhat similar to an aeroplane wing. In fact the similarity does not end in the appearance because they may be regarded as being a very large number of small wings each contributing its quota in applying a torque to the shaft. Although the pressure per blade is small (say between 1 and 2 lb.) the number of moving blades

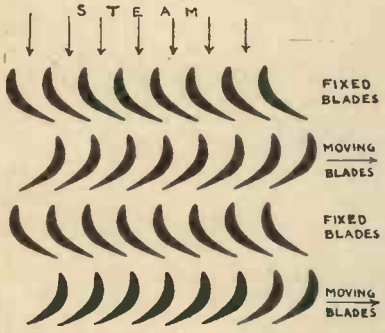


Fig. 2.—In addition to rotating blades there are stationary blades arranged in alternate rows to the rotating blades, as shown.

may be perhaps 100,000 and as they are all in continuous operation it will be readily seen that large forces are involved. The reader may perhaps remark that in Fig. 2 the " angle of incidence " looks all wrong, but this is only apparently so, for if account be taken of the fact that the blades are in rapid movement, the objection disappears.

The rotational speed of this type of turbine is much lower than the De Laval type, because the drop in pressure at each row of blades is comparatively small, and the steam velocity is therefore lower with consequent lower blade velocities. For driving electric generators, such turbines may be directly coupled, the generators being specially designed to suit the turbine speed. In the case of ship propulsion, however, the efficient speed of the turbine is still well above the efficient speed for a propeller, so modern ships are generally equipped with reduction gears. Many ships have been built with turbines driving the propellers direct, a compromise being effected in design of both turbines and propellers. The *Mauretania*, for instance, had direct drive, but it has been estimated that by using high-speed turbines driving low-speed propellers by means of reduction gears, together with higher steam pressures, the fuel consumption of such a liner could be reduced by about 40 per cent. This represents an enormous saving in cost of operation and no doubt is one of the main reasons that this fine ship was broken up recently.

Reduction Gears on Ships

Single reduction gears on ships may have a ratio approaching 20 to 1, but even this is not high enough for best efficiency, and double reduction gears, allowing a turbine speed of say 5,000 r.p.m. and a propeller speed of about 80 r.p.m. are now used considerably, the reduction being therefore about 60 to 1. It is probable that when the *Mauretania* was built, although the need for reduction gear was realised, suitable gear wheels were not obtainable, but subsequent advances in gear cutting have put turbines on a more favourable basis for marine work. The reduction gears of a ship are in themselves a wonderful engineering achievement and up to 20,000 h.p. is sometimes transmitted through a single pinion. Two pinions, driven by two individual turbines, are frequently meshed with one large gear wheel on the propeller shaft.

An important advantage of turbines for power stations, is that they can be made in large units. There are many in operation of 200,000 h.p. and over. Contrast this with a maximum of say 10,000 h.p. for a reciprocating engine; though of course such engines are now obsolete for electrical machinery.

SPEED SECRETS OF THE QUEEN MARY

Four spare propellers are to be kept at Southampton for the use of this monster liner.

Each propeller weighs 35 tons, is 20 ft. wide, and has blades of a maximum breadth of over 6 ft.

They are the largest ever made and, for technical reasons, their size is not likely to be surpassed.

Every minute as the liner travels on her voyages, 6,500,000 gallons of water will be " expelled " by each of the four screws.

The tips of the blades of the propellers whirling through the water at 150 m.p.h., will travel a distance of about 30,000 miles on the round trip.

So great is the strain imposed upon the equipment that the propeller shaft is twisted round several degrees from the normal.

A mild electric current is actually set up between the ship's hull and the churning screws as she travels through the water.

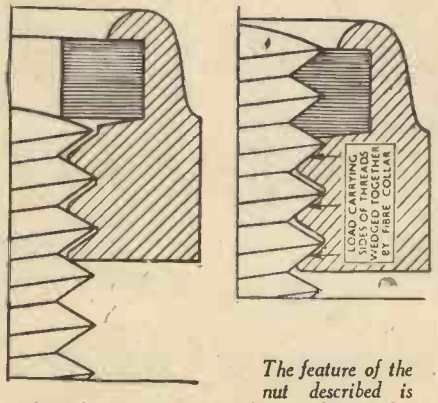
The Simmonds " Elastic Stop " Nut

FOR years there has been a demand for a nut that can be rigidly locked, yet be readily adjustable. Previous methods of locking have been by double nuts, split pins, and specially designed nuts, each of which has some slight drawback. A nut that has endless applications and can be efficiently locked, is now being sold under the title of this article.

In design it is a standard nut with its height slightly increased to incorporate a collar of special fibre. This collar has an internal diameter slightly less than the diameter of the bolt, and is itself initially not threaded. Before the bolt reaches the fibre collar the nut has every property as well as every shortcoming of a standard nut, for the play between the threads is to specification tolerances. Every engineer realises that it is this play, necessary as it may be for easy assembly, that is the main cause of an ordinary nut backing off under vibration.

How the Nut Differs

In the case of the Simmonds nut, when the bolt has passed through the threaded portion of the nut and reaches the fibre collar, this collar, due to its smaller hole, momentarily resists the further advance of the bolt. In overcoming this resistance the bolt presses against the collar, and in so doing forces the nut upwards away from the head of the bolt, until the sides of the thread are in contact. The harder the fibre material, the greater the force necessary to make the bolt enter the collar, and the harder the nut is pressed upwards. On a $\frac{5}{8}$-in. B.S.F. or Whitworth bolt this axial force amounts to 700 lb. This force distributes itself as a pressure on the underside of the bolt thread and, what is most important, this is also the side of the thread which, when the nut is drawn home, will carry the normal load.



The feature of the nut described is shown by these two views through the nut, before and after tightening.

It will be clear that this pressure causes heavy friction between the sides of the thread in contact, and thus a very heavy anti-rotational force will be exerted if ever the nut should tend to turn.

An Airtight Grip

After the upward pressure has reached the maximum, the bolt makes its own thread through the fibre collar, and the fibre wedges into the bolt threads. Owing, however, to the elasticity of the fibre, no chips are removed, and the fibre closes around the bolt with an airtight grip.

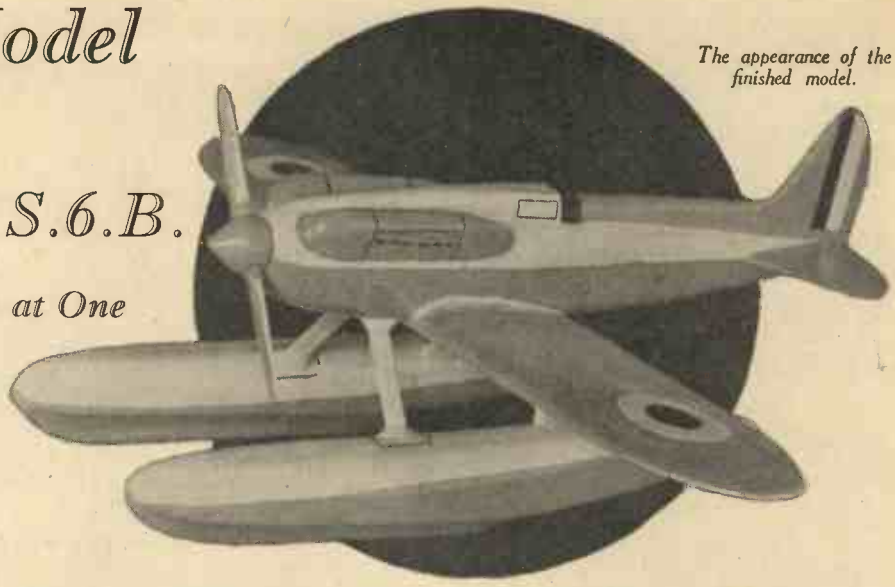
Lastly, the pressure between the fibre collar and the bolt further increases the anti-rotational characteristics of the nut. The nut is made in bright mild steel, stainless steel, light alloy, brass, etc., and can be obtained in a variety of types, such as, anchor nuts, clinch nuts, and hexagon, with either British, metric, American, or special threads.

Its Uses

It can be used for terminal connections, instruments, switches, switchboards, transformers, relay adjustments, rock drills, tanks, trains, cars, etc., and is absolutely dependable under vibration. The nut also offers advantages of particular interest to electricians. Its principle makes it capable of carrying large loads through the threads with a minimum of resistance. Applied to terminal connections, Simmonds nuts avoid the necessity of using steel lock washers with resulting troubles. Brass and bronze nuts are also used to hold transformer connections immersed in oil.

A Scale Model of the Supermarine S.6.B.

A Model of the Plane that at One Time Held the World's Speed Record, and also Secured the Schneider Trophy for Great Britain



The appearance of the finished model.

NO collection of model aircraft would be complete without the S.6.B., the machine which for some time held the world's speed record, and at the same time secured the Schneider Trophy for Great Britain.

The following is the list of parts and the sizes of the pieces of wood from which they are cut, the first column indicating the run of the grain.

	Long.	Wide.	Thick.
Fuselage	5·9	·7	·8
Windscreen and fairing	2·7	·3	·2
Engine cawls—two	1·9	·3	·3
Fin and rudder	3·1	1·5	·2
Elevators—two	1·1	1·05	·075
Propeller blades—two	1·1	·3	·1
Forward float struts—two	1·6	·15	·075
Rear float struts—two	1·7	·15	·075
Floats—two	5·6	·65	·75
Wings—two	3·4	1·45	·1

The Prop-Boss

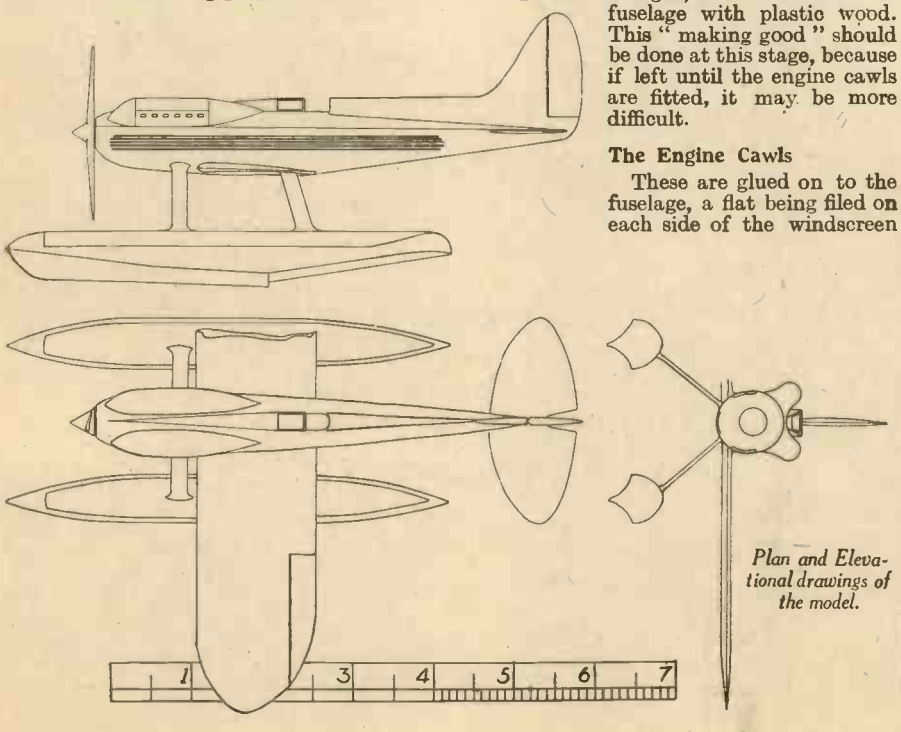
Commence by turning or shaping in a hand brace, the spinner and prop-boss. It has to be ·4-in. high and ·3-in. diameter at the base, a parallel portion ·15-in. long being left to which the propeller blades are fitted. The prop-boss can now be used as a guide for the shaping of the fuselage, which should be made next.

First mark out the elevation and remove the unwanted wood. Then mark out the plan and shape off. Round off the fuselage along its entire length and sandpaper smooth. The radiator panels (oil system) along each side of the fuselage can be represented by scoring heavy lines in the wood or left till later and painted in. Another alternative is to cut the panels out and lay in lengths of copper wire, which is more correct than either of the foregoing methods. The cockpit is also cut out and extends forward under the windscreen but should not be more than ·15-in. wide nor too far forward or a gap will be left when the windscreen is placed on top. Then cut the windscreen and fairing. Note that it tapers flush into the fuselage at the front. The back end of the windscreen can be hollowed out if so desired, and the three windows filled with celluloid sheet. The windscreen is square but the fairing forward is rounded throughout its length, and faired into the fuselage with plastic wood. This "making good" should be done at this stage, because if left until the engine cawls are fitted, it may be more difficult.

The Engine Cawls

These are glued on to the fuselage, a flat being filed on each side of the windscreen to facilitate gluing, the underside of the cawls being flat. These cawls must also be faired into the fuselage with plastic wood. Next cut, shape and secure the fin and rudder. The rudder can be separated from the fin and hinged, only one hinge being necessary, as the lower end of the rudder only requires a single pin fitted vertically. The elevators are next fitted to the fuselage, a cut-off pin passed through the tail end, locating the two halves of the elevator correctly. This concludes the fuselage parts, which now only require a touch with sandpaper or plastic wood to finish it completely.

Four holes to take the float struts are then drilled in the underside of the fuselage. The position and direction of these holes must be accurate or incorrect positioning of the floats will result, there being no inter-float struts by which correction could be effected later. The struts are shaped with a fret saw, a tongue for insertion into the floats and fuselage being left at each end. The four struts are glued into the fuselage and allowed to set minus the floats. The struts may be corrected for angle by inserting sharp slips of wood down the side of the struts and into the holes, excess being removed after the glue is hard.



Plan and Elevational drawings of the model.

The Floats

The floats may now be cut out. When finished drill the holes for the struts and glue into position.

The propeller blades are then shaped and pinned and glued to the spinner. First push a cut-off pin down the centre of the cone, to provide the means for fixing to the nose and mark off the position of the blade fixing pins. Press a pin into the spinner, the centre pin preventing it going too far, cut off the head, leaving about ⅜-in. sticking out, and reverse the pin in the hole. This leaves a sharp point on to which the propeller blade may be pushed. The other blade is fixed in the same manner.

The model can now be painted. The fuselage and under-water portions of the floats are blue. A white panel also extends on the top of the fuselage from the nose, across the windscreen, separating on either side of the fin and tapering to a point on each side of the rudder. The upper sides of the floats and the struts are also white. The wings, both upper and lower are silver doped and carry the usual red, white and blue discs. The rudder is striped red, white and blue in the usual way.

A front view of the finished model biplane.

A Petrol-Driven

By Capt. C.

(Concluded from Page 246

PLACE ⅛-in. balsa wood slats on each side of the main legs and the crossbar, with strips of balsa between, in front of and behind the wire, with plenty of glue placed between.

The whole should then be bound with aeroplane elastic and allowed to set hard.

The elastic can then be removed, and the balsa fairing shaped up to a streamline form. The final finish can be obtained with glasspaper. After the above operations, it merely remains to cut some silk in long narrow strips, smear photopaste all over the fairings, and bind the silk strips carefully around them, so that the edges just overlap. Now dope the whole with one coat of clear full-sized aeroplane dope.

After this is dry, a coat of coloured paint can be applied to waterproof the silk.

The balsa fairing, binding, and doping will make a tremendously strong undercarriage that will give no trouble.

The wheels fitted to the original model are old ones of 3½ in. diameter with elektron hubs and Dunlop tyres specially made up for the job, and weighing 5 oz. the pair.

These wheels are rather on the small size and constructors are recommended to either make up some wooden 3-ply wheels covered with silk and doped, or to fit the smaller type of wheel described in an article on undercarriages and wheels recently published in PRACTICAL MECHANICS. The 3-ply type of wheel is excellent for getting off grass, but has very little shock-absorbing properties.

Heavy Wheels

Wheels are rather a pattern of individual taste, but it should be remembered that a moderately heavy wheel is not a disadvantage, as it all helps to keep the centre of gravity low. On the other hand, too heavy a wheel will put up the wing loading and spoil the slow-flying properties of the model.

If desired, the 3½-in. diameter tyres can be obtained from the Dunlop Rubber Company for a very moderate sum.

The Tailplane and Fin

These two surfaces are formed into one unit, and are double surfaced. They are kept in position on the fuselage by means of rubber elastic bands. The tail unit is therefore quickly detachable, and on striking an object, will knock off and be undamaged provided the elastic bands are sufficiently loose and yet sufficiently firm to retain the tail unit in position under flying load. Fig. 13 should be studied when constructing the tail unit, whilst full dimensions can be obtained from Fig. 3. If it is found on final erection of the model, that the leading edge and trailing edge are not quite in line with the thrust line, a small alteration can be made to obtain this important setting by packing the rear with balsa wood.

It is very important to ensure that there is no warp on the tailplane.

The fin is built up of a wire outline of No. 18 S.W.G. Balsa streamline shaped ribs are inserted at equal distances. The fin is covered with silk on both sides after the tailplane has been covered and doped. The reason for this is that the hard doped surface makes a suitable base on which to stick the silk at the bottom of the fin when covering this component.

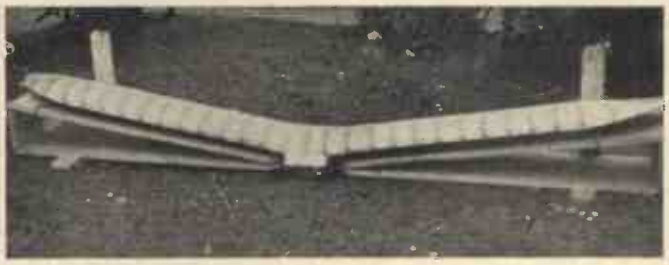


Fig. 14.—A wing bed with a wing upon it.

The tailplane is constructed with a leading and trailing edge of ⅛ in. × ⅛ in. spruce or birch. Spruce is light, if available, and sufficiently strong for this job. There are two central spars of the same wood 3 in. from the leading edge.

The thirteen ribs are cut from ⅛-in. thick balsa slats to the pattern shown in Fig. 13.

The best method of making these is to make up one pattern rib in 3-ply wood. and then make each balsa rib separately by running an old safety-razor blade around the pattern on a balsa slat. The ribs at the tailplane tips are slightly smaller. The tailplane tips are formed from 18 S.W.G. spring steel piano-wire bound on to the leading and trailing edge and glued with durofix.

The ribs are glued to the leading and trailing edge and two central spars, and allowed to set.

Gluing the Ribs into Position

It is advisable to make a full-sized plan drawing of the tailplane on kitchen paper as in the case of the fuselage. Place greaseproof paper over this drawing, and erect the tailplane over the drawing. There is then no difficulty in ensuring that the ribs are glued in their exact position.

The wire saddles as shown in Fig. 13 should then be bound and glued in position.

These saddles straddle the fuselage, and have hooks at their ends to take the retain-

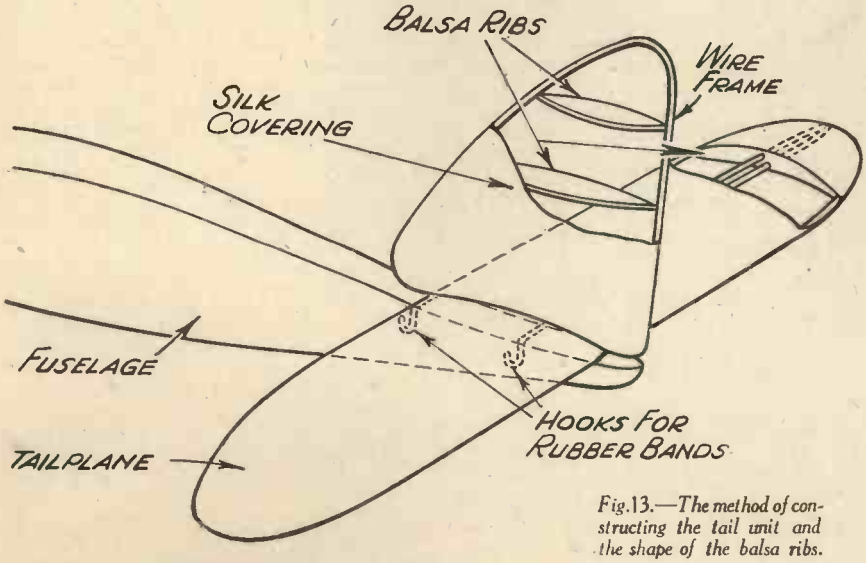
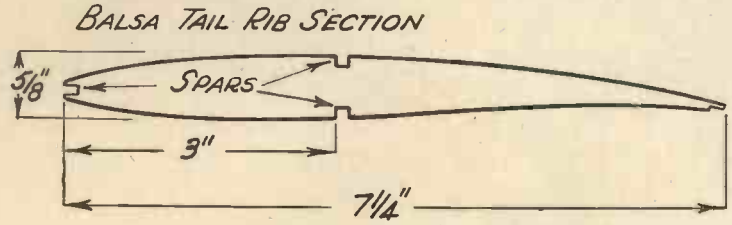


Fig. 13.—The method of constructing the tail unit and the shape of the balsa ribs.



Model Biplane

E. Bowden

(of Last Month's Issue)

A three-quarter rear view.

ing elastic bands to keep the tail unit in position for flying purposes. The fin is then built on to the tailplane.

Covering

The tailplane is next covered with damp silk as in the case of the fuselage, allowed to dry, and then given one light coat of full-sized aeroplane clear dope. This is allowed to set, with weights on the tailplaine to prevent warping whilst drying.

A thin coat of colour can be given to the whole tail unit to complete.

The Mainplanes

The mainplanes have been left until last, as it is often useful to test one's engine in the completed fuselage, and get the hang of running it in, etc., whilst construction is going on with the rest of the model.

A full-sized drawing must first of all be made in plan form for each plane. Now two wooden jigs or beds should be constructed from old boards, wide enough to accommodate the planes. These jigs form platforms upon which to build up the planes. They are constructed with the correct dihedral angle, as shown in the front elevation view of the model in Fig. 10. It will be noticed that there is a far greater angle on the top wing. This is important in the design of the model for stability, and must be rigidly adhered to.

The wooden beds not only make it easy to build up the wings, but they ensure obtaining correct dihedral angles. They also make convenient platforms to weigh down the wings when setting after doping, and also when the model is not in use, the wings should be left on their respective beds under weights. In this way the wings will not warp, and the model's flying capabilities will remain constant.

Fig. 14 shows a wing bed with a wing upon it.

Having constructed these wing beds, the full-sized drawings of the wings in plan should be pinned on to the beds with a sheet of greaseproof paper over each, starting on either wing.

Now cut to the correct length, the leading and trailing edges of the plane from ⅛-in. × ¼-in. spruce. Lay them on the drawing, and cut two main spars for each wing half of ⅛ in. × ¼ in. birch.

The Mainplane Ribs

Make the correct number of balsa ribs as shown in Fig. 3. The outline of the ribs can be obtained from Fig. 15 and should be very carefully adhered to, if stability is to be good, as this wing section is both quick lifting and stable, and varies slightly for top and bottom wing, as each wing has a slightly different function in the design of this model. The ribs are kept a uniform chord, except at the wing tips, for ease of construction. The ribs are made of ⅛-in. thick balsa wood slats, and riblets are used alternately. Their position will be evident from Fig. 3.

The ribs are now placed in position over the drawing and glued to the spars.

When both wing halves are set hard the wing tips can be bound on and glued. These are shaped from 18 S.W.G. piano-wire.

In the case of the bottom wing, a solid balsa tip is inserted and sanded to shape, in order to keep the wire tips out to their rather pointed shape.

After the above operation the two wing halves are placed on the appropriate bed, and wire centres with the correct dihedral are shaped. These wire centres are made from ⅛-in. diameter piano-wire. The leading and trailing edge wires have wire hooks bound and soldered on, to take the stout elastic bands that will keep the planes in position on the fuselage.

In the case of the top wing, the hooks point downwards and in the case of the bottom wing the hooks of course point upwards. The hooks are of 18 S.W.G. wire.

The wire centres can now be bound and glued on to the main spars and leading and trailing edge, and allowed to set hard, after which reinforcing lengths of wood are placed under or behind each piece of wire and glued and bound. These pieces of wood form continuations of the spars of the wings. Figs. 16 and 17 should here be studied for both top and bottom wings.

Covering the Planes

It will be noticed that the bottoms of the wings have a deep under camber. It is therefore necessary to stitch the silk to each rib after covering the bottom of the wing and, of course, before covering the top. This is rather a tedious operation, but absolutely necessary in the same way that it is necessary to retain this under camber for purposes of stability.

(*Continued on page* 324)

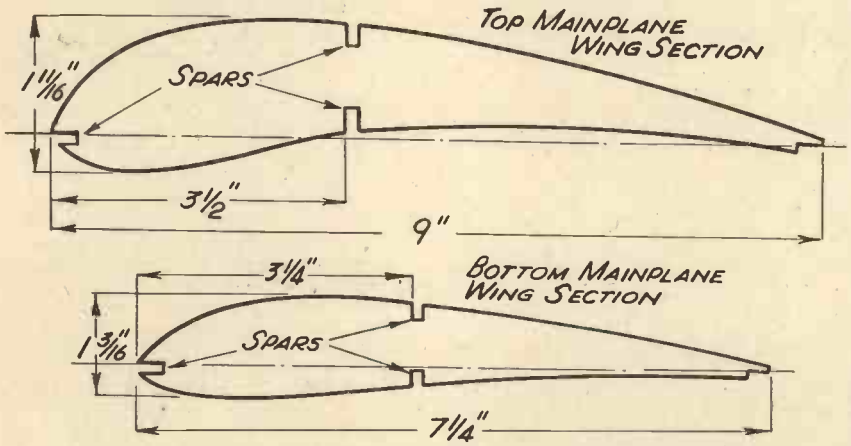


Fig. 15.—The outline of the mainplane ribs.

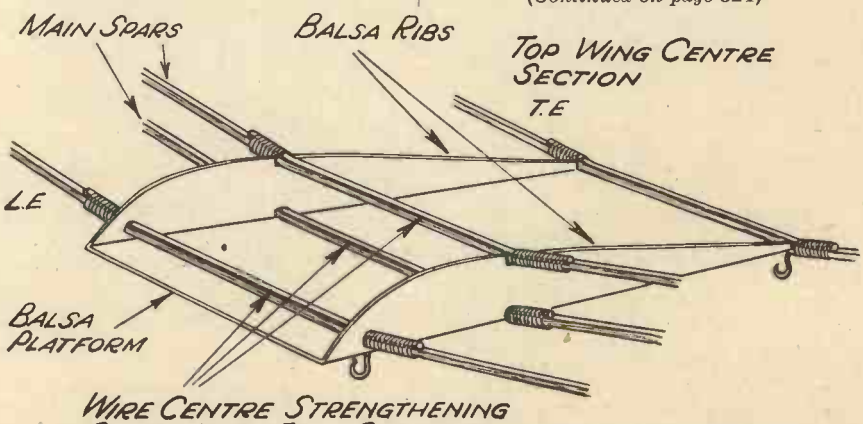
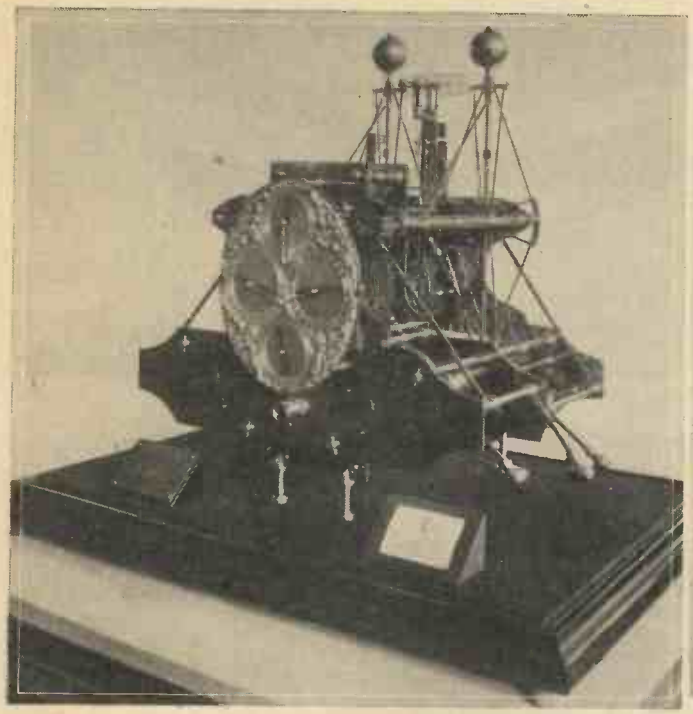
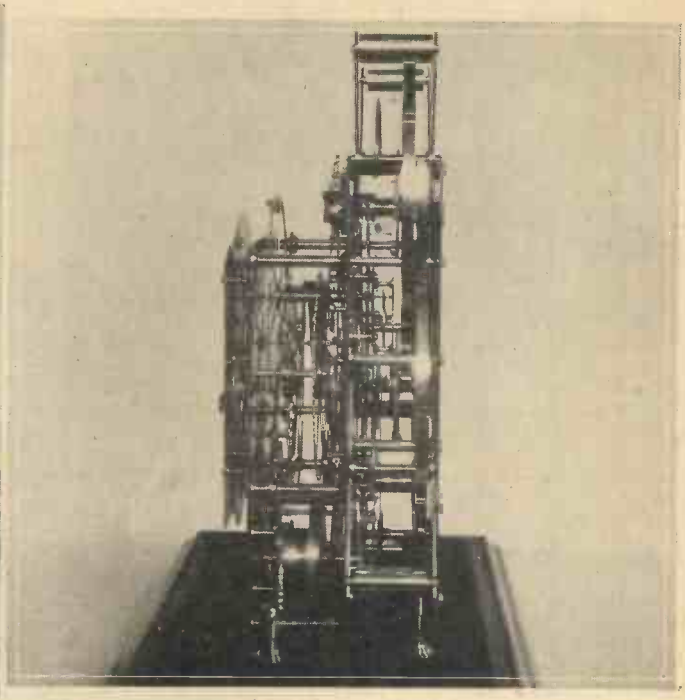


Fig. 16.—This sketch should be studied for the top wing construction.





Figs. 1 and 2.—(Left) Harrison's first marine chronometer, 1735, and (right) a side view of Harrison's third chronometer shown below.

FINDING LONGITUDE AT SEA

By G. R. M. Garratt, M.A.

After all the Cleverest Scientists and Watchmakers in the World had failed in their efforts to Invent a Device for accurately finding Longitude at Sea, it was left to a Yorkshire Carpenter, John Harrison by name, to succeed where they had failed. How he produced the Harrison Chronometer which won him a Reward of £20,000 makes a Fascinating Story

WE are so accustomed to-day to the almost perfect schedules which are maintained by trans-Atlantic liners, that it seems difficult to realise that less than two hundred years ago, even a short sea voyage was attended with serious risks. In those days navigation was almost entirely a matter of guesswork, and if one was out of sight of land for many days it was quite impossible to estimate one's position with any degree of certainty. All that the navigator could do was to keep as accurate a check as he could of the courses steered and the distances travelled, making such allowances as he judged best for leeway, bad steering, currents and tides, and trust that the final result would not be widely wrong. Such methods involved growing uncertainty as to the position of the ship, and it was quite usual for a ship to be several degrees out in her longitude after only a week at sea. Far too often this resulted in serious privation and shipwreck.

It is, of course, relatively easy to ascertain one's latitude from observations of the sun or stars, but the determination of longitude is quite another matter. Latitude is the angular distance of a point North or South of the Equator, while Longitude is the angular distance East or West of the Meridian of Greenwich.

A Committee Appointed

In 1713, a Committee was appointed by the Government to consider the whole question of finding longitude at sea, and in the course of their work, the committee, which later became known as the Board of Longitude, consulted Sir Isaac Newton. Newton told them that one method " is by a Watch to keep time exactly: But by reason of the Motion of a Ship, the Variation of Heat and Cold, Wet and Dry, and the Difference in Gravity in different latitudes, such a Watch hath not yet been made."

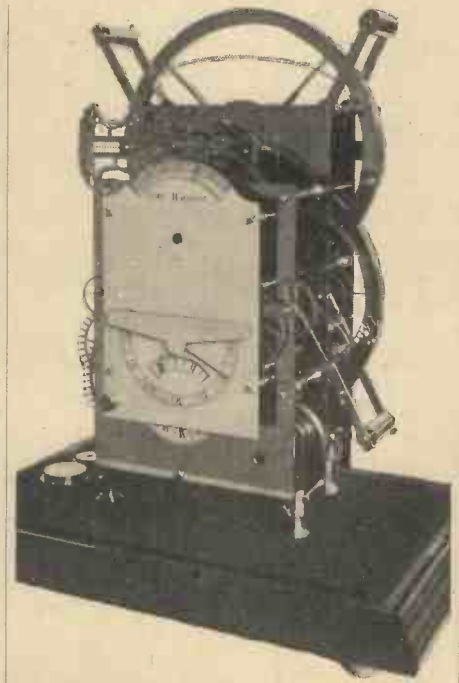


Fig. 3.—Harrison's third chronometer, completed in 1757. In this instrument, Harrison incorporated every mechanical refinement which could possibly improve its performance. It is a masterpiece of design and construction, but although easily capable of winning the reward of £20,000, it was never tested at sea on account of the equally good performance of No. 4.

In Newton's time, as he remarks, no timekeeper known was capable of going with anything like the requisite accuracy under sea conditions, and it is clear that he regarded the construction of a suitable mechanism not far removed from impossibility. He went on to describe various other possible methods, but admitted that one and all were impractical at sea, and the board of Longitude, in desperation, succeeded in persuading the Government to offer a substantial reward for any " generally practicable and useful method of finding longitude at sea." The reward was to be graduated from £10,000 to £20,000 according to the magnitude of the error, and to obtain the maximum sum the inventor had to devise a method which would be accurate within thirty miles at the end of a voyage lasting six weeks. Other nations had previously made similar offers, but this reward of £20,000 was by far the largest, and it has the additional distinction of being the only reward of its kind which was ever paid.

The cleverest clockmakers and scientists had failed to find a solution after trying for nearly twenty years, when John Harrison, the son of a Yorkshire carpenter, arrived in London. Harrison had been brought up to follow his father's trade, but mechanisms attracted him at an early age, and, without ever serving an apprenticeship to any clockmaker, he managed to acquire sufficient

knowledge to repair and even to construct a number of clocks. Who would have thought that this son of a humble Yorkshire carpenter was destined to solve the problem and win the reward, thus becoming the first and most famous maker of marine chronometers who has ever lived?

"Honest Graham"

Harrison's object in coming to London was to enlist the aid of the Board of Longitude in the construction of a timekeeper for which he had already prepared the plans. His limited resources prevented him undertaking the construction unaided and, in his ignorance, he hoped for assistance from the Board of Longitude. He was disappointed, for the Board refused to grant him a single penny and so nearly thwarted the only reasonable design which had ever been offered to them. Fortunately, however, Harrison was received courteously by the Astronomer Royal, the celebrated Halley, who gave him an introduction to a famous London clockmaker, George Graham. "Honest Graham," as he was known, was also a Northcountryman and was as generous as he was honest; he advanced Harrison the necessary funds without security or interest, and one cannot but regret that Graham was resting in Westminster Abbey long before he could witness Harrison's eventual success.

With Graham's loan in his pocket, Harrison returned to Barrow and spent the next six years in constructing his first chronometer. It is just two hundred years since its construction was completed in 1735, and, thanks to the patience and skill of Lt.-Cdr. R. T. Gould, R.N. (Retd.), in restoring Harrison's machines in recent years, not only the first but all five are working to-day in the Science Museum at South Kensington.

In his effort to attain absolute constancy of rate, Harrison saw the necessity of taking the most extreme precautions against friction, temperature errors, and the disturbing effect of the motion of the ship. In consequence, he embodied numerous devices of great originality and his eventual success was entirely due to his skill in inventing and constructing ingenious mechanical devices. His first timekeeper is the most simple of the five, but most of the constructional features are typical and merit a brief description.

The Balance System

The balance system was a duplicate one consisting of massive brass arms and brass weights. The balance arms were mounted on anti-friction arcs of large radius, and were connected together by means of thin cross-wires which ran on brass arcs attached to the balance arms. This arrangement caused them to swing as though geared together but with negligible friction, and it had the merit that the period of the balance system was practically unaffected by the motion of a ship.

The balance system was controlled by four helical springs, the tension in which was varied by a triple linkage of brass and steel rods in order to provide the requisite temperature compensation, and it is of interest to note that this was the first occasion upon which a temperature compensating device had ever been used in a timekeeper. All the wheels of the train, with the exception of the escape wheels, were constructed of oak, and the teeth, which were also of oak, were morticed into the rims. The teeth of one wheel meshed with little anti-friction rollers of lignum vitae on the next wheel in the train, and every wheel was mounted on anti-friction rollers.

Rewinding

Of the many possible causes of serious inaccuracy in a timekeeper, one of the most important is due to the variation of the angle through which the balance swings as the main-spring torque reduces between the intervals of rewinding. In all Harrison's later chronometers and in every chronometer which has been made since, this is avoided by the incorporation of an arrangement known as a "remontoire." In this arrangement the balance and escapement are maintained in operation by a separate spring which is rewound at very frequent intervals by the mainspring. Rewinding occurs every few minutes at fixed intervals, and thus the actual driving torque is maintained at a practically constant value. Harrison's first timekeeper, however, did not incorporate a remontoire, but depended on a fusee for maintaining an approximately even torque. A fusee is not nearly so perfect as a remontoire, but is far less complicated.

Having successfully completed the first timekeeper—one might almost call it a "machine," for it weighs over 70 lb.—Harrison tested it on a barge in the Humber and then brought it to London in 1736. The Admiralty decided to test it on a voyage to Lisbon, and Harrison accordingly embarked with it on H.M.S. *Centurion*. The correspondence between the First Lord of the Admiralty and the Captain of H.M.S. *Centurion* is worth quoting:

"ADMIRALTY,
"*14th May*, 1736.

"To CAPTAIN GEORGE PROCTOR,

"The Instrument which is put on Board your Ship, has been approved by all the Mathematicians in Town that have seen it (and few have not) to be the Best that has been made for measuring Time: how it will succeed at sea you will partly be a Judge . . . The Man is said by those who know him best to be a very ingenious and sober Man, and capable of finding out something more than he has already, if he can find Encouragement. I desire, therefore, that you will see the Man be used civilly, and that you will be as kind to him as you can."

"H.M.S. *Centurion*, at Spithead,
"*17th May*, 1736.

"To ADMIRALTY.

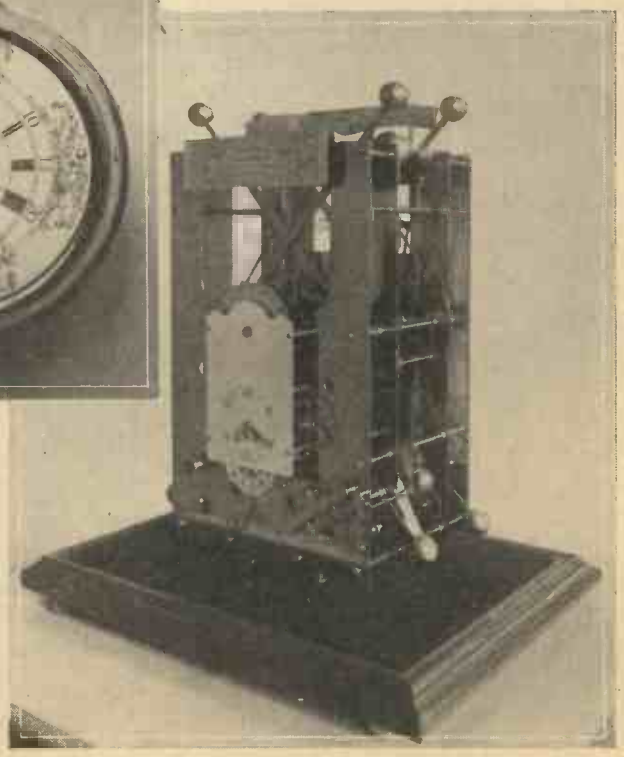
"I am very much honoured by yours of the 14th, in Relation to the Instrument I carried out, and it's maker: the Instrument is placed in my cabbin, for giving the Man all the Advantage that is possible for making his Observations, and I find him to be a very sober, a very industrious, and withal a very modest Man, so that my good Wishes can but attend him: but the Difficulty of measuring Time truly, where so many unequal Shocks, and Motions, stand in opposition to it, gives me concern for the honest Man, and makes me feel he has attempted Impossibilities: but, Sir, I will do him all the Good, and give him all the help, that is in my Power, and acquaint him with your Concern for his success, and your Care that he shall be well treated. . . ."

Harrison Succeeds

The chronometer must have behaved excellently, for the Certificate which was given to Harrison after the voyage reads:

"When we made land, the said land, according to my reckoning (and others) ought to have been the Start; but, before we knew what land it was, John Harrison declared to me and the rest of the ship's company that, according to his observation with his machine, it ought to be the Lizard—the which, indeed, it was found to be, his observations showing the ship to be more West than my reckoning, above one degree and twenty-six miles."

Considering that this was the first trial ever made at sea, the success was a remarkable performance. While dead reckoning resulted in an error of about seventy miles after only a few days at sea on a well-known route, the error of Harrison's chronometer was practically negligible. In consequence of the excellent report on the chronometer, the Board of Longitude began to advance small sums to Harrison for the construction of improved versions. In 1737–39, Harrison constructed No. 2, an even heavier but more compact instrument with a number of important mechanical refinements. It is fitted with a remontoire mechanism, and Commander Gould has declared his belief that it was capable of winning at least the £10,000 award.



Figs. 4 and 5.—(Above) a front view of Harrison's fourth chronometer and (right) Harrison's second chronometer, 1739. This was the first to embody a "remontoire" mechanism for keeping a constant torque at the escape-wheel. It was never tested at sea because Britain was at war with Spain, but it was probably capable of winning the £10,000 reward.

No. 2 was never tested at sea. Britain was at war with Spain at the time and there was a risk that it might fall into the enemies' hands. I should perhaps mention that No. 1 never went to sea again after the voyage to Lisbon, but it demonstrated the excellence of Harrison's workmanship by going *continuously* for over thirty years in Harrison's house. It was never stopped once for cleaning or oiling during the whole period.

A Third Instrument

Between the years 1740 and 1757, Harrison constructed a third instrument. Both in construction and in operation, it is fundamentally different in design to the two previous timekeepers, and mere words are inadequate to describe the perfection of workmanship and mechanical detail which Harrison incorporated. A close examination is necessary to appreciate the real beauty of the instrument which, from the mechanical point of view, is almost perfect.

The bar type balance arms used in the previous instruments were replaced by a pair of large balance wheels connected, as before, by cross wires. A remontoire mechanism is fitted which rewinds every thirty seconds and is so devised to give an absolutely constant torque at the escape wheel. It is probably the most perfect remontoire mechanism ever made.

In 1757, Harrison informed the Board of Longitude that he would shortly be ready to compete for the £20,000 reward, but he suggested that before doing so, he should construct a much smaller timekeeper to serve as a check on the main one. His proposal was approved and Harrison, with the aid of his son, constructed his fourth chronometer—the most famous timekeeper which has ever been made.

It is very much smaller than the earlier instruments and is really a large watch, just over five inches in diameter. Even although No. 4 was only intended as an auxiliary to the main instrument, Harrison lavished almost unbelievable pains upon its design and construction. It is perhaps not altogether surprising, therefore, that it turned out to be just as perfect a timekeeper as was No. 3, and it had of course the very great advantage of being very much lighter and more portable. As a result, No. 3, which had taken Harrison seventeen years to perfect, was put aside and almost forgotten. It was never tested at sea.

The Success of No. 4

No. 4 underwent its first sea test in 1761 on a voyage to Jamaica in H.M.S. *Deptford*. The course had been set to touch at Madeira, and after nine days at sea there was a discrepancy of 1½ degrees in the longitude as indicated by dead reckoning and by No. 4. This was a serious matter, for it might mean missing Madeira altogether.

However, Harrison insisted that the chronometer was correct, and said that provided the longitude of Madeira was correctly marked on the charts they would sight the island the next day. The Commander, Captain Digges, offered to bet Harrison five to one that the chronometer was wrong, but he held to Harrison's course and the island was sighted the following morning—much to the relief of the ship's company!

On reaching Jamaica after a nine weeks' voyage, the total error of the chronometer was only five seconds, corresponding to less than one mile. Provided, therefore, that Harrison could show that his timekeeper constituted a "generally practicable and useful method of finding longitude at sea," he was entitled to the full award of £20,000. It was to prove almost easier to make the chronometers however, than to wring the reward out of a reluctant and obstinate Board of Longitude. They paid him £2,500, but stubbornly refused to pay another penny until further trials had taken place. They claimed that the longitude of Jamaica was not precisely known, and seem to have believed that the astonishing accuracy of the timekeeper was due to a fortuitous cancellation of errors.

A second trial took place in 1764, on a voyage to Barbados. This time, the total error of the chronometer was 38 seconds fast, corresponding to 9½ miles, but, allowing for the slight temperature correction which Harrison had declared beforehand, the gross error at the end of a five months' voyage was only a loss of 15 seconds.

Only Half of the Reward Paid

The Board of Longitude, however, would still not give way, although they finally agreed to pay a further £7,500 provided Harrison gave a sworn declaration of the mechanism to a responsible committee. They refused to pay the final £10,000 unless Harrison made two more chronometers of equal performance.

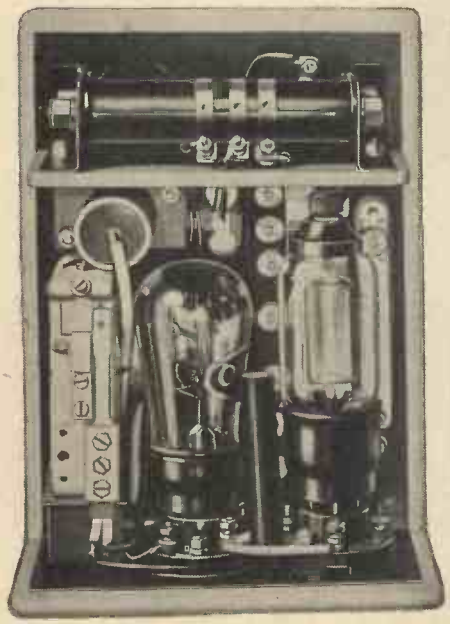
Harrison was now over seventy years of age and his sight was failing. He was eventually paid the £7,500, but he regarded the final instalment of £10,000 as lost for ever. He did, in fact, manage to construct one more instrument which is almost an exact copy of No. 4, but with less ornamentation. The Board of Longitude had evidently got a little common sense left, for they then commissioned Larcum Kendall, a well-known London watchmaker, to make a copy of No. 4, which he did at a cost of £450. The very remarkable performance of Kendall's copy was a most striking vindication of Harrison, and it was used by Captain Cook in his second and third Antarctic voyages between 1772 and 1777.

The Final Instalment

Still the Board would not give way, and it was not until Harrison found a supporter in the person of King George III that the Board were placed on the defensive. The King used his influence in Parliament, to whom Harrison presented a Petition. Difficult questions were asked and the Board's outrageous treatment of Harrison was exposed. A full debate of the House nearly took place, when the Board gave way before the storm of indignation and paid the remaining balance.

Harrison had won his battle; he had proved himself the first and foremost maker of marine chronometers of all time, and we cannot but feel sincere regret that the old man, who had devoted the whole of his life in the interests of safety at sea, should have lived so short a while afterwards to enjoy the benefits of his reward. John Harrison died in 1776 at the age of eighty-two, only three years after receiving the final instalment. Harrison had solved the problem which had baffled Halley, Newton, Leibnitz, and hundreds of others, and, working in the face of complete scepticism, Harrison had devoted fifty years to its solution.

Such was John Harrison's service to Humanity; he was a man to whom we, as the greatest maritime nation, should be deeply grateful, and of whom, as his own countrymen, we must be immensely proud.



Showing the internal construction of the Osram photo-cell amplifier.

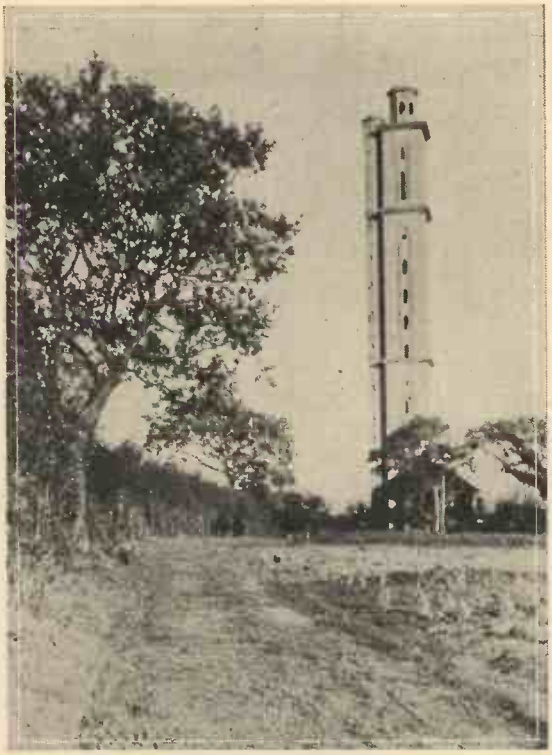
A NEW TYPE OF PHOTO-CELL AMPLIFIER

A NEW design of Osram photo-cell amplifier has just been placed on the market by the G.E.C., known as type FDL50. The unit has been designed for industrial installations requiring a small compact set, and for such other cases where the existing B4 amplifier is not adaptable. The circuit embodied in the new unit, while in principle the same as that of the existing type B4, has a number of small but important improvements.

Modification has been made to incorporate a modern valve of the L21 type while retaining the advantage of being able to use the set on A.C. or D.C. supply indiscriminately. The consumption of the unit is low. The assembly has a single-hole fixing, and efficient ventilation is provided for the resistances which are placed at the top of the case to avoid any possible effect of temperature changes of the circuit.

An improved form of relay, with low operating current, in which the armature is anchored to its knife edge, is also incorporated, and permits the unit to be used in any position.

The cover of the photo-cell amplifier.



(*Above*) *Peterson's Folly, in the New Forest, which is a well-known landmark on the Bournemouth line, and* (*right*) *The village church at Holnest is overshadowed by a gigantic mausoleum which is built in the architectural style of Charing Cross Railway Station.*

SOME BRITISH FOLLIES

By George Long, F.R.G.S.

Architectural Freaks Which Have Cost Thousands of Pounds to Build but Which Are Utterly Useless and Have Therefore been Termed "Follies"

RECENTLY we described a number of architectural freaks at home and abroad under the general title of "Crazy Buildings," and touched briefly on "Follies."

The mighty Barnum once observed that a sucker is born every minute, and as Nature has maintained a supply of fools, we shall also discover many follies, which are frequently the result of much money and little brains. Some writers, however, dispute this derivation of the word, and suggest that the term "Folly" as applied to a building is *French* "folie" and not English "Folly." A reference to our dictionary establishes the fact that although the usual rendering of "folie" is frenzy or madness it can also be translated in a number of other ways. Thus folie may signify caprice or fancy (as in the well-known Folies-Bergeries), and can even be translated as "country-house."

Faringdon Folly

There is a Berkshire Folly which no doubt represents this idea of a whim or fancy, it is known as "Faringdon Folly," or more frequently of late as Faringdon Clump, for it is only a bold group of trees on a hill-top, which does much to improve the landscape. It almost seems as though the present owner desires that Faringdon Folly shall retain its title for ever, for it is reported in the press as I write that a remarkable tower has just been completed among the trees on the summit of Faringdon hill. It is a square structure, not unlike a church tower, and is 100 ft. high. The building was duly "opened" with a display of fireworks, so that everything went with a bang.

The value and purpose of this strange structure remain a mystery, but it resembles other follies in that it is a lofty tower on the summit of a hill, whose practical value is not evident.

Queen Anne's Mansions is another folly which is not foolish. When first built this imposing structure was known as "Hankey's Folly" as the Victorians could not conceive that a ten-storied block of flats could be a sound business proposition. To-day we are familiar with American sky-scrapers which make "Hankey's Folly" look like the Queen's Dolls' House.

Peterson's Folly

One of the most modern and characteristic of true follies is Sway Tower, or Peterson's Folly, in the New Forest, which is a well known landmark to travellers on the Bournemouth line. It is more than 200 ft. in height, and is built throughout in ferro-concrete. It is said to be the first tall building to be erected of this material in England. There are many and varied stories about the creator of this Folly. His name was Andrew Peterson, a wealthy and eccentric barrister, who had practised at Calcutta. It is evident that he intended to attain posthumus fame as a result of his expenditure, for—if local gossip can be trusted—his original instructions were that his corpse was to be placed within the open lantern of the tower for burial, after the same plan as the Parsees still observe in India. It is further stated that he ordered that a powerful light should be kept burning at the summit at night; but the tower is near the busy sea-lane forming the western gate to Southampton Water, and it is said that on the first night so much confusion was caused to shipping by this unofficial beacon that the Admiralty promptly stopped it. Certainly no light is now exhibited, but as some of the three hundred steps to the summit are now out of repair, I was unable to ascend. It might be added that some local people declare that Peterson was really quite a clever man, and a pioneer of ferro-concrete construction. They say he intended the tower to be both a demonstration of a new building method, and a form of relief to the poor during a hard winter.

It must be confessed that as a close-up it is ugly in the extreme, but at a distance it is not without some dignity and charm.

Faringdon Folly, Berkshire, the purpose and value of which remains a mystery.

Gamblers' Follies

There are several Follies which owe their

origin to a fortune won at cards, and which preserve the story in the details of their construction. Two of these are to be found in the Park at Midford, a small village on the road from Bath to Warminster. One of them is the so-called "Castle" and the other a game-keeper's cottage, but both are constructed on a ground plan in the shape of the Ace of Clubs which was their owner's lucky card. His name was Roebuck, and he lived in the late seventeenth century. It is said that he made a fortune in a single night, thanks to the Ace of Clubs.

The Squire of Coombe Martin was another west country gambler, who owed his fortune to a pack of cards. He lived about the same time as Roebuck, and like him, has left a Folly to tell the tale.

"The Pack of Cards"

It was formerly the village inn at Coombe Martin, aptly known as "The Pack of Cards," for every detail of the building connects with cards. Thus there are fifty-two windows—one for each card in the pack—thirteen doors—one for each denomination, and four stories—one for each suit. The general effect is very striking, with tall chimneys, and a central part like a castle tower, which is intended to represent a house built of cards.

With the rapid development of Devonshire for tourists, "The Pack of Cards" has now become a popular hotel, but still retains its original and distinctive design.

McCraig's Tower

Another popular seaside resort owns two striking buildings which might be regarded as follies. They are on the hill behind Oban and each is a folly of a sort. McCraig's Tower is a true folly, that is a totally useless building designed to bring posthumous fame to its creator. It is said to have been designed as a view tower, museum and art gallery, but was never finished, and stands gaunt, empty and ugly, like a bad copy of the Colosseum at Rome.

The other was intended as a hydropathic, but the folly was that of the man who started to build without counting the cost, and consequently ran out of funds and left it uncompleted and useless, something like the huge Jezreel's Tower at Chatham which was described in a previous article on "Crazy Buildings."

A Gigantic Mausoleum

Follies sometimes run in families, and the Dorsetshire Drax clan are a striking example of this. Certain long-deceased members of this family seem to have possessed an exaggerated idea of their own importance, and spent large sums of money in monuments to nonenities.

Thus the charming little village church at Holnest (Dorset) is utterly overshadowed and spoilt by a gigantic mausoleum for the remains of Mr. Erle-Drax, built in the architectural style of Charing Cross railway station, and in the park hard by there is a huge bronze statue to the same individual who seems to have been nothing more than a lord of the manor.

Major Drax (who flourished in the eighteenth century), was the builder of a much more conspicuous folly, which is known as Ring's Hill Speer. It is a very tall, circular Gothic tower, very much like a cathedral pinnacle which has been mislaid, standing on the top of a wooded hill close to the Drax mansion in Charborough Park, Dorset. The original structure was struck by lightning, but was unfortunately rebuilt, and still stands a perfect example of a rich man's folly, totally useless for any purpose.

Hasting's Folly

There is another still bigger folly at Horton, also in Dorset. It is known as Horton Tower (or Hasting's Folly) and in appearance resembles the keep of a mediaeval castle, it stands on a hill-top above the village of Horton. Mr. Thomas Hardy (the Dorset novelist), has described it as an observatory in *Two on a Tower*, but I fancy he has blended it with Ring's Hill Speer, and so formed a composite picture of two conspicuous follies.

A very common form of folly, is the hill-top castle or tower A well-known example is Sham Castle, on the hill above Bath. From the front it seems to be a frowning mediaeval castle, but a back view discloses the sham.

Hill-top follies are almost too numerous to mention. We find them everywhere, sometimes to improve a view, more often to glorify some nit-wit. There is one in Leicestershire, however, which serves to commemorate a real public benefactor, though not built for that purpose. This is the tower—or sham castle—on the rugged hill-top close to the ruins of the Manor in Bradgate Park (Leicestershire). When this glorious park was given to the people through the generosity of Mr. Charles Bennion in 1928, it was decided to make the tower a memorial of the donor, and a tablet has been placed on it recording the gift.

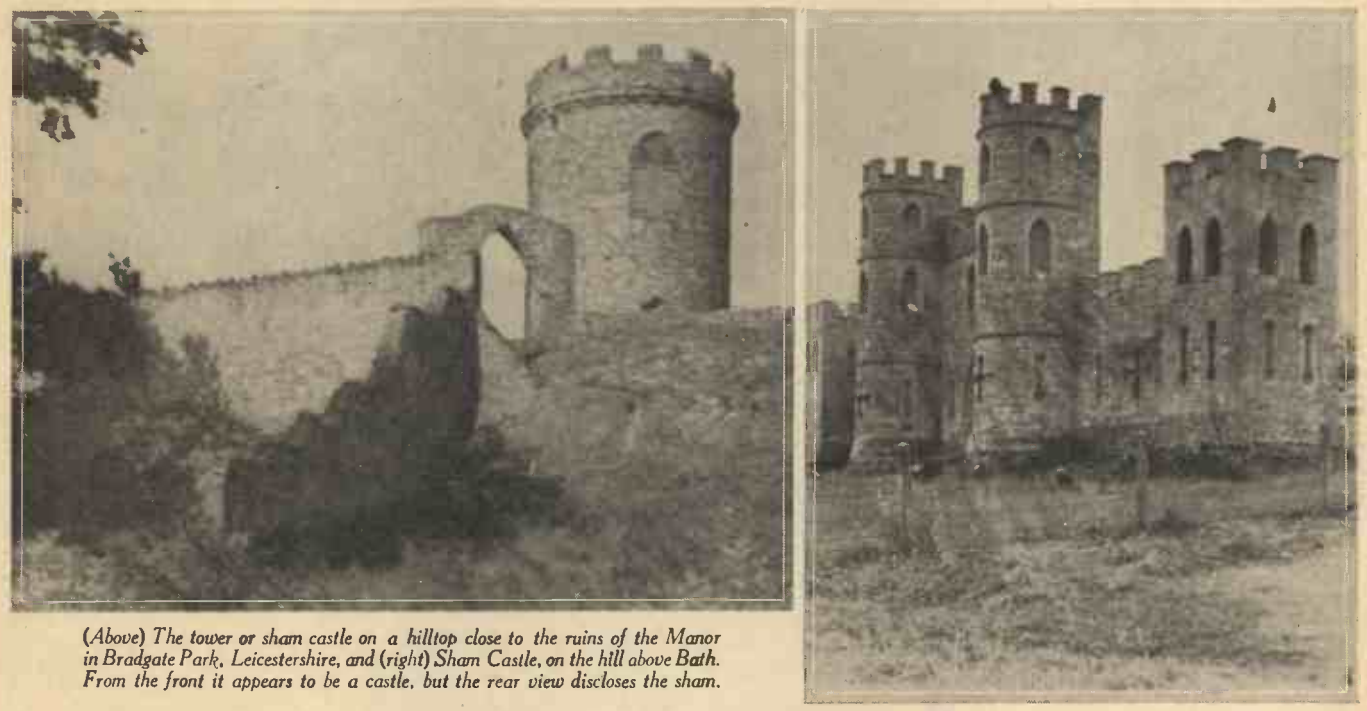
The House on the Sands

There is a somewhat unusual, and little-known folly, on the shore at Canford Cliffs, about a mile west from the well-known Branksome Chine (Dorset).

Just over sixty years ago this lovely spot was a mere lonely beach, backed by pine-woods, and having no dwelling in sight.

Some enterprising individual who was attracted by the beauty of the site, decided it was an ideal spot for a home. He built an imposing, and very solidly constructed house beneath the cliffs, just above high-water mark, but omitted to base his foundations on a solid rock, and down it came. The ruins still remain, and for years were known as the folly, but during the last decade there have been great developments along this lovely shore, with promenades, and buildings of various kinds, all of which stand securely, because their foundations are secure.

Some fragments of the gaunt walls of the "House on the Sands" still remain in mute witness to the folly of building on sand, and have served as a useful illustration to many local clergymen when dealing with the well-known parable.



(Above) The tower or sham castle on a hilltop close to the ruins of the Manor in Bradgate Park, Leicestershire, and (right) Sham Castle, on the hill above Bath. From the front it appears to be a castle, but the rear view discloses the sham.

Ice: Flying's Gravest Risk

The Accumulation of Ice on the Wings of an Aeroplane not only Renders the Machine Difficult to Navigate but May Easily Result in Loss of Flying Speed, and Disaster

WHEN Man attempts to defy Nature, as he does when he essays to sail the seven seas, to explore the unplumbed depths of the ocean, or to take unto himself wings and to soar into the heavens, Nature, resentful of his intrusion, brings to bear all her most potent forces to preserve the sanctity of her secret places. And none does she guard more jealously than the upper air, as so many flyers have found to their cost. Winds, clouds, electrical forces, fog, and ice are among the most formidable of Nature's frontier guards, and it is in overcoming them that the greatest thrills are provided for the pioneer airman, and the greatest perils for the routine flier.

One by one, these pitiless obstacles to the peaceful penetration of the airways are being conquered. The skill of the designer, and the craft of the engineer, have produced 'planes which will survive the severest buffetings, and directional wireless and other ingenious devices permit "blind flying" in cloud and even "blind landing" in fog. But the perils of ice are not yet entirely surmounted.

To understand the danger resulting from the formation of ice on the surface of an aeroplane, it must be remembered that the flying qualities of any aircraft are mainly dependent upon the shape and contours of the various surfaces of the machine—wings, struts, and rigging. These are the subject of the most intricate calculations, based upon theoretical principles and practical research, and their final form is so accurately designed and finished that comparatively small variations seriously affect efficiency, while considerable alterations in contour, area, or shape, such as would result from the accumulation of ice, not only renders the machine difficult to navigate, but may easily result in loss of flying speed—and disaster.

Reducing the Ice Risk

Various devices, each achieving some measure of success, have been developed for reducing the ice risk, and in order to appreciate the problem more completely it is necessary to consider the condition under which ice can be formed and deposited. Ice postulates the presence of water. Now there is always a certain percentage of water vapour in the atmosphere, and under certain conditions of temperature and pressure, it forms more or less dense masses of tiny droplets called clouds. Other conditions, such as those produced by currents of cold air, the presence of high land masses and so forth, may result in the precipitation of the water in the larger drops known as rain. Raindrops, carried upwards by ascending air currents, may freeze, subsequently falling as the small balls of hard ice termed hail. In certain circumstances atmospheric water vapour freezes without first liquefying, and thus falls as snow.

It will thus be seen that there is a wide range of conditions, likely to be met with in ordinary flying, that favour the formation of ice on the wings, struts, and even propellers. But this is not all, for the interactions of temperature and pressure, winds and speeds, taken into consideration with altitude and geographical position, are so complex that even at temperatures which might be thought unfavourable to the production of ice, danger, swift and pitiless, may suddenly appear.

A thorough understanding of meteorology and a watchful eye on air temperature recorder and altimeter may help the aviator to avoid these risks, but the subject is so vast, so complex, and so little understood at present, that skill and care afford but meagre protection; in addition, the necessity of maintaining course, and of adhering to time schedules, reduces the chances of dodging ice. It is therefore highly desirable to perfect means for automatic protection from the menace of ice.

Ice-prevention Apparatus

Very considerable ingenuity has been shown in the several devices already developed. These may be roughly divided into three classes, each class utilising a different principle.

The obvious fact that ice is associated with low temperature has prompted some investigators to explore the possibility of heating the surfaces it is desired to protect from ice formation. There are at least three possible ways in which heating could be performed: electrically; by utilising the heat contained in the cooling water of the engines; or by employing the waste heat in the exhaust gases. The first-mentioned is likely to be ruled out at once on account of the large amount of power required, for it must be remembered that it

would be necessary to heat the whole of the plane surfaces and not, as might be thought only the leading edges. Heating from the cooling water seems more hopeful, although it greatly increases the risk of fracture or leakage in the circulating system, and further, is only applicable to to machines fitted with water-cooled engines.

In using the heat from the exhaust gases, the idea is to discharge the hot gases along the leading edges of the planes. This scheme, however, is fraught with difficulties. In the first place its use must be restricted to machines of all-metal construction; secondly, provision must be made to allow for the expansion and contraction of the exhaust pipes; and thirdly, means must be found for protecting the petrol tanks from contact with hot gases and for avoiding the accumulation of explosive and/or poisonous gases.

A Mechanical Device

The second class of ice-prevention apparatus operates on purely mechanical principles. The most encouraging form is that in which a rubber tube is fixed over the leading edges of the wings, the tube being caused to expand and contract rhythmically by compressed air. Ice surfaces are in this way broken up as soon as they are formed, and are then carried away by the wind.

By far the most successful results, however, have been achieved by using the well-known properties of certain chemicals which, in solution, have freezing-points very much lower than that of water. As most people are aware, when the local council employees sprinkle salt on snowy or icy roads, the snow or ice melts. The reason is that a solution of common salt in water requires a temperature considerably below the normal freezing-point of water before it will solidify. By making available a supply of a suitable chemical composition at the leading edges of the wings, any moisture deposited from the atmosphere is prevented from freezing at any temperature likely to be encountered in normal flying.

This principle can be combined with the mechanical action of certain substances of a sticky or slippery nature which prevent ice, if formed, from adhering to the machine, so that it is blown away as soon as it is deposited and no accumulations of dangerous proportions can be produced.

Anti-ice Dope

Practical apparatus for maintaining a continuous supply of anti-ice dope has been developed and has been used experimentally with considerable success. In one form the chemicals are pumped along a tube having holes at close intervals, fixed to the leading edges of the wings. The dope is thus discharged through the small holes on to a strip of cloth, whence it is distributed by capillary action.

A wide range of substances has been used, either singly or in combination—molasses, salt, soap, and other familiar substances in the earlier experiments. The latest dopes contain mixtures of lesser-known chemicals rejoicing in complicated polysyllabic names and the actual formulæ, it appears, are still closely-guarded secrets.

IN THE WORLD OF SCIENCE

The World's Smallest Brewery

THE smallest brewery in the world will shortly be in operation at Birmingham University. Covering an area of only five square feet, it comprises four complete brewing plants, each capable of producing one gallon of beer per brew.

It will be used for testing hops, barley, and yeast in connection with the research work organised by the Institute of Brewing, and the plant has been designed so that conditions in a full-size establishment can be exactly simulated.

From Beer to Water

A RECENT analysis has shown that 70 per cent. of the weight of the human body is composed of water. The eyes are 95 per cent. water, blood contains 80 per cent., bones vary from 30 to 40 per cent., while our brains contain 90 per cent. The remaining weight of the average full-grown man consists of numerous chemicals, all of which could be purchased from any wholesale chemist for less than 2*s*. 6*d*.

A New Cinema Screen

THOSE of us who have to patronise the cheaper seats, have often only seen a distorted picture when the screen is viewed from one side or in the extreme front. A new screen which consists of thousands of tiny glass globules has recently been invented and it is claimed that distortion of the picture is avoided.

X-ray Dangers

EXCESSIVE exposure to X-rays induces a terrible wasting disease known as dermatitis and many sad amputations have resulted in the past among X-ray operators on account of the ravages due to repeated exposures. Precautions can be taken, up to a point, but now an ingenious "tell-tale" device has been evolved which will keep a check on the amount of exposure encountered. It consists of a small rod of elektron, charged to a potential of 400 volts and contained in an insulating case. Exposure to X-rays causes the charge to leak gradually away and a simple measurement of the charge remaining will warn an incautious operator in time.

A Building Machine

A MACHINE has recently been constructed by Mr. James Haigh, of Leeds, which can mix, shape, and lay cement bricks quicker than any bricklayer. The machine can also construct floors, staircases, and flat roofs. Although at present it is only suitable for the construction of circular buildings, the cylindrical houses, several of which have already been completed, have an unusual appearance, and they will at least be preferable to the dingy rows of small council houses to which we have become accustomed. We only hope that Mr. Haigh does not suffer personal injury at the hands of the builders and bricklayers of Leeds—a risk which would not have been a small one a century or two ago!

Flawless Welding

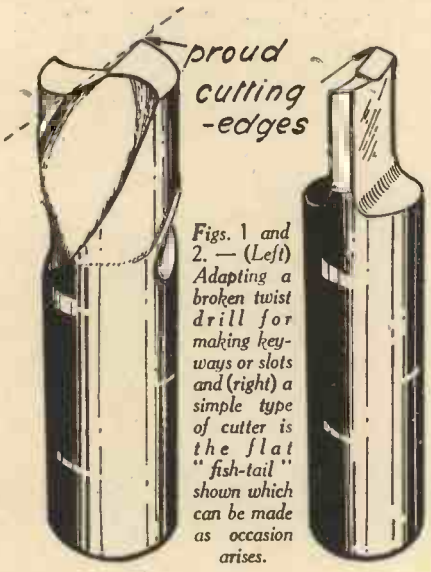
THE electric-arc welding process has been developed to a high standard of efficiency, and it is being used to an ever-increasing extent in production and repair work. A weld in practically any kind of steel made by the electric-arc process has great strength, can be readily machined, shows little indication of the joint, and can be produced with various degrees of ductility. It has not, however, always been possible to eliminate every trace of the weld, and as it is important with some work that no sign of welding should be apparent, recent research has been directed to the endeavour to obtain welds that will have a perfect appearance and finish. This has not been easy to attain, as the oxygen in the atmosphere has some effect upon the surface of molten metal, and the problem of excluding oxygen from the weld has not been easy of solution, because oxygen is the gas that supports combustion. It was known, however, that welding could be carried out in a hydrogen field, and this principle has now been put to practical application by surrounding the arc and the end of the feed rod with a "field" or "envelope" of hydrogen, which is released from the electrode coating or supplied from cylinders. Messrs. Barimar Ltd., the welding engineers, inform us that as a result of these developments they are now able to build up worn shafts and similar parts of all weights and dimensions, and machine them to the required size at very moderate cost, with a superfine finish that is at least equal to the "finish" obtainable on unwelded metal. The welding of thin steel sheets, and various alloy steels is done with equal success by the same process. This highly successful result has been achieved by means of the welding process mentioned, in conjunction with very skilful machining.

A trained engineer "flawless" electric-arc welding a crankshaft at the Barimar works.

Small Tools and Cutters—5

By W. H. Deller

The Previous Articles on this Subject Appeared in "Practical Mechanics" Nos. 21, 23, 25 and 27



Figs. 1 and 2. — (Left) Adapting a broken twist drill for making key-ways or slots and (right) a simple type of cutter is the flat "fish-tail" shown which can be made as occasion arises.

PROVIDING that certain precautions are taken, a broken twist drill can be utilised to mill very satisfactory key-ways or slots. The first point is that the fluted part of the broken drill must be ground off extremely short, the relief being ground in a similar manner as for a flat-bottoming drill, but with the following exceptions. Instead of the normal cutting edges being in line at right angles to the axis, they are ground to form proud cutting edges adjacent to the lands as seen in Fig. 1. This permits the centre to clear properly, and allows fairly heavy cuts to be taken. Other important points are that the cutter runs perfectly true and is rigidly held. For the latter reason, where small drills are so utilised, unless a collet is available for holding, they must needs be sweated into a stiff mild-steel bar-holder leaving little more than the fluted part projecting. Although fairly heavy cuts can be taken, in comparison with the diameter of the drill of course, each cut has to be "worked" on if wobble is to be avoided, that is to say, each cut is put on gradually while the work is being traversed backwards and forwards for a short distance, and when sufficiently deep, carried to the full distance required.

Cutter Wobble

Where the cut is fed straight in, the tendency of the cutter to wobble, and as a consequence increase the width of the slot at one point, is caused by the resistance offered by the pip formed between the points of the cutter. As for instance, if a $\frac{1}{32}$-in. cut can be taken, a conical piece of metal of this height has to be removed before the traversing cut can commence freely. In overcoming this obstacle, the cutter is either forced upwards or downwards according to the direction of traverse, and will more than likely result in breakage. These remarks, by the way, apply to all types of end-milling cutters when used for the purpose of producing work of the same character as blind-ended slots.

A Simple Type of Cutter

A simple type of cutter and one that can easily be made as occasion arises is that shown in Fig. 2. This is a flat "fish-tail" cutter and can be used for the same purpose as the cutter which was improvised from a drill, or for light surfacing operations. The cutter will probably do all that is required if made from silver-steel rod, and the actual making is quite a simple matter. After flatting off the sides to leave a short central tongue, the relief is filed on the front and sides. It may be mentioned that no land is left at the sides, the relief being brought up to a sharp edge. Such cutters will be about right if made proportionate in every respect to the sketch. Subsequent hardening and tempering will, of course, be necessary before using.

Fluted Cutters

Fluted or toothed-end milling cutters are obtainable in both carbon and high-speed tool-steels. As regards the style of the shank, they are made in both parallel or straight, and the usual standard machine tapers. Again the teeth may be either straight or spiral cut. Figs. 3 and 4 show two types of spiral cutters. Of the two, that having the recessed centre is perhaps the most serviceable, at all events, as far as ease in resharpening is concerned. The benefit of the latter with spiral teeth will be noticed where the side of the cutter is used, as not only will less power be required for driving, but the thrust created is such that it tends to force the taper shank of the cutter hard into its socket.

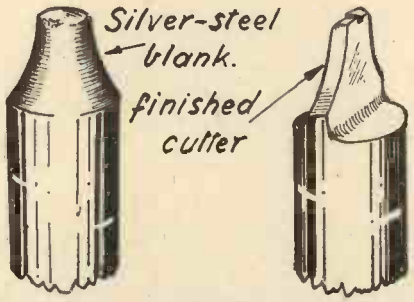


Fig. 5.—(Left) the blank from which is made the cutter, shown on the right. It will be found useful for awkward jobs.

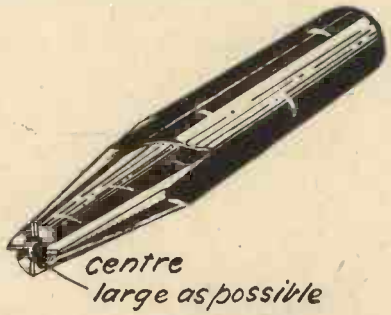
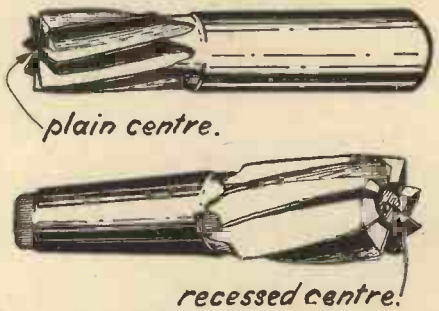


Fig. 6.—Slender cutters of a special nature are best made in the toothed form shown.

Resharpening

To make a satisfactory job of resharpening the end teeth, it is necessary that it be done in such a manner that each tooth will do an equal share of the cutting. The proper way to ensure this is by regrinding



Figs. 3 and 4.—Showing two types of spiral cutter. That with the recessed centre will be found the more serviceable of the two.

in a special fixture on a tool and cutting grinder, but if a stone is held against the face of the teeth while the cutter is run backwards, a "land" will be produced to serve as a guide for careful hand grinding to give a relief of from 5 to 7 degrees to the teeth. It is not advisable to attempt to grind the sides of the teeth by hand, as this is essentially a machine operation. End mills with straight-cut teeth may be touched up in a minor degree by "stoning," it being remembered that no land is required. When using the side of an end mill, an important point to bear in mind is to feed the work against the direction in which the teeth are rotating. In fact this rule applies to the use of all milling cutters.

Profiled End Mills

Standard cutters may be slightly modified to produce slots with chamfered or radiused corners, by appropriately altering the corners of the teeth to achieve the desired result. On the other hand, by preparing a turned blank to the shape, as for example that shown in Fig. 5, left hand, and from it making a cutter in the form shown in Fig. 6, right hand, awkward jobs may be overcome. Notice that the centre of the cutter is slotted so that the front cutting portions slightly overlap. This overlapping of the cutting edges is important where the end of the cutter is used to form a channel as, if

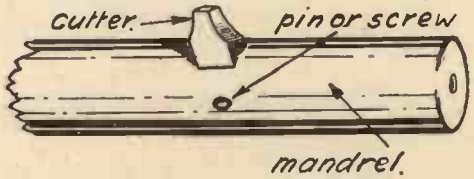


Fig. 7.—An alternative cutter with reversable bit.

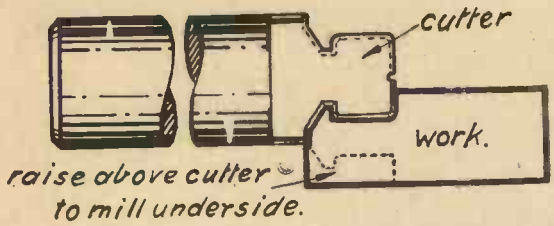


Fig. 8.—Another type of flat cutter which will perform an endless number of jobs.

the slot is straight cut a rib will be left along the centre of the work. The length of the side-cutting edges must not be overdone and, where the profile is deep, it is more satisfactory to break the cut into two operations by means of separate cutters.

Slender Cutters

Slender cutters of a special nature are best if made in toothed form. After making the blank the teeth may be milled in the correct manner, but a satisfactory and quick method is to file them with a half-round file to the shape shown in Fig. 6 (this remark is intended to apply to small cutter making and where ready facilities for cutting by other methods are lacking). The centre in the cutting end should be as large as possible in diameter, but at the same time not carried to a sufficient depth to cause weakness.

Different Types of Cutters

Cutters of the types so far described and which to accomplish the work in hand must be made in such a form that the cutting end terminates in a sharp point, will prove unsatisfactory in use. Therefore, where such a condition arises, recourse should be made to a different type of cutter. The most simple form in which a suitable alternative cutter can be provided is shown in Fig. 7. The mandrel is driven in the machine, with a fly-cutter of suitable profile projecting above the surface. As regards clearance, the tool should be treated in the same manner as if it were to be used for a boring operation. Another type of flat cutter which will perform an endless variety of jobs is shown in Fig. 8. A feature possessed by such a cutter is that all of the milled surfaces can be machined with it so that they will be parallel to each other at one setting. Where the section to be milled is such that a "necked" cutter like that shown is required, take care when designing the cutter, not to make the narrow portion too weak to withstand the "spring" of the front part when under cut. Cutters having parallel bores are intended to be used in a horizontal milling machine and are made in various sizes to suit standard mandrels. Such cutters are clamped on the mandrel between distance collars, and where heavy cuts are to be taken, "cutter slip" is checked by means of a key.

Roller Cutters

The type shown in Fig. 9 is what is known as a roller or cylindrical cutter, and its use is confined to purely surfacing operations. Where sufficient power is available, and the teeth so arranged to provide plenty of chip space between them, extremely heavy cuts can be taken.

That shown in Fig. 10 is a side-and-face cutter. Such cutters are made in a range of standard widths and diameters. As may be gathered, they cut on the sides as well as the face and therefore will machine vertical faces equal in height to the distance from the edge of the teeth to the centre boss. They are often used in pairs or gangs separated by distance pieces of approximate width to machine both opposite vertical faces of a part at one setting.

Slotting Cutters and Slitting Saws

Slotting cutters are made in various standard widths so that they will cut a slot of the required size in one cut. A cutter of this description is illustrated in Fig. 11. Binding of the cutter in the slot is prevented by the fact that the sides are hollow ground. Cutters which are intended for metal saw-

Fig. 9.—This type of cutter is known as a roller or cylindrical cutter

ing are given clearance in this manner, and can be had in a very wide range of different thicknesses.

An example of an angle cutter is shown in Fig. 13. This particular cutter is called a double-angle (equal) cutter and can be had in angles of 45, 60, and 90 degrees. Single-angle cutters are made right and

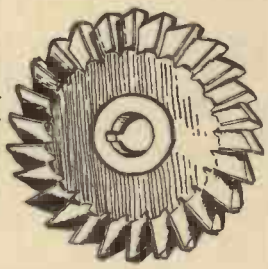


Fig. 10.—A side-and-face cutter which is made in a range of standard widths and diameters. They are often used in pairs or gangs separated by distance pieces.

left handed, in angles of 45, 50, 60, 70, and 80 right hand and 30, 40, and 45 degrees left hand.

Double-angle cutters having unequal angles are used chiefly for gashing or fluting spiral cutters, and are made with one side always at 12 degrees and the opposite side at 48, 53, 58, 63, 68, or 73 degrees.

Form-relieved Cutters

Cutters which are form-relieved to give radial clearance maintain the same profile throughout the length of their grinding life. A convex cutter of this type is shown in Fig. 14. Resharpening is carried out by grinding the faces of the teeth, but for the shape produced by the cutter to remain constant, the front of the teeth, after grinding, must always be on a radial line. Besides the shape illustrated they are also made in other shapes, notably concave, right- and left-hand corner rounding, and double-corner rounding and as standard, can be obtained to give radii from $\frac{1}{16}$ in. and upwards

Cutters for special purposes such as twist-drill and reamer fluting, thread milling and gear cutting are also made in the same manner

Cutters for milling gear teeth can be obtained for producing 14½-degree involute, 20-degree stub, and epicycloidal gears, and also for cutting both roller and silent chain wheels.

General Considerations

As may be imagined, these cutters are expensive, and unless any one particular cutter is likely to have a considerable amount of use, a fly cutter can often be pressed into service for a "one-off" job. The question of expense from the amateur's point of view, can be relieved by using a cutter bar holder containing a tool in lieu of a side-and-face cutter of large diameter. The bar, a piece of flat mild steel can be bored at one end to fit the mandrel and slotted at its outer end to receive a tool-bit at an angle of 45 degrees. The end of tool is ground to a 90-degree point, and is arranged to project beyond the side and end of the bar. A separate tool will be required for right- and left-hand working, but to meet these conditions, the bar can be reversed on the mandrel.

Woodruff Cutters

A special type of cutter is made for cutting woodruff key seats, like that in Fig. 12. These cutters are made in sizes to correspond with the standard keys and are not expensive to buy. On this account they are extremely handy for general use in carrying out small milling operations in the lathe, and they lend themselves to slight modification for special purposes.

Owing to the ready manner in which this type of cutter can be held, it provides, in the long run, the easiest way of making small special cutters for lathe use. There is one objection to making cutters integral with the shank, and that is the fact that it is in some cases not easy, if at all possible, to cut teeth on the back face of the cutter, but this objection can be overcome by tapping the centre of the cutter and making the shank with a screwed spigot.

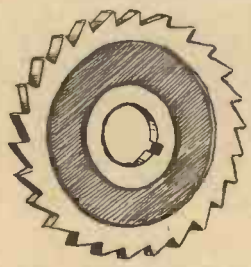


Fig. 10.—A slot cutter which is made in various standard widths.

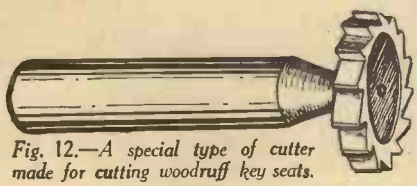


Fig. 12.—A special type of cutter made for cutting woodruff key seats.

Fig. 13.—An angle cutter.

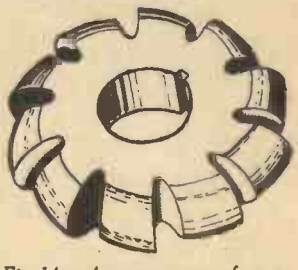
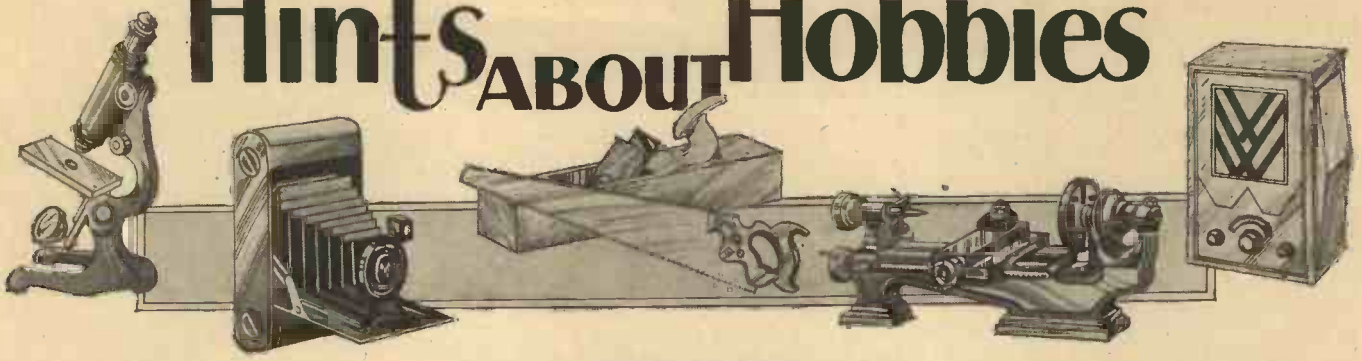


Fig. 14.—A convex cutter form relieved to give radial clearance.

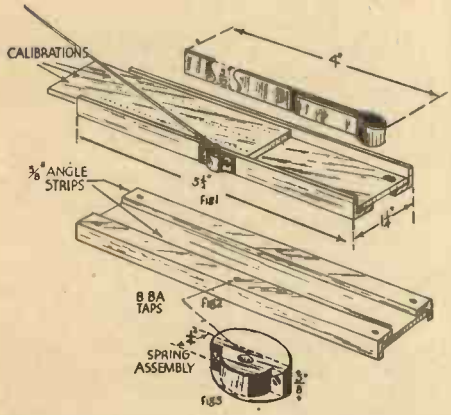
Hints ABOUT Hobbies



The Multicalculator

THIS very useful instrument is designed on the slide rule principle and its operation constitutes the well-known ABAC method.

The following material is required to make the device: one strip of aluminium 1 ft. × 1 in × ⅛ in., cut with a hacksaw into two pieces, one being 5½ in. in length and the other approximately 4 in. (this approximation is dependent on the particular ABAC scale which is used). One foot of angle strip (aluminium) ⅜ in. angle × 1/16 in. thick. This is cut into two 5½-in. lengths and assembled in the manner indicated in Fig. 2, the taps being 8B.A. for ⅜ in. brass c'sk. screws (the ends of which may be filed down after assembly). Seven 8B.A. c'sk. brass screws, ¼ in. in



The construction of the multicalculator which is based on the slide rule principle.

length. One back spring 6 in. long by approximately 3/32 in. A set of (small) figure punches is advisable when calibrating the scale but an alternative method would be to scratch the numerals on with a bradawl.

The calibration is attained by ruling off lines with a keen steel point. One brass disc 1 in. diam. × ⅛ in. thick (Fig. 3). This is cut in half as shown and filed down to the measurements given. No great degree of accuracy is required here although concentricity is the basis of neatness. This spring assembly should be fixed to the calculator in the manner shown, the drillings being 8B.A. throughout and the centre tap being 8B.A. (for fixing the spring). One other point. The degrees on the sliding tablet (Fig. 1) should be punched along the lines already referred to, and before this can be done, the points should be measured off and a pin-prick made against each place punched.—R. HOBBS (London).

THAT HINT OF YOURS

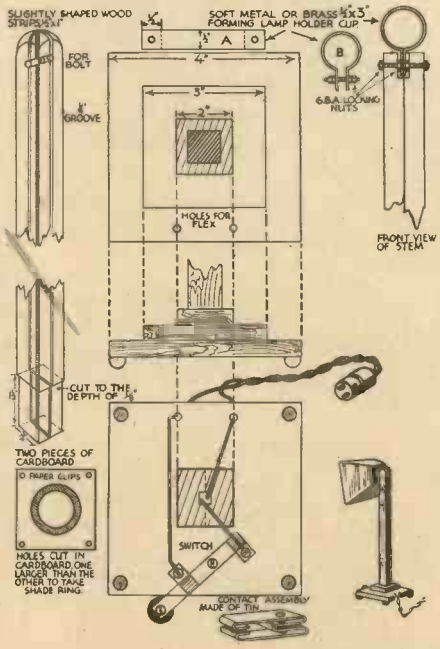
Every reader of PRACTICAL MECHANICS must have originated some little dodge which would be of interest to other readers. Why not pass it on to us? For every item published on this page we will pay 5s. Address your envelope to "Hint," PRACTICAL MECHANICS, George Newnes Ltd., 8-11 Southampton Street, W.C. Put your name and address on every item. Please note that every hint sent in must be original.

A Useful Table Lamp

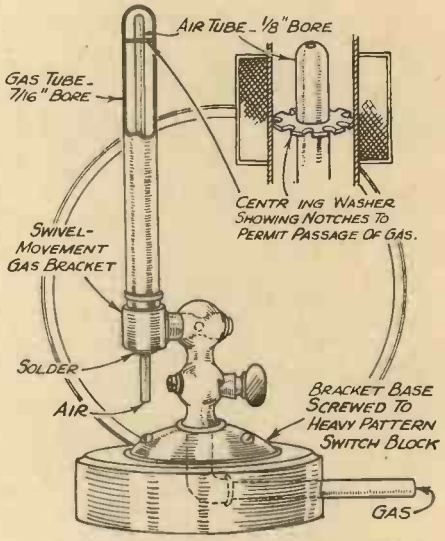
THE accompanying diagram shows a very handy (and inexpensive) table lamp. The stem consists of two lengths of ½ in. × 1 in. wood, with one side slotted to take the flex, and both tops are slotted to receive the clip. The base is three pieces of wood seccotined together, with a ¾ in. × 1 in. hole in the centre.

The clip (A) is folded round the lamp holder and fixed by means of a 6 B.A. bolt held by two nuts on either side (B). After securing the holder, with the flex wired in, of course, run the flex down the slotted stem as shown. The base of the stem is tightly fixed into the base itself, thus holding the wire secure. Any switching arrangement may be used but the one shown is very simple.

The shade is made of 18 S.W.G. and the only point to remember is to leave the four wires protruding one inch. Now cut two pieces of cardboard and cut a hole in the centre of each. One hole should fit the lamp holder exactly and the other hole should be ¼ in. larger. Place the card with the larger hole *underneath* the four wire ends and the other card on top, and secure with paper fasteners, wire, or seccotine. The cover for the shade can be made from a sheet of coloured paper.—N. MCLEOD (India).



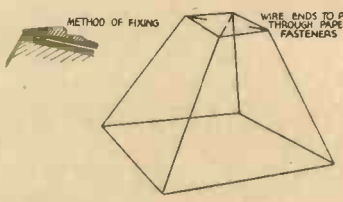
A handy and inexpensive table lamp.



Details of the soldering blow-pipe.

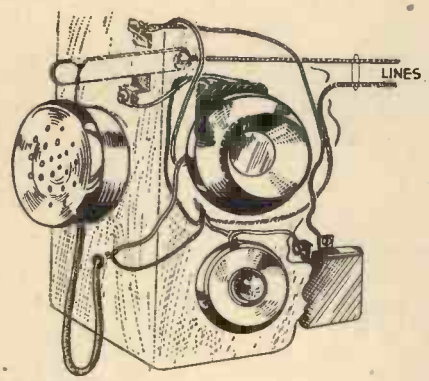
A Soldering Blow-pipe

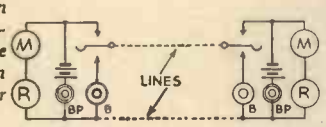
THE accompanying sketch shows a soldering blow-pipe constructed from a gas-bracket. The nipple ends, on the gas and air tubes, were formed by hammering, the tubes being supported on a hollow block during the process. When sufficiently reduced, the tube ends were reamered to size, the orifice of the gas-nipple being 3/16 in. dia., while that of the air-nipple is 1/16 in. dia. Flexible tubes connect the gas and air tubes to their respective sources of supply. While soft-soldering jobs can be executed by blowing the flame with the mouth, brazing requires the use of foot-bellows. When the air supply is derived from bellows, a cock fitted to the air tube will give better regulation of the flame.—S. RAINEY (Lanarkshire).



"A Home-made Telephone"

WITH reference to your article in the December issue of PRACTICAL MECHANICS on "A Home-made Telephone," the batteries are shown in circuit with the microphone and receiver. As the transmitter creates its own current, the best results cannot be obtained when the batteries are in use. The accompanying circuit,



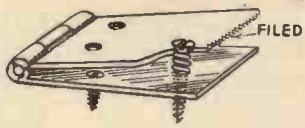


A modification for the home-made telephone described in our December issue.

however, will be found quite efficient, and has the advantage of costing nothing to run, as the batteries are only used to work the buzzers.—G. STEPHENS (Bristol).

A Novel Bench Stop

THE sketch on this page shows a bench stop, made from an old hinge and a small spring. To fix in place, screw one side of the hinge down to the bench by means of two screws and then insert a long screw through



An ingenious bench stop made from an ordinary hinge.

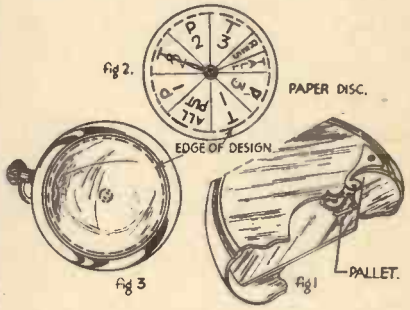
both halves as shown, with a small spring in the centre. When the screw through both halves of the hinge is tight, the device should be flush with the bench. When in use for planing, release it to the required height.—J. HOLROYD (Morecambe).

A Watch "Put and Take"

THE materials required for making this simple device are a cheap watch, a sheet of thin note-paper, and some water colours. Remove the back of the watch and with a pair of snipe-nosed pliers, carefully extract the escapement (see Fig. 1). This will allow the hands to spin round when the watch is wound up.

Next remove the front of the watch, very carefully prise off the hands, and remove the dial. A circle should then be cut from the note-paper (the size of this circle being effected in accordance with the size of the original dial) and be ruled off into eight sections and one section divided by another line into two sections. These sections should then be coloured and the printing done in accordance with the illustration. P representing the word PUT, and T representing TAKE. RES means RESPIN and T. ALL being TAKE ALL. It is advisable to paint the sections up to the dotted line as in Fig. 2, the reason being apparent on referring to Fig. 3. Next stick the paper disc on to the chassis of the watch (after making a small hole to allow for the hand "drive") and then replace the minute hand only, and finally the casing.

Should the watch have an unbreakable



A new version of the game of "put and take."

celluloid cover (not glass), this will be an asset, since by a slight pressure of the thumb (to prevent the hand turning), a good wind can be effected and consequently a good spin attained on removing the thumb.—R. HOBBS (London).

A NEW IDEA FOR DRAUGHTY ROOMS

By W. H. Fuller

THE draught problem, especially in small rooms, is always a difficult one. It is usually caused by the unavoidable disposition of the doors, windows, and fireplace, and even the careful arrangement of these in a modern home, does not entirely overcome this difficulty. The main cause of draughts is the fire, which, heating the air immediately over the burning coals, causes volumes of hot air to rise up the chimney. This air must be replaced, and it comes through chinks and cracks in doors, windows, keyholes, etc.

Solving the Problem

A solution that is worth trying is to provide a supply of air direct to the fireplace without it having to cross the room, chilling everything in its progress. This can be done by providing an air duct of reasonable size from the outside of the house to the front of the fireplace. Such a duct was recently fitted to a small house with wood block and concrete floors, and proved a success. The room warms up very quickly, and the distribution of warmth all over the room is remarkably even. There are no cutting draughts along the floor, and the fire burns bright and cheerily.

Details of the Air Duct

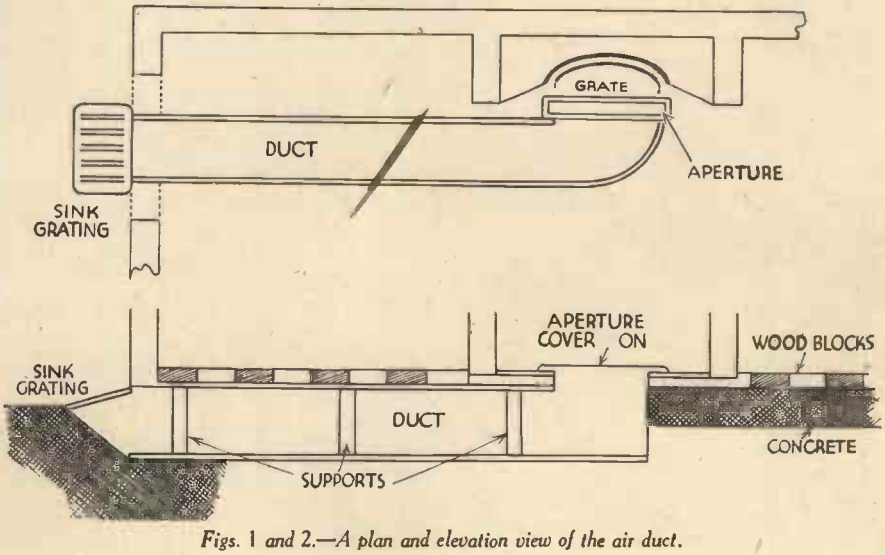
Figs. 1 and 2 show a plan and elevation view of the duct, and the procedure is as follows. First the position of the duct was marked out across the floor, and the wood blocks lifted. The rubble and earth below was removed until space to take a 12-in. × 10-in. deep duct had been excavated. Then the outside of the house was tackled. The concrete surround was broken through and a tunnel linked up with the channel inside. The duct itself was made of 1-in thick boards and built into the channel, the sides being well packed with concrete made up from the material previously removed. The top board of the duct was made level with the top of the concrete floor to facilitate re-laying the blocks. The fireplace end of the air duct curved upwards to meet an aperture left by omitting three 4-in. tiles in the hearth. This aperture was covered with a piece of open mesh iron gauze to prevent ashes or dust falling through, and was also provided with a polished oak cover for use when the fire was not alight.

The outside end of the air duct was finished off with cement, and an ordinary air grating used to cover the end.

Other Suggestions

Similar ideas can, of course, be fitted to houses with ordinary board and joist floors. In these cases, no duct would be necessary as the space under the floor would amply provide for any amount of air. The ventilating grills placed in the foot of the walls should of course be kept clear.

In the case of upstairs rooms, the space between the floor and the ceiling provided by the joists, can be employed for bringing air to the grate, providing the run of the joists is direct to the outside wall. Where the floor construction crosses, it is inadvisable to attempt to interfere as weakening of the structure is liable to result. Where a straight inter-joist run can be found, a few bricks must be removed at the wall end to allow air to enter, and should be finished off with the usual ventilator case and grille.



Figs. 1 and 2.—A plan and elevation view of the air duct.

WOOD FINISHES

Useful Hints for the Home Woodworker on Effective Methods of Treating the Surfaces of Various Woods

IT is not generally known that home-made articles of wood, old furniture, etc., may easily be finished in a variety of ways by the handyman. The usual methods of staining with proprietary stains, though not excessively expensive, are nevertheless much more so than many processes of finishing woodwork. The common softwoods, deal and spruce, can indeed be finished to display in a most effective manner, their far from unattractive grain, and the home woodworker will be surprised at the effective articles of furniture that can be made from these cheap and easily worked timbers.

The first stage in finishing any woodwork is to obtain a smooth surface free from any tool mark or other blemish. This is best done in the case of softwoods by glass-papering, and in the case of hardwoods by scraping. The grade of glass-paper used should not be coarser than 1 or 1½; the coarser grades are only useful for the rubbing down of mouldings. A cork or flat lino-faced wood rubber should always be used on flat surfaces, and the sanding must be done with light pressure only, as otherwise the heat generated may melt the glue of the glass-paper to the detriment of the surface being treated. Many scraper holders are now obtainable which make the satisfactory scraping of hardwoods an easy matter, merely calling for patience. After the first sanding or scraping has been carried to a successful conclusion and a smooth even surface obtained, since the stains recommended in this article are water or spirit stains and raise the grain of the wood, it is advisable to sponge over the surface with hot water, and when dry, again sand or scrape the surface smooth, rubbing always with the grain.

Removing Bruises in Wood

Bruises may be removed by local application of hot water, or if stubborn, by ironing over a damp cloth or flannel with a hot flat-iron. Glue stains must be carefully removed as otherwise they will prevent the stain from reaching parts of the wood. This may be effected by the application of a dilute solution of oxalic acid, which incidentally will also remove iron stains. To prevent end grain from staining a darker shade it should be treated with a smear of wax polish well rubbed in, a coat of brush polish, or alternatively stained with diluted stain.

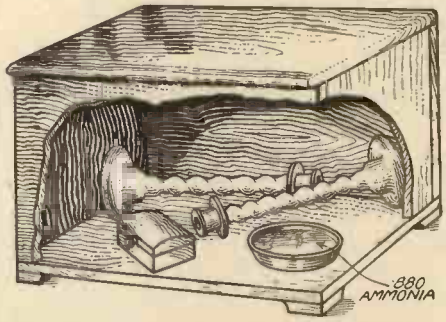
Before the staining is commenced the grain must be "filled," in the case of softwoods preferably by a liquid filler, and of hardwoods by a paste filler. Glue-size or shellac varnish made by dissolving 2-3 oz. of flake shellac in 1 pt. of methylated spirits, make excellent liquid fillers, and are applied with a brush, the surface being again rubbed down with worn glass-paper when dry. The best paste filler is made by mixing plaster of Paris to a moist consistency with water, rubbing this well into the grain and removing the surplus while still moist. When thoroughly dry the surface must be again lightly scraped. All fillers, whether paste or liquid, are preferably stained to match the surface of the wood, and lighter parts, sapwood, etc., may be stained lightly as a preliminary to ensure even colouring of the finished work. Cracks in wood already stained may be filled with a paste made by melting together 1 part beeswax, 1 part powdered resin, 12 parts white shellac, and colouring to match. Yellow beeswax alone makes an excellent stopping for oak or teak. All holes should be undercut to key in the filling. Considerable care should be taken in the careful preparation of the surface as this will make or mar any subsequent treatment.

Varnishing

For utilitarian articles in deal, spruce, yellow pine, or canary, the finish may be one of the following: varnish alone; stain and varnish; paint and varnish; enamel or cellulose. Varnishing should follow filling, and preferably three coats should be applied; the first worked outwards from the centre and rubbed down with fine glass-paper when thoroughly dry; the second applied across the grain and rubbed down with pumice stone or dust, using oil as a lubricant; the final coat is given down the grain. Each coat should be wiped over when thoroughly dry and set with a rag moistened with turpentine, and if possible some days should be given for each coat to harden before application of the next. If staining is to precede varnishing the following classes of stain are avaliable: water, spirit, oil, wax, and creosote. Water stains are by far the cheapest, and if the foregoing precautions have been observed they give excellent results. Any colour can be obtained in water-soluble stains; the following powders being cheaply purchased at all chemists: brunswick brown and vandyck brown giving a brown stain; walnut crystals a warm brown; bismarck brown a red; mahogany crystals a dark brown; and black what its name implies. In addition the well known fairy dyes can be obtained in every colour of the rainbow and are equally effective in water or in spirit. All the foregoing are soluble in methylated spirits, making spirit stains and in addition very powerful yellow and green spirit-soluble powders can be obtained. Oil stains must be purchased from the colourman and are comparatively expensive, but more suitable if french polishing is projected as they do not raise the grain. Wax stains are an attempt to combine two processes in one, viz. staining and polishing, and in common with all such attempts are only moderately successful. They may be made by adding to 1 part beeswax and 8 parts turpentine, sufficient oil stain to give the required colour. They are applied with a brush and polished when dry. Creosote stains are limited in variety but cheap and efficient in action. Jacobean oak may be produced by adding 3 oz. bitumen black to 1 pint creosote; golden oak by 1 oz. brown umber and 12 oz. creosote; mahogany by adding to creosote a spirit solution of bismarck brown to the required shade. This class of stain is best followed by a coat of brush polish and a wax polish, but may be varnished.

Cellulose Paints

Any ready mixed paint may be followed by varnishing to produce a glossy surface: enamel contains the varnish when purchased and needs no further treatment. Many reliable cellulose paints can now be purchased and their use produces a most pleasing and durable surface. Paints, enamels, and cellulose should all be applied after filling the grain as described above, and their durability and effect as in the case of varnish alone, are immensely increased if each coat is allowed a considerable time to harden before the application of a following coat. Paint and cellulose may satisfactorily be applied with good varnish brushes, if each coat is carefully rubbed down when hard, but the man who projects much work in cellulose is advised to purchase and use one of the paint sprays now marketed as these remove much of the drudgery and need for care in covering large surfaces.



A fumed-oak finish may be obtained by placing articles in a sealed chamber together with a open dish of ammonia.

Softwood Articles

The foregoing stains are primarily intended for the treatment of softwood articles and, as mentioned at the commencement of this article, the craftsman will be surprised at the beauty of the grain of common deal or spruce when carefully stained according to the directions given here and finally polished in one of the following ways. There are two types of polish suitable for the home worker; one the wax polish, the other a modification of french polishing. The experience and practice necessary to obtain the best results from french polish are beyond the average man, in his hours of leisure, although by the use of ready-made-up polish and the slavish adherence to the vendor's instructions he may make a fair show. Wax polish may be bought ready made or much more cheaply made by dissolving flaked beeswax in turpentine, warmed by standing the containing vessel in hot water, until the polish assumes the

consistency of a thick cream. This polish is applied to the stained surface with a piece of flannel, rubbing well into the grain.

The method of finishing hardwood articles varies with the wood in question and instructions will now be given for a variety of finishes suitable for different cabinet woods. Mahogany, the cabinet timber par excellence, is only suitably finished by expert french polishing, but the method of brush polishing given above can be relied upon to produce a fair substitute. The colour of the wood should be deepened first by the application of a solution of potassium dichromate in water, the surface lightly scraped when dry and the paste filler, suitably stained, applied as described before. The brush polish is best made by the solution in methylated spirit of bleached shellac in the proportion of 6-8 oz. flakes per pint of spirit. Yellow shellac may be used but is inclined to obtrude its own colour in certain lights. Walnut is traditionally and most satisfactorily finished by wax polishing and presents little difficulty to the amateur. The figure may be brought into prominence by rubbing in linseed oil, which must be allowed to sink thoroughly in before polishing. There are many methods of finishing oak, but the reader is warned that in the case of Japanese oak, those processes which depend for their efficacy on reaction with the gallic acid in the wood, are apt to be unsatisfactory.

A Limed Finish

The popular weathered or limed finish may be obtained by the application of a paste of freshly slaked l me, which should be rubbed off after several days leaving the white lime in the pores, or faked by staining with a weak black stain and rubbing a paste of whiting into the pores. With Japanese oak the reader is advised to use instead of lime, a fairly strong solution of potassium hydroxide (caustic potash) as the action of lime is very slow on this variety of oak. This finish is often french polished but this is not recommended, as the high gloss produced is not in keeping with the character of the timber and the home worker is advised to fix the colour with a coat of brush polish and then polish with wax.

A most durable polish may also be obtained by rubbing across the grain with a warmed cake of beeswax and burnishing with a piece of soft wood. Fumed oak is easily produced in small pieces, but larger articles present some difficulty as the essential for this process is a sealed chamber of sufficient size to accommodate the whole work. In this chamber is placed an open dish of 880 ammonia solution (liq. ammon. fort) with the article to be fumed and the chamber is securely sealed to prevent the egress of the gas.

SUN MOTORS

By V. E. JOHNSON, M.A.

A SUN motor is a motor for *directly* using the heat rays of the sun, and, provided that a suitable, efficient, and economical form of sun-motor plant can be set up, any place on the earth's surface where the outside temperature ranges from 110 degrees to 140 degrees F. is suitable (from a heat point of view) for such a plant. Any place in the tropics where the sun shines throughout the year and where ordinary fuel is expensive offers excellent opportunities for this type of plant. As an irrigation agent, there is practically no limit to the amount of power that can be profitably employed.

All our energy comes initially from the sun, but it is extraordinary how little *direct* use is yet made of that same energy. Early experimenters on sun motors failed because they tried to concentrate the heat rays of the sun, by means of parabolic mirrors on *small* boilers, in order to get great steam pressure as in ordinary steam engines. A number of such plants have been constructed and made to work, but they are not efficient or economical as they have been constructed on the wrong principle, the heat losses by conduction, convection, and radiation being very great. Now a sun-power plant to be of any value must be highly efficient. It must be capable of being built of any size, must not be too expensive to buy or set up, and must also be lasting and not expensive to run. It need not run continuously, and could be called highly efficient if it worked eight hours out of every twenty-four.

The First Shuman Sun Motor

This consisted of a wooden box with a top consisting of two layers of glass, with a small air space between. In the box was placed a small blackened boiler containing ether, because ether boils and gives off vapour at a much lower temperature than water (about 35 degrees C.). When exposed to the rays of the sun, a small toy engine was run by the apparatus. A larger and somewhat similar piece of apparatus some 60 ft. × 20 ft. × 1·5 ft. generated enough power to drive a small vertical engine of the reciprocating type.

The Tacony Plant

As long ago as 1910 the following plant was set up at Tacony, Philadelphia, U.S.A. A lamellar boiler, consisting of two thin copper sheets 6 ft. × 2·5 ft. × $\frac{3}{16}$ in. in depth, containing water was used. Cold water was admitted at the lower edge of one corner and the steam pipe was attached to the upper edge of the opposite corner. The boiler was contained in a wooden box, the top of which consisted of two sheets of ordinary window glass with a 1-in. air space between and another space of 1 in. between the lower sheet of glass and the top of the boiler. Beneath the bottom of the boiler was a $\frac{3}{8}$-in. air space connected with the air space at the top. Below this space was a 2-in. layer of "lith" (jute waste mixed with mineral wool) and a wooden board 1 in. thick formed the bottom of the box.

No Mirrors Used

It will thus be seen that no mirrors of any kind were employed, and the entire effect was brought about by the use of glass, which readily allows the sun's radiations to pass through, but will not conduct the sensible heat from the hot air on the other side of the glass. The reason for this being that glass and air are conductors of heat, and therefore, the air spaces act as very efficient heat insulators. The solar radiation does not manifest itself as heat, until it impinges on something more solid than air. It should be mentioned that the entire apparatus, including the boiler, is painted a dull black, as this is the best-known surface for absorbing solar radiation and converting it into heat.

The main feature of this plant and of others of an improved design and vastly greater power, is *the extremely low pressure at which they work*, necessitating, of course, the use of a condenser. The Shuman boiler differs, however, from those of previous sun-motor designs, as it enables a very light and cheap boiler to be used instead of one that is heavy and strong. An efficient 30-h.p. engine using steam at atmospheric pressure (i.e. 14 lb. per sq. in.) is used in conjunction with this plant. Two independent tests showed that even for so small an engine as 30 h.p. it required only 26·5 lb. of steam at atmospheric pressure per b.h.p. hour.

The next engine was one of 125 h.p. (steam at atmospheric pressure), and in this case it required only 23 lb. of steam to produce the same result.

This remarkable engine was in many ways similar to the Corliss valve-gear steam engine, the main difference being in the valve gear, the steam and exhaust valves, and the fact that there were two pistons rigidly attached to the single piston rod with a considerable space between them. This arrangement enables the steam jacket to have greater effect in warming the cylinder walls. One advantage in this type of plant is the fact that a low steam pressure meant a correspondingly low temperature and much less loss by radiation. All such plants must, of course, be fitted with an efficient condenser.

The Egyptian Plant

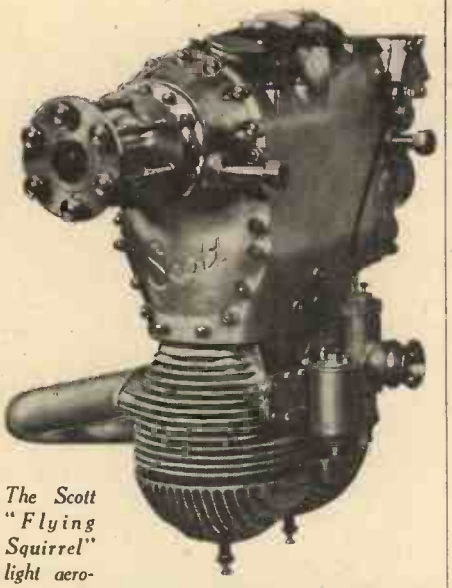
This sun-heat absorber is made up of five units, each 200 ft. long. Each unit consists of a glass reflector and a boiler. The reflector is in the form of a channel of mirrors, the cross section being parabolic and some 14 ft. wide at the top. The mirrors themselves, are flat and arranged in a number of narrow sections so as to give the curved parabolic form necessary for reflecting the sun's rays on the long small sectional boiler placed in the focus of this curve. The cross section of the boiler is roughly in the shape of a 4-in. steam pipe, to the bottom of which is attached a U-shaped portion of steel, 1 in. wide and 10 in. deep. Thus the total over-all depth of the boiler is 15 in., while its length is the same as that of the reflector, i.e. 200 ft. for each unit.

The Reflector Supports

The reflectors are supported by steel crescent-shaped light lattice frames, the outer members forming a circular arc resting on two small rollers. The circular members are fitted with racks into which small pinion gears work at the bottom. In this way the reflectors are made to slowly rotate during the day, so as to keep them always directed towards the sun. A thermostat automatically regulates this motion. The boilers are protected from loss of heat by means of common window glass fixed round them so as to form a hot-air space. The total area of sunshine collected by this plant is 15,000 sq. ft. The plant gives 1 h.p. for every 100 sq. ft. of heating surface. It is admirably adapted for irrigation purposes, part of the water pumped up being passed through the surface condenser. The power to run this plant has proved, on test, to be only 2 per cent. of the total power generated. The thermal efficiency of the plant is over 43 per cent. Sun motors are, therefore, a practical proposition, but their chief drawback is the large initial cost compared with the power returned. It must not be forgotten, however, that there is no fuel bill to pay.

THE SCOTT "FLYING SQUIRREL" ENGINE

A Light Aeroplane Engine which can be fitted into the "Flying Flea." It is Highly Economical, Unusually Light, and, coupled with Sturdiness in Design, makes for a High Degree of Reliability. The Construction of the "Flying Flea" was dealt with in Previous Issues.



The Scott "Flying Squirrel" light aeroplane engine which develops 28 h.p. and sells at the moderate price of £50.

AN engine that will be found eminently suitable for the "Flying Flea," in fact, for any type of ultra-light aeroplane, is the Scott "Flying Squirrel" shown on this page. This moderately priced and compact little engine is being manufactured by the Scott Motor Cycle Co., Shipley, Yorks, England. The secret of its simplicity lies in the fact that it has only five working parts, none of which are subjected to hammer blow action, and no valves, valve gear or tappets.

The Cylinders

These are made of light alloy, with encast chromidium liners. Special attention has been given to the fining and graduation of wall thickness in order that distortion may be avoided, and an even cooling effect obtained. The pistons are in die-cast alloy with a Scott patented arrangement of skirt, and gudgeon-pin fastening. This arrangement ensures that the area around the gudgeon-pin boss has a greater clearance than the rest of the piston. Three gas rings are fitted but no scrapers. Scraper grooves are provided, however, which effectively control the oil distribution.

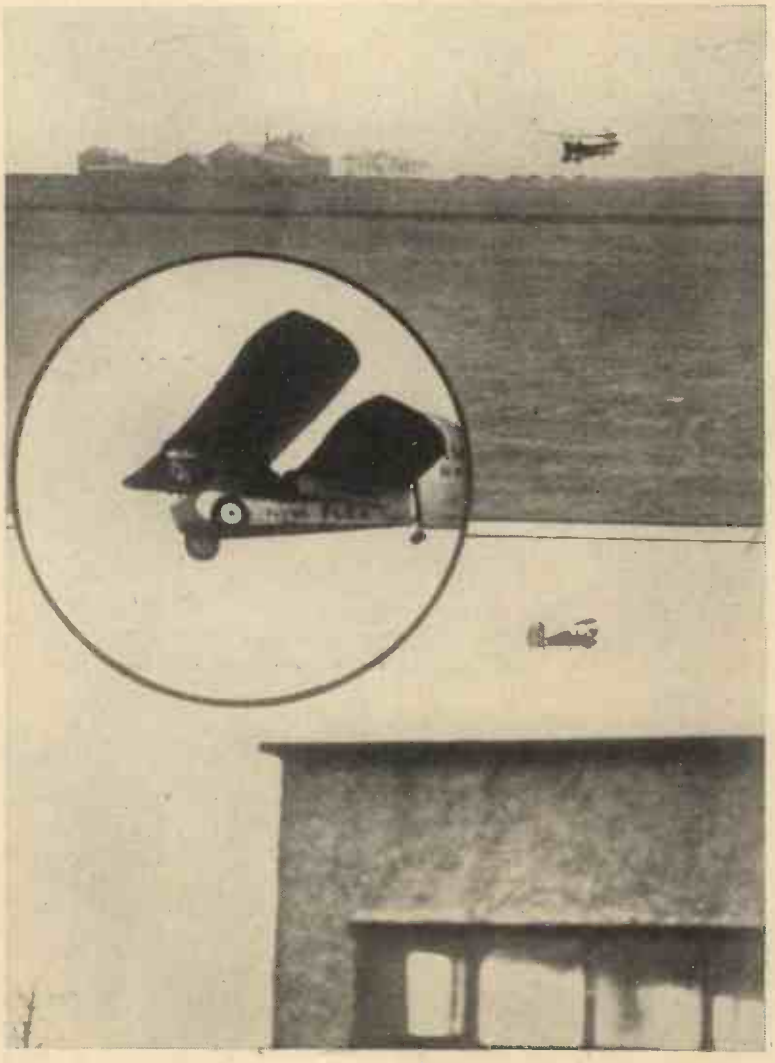
The engine has a standard Amal carburetter, and a two-spark magneto running at engine speed. The drive is taken from an extension of the propeller shaft.

Reduction Gear

Because of the high engine speed, the propeller shaft is geared down with reduction gear of the straight spur type having a ratio of two to one. A feature of the reduction gear is that the driving pinion is mounted between the two crankshaft sections, and not at the end. The reduction wheel, which is splined to the propeller shaft, is machined from solid forging, and the shaft and its gear are dynamically balanced. The lubricating oil consumption is given as 0·03 lb., and the fuel consumption is 0·56 lb. per brake-horsepower hour. Four trunnion stubs are provided for mounting the engine.

Proposed "Flying Flea" Clubs

WE have recently received from Messrs. E. G. Perman & Co., 24/26, Brownlow Mews, Gray's Inn Road, W.C.1, particulars of their proposed scheme to enable the public to pilot their own aircraft, and to fly cheaply and with safety. They propose that where sufficient encouragement is forthcoming from any one centre, to send one or more "Flying Fleas" to the aerodrome nearest the centre, or to any suitable field or aerodrome stipulated by the members of that centre. These machines will then become the property of that branch of the club, the members of which are entitled to fly the machine for payment of 2s. (the cost of the fuel and oil). All readers interested should communicate with the above firm, who will supply them with full details of this offer.



Showing a "Flying Flea" in flight fitted with a Scott "Flying Squirrel" engine.

SCOTT "FLYING SQUIRREL" DATA

Direction of Rotation of Airscrew.	Anti-clock viewed from Propeller.
Bore.	73 mm.
Stroke.	78 mm.
Swept volume.	652 c.c.s.
Compression ratio.	6·8 : 1.
Normal b.h.p.	16.
Normal r.p.m.	3,200.
Maximum b.h.p.	28 at 4,000 r.p.m.
Weight complete.	85 lb. + or − 5 lb.
Fuel consumption at normal r.p.m.	0·56 lb./b.h.p./ h.r.
Oil consumption.	0·03 lb./b.h.p./hr.
Oil pressure.	30 to 40 lb. per sq. in.
Oil in circulation.	0·5 gallons.
Length over spinner.	600 mm. (23½ in.) approx.
Height overall.	575 mm. (22½ in.) approx.
Greatest width.	250 mm. (10½ in.) approx.

Working Model

Constructional Details of the Water-tube Boiler described in our December issue are given

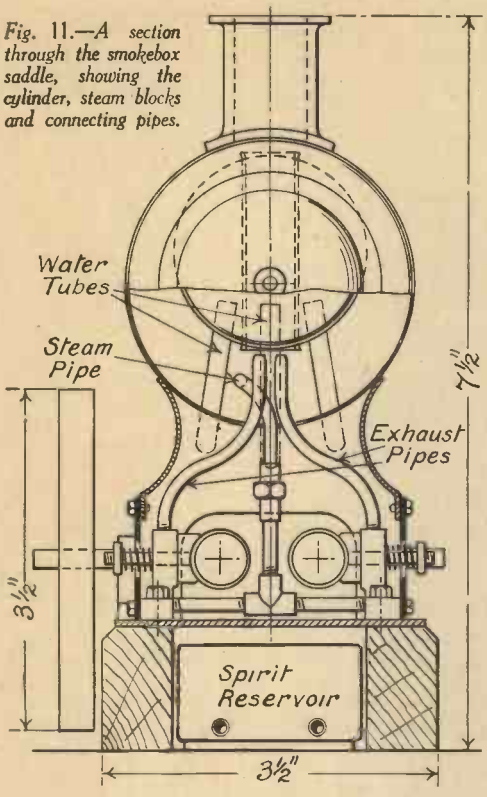


Fig. 11.—A section through the smokebox saddle, showing the cylinder, steam blocks and connecting pipes.

IN assembling the driving gear, place the cylinders in position on the steam distributing blocks by passing the pivot pins through the latter, slip on the coil springs, and screw on the adjusting nuts. Screw the ends of the short projecting steam pipes into a T-piece, as shown in Fig. 11. After making any slight adjustments that may be found necessary to ensure that the axes of the cylinders are quite parallel and the correct distance apart, the blocks can be screwed down on the bedplate.

Apply a little lubricating oil to the interior of the cylinders, place the pistons in position, and connect the piston-rod heads to the crank-pins by screwing in the cotter bolts. Lubricate all the rubbing surfaces, and revolve the flywheel a number of times to make sure that everything runs smoothly, after which the engine will be ready for testing under steam.

Boiler Construction: The Inner Barrel

As previously mentioned, the boiler is of the enclosed water-tube type, and for the inner barrel a piece of solid draw copper tubing, 2 in. outside diameter and 10 in. long, will be required. The tubing should be No. 19 S.W.G. or $\frac{3}{64}$-in. in thickness.

After filing the ends square, scribe a centre line and set out the position of the three holes, as indicated in Fig. 12. A hole for the flue tube has to be drilled through the bottom as well as the top of the boiler barrel, and these holes must be diametrically opposite. The central hole along the top of the barrel should be made a good fit for the safety-valve bush which has to be soldered in place before the boiler is fixed in position in the outer casing, and this also applies to the bush for the steam tap.

A spring safety valve, of the pattern shown in Fig. 6 (December issue), can be purchased cheaply, complete with a screwed bush. The adjusting nut should be screwed up against the spring so that the valve "blows off" at 20 to 25 lb. per square inch. Although not shown in the drawings, a small steam-pressure gauge could be fitted to the boiler backplate if desired.

Drill six $\frac{7}{32}$-in. holes in the bottom of the boiler barrel in the positions indicated to take the ends of the three water tubes. For these, three 9¼-in. lengths of $\frac{7}{32}$-in. outside diameter thin copper tubing will be required, the ends of each tube being bent, as shown in the sectional elevation, Fig. 6, after being annealed. Well clean the ends and also the boiler barrel round the holes for the tubes, and press the ends of the latter into the holes till they project about $\frac{1}{8}$-in. on the inside of the barrel at the rear end and about $\frac{3}{8}$-in. at the front end, after which well solder all the joints. Give the tubes a slight bend in the middle before soldering in place, to form a camber, as in Fig. 6. When the tubes are in position the lower surfaces must not be more than $\frac{3}{4}$-in. below the bottom of the inner boiler barrel, where they pass the throat plate of the firebox, otherwise they will not clear the latter.

The flue or chimney tube consists of a 2⅛-in. length of thin copper tubing, $\frac{9}{16}$-in. outside diameter. After well cleaning the ends with fine emery paper press the tube in place and slightly expand each end, after which well solder the joints.

Boiler Ends

For the boiler ends two flanged brass castings or stampings will be required, and these must be carefully filed till they are a good push fit in the ends of the boiler barrel. The ends should also be filed flat on the outer faces.

Carefully mark out the positions of the holes, and drill and tap these as indicated in Fig. 14. The two holes in the rear end to take the screwed stems of the test cocks must be tapped out with corresponding threads, while the holes for the stay rods can be drilled a clearing size for the screwed ends of the latter.

With a piece of emery cloth well clean the inside of the boiler barrel at the ends, after which, press one of the boiler ends in place and adjust it so that the holes come in the correct position in relation to the top and bottom of the boiler. The ends should be pushed in till $\frac{1}{16}$-in. of the latter projects, thus forming a narrow flange to assist the solder to flow. After well sweating the solder round the joint, treat the other end in exactly the same way.

From a length of brass wire, $\frac{3}{32}$-in diameter, cut two pieces 10¼ in. long for the boiler stays, and cut a thread on each end for a distance of ¼-in. to take the clamping nuts. Pass the stays through the holes in the boiler ends, and screw on the nuts, after which well solder them to the boiler ends and rods to make steam-tight joints. The projecting edges of the boiler barrel can now be filed flush with the surface of the boiler ends, so as to remove all superfluous solder, and the rear end can be rubbed over with fine emery cloth and oil to give it a smooth finish, as this end is visible outside the backplate.

The boiler can now be put on one side till the outer boiler casing and backplate are ready.

Boiler Backplate

For this a piece of sheet brass will be

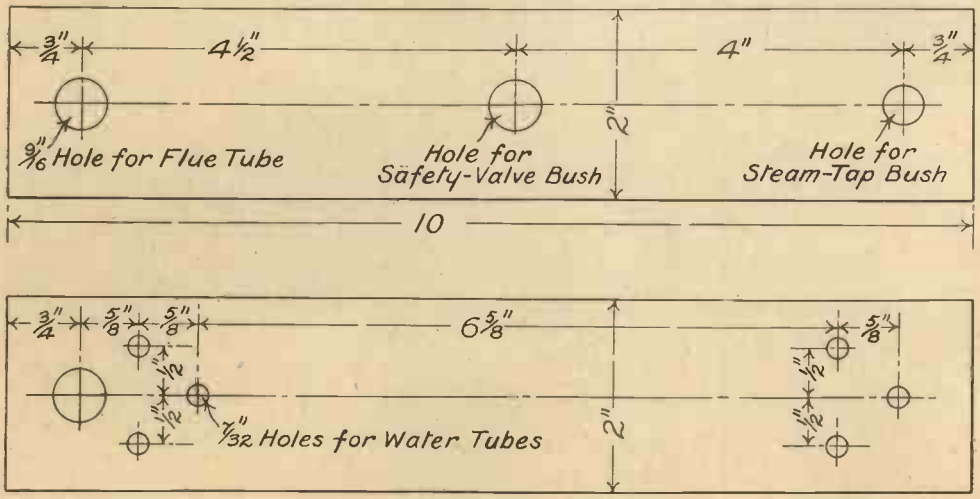


Fig. 12.—(Left) A plan and underside view of the inner boiler barrel.

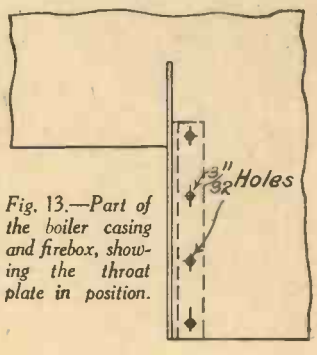


Fig. 13.—Part of the boiler casing and firebox, showing the throat plate in position.

Steam Engines

for the Small Undertype Steam Engine in this Sixth Article of the Series

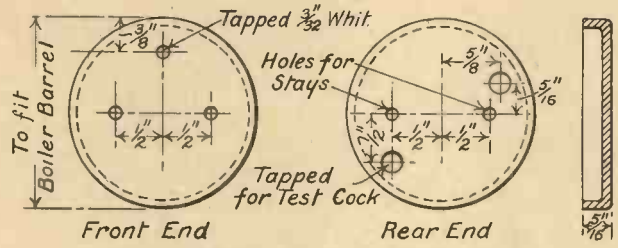


Fig. 14.—Elevations and section of boiler ends.

required 5 in. by 3 in., by $\frac{5}{32}$in. thick, on which the shape and positions of the various holes can be carefully marked out to the dimensions given in Fig. 17. The large hole to take the boiler end can be made by first of all drilling a number of $\frac{1}{4}$-in. holes round the inside of the circular scribed line, and then cutting through the metal between the holes with a metal piercing saw. The rough edges can be filed down to the scribed line, leaving the edge of the hole square with the face of the plate, and a good fit to the inner boiler barrel. A $\frac{3}{4}$-in. diameter hole can be drilled out for the firehole, and immediately above this drill and tape a $\frac{5}{32}$-in. hole to take a small screwed pin for fixing the firehole door in position. Another hole $\frac{3}{16}$-in. diameter can be drilled, as indicated, on one side of the centre line, to allow the steam pipe to pass through.

Outer Boiler Casing

A piece of tinplate can be used for the outer boiler casing, and the plate selected should measure 12 in. by $10\frac{3}{4}$ in.

Carefully mark out the developed shape of the casing to the dimensions given in Fig. 16, and set out the positions of the three holes on the centre line. Drill these holes with a $\frac{3}{8}$-in. or $\frac{1}{2}$-in. drill, and finish to size with a reamer or half-round file. Scribe two lines, A and B, $\frac{3}{8}$-in. from each side edge of the plate and at $\frac{3}{16}$-in. from the lower edge scribe another line and proceed to mark out the positions of the holes for the rivets as indicated. After centre-punching, drill holes through at the points marked with a $\frac{3}{32}$-in. drill. The holes in the other edge of the plate can be drilled after the casing is bent to shape, and the two edges made to overlap to the extent of $\frac{3}{8}$-in. as indicated by the dotted lines. The holes already drilled will then act as guides, so ensuring the holes in the two edges registering correctly, and allowing the rivets to be inserted without any trouble.

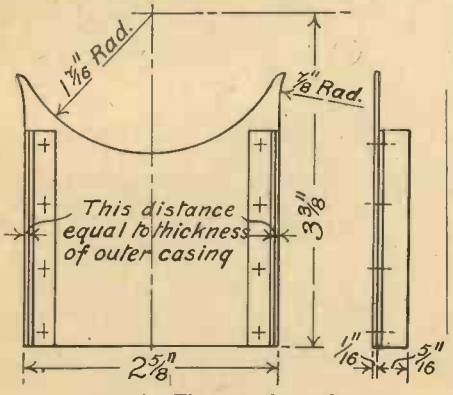


Fig. 15.—The boiler throat plate.

The casing can be easily shaped by bending it round a wooden mandrel about 3 in. diameter. After getting the two edges to overlap correctly, lightly solder the joint, and then proceed to drill the holes through for the small copper rivets. The casing will have to be placed over an iron mandrel (a piece of 1 in. gas-piping held in a vice will do) when riveting the joint.

When this has been done, drill and reamer out a hole in the underside of the casing, through the lapped joint, about $\frac{1}{2}$ in. diameter, the centre of which should be $1\frac{1}{2}$ in. from the front edge of the casing.

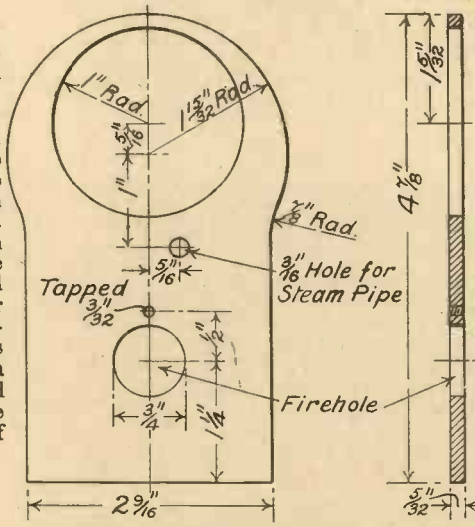


Fig. 17.—A rear elevation and section of the boiler backplate.

This hole is to allow the steam and exhaust pipes to pass through, as will be readily understood by reference to Fig. 6 (December issue). That part of the plate forming the firebox sides must be carefully bent to fit round the boiler backplate.

Firebox Throat Plate

This is simply a piece of stout tinplate cut to the shape shown in Fig. 15, and it should be of a thickness equal to the width of the saw-cuts made previously in the outer casing. Two angle-pieces of tinplate, or

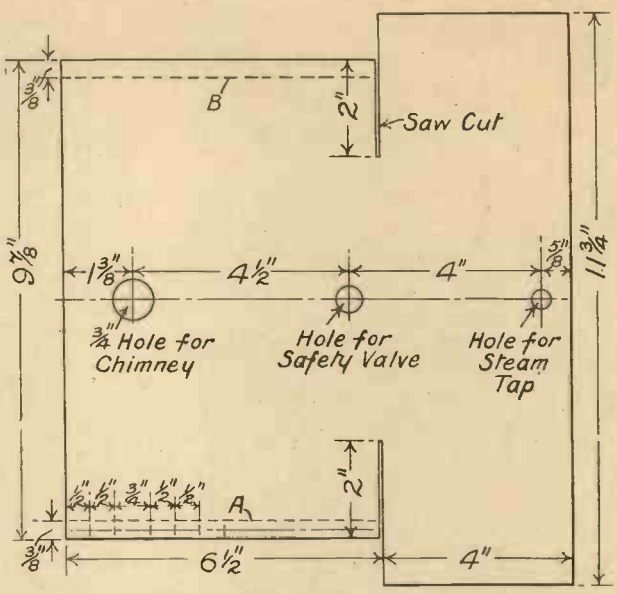


Fig. 16.—The sheet-metal plate for forming the outer boiler casing.

sheet brass, should be riveted on, in the positions shown, for fixing the plate to the firebox sides. Having done this, slip the throat plate in position and adjust it so that the top curved edge projects about $\frac{1}{32}$-in. inside the boiler casing, and then lightly solder the joints under the boiler casing, and at the corners of the firebox.

Now mark out the position of the four holes in each side of the firebox casing, as indicated in Fig. 13, and after drilling the holes through with a $\frac{3}{32}$-in. drill, rivet up with copper rivets.

A suitable chimney can be made with a piece of $\frac{7}{8}$-in. diameter brass tubing $1\frac{3}{8}$-in. long, and two brass washers. One washer is soldered round the top end of the tube to form a flange, the other one being soldered to the bottom end of the tube after being bent over a mandrel to fit the boiler casing. The base flange of the chimney can be fixed to the boiler casing with $\frac{1}{16}$-in. rivets.

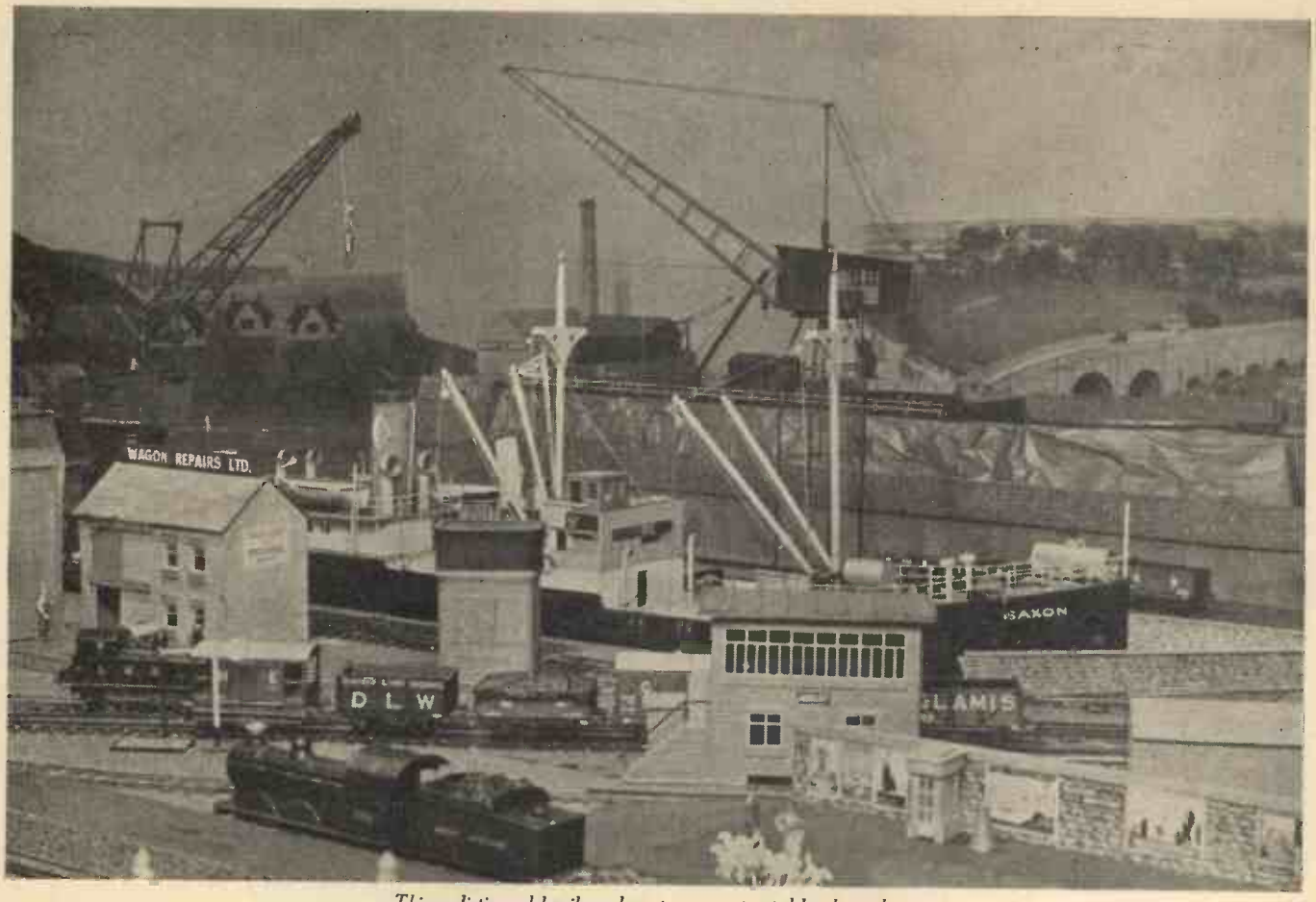
Assembling the Boiler Barrel and Outer Casing

The inner boiler barrel and backplate can now be fixed in position. For attaching the front end of the boiler to the outer casing a small fitting will be required, which can be filed to shape out of a piece of stick brass, and holes drilled and tapped as indicated in Fig. 1 (see December issue). A hole must also be drilled and tapped in the front boiler end, and after screwing the fitting tightly in position, as shown, solder the joint to ensure steam-tightness.

The rear end of the boiler barrel can now be pushed through the hole in the back-plate till it projects $\frac{3}{16}$-in., and both can then be placed in position within the outer casing. By means of a screw clamp hold the rear edges of the outer casing firmly to the sides of the back-plate, drill the hole in the casing in front of the chimney, and screw in the fixing screw to clamp the front end of the boiler barrel in position.

Before removing the screw clamp proceed to mark out the positions of the holes for the screws for fixing the rear edge of the outer casing to the backplate. These should be carefully set out $\frac{7}{16}$-in. from the edge of the casing and spaced $\frac{1}{2}$-in. apart. After centre-punching, drill holes about $\frac{3}{16}$-in. deep into the back-plate, and tap $\frac{1}{16}$-in. Whitworth to take round-headed screws.

(To be concluded)



This realistic model railway layout was constructed by the author.

Making Track and Baseboards

By E. Beal

How to Build up a Permanent Model Railway with Details for Constructing Curves, Points, etc.

THE height above the floor at which the layout will be arranged, is largely a matter of taste on the part of the constructor. Some prefer the bird's-eye view, some the standpoint of a pedestrian's position. On the whole, however, for an adult operator or observer, about 3 ft. 6 in. is a good level. The best form of trestle and the simplest and cheapest is shown in Fig. 1. Side supports are a needless expense if the boards which form the base of the layout fit tightly between the walls of the room; the walls themselves then give lateral stability. Where this is not possible owing to the presence of a doorway or other gap, the free end of the trestles can be supported by means of cheap metal brackets of the smallest kind screwed to the floor, with a larger pair of brackets attached in a lateral position to the underside of the baseboard and the end trestle. This form of trestle is made from 3-in. × 1-in. battens, held together by screws as shown.

For the baseboard use ¾-in. floorboards, thoroughly well-seasoned, and held together by screws. When the baseboard is finished, plane off the rough edges of the planks on the surface.

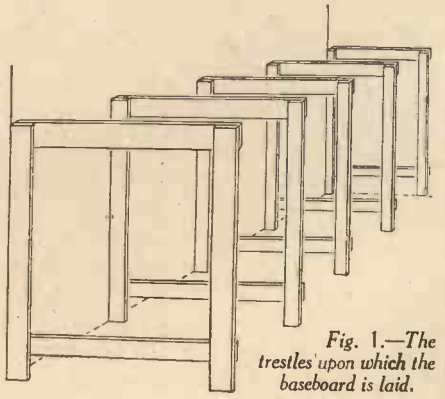


Fig. 1.—The trestles upon which the baseboard is laid.

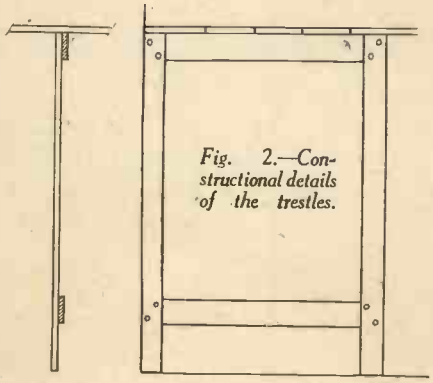


Fig. 2.—Constructional details of the trestles.

00-Gauge Track

Track for 00-gauge can be made in a variety of ways, as new methods are always being evolved. Much will depend upon the number of sleepers to be used, and the material of which these are to be made. Merco track, and parts for the same, will be found quite suitable. The sleepers are of tinplate and are soldered to the outside of the rails, being attached at intervals to the formation by means of sprigs. Sleepers readily drilled are sent out with each package of ordinary type for this purpose. If time is more plentiful than cash, tinplate sleepers of the drilled kind at intervals are recommended, the gaps being filled by cardboard sleepers of an identical thickness, these being cut by hand, fixed down before painting, and painted black along with the baseboard before the metal part of the track is superimposed. This is the scheme which will now be described.

A Jig for the Track

The handiest jig is that shown in Fig. 5. It consists of a length of plywood with two pieces of stripwood arranged along its edges as shown. Along the top edges of these

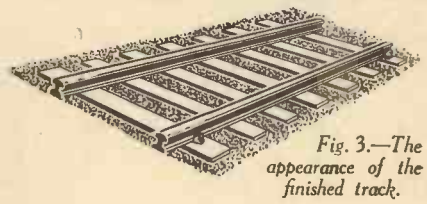


Fig. 3.—The appearance of the finished track.

strips there is arranged a gauge-piece consisting of a short length of brass T-section having notches filed out to engage the

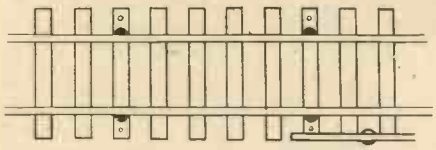


Fig. 4.—Showing card and soldered sleepers.

top edges of the four rails of the double track to be made. But the jig may be used for single track as well. The metal sleepers are set at intervals of 1¾ in. only, and are arranged to be held in place for soldering by pins without heads, set as indicated. There are three pairs for each long sleeper, the two pairs at the one end being for single track. The brass track gauge has the desirable quality of pressing the rails down on the surface of the sleepers for soldering, and simply slides along, holding the four rails perfectly upright and rigid. The jig might be a yard long, so that full-length sections may be made at a time. If single track only is wanted, the double-track sections may be cut along the middle on a tinsmith's guillotine. Fig. 3 shows how the track appears when laid, and Fig. 4 is a plan which indicates the position of the tinplate and the card sleepers. The great advantage of using cardboard is that the finished track is more silent, and, of course, the tedious work of soldering is much reduced. Sleeper work is perhaps the least fascinating of all soldering jobs.

The Sleepers

For the sleepers use thin card, such as a postcard. Cut them 1¼ in. × ⅛ in. each for single track, or 3¼ in. long for double if they are to run right through. The laying of the card sleepers is rather an intricate job. Use a tube of adhesive, and stick each sleeper down separately. It is not necessary to run glue on the whole length; simply a little at the ends of the sleepers will allow more ready removal of the latter if the track has to be dismantled. The latter eventuality is the main objection to the use of cardboard, but an advantage which almost compensates with it is that a most fruitful cause of irritating short-circuits is entirely eliminated by use of cardboard—there is no danger of the current passing to the conductor-rail screws through the sleeper ends. In fixing down these sleepers, the work can be aided by the use of a stripwood or metal T-square. This is shown in Fig. 8. Sleepers *A* and *B* are laid first, and the square is then run along from right to left, and others are then laid down. For single track, a single piece of

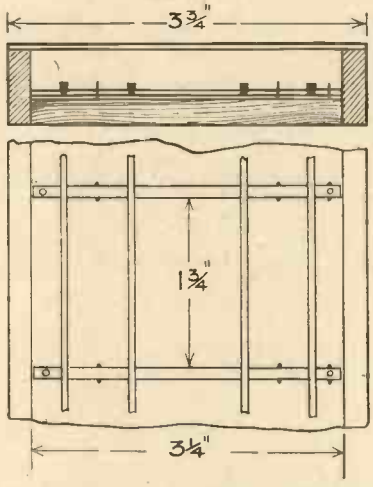


Fig. 5.—A jig for making double straight track.

Figs. 6 and 7.—(Left) A section of the brass used for the jig shown in Fig. 5, and (right) the method of sloping off the conductor rail.

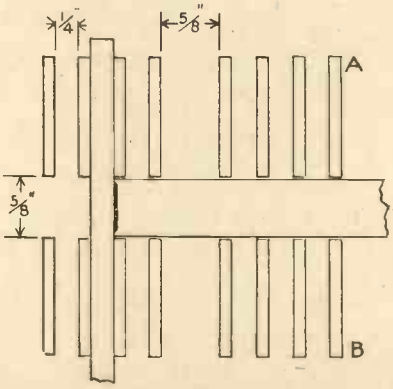


Fig. 8.—A useful device for accurately spacing cardboard sleepers.

¼-in. strip metal can be used for a gauge. Paint the finished work, and also the metal track, with flat-drying black, and rub off the surface of the rails before the paint dries.

Some of the important dimensions are as follows. Remember that the track gauge is *not* ⅝ in., but 16·5 millimetres. This is of the very greatest importance. On curves, also, the gauge should be increased to 17 millimetres. Sleepers are spaced at ¼-in. intervals, and the distance between the ends of the sleepers (inside) for double track is ⅝ in., for the distance of the conductor rail from the outer edge of the running rail is between 3/16 in. and ¼ in., and the height of the conductor surface above the running surface is 1/16 in. These dimensions are not arbitrary, but must be strictly and meticulously adhered to.

Curved Track

Coming now to curved track, a jig for this purpose is shown in Fig. 9. In this jig, the gauge (17 millimetres between track rails) is just the same as in the straight jig, but is soldered to the end of a length of strip metal—0-gauge rail will do—which acts as a trammel, being pivoted to the jig-board at the other end. Lines for the pins should be drawn in pencil, using the trammel before the gauge is soldered on, and thus getting the sleepers in tangent with the radius. The sleepers are arranged at intervals of 1¼ in. as before, but the measurement is taken along the centre of the curve of track, between the two tracks themselves. An additional pin is needed at the top-centre of each sleeper to hold the latter from sliding laterally. The board for the jig is of stout plywood and is rather

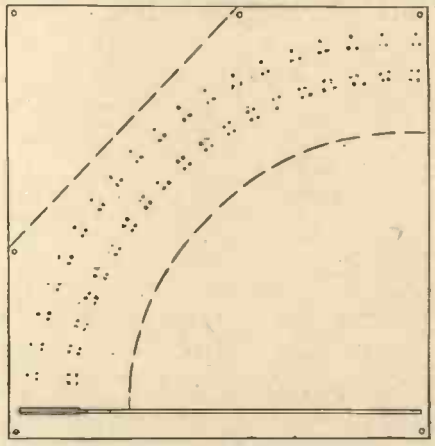


Fig. 9.—A spacing jig in constructing double curved track.

cumbersome in size, being 28 in. square; but the awkwardness can be mitigated by cutting off the corner by the dotted line and setting this cut edge at the front side of the table before screwing down the board. The jig can be used for single track as well as for double. The trammel of the jig is bent as in Fig. 10, in order to bring the gauge correctly over the rails. For laying the sleepers, there seems no better method than to cut cardboard templates (Figs. 11 and 12) and mark out the path of the sleepers in pencil by this means. For the double track the template is 3¼ in. wide and 26⅛ in. radius to the outer edge; but for single track it is 1¼ in. wide and 24¼ in. radius to the outer edge.

Points

For making 00-gauge points, if there are a number to be done, the best way will be

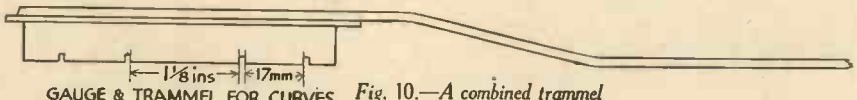
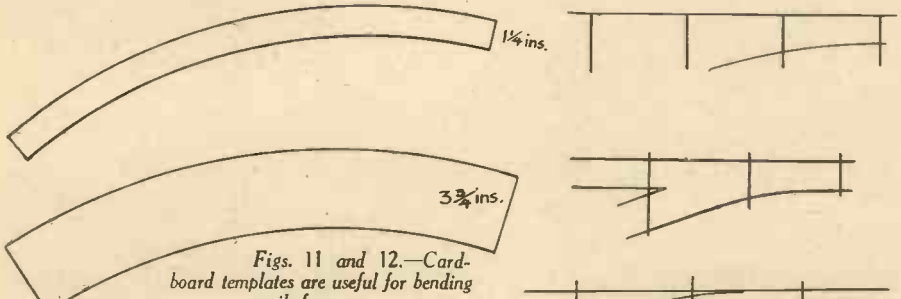


Fig. 10.—A combined trammel and spacing gauge for curves.



Figs. 11 and 12.—Cardboard templates are useful for bending rails for curves.

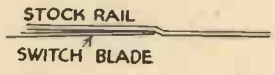


Fig. 13.—How to bend stock rails for good point work.

Figs. 14 to 16.—The various rail formations used in building up points.

to buy a Merco standard point and remove the switch-blade and check-rails, take the remainder to a joiner, and get him to cut a thin wooden jig to fit inside accurately. The point can be re-assembled if desired afterwards. This jig will be found most useful in forming the stock-rail shapes of points. If few points are needed, they are really not worth making when they can now be purchased very cheaply. The way to proceed with a point is to first fix the two stock-rails on four sleepers (see Fig. 14). Before this is done, however, it is as well to joggle the stock rails at that place where the switch-blades are to lay alongside (Fig. 13). This is done by kinking the rail with pliers, and bending back to the straight direction. The kink should not be too deep; it has to receive merely a feather-edge of the blade. Switch-blades can now be had ready filed. The four sleepers are arranged so that the third from the entrance of the point will engage the underside of the frog. The exact distance between each will, of course, depend on the radius of the point. The next task is to solder securely the frog rails. It is possible to buy an excellent little solid frog all ready made in one piece, and these are a great advantage. We have now arrived at the stage shown in Fig. 15. Next (Fig. 16), the switch-rails are accurately bent to shape and soldered in. In doing this, use a piece of $\frac{1}{16}$-in. brass strip as a gauge between the wing-rails and the frog, with a second piece of similar strip for the alignment of the switch-blade with the branch side of the frog. The straight switch-rail (dotted) is set in last; and after this there are only the check rails to fit. For the gauge in setting these, do not use $\frac{1}{16}$-in. strip, but a piece of common 00-gauge rail (see Fig. 18). The point is now complete so far as the soldering is concerned, except for the sliding

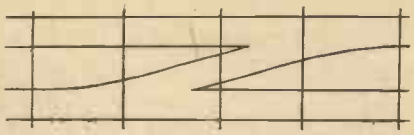


Fig. 17.—The running-rail formation for a crossover.

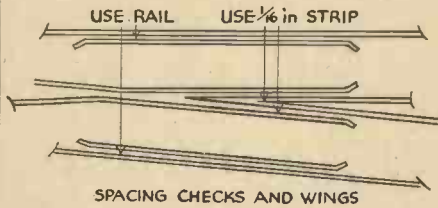


Fig. 18.—Method of arranging frogs and ramps at the points.

sleeper, which may be temporarily fixed now, rather close up to the first fixed sleeper, and inside of it.

Crossovers

For crossovers the work is almost the same. First form the shape of Fig. 17. See that there is a straight section between the two tracks in the crossing. This can be arranged by means of a piece of stripwood 16·5 millimetres wide. Better still is a piece of metal, as this does not wear off the true guage. Conductor rails are always best when placed outside the track. This entails much less work and complication of wiring at points, and looks better. Correct brass holders can be obtained commercially, though $\frac{3}{8}$-in. No. 5 round-headed brass screws will be found useful. These are screwed flush with the baseboard. Set them in where there are to be only cardboard sleepers. The conductor is then soldered on, taking care to bend down the end of the conductor as shown whenever such an end occurs. Fishplates should be used throughout the whole of the track and conductor-rail system.

With cardboard sleepers, ballasting is desirable. When all the track is ready for laying, and before the metal portion is fixed down, coat the bed of the ballasting with slightly diluted glue. Work in between the sleepers, but avoid touching any part of the cardboard surface. Now lay the length of metal track and fix down while the glue is drying. The glue should be duly diluted so that it will not set beyond the tacky stage until the track is laid. Then sprinkle the whole surface with ballasting material—bird-grit (very fine), emery powder, coarse *washed* sand (salt sand will not stick), or whatever is desired. Let it thoroughly set, then dust off the loose with a painter's dust-brush. A good working standard radius for single curves is 24 in. to the outer edge of the outside rail. The 6-ft. way is $1\frac{1}{8}$ in. between rails, and the diameter of the outer curve of double track $25\frac{7}{8}$ in. These are not inflexible dimensions, but they have been adhered to in this article.

RANDOM NOTES

A Tool Capable of 50,000 r.p.m.

THE enormous speed of 50,000 r.p.m. is attained by a small hand-operated grinding device with flexible shaft (when working permanently), which will be shown at the coming Leipzig Spring Fair. It is capable of tooling the hardest working materials, and in addition to grinding, filing and milling can be done, also polishing and brushing of steel pieces. Furthermore, it may be used for engraving and carving and for swaging of any kind. Glass, too, can be tooled with it. In spite of the very high number of r.p.m., and the fair-sized motor of $\frac{1}{8}$ h.p., the price of the machine is reasonable, and it will stand hard wear and tear.

A Universal Bending Device for Mechanics

IT is always a troublesome task to bend pipes of any size, iron bars, and profile iron. It generally necessitated the use of two special machines. A universal bending device has now been produced which combines both kinds of existing designs and will bend rigid pieces of metal, as well as pipes of any size and gauge, without core. Work can be done either cold or warm, and the device can be adjusted to any kind of bending, whether the angle is round or acute. It should be specially mentioned that the device turns out work evenly and neatly.

Novel Soldering Bit

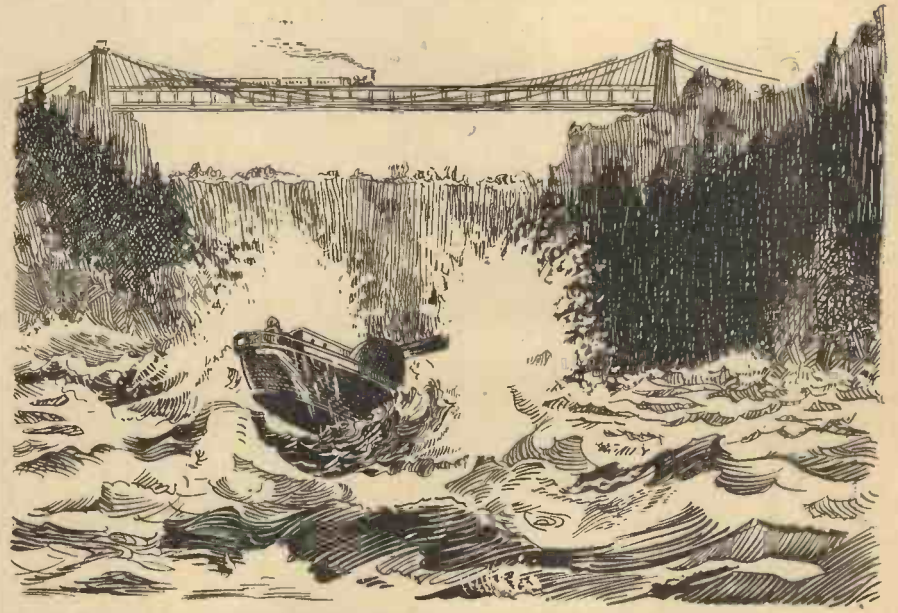
FOR wireless amateurs and domestic work there will shortly be introduced an electric soldering bit, where the current can be switched on by simply pressing down the thumb at the handle. This novel apparatus works neatly and economically as regards current consumption. Owing to the heating device being embedded in the copper point, the efficiency is high and the time required for heating up short.

Aerial with or without Screen

THE latest wireless device takes the form of a novel design of screen for aerials which will improve wireless reception. Within the screen, there is a device for relieving the stress, so that the screened cable may be freely suspended. By means of a special switch, reception without screening is possible with short-wave reception, and when there is no interference. This switch is fitted as easily as a wave trap, since it is fitted in the same way.

A Novelty for Lathes

AMATEURS and small mechanical workers have always been at a loss to get a lathe chuck, which is both exact and light. At the coming Leipzig Spring Fair such a chuck, at a reasonable price, will be exhibited in sizes of $3\frac{9}{32}$-in., $4\frac{9}{64}$-in., and 6-in. diameters. The tension of the chuck, its exactness, and its durability are quite equal to those of more expensive designs. For light lathes, the same firm is showing a novel design in which the weight of the lathe-chuck is reduced by one-third without impairing its durability and its exactness.



The small steamer shown, which is known as the "Maid of the Mist," daily performs the hazardous task of navigating the dangerous torrent below Niagara Falls. An article which describes the trip in detail appeared in our December 1935 issue.

Model Aero Topics

Capt. Bowden's "Blue Dragon" flying in Scotland.

By F. J. Camm

THE world-wide interest in miniature petrol-engined model aircraft has brought into prominence the defects in the present system of timing records. As it is, a record flight is timed from the moment it leaves the ground (or water as the case may be), until it passes out of the vision of the official time-keeper. He is not allowed to move from the spot where the timing commenced, he may not use field glasses, and he must not follow the flight of the model on a bicycle, motor-cycle, motor-car, or chase it in a full-sized aeroplane. Thus, one builder may be fortunate in selecting an officially-pointed time-keeper whose sight enables him to follow the flight for a maximum time, whereas another may have the misfortune to pick a time-keeper whose sight is weak; or again, on one day visibility may be good, whilst on another it may be poor. Thus the record, instead of being decided as a matter of fact is largely dependent on luck. I do not cast any aspersions on the bona fides of a time-keeper, and I am sure that they do their best to interpret a rule which they helped to make. I learn from an authoritative source, that this rule is likely to be changed in the near future. At least, I hope it will, and that the whole question of the control of model aircraft in this country is subjected to severe overhaul. I would remind my readers of the following facts.

The Only Officiating Body

At present the S.M.A.E. is the only body recognised by the Royal Aero Club to govern the sport of model aircraft in this country. Before the War, this authority was delegated to the Kite and Model Aeroplane Association, whose active Secretary was Mr. W. A. Akehurst. After the War, this Association was not resuscitated, and it was at my suggestion, made at one of the meetings of the London Model Aero Association, that they approached the Royal Aero Club with the idea of taking over control. They acted upon my advice and became the official body. Unfortunately, the ideal which I sought to attain has not materialised. I had in mind the creation of a National Body, whereas the S.M.A.E. has never been much more than parochial, with a competition committee which makes competition rules, and is enabled to enter its own competitions. I also had in mind the fostering of the amateur spirit, whereas it is idle to deny that trade interests are permitted to enter into competitions and those engaged in the manufacture of model aeroplanes are allowed to compete with amateurs. This is definitely wrong, and I should like to see that system changed. The competition rules have always been ambiguous, and this rule about the timing of records is perhaps the most fatuous of all of them. I am well aware that my opinions are distasteful to some members of the S.M.A.E., but I am sincere in my expression of them. I have drawn the attention of the Royal Aero Club on one or two occasions to these drawbacks but so far without effect. I should like it to be clearly understood that my opinions are impersonal, and are directed against principles and not persons.

An American petrol engine mounted on a test block. It is fitted with a cast-iron liner, one ring, balanced crankshaft, rotary valve. It weighs, all on, 2 lb.

Cross-country Flights

There is another aspect of the record timing problem which needs to be taken into account. Unless something is done to control cross-country flights of models weighing between 6 to 8 lbs. and driven by an engine and airscrew turning over at anything between 3,000 and 6,000 revolutions per minute, it will shortly be made illegal for such flights to be made. As it is, petrol models are sent up and, in many cases, fly out of sight. They may fly into other aeroplanes, or fly into the windscreen of passing cars; they may sadly mutilate some human being. Therefore I would urge that in future record attempts where a time-control device is not fitted, a rule should be made that the model must keep to a circular course and be fitted with automatic lateral control devices. The flight of a petrol model is nowadays limited only to the amount of petrol

Two camps at the National Model Aeroplane Meet at St. Louis, Missouri, during last September.

carried, and the time seems ripe to overhaul the whole structure of model aircraft government and competition rules.

In America

The situation in America is vastly different; there they have enormous tracts of land, ideally situated for the flying of such models. There are literally hundreds of people in America who have built and are building power-driven aircraft and some of the pictures which I give this month have been sent to me by one of the leading American model fliers and manufacturers—Mr. J. S. Ott, to whom I am indebted for permission to reproduce. Whereas in England we build solid, fairly heavy jobs requiring a flying speed of from twenty miles an hour upwards, in America, models of 8 ft. span are made weighing only 3 lb., and they fly very slowly.

Another competitor at St. Louis, tuning up.

Lighter Models

It would seem, therefore, that in England, we might reasonably explore the possibilities of building lighter models with lighter loading, and hence low-flying speed. I also feel that some protective device should be fitted round the airscrew. It will be remembered that rubber-driven models before the War, had to be fitted with protectors when models were of the tractor type. This encourages the thought that machines of the Canard and Farman type are less dangerous, and in any case, entail less risk to the power unit, or to members of the public in the event of a crash.

It would seem also, now that the possibilities have been demonstrated, that smaller petrol engines might be used, suitable for models of not more than 3 ft. wing span.

I am very pleased to know that so many readers have successfully built and flown the petrol-engined model which I designed and described in these pages towards the latter end of last year. Blue Prints for this model are still available.

There seems room for the suggestion that there should be a special club for builders and fliers of power-driven model aircraft. Any readers who are interested in this suggestion might get into touch with me.

A fine example of power-driven model aircraft.

An interesting photograph showing a rubber-driven model just about to take off.

ALL RADIO QUESTIONS ANSWERED FREE

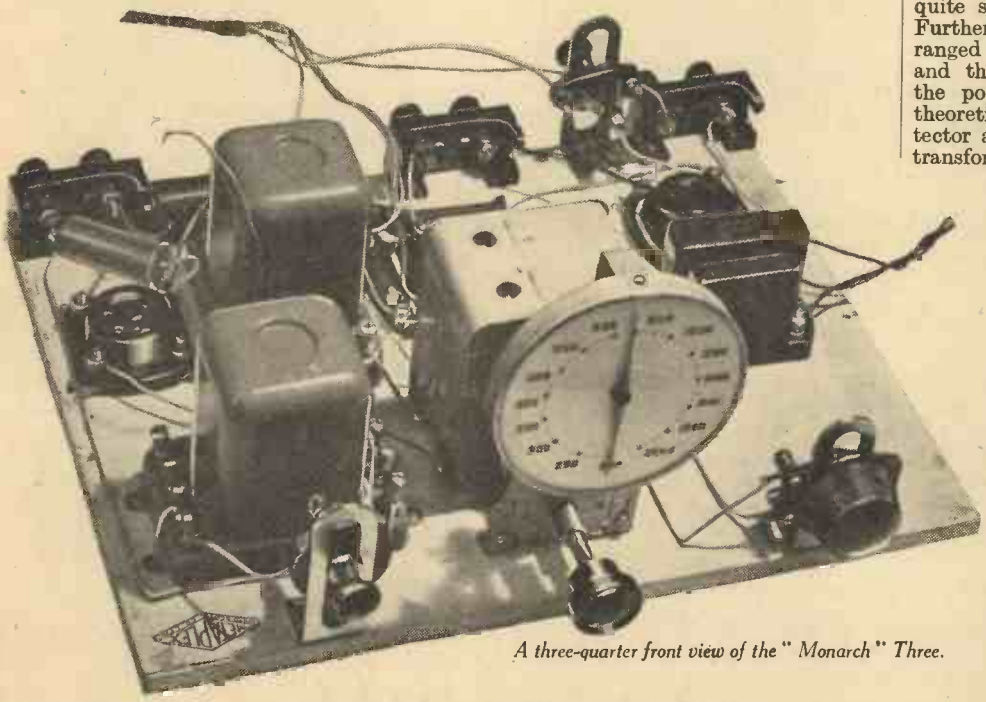
Every Question must be accompanied by the Coupon on page iii of Cover

The PRACTICAL MECHANICS Wireless Experimenter

THE "MONARCH" THREE

An Efficient Three-valve Battery Receiver Designed on Strictly Economical Lines

A STAND-BY receiver will appeal to every constructor, and to many beginners there will also be an appeal in a simple three-valve set which may be constructed in the shortest space of time and which may be relied upon to provide good reception of a number of stations without tricky adjustments or complicated trimming settings. The "Monarch" Three has been designed to fulfil these needs and, as will be seen from the illustrations, we have departed from our usual chassis form of construction. Many constructors have written to us asking for a design which could be built upon a normal flat baseboard, and we decided that the next simple receiver which we designed should be arranged on these lines to meet this request. Consequently, the constructional work is slightly simplified in this receiver, although in view of the very few wires that are required, there is not a great deal of work required in any case. The overall dimensions are naturally increased somewhat, but the layout is perfectly straightforward, and bearing in mind the fact that many beginners will be anxious to make up this receiver the parts have been so arranged that every terminal is in an easy-to-get-at position, and every part is ready to hand for testing on future occasions should a fault develop.



A three-quarter front view of the "Monarch" Three.

The Circuit

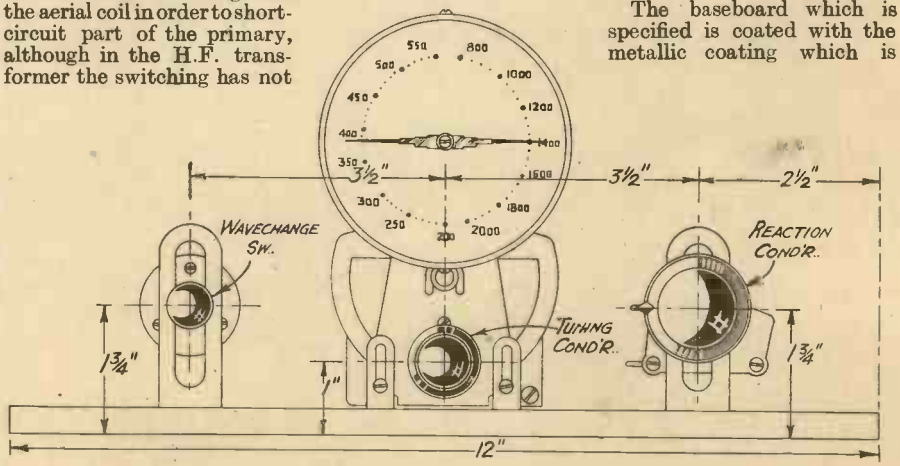
As may be seen from the circuit the familiar S.G., detector, and output stage are employed, and tuning is accomplished by means of a two-gang condenser connected to two H.F. transformers. The latter are of an entirely new type, produced by Messrs. Wright and Weaire, and these are similar to the Universal coils previously placed on the market, with the refinement of a tapping on the primary. In the circuit it will be seen that a switch is arranged in the aerial coil in order to short-circuit part of the primary, although in the H.F. transformer the switching has not been adopted. This simplifies the connection by enabling a simple three-point switch to be employed, and the results on both long and medium waves are almost as efficient as if the coil were switched.

The Layout

To render the circuit perfectly stable the coils, which are of the screened type, are not arranged symmetrically. The method in which they have been arranged permits of a very short lead to the tuning condenser in each case, and the remaining connections to the terminals also become quite short and interaction is prevented. Furthermore, the screen-grid valve is arranged on one side of the H.F. transformer and the remaining valves are placed in the position which they occupy in the theoretical circuit. Coupling between detector and output valve is by means of a transformer which has a ratio of 5 to 1, thus providing a good step up in strength. Ordinary leaky-grid rectification is employed and reaction is applied to the H.F. transformer. Pick-up connections are provided and the leads to the pick-up are left permanently in circuit, although, if desired, a switch may be incorporated at a later date in order to prevent radio break-through when records are being played. It will be noticed that the on-off switch has been mounted on the rear of the chassis, but this is no detriment as the majority of mains receivers have the on-off switch mounted in some position other than on the panel and the switch is only operated before and after listening. The remaining controls thus form a symmetrical layout, and there is no loss of balance due to the inclusion of an odd number of controls.

Constructing the Receiver

The baseboard which is specified is coated with the metallic coating which is



Cabinet drilling dimensions of the "Monarch" Three.

LIST OF COMPONENTS

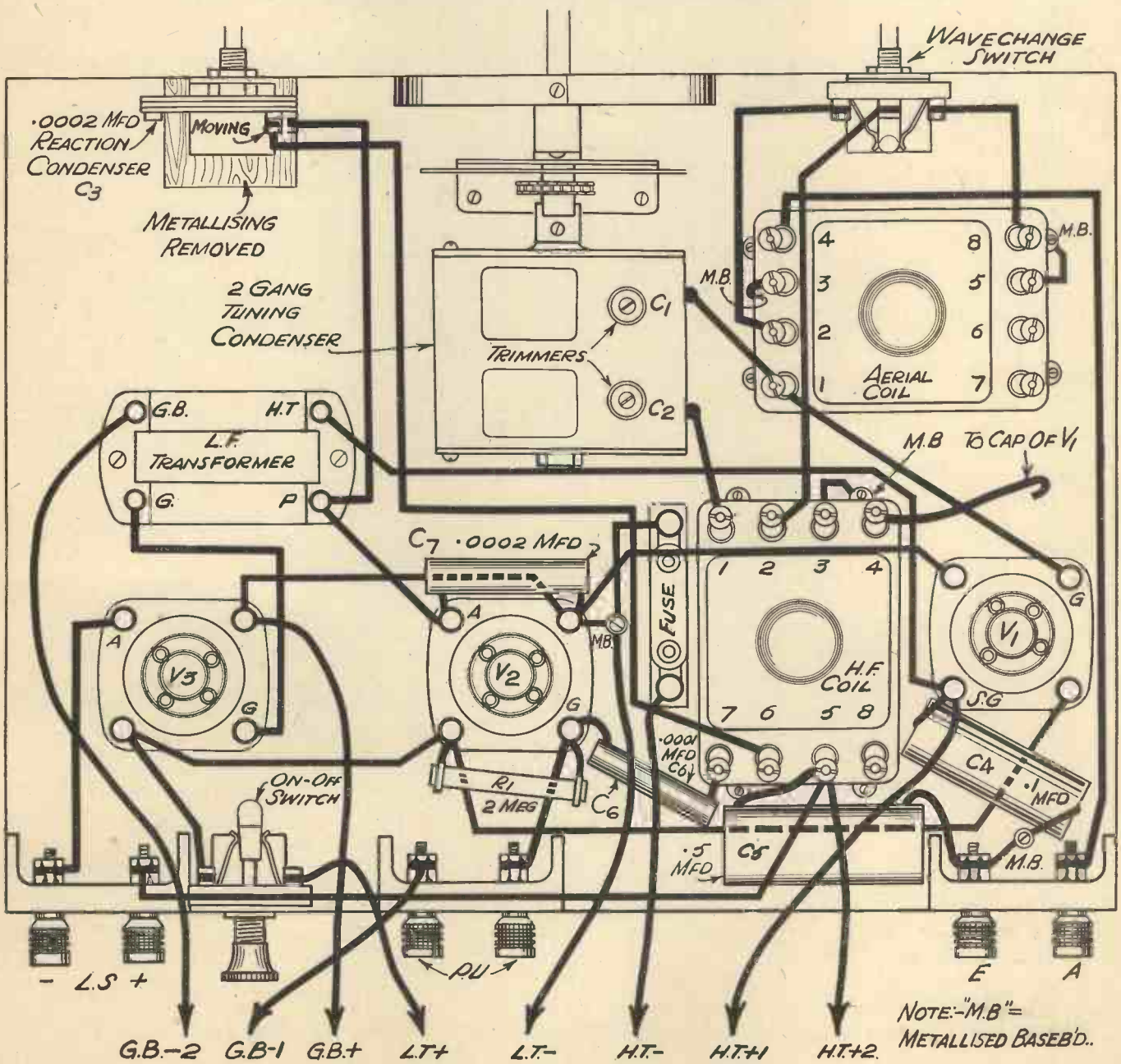
Two " Unigen " coils (Wearite).
One Baby ·0005-mfd. Two-gang Condenser (C1 and C2) (J.B.).
One Airplane Dial (J.B).
One Dilecon ·0002-mfd. Reaction Condenser (C3) (J.B.).
One 5-1 L.F. Transformer (L.T. 150) (B.T.S.).
One ·5-mfd. Tubular Condenser (C5); one ·1-mfd. Tubular Condenser (C4); one ·0001-mfd. Tubular Condenser (C6); one ·0002-mfd. Tubular Condenser (C7) (Amplion).
One 2-megolm Grid-leak (R1) (Amplion).
One Three-point Wavechange Switch (SW1) (B.T.S.).
One On-off Switch (SW2) (B.T.S.).
Three Component-mounting Brackets (Peto-Scott).
One Microfuse (100-mA) (Microfuse).
Three Vibrolders (Benjamin Electric).
One Metaplex Baseboard, 12 in. by 9 in. (Peto Scott).

Accessories

One SG.215 Valve (V1); one D.210 Valve (V2); one P.220 Valve (V3) (Hivac).
One Amplion Loudspeaker.
Three Terminal Mounts (Belling-Lee).
Six Terminals, A., E., L.S., L.S., P.U., P.U. (Clix)
Six Wander Plugs: H.T. + 1, H.T. + 2, H.T. −, G.B. +, G.B. − 1, G.B. − 2. (Clix).
Two Spade Terminals: L.T. +, L.T. − (Clix).
One H.T. Battery " Super Life " (120-volt) (Drydex).
One L.T. Accumulator (2-volt) Type DMG—C (Exide).
One 9-volt G.B. Battery Type H1001 (Drydex).

adopted on the chassis which we normally employ, and this facilitates certain earth return connections. Before commencing construction, the various components should be placed in the position they are eventually to occupy, taking as your guide the illustrations and the wiring diagram. Having ascertained that every part is in its correct position the various screw fixing holes should be marked through with a pointed instrument and the holes for the ganged condenser, carefully set out by the aid of the makers' template. These holes should be drilled through the chassis with an $\frac{1}{8}$ in. drill, and the under surface should be recessed with a $\frac{1}{4}$ in. drill to approximately half the thickness of the baseboard to enable the screws to be countersunk. Now before mounting the condenser unit carefully tin the two connecting tags on the side and attach to these a short length of connecting wire. Mount the condenser and then screw down the valve-holders, transformer and terminal blocks. The left-hand component-mounting bracket is next attached, and when the position for the right-hand one is accurately located the metallised

WIRING PLAN OF THE "MONARCH" THREE

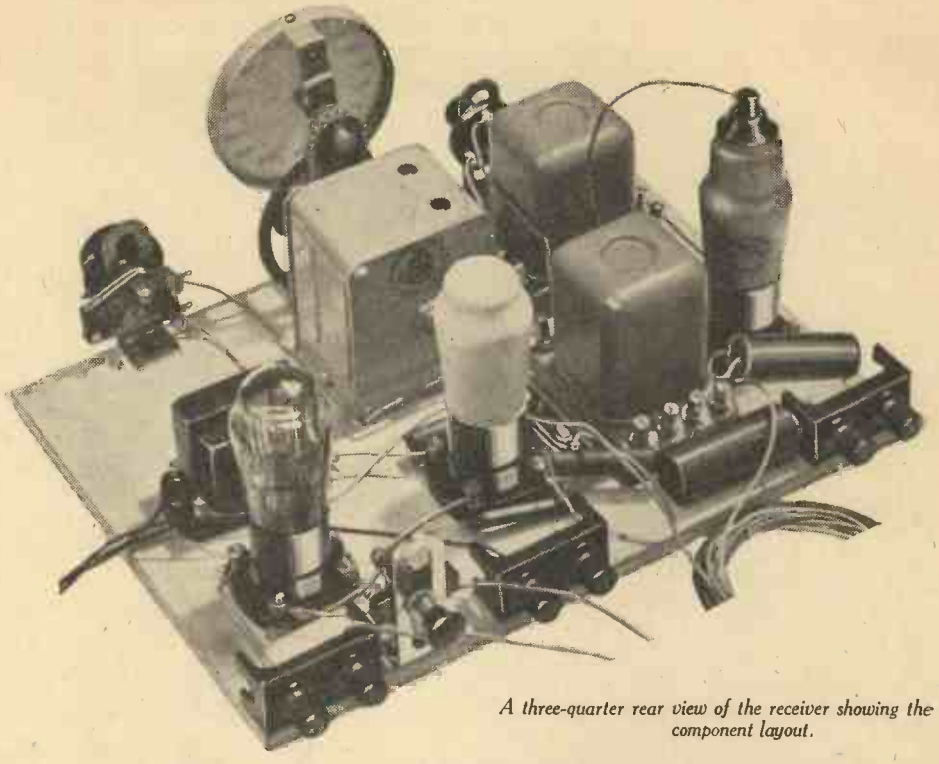


coating of the baseboard should be scraped away. An ordinary penknife will suffice for this operation and the area which is cleaned should be slightly greater than the foot of the bracket. Now mount this bracket and next mount the two coils. It will be seen in the wiring diagram that there are some wires attached to the terminals on the coils which are marked "M.B." These are short bare wires, attached to the terminals and turned underneath the coil base before tightening up the holding-down screws, and the wires are thus in contact with the metallic surface of the baseboard, which is earthed, and as the left-hand component bracket is also in contact with the surface the coil switch becomes automatically converted into a four-pole shorting switch and is placed across the coils in the correct manner.

Testing

When all parts are in position the wiring may be commenced, and for this purpose the ordinary type of covered wire should be bared for a distance of about ½ in. in order to permit the bare wire to make good contact beneath the terminal head. Remember to make the loop in a clockwise direction so that when the terminal head is tightened up the loop will be kept beneath it and not forced out. The tubular condensers are attached direct from terminal to terminal without the necessity for soldering, and the lengths of wire attached to these components may be cut to preserve a neat appearance. Each wire should be placed, as nearly as can be ascertained, in the position shown in the illustrations and wiring diagram. This applies especially to the lead from the reaction condenser to the coil No. 2, and it should be noticed that this lead is joined to the terminal on the reaction condenser which is connected to the moving vanes. This precaution will avoid hand capacity effects. The leads (those for the grid bias supply H.T. and L.T.) are made from flex and wander plugs are attached to these. The length of these leads should be chosen so that the batteries may be placed on the baseboard on the right. The leads may be attached to the chassis by means of a small wooden or ebonite cleat to avoid them being pulled off and a short-circuit resulting.

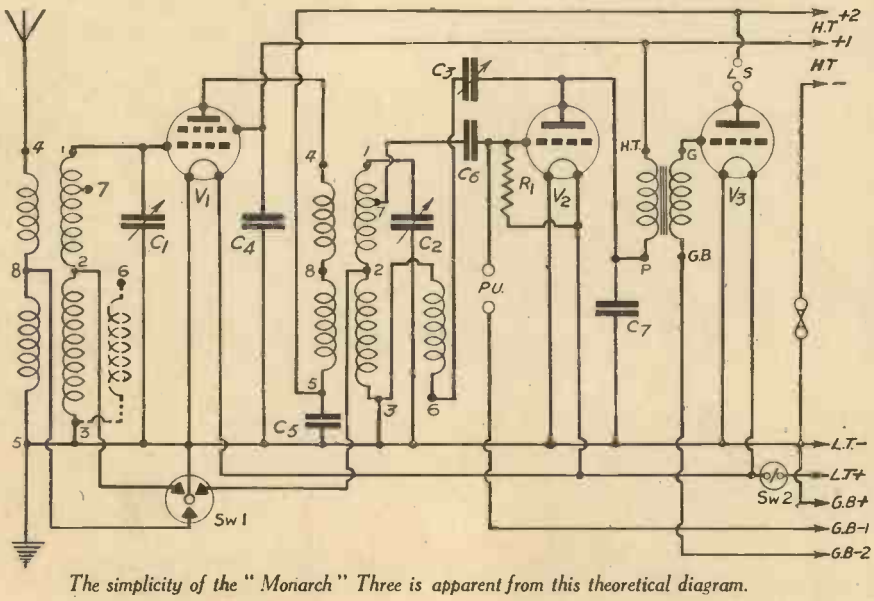
The three valves should be inserted in the order shown, the screen-grid on the left and the pentode on the right. The detector valve occupies the central position. The battery leads should be inserted into the H.T. battery, the positive 2-plug in the 120-volt socket, the positive 1 plug in the 60-volt socket, and the negative plug in the negative socket. The grid-bias plugs are inserted as follows: G.B. + in the positive socket, G.B.1 in the 1.5-volt socket, and G.B.2 in the 9-volt socket. Pull out the left-hand switch (thus bringing the circuit into use on the medium-wave band), and set the reaction condensor to zero.



A three-quarter rear view of the receiver showing the component layout.

Operating Instructions

Pull out the switch at the rear of the chassis and the receiver is in working condition. Rotation of the tuning dial should bring in the local station without any need of trimming, although to obtain maximum sensitivity it is essential that each of the circuits is correctly adjusted. With a screwdriver or similar implement carefully turn the trimming screw on the section farthest from the controls, carrying out this adjustment on a station at the lower end of the scale and then turning to the upper part of the medium-wave band.



The simplicity of the "Monarch" Three is apparent from this theoretical diagram.

THE BENNETT MICROPHONE

A VERY neat and low-priced microphone has been produced by H. J. Bennett, and this is suitable for use with practically any type of broadcast receiver or amplifier. The unit, which is of the small carbon type, is provided with an additional diaphragm of special construction, having an over-all diameter of 2⅛ in. This is housed in a rectangular metal box provided with a 2¼-in. by 1½-in. opening protected with the usual metal gauze, and this box is suspended by three springs in a metal ring 6 in. in diameter. This in turn is mounted on a vertical support fitted to a metal and wood base in which is a standard type matching transformer. The secondary and primary terminals are brought out to terminals so that the microphone may be connected to any type of input circuit with provision for biasing, and also for the inclusion of a small voltage across the microphone and primary to improve sensitivity. The maker's instructions should be carefully adhered to when connecting this useful device to a receiver, and when suitably placed in respect to musical instruments, or with regard to a speaker or announcer, very good results will be obtained. The base of the microphone is felt-covered to prevent damage to any polished surface upon which it may be placed. The price is 10*s.* 6*d.*

The LATEST Novelties

The address of the makers of any device described below will be sent on application to the Editor, PRACTICAL MECHANICS 8-11, Southampton St., Strand, W.C. 2. Quote number at end of paragraph.

The "Avo" Exposure Meter

THE ingenious photo-electric exposure meter shown below has been designed to enable the photographer who values good results, to take his pictures with the assurance of success, avoiding the all-too-frequent failures due to exposure errors. It is equally suitable for still and cine cameras, giving direct reading of exposure time or "*f*" stop without calculation. A simple setting is made to allow for the speed of the plate or film which, when set, need never be altered unless films of a different speed are used. The meter is extremely sensitive to weak light. It is designed in such a way that extraneous light outside the normal picture angle is excluded, by placing the light-sensitive cell deep back into a partitioned compartment of the meter. More accurate exposures are therefore assured. The meter is free from errors due to eye fatigue when using the optical type, while the fact that it can be used to give instantaneous indication of exposure immediately

The Avo exposure meter is a simple instrument from which can be read directly the exposure that is necessary for the prevailing conditions at the time of taking a photograph. This instrument is suitable for both still and motion cameras.

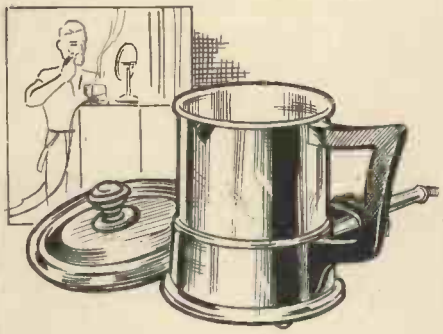
before taking a photo, ensures the possibility of obtaining suitable exposures under rapidly changing light conditions. It costs 57*s.* 6*d.* [169.]

Paint-spraying Equipment

PAINTING and decorating by means of a brush is rapidly becoming a thing of the past. The modern method of applying paints and other liquids to surfaces is by means of an atomised spray projected from a mechanical device—known as the spray gun—the function of which is to "mix" the air and the liquid and project it fan-wise onto the required object in an even stream. Thus the advantages of the "Bedal" Crystal spray gun, which is now being marketed at the moderate price of 35*s.*, are enormous. There are no brush marks to worry about, and the paint is evenly distributed over the object being painted. The gun is constructed for use with any domestic vacuum cleaner, and sprays any liquid. It requires no cleaning between colours, as it is only necessary to change the container. The speed of the spray over flat surfaces is remarkable. Three square yards can be thoroughly covered in from 40 seconds to 1½ minutes, according to the efficiency of the vacuum cleaners used. [170.]

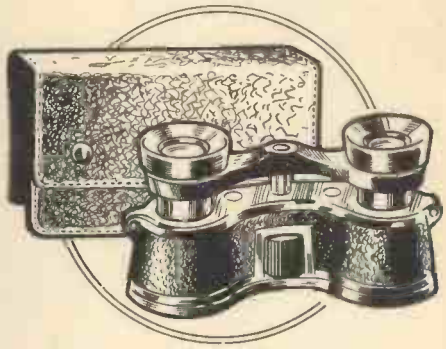
Bakelite Novelties

WE show at the foot of this page a clock, thermometer and barometer, each of which is fitted in an attractive bakelite case.



This electrically-heated shaving pot will make its appeal to all men who appreciate really hot shaving water.

The cases can be obtained in black, brown, walnut, oak, mahogany or various mottle finishes. The clock, which is an accurate timepiece, measures 3¼ × 4¼ × 1¾ in. and costs 6*s.* 9*d.*, whilst the thermometer, which is similar in size, and is an extremely reliable instrument, costs 5*s.* 6*d.* The third item, the barometer, is fitted with a sensitive and accurate movement and is marketed at 12*s.* 6*d.* [171.]



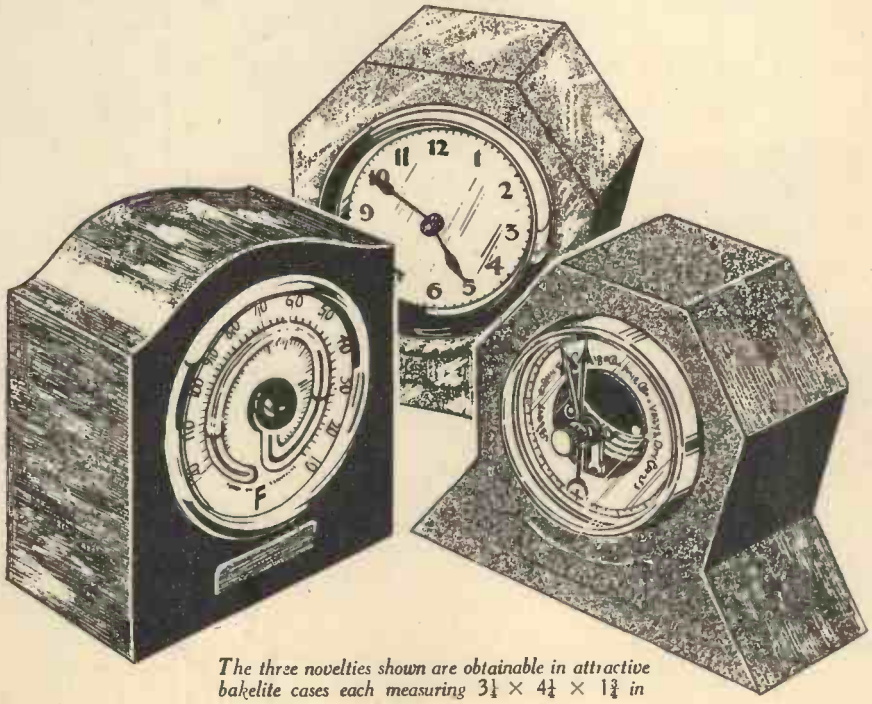
Sturdily constructed opera glasses which can be obtained in a variety of colours and are supplied complete in a case with a carrying strap.

An Electric Shaving Pot

EVERY man appreciates really hot water for shaving, and as the shaving pot illustrated heats the water in two or three minutes it should prove a popular accessory for the bathroom. It is sturdily constructed of chromium plated copper, and is mounted on heat insulating feet. Priced at £1 7*s.* 6*d.*, it is supplied complete with connector, 6 ft. of flex and a bakelite lampholder adaptor. [172.]

Compact Theatre Glasses

MODERATELY priced at 25*s.* these theatre glasses (see above) are of excellent workmanship, and are obtainable in a variety of colours. The polished moulded body is of synthetic material of dainty, yet sturdy, design, and the metal parts being chromium-plated makes for "serviceability." The optical elements are accur-

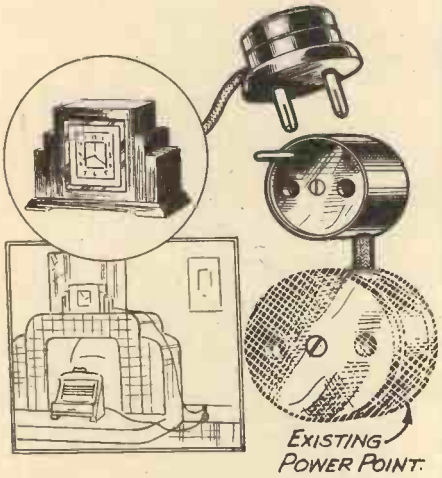


The three novelties shown are obtainable in attractive bakelite cases each measuring 3¼ × 4¼ × 1¾ in

ately computed and a magnification of 2½ times is obtained by means of a unique optical design which gives a wide-angle field of view. The glasses are supplied complete with black morocco or black moire silk case, fitted with a neat carrying strap. [173.]

A Safety Power Point

SPECIALLY designed for use with electric clocks the plug and socket illustrated is sold at 2*s*. 10*d*. The projecting pin on the



A safety power point specially designed for use with electric clocks.

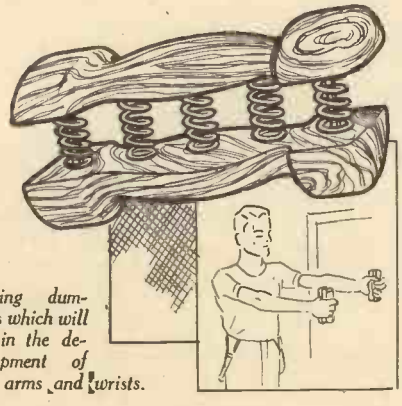
socket fits into a hole in the plug, and is locked in position by tightening the set-screw at the side of the latter. This prevents the plug being inadvertently knocked out and so stopping the clock. [174.]

Shaving Blades with Two Kinds of Edges

SHAVING blades with two kinds of edges, called "Contento," are a novelty which has been introduced by a firm in Solingen. Either of the two cutting edges of the blade is ground narrow on one side and wide on the other. It does not matter how the blade is inserted into the shaving device, there will always be a narrow edge on the one and a wide edge on the other side. For a clean shave it is, therefore, only necessary to turn the shaving device round. The great advantage of this novelty is that the edge of the blade with the narrow side, comes much closer to the comb than the one with the wider edge, so that the latter is specially suitable for preliminary and final shaving. [175.]

Spring Grip Dumbells

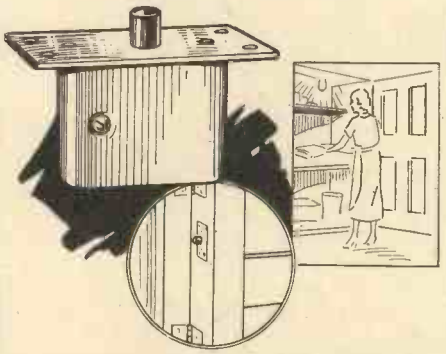
COMBINING the advantages of the wrist exerciser and the dumbell these should prove popular with all readers interested in physical culture. They are made in weights varying from 1 lb. to 3lb. and with 3, 4, 5 or 7 springs incorporated, and are finished in a range of bright-coloured enamels. They cost from 5*s*. to 8*s*., but polished nickel-plated models are obtainable at 7*s*. to 11*s*. 6*d*. The carriage is extra. [176.]



Spring dumbells which will aid in the development of the arms and wrists.

An Automatic Switch

ROBUSTLY constructed, the switch illustrated will be found useful for a variety of purposes. The inset sketch

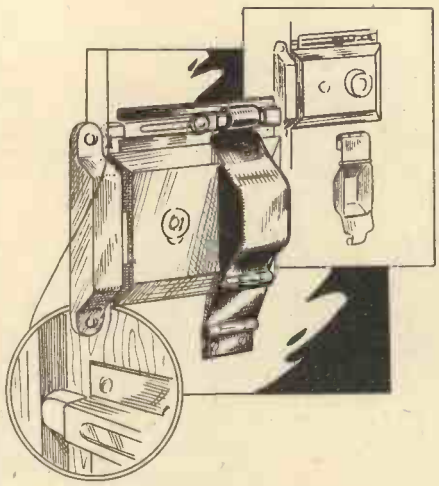


An automatic switch which, when fitted inside the jamb of a door as shown operates a light inside the cupboard when the door is opened.

shows the switch fitted in a cupboard door and, being normally in the "on" position, the light will be switched on automatically when the door is opened. The closing of the door presses the button in and switches off the light. The capacity of the switch is 1 amp at 250 volts and costs 5*s*. 6*d*. post free. [177.]

A Safety Lock Protector

THE lock protector sketched, forms a neat and efficient method of preventing the door being opened except by means of a key. It is particularly useful for the type of front door which has a glass panel close to the lock, for it is a simple matter



A safety lock protector.

to break the glass, insert the hand, and turn back the lock. This shield, however, fitting over the door knob, is held in position by the bolt and can only be removed when the door is open. The fitting is supplied complete in two finishes, stove black at 2*s*. 9*d*. and oxidised at 3*s*. 3*d*. In both cases the carriage is paid. [178.]

A Weather Cottage

A Simple Little Novelty for Indicating Wet or Dry Periods

Fig. 1.—The finished weather cottage. The girl indicates fine and the man wet weather.

MOST readers are familiar with the novel type of weather cottage shown in Fig. 1. Simple in construction, it should offer no difficulties to the average handyman. Commence by cutting the base of the cottage from a piece of wood measuring 7 in. × 2½ in. × ¼ in. The dotted lines shown in Fig. 2 indicate the position of the back, front, and ends. Next mark out the front as shown in Fig. 3, which is cut from a piece of wood measuing 9⅛ in. × 6½ in. × 3/16 in. The dotted lines round the window on the right indicate the position of the overlays for holding the glass in place. These are cut to the dimensions shown in Fig. 3. The window sills, which are 2 in. × 3/16 in. × ⅛ in. are then glued underneath the windows in the position shown by the dotted lines (see Fig. 3).

The Back

This is cut to exactly the same shape as the front, omitting all interior openings, but having the slot in the top to take the ridge piece. The two ends are just plain rectangular pieces, measuring 5⅞ × 2 in. × 3/16 in. Having cut the parts mentioned, screw them together as shown in Fig. 6.

The figures may be cut from a magazine, and should measure about 2½ in. in height. Paste them on to a piece of ⅛-in thick wood, and cut to outline, leaving a tenon ¾ in. long by ⅛ in. deep on the botton edge to fit into the mortice in the platform. Cut the platform as shown in Fig. 5, with a mortice ¾ in. × ⅛ in. in each end, ½ in. from each edge. Drill a hole in the centre in which to fix the catgut.

Glue the tenons on the figures into the mortices in the platform and fit the catgut as shown in Fig. 6. Now adjust the catgut so that the platform swings about ⅛ in. clear of the floor of the cottage.

Having fixed the interior parts, the front may now be screwed into place. Next cut the ridge piece as shown in Fig. 4 and glue this in the openings at the front and back of the house.

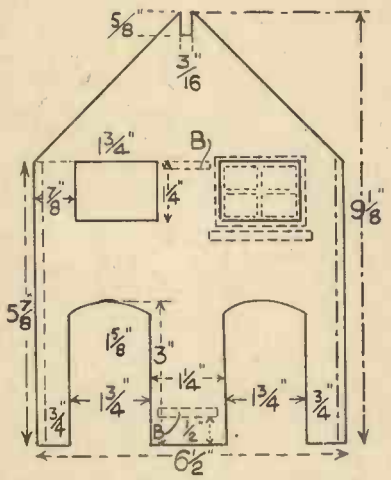


Fig. 3.—The front of the cottage.

The Roof

Cut the two roof slopes measuring 5 in. × 2½ in. × 3/16 in. Chamfer them only on the top edge to fit close to the ridge piece, and screw into place. The two gables should then be cut as shown in Fig. 4, and fitted into place.

The cottage is now complete and may be finished by covering with brick paper and the roof with tile paper.

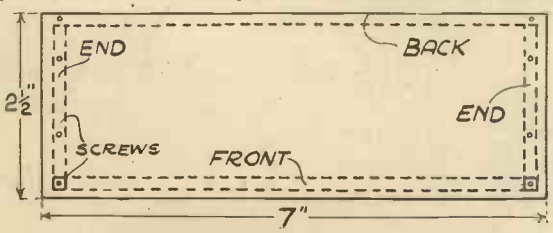


Fig. 2.—The measurements for cutting out the base.

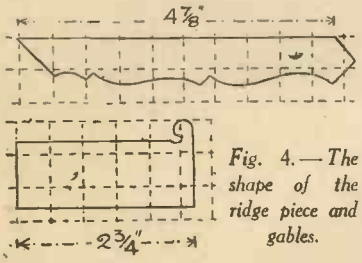


Fig. 4.—The shape of the ridge piece and gables.

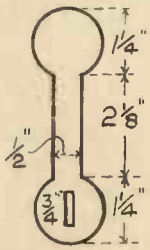


Fig. 5.—The platform.

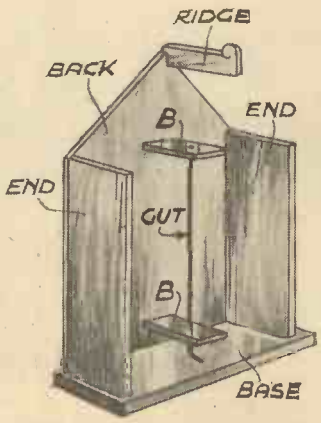


Fig. 6.—How the back is screwed together.

THE "SIMPLAT" SOUND-RECORDING DISC

DURING the past ten years, various efforts have been put forward to produce a sound-recording disc for immediate play back, that will give results approaching ordinary gramophone records. However, the construction of the carrier of the disc and the composition of the coating have sometimes given disappointing results with regard to quality, surface noise, and durability, and these discs have seldom had serious consideration.

As a result of careful investigation and tests, the V.G. Manufacturing Co., Ltd., have now succeeded in producing a sound-recording disc under the name "Simplat," giving in every respect results equal to those obtained on the present-day electrically-recorded gramophone record.

The Construction of the Disc

The "Simplat" sound-recording disc consists of a glass carrier coated with a special composition, which makes it very easy to handle, so that the cut is very clean and noiseless. The glass acts as an excellent sound carrier, enabling the record to take, and reproduce an unusually large frequency range. At the same time, by being absolutely flat under all conditions, it makes the cut safe and regular. No elaborate system or method is required for recording, and any reasonable standard outfit, consisting of a wireless receiver or amplifier, turntable, and pick-up with tracking device, is suitable to make recordings from the ordinary wireless programmes. Of course, for direct recording purposes, a microphone has to be used in front of the amplifier or wireless receiver.

How Records are Cut

To cut the discs, the firm recommend their special sapphires, each of which will normally cut 24 double-sided 10-in records, if not roughly handled.

Ordinary steel cutting needes may also be used, and in this case up to one 16-in. record may be cut on both sides. The results obtained with their special steel needles are almost as good as those obtained with a sapphire. The correct cutting depth of the groove should be—when using a normal space between the grooves (commercial records)—so that the distance between two grooves equals the breadth of one groove. In this case, the best results as to surface noise and quality, will be obtained. It will be noted that a continuous thread comes off the record, which is not sticky, but sharp and clean. The best cutting angle (angle between cutting needle or sapphire and record surface) should be about 80 to 87 degrees. In the case of the sapphire, special care should be taken to insert it absolutely straight into the cutting-head armature.

After recording, the disc can immediately be played back and will last for about 15-20 playings. To make the record permanent for at least 200 playings, it should be hardened and polished by means of the special fluids supplied by the above firm. Full instructions for use are given on each flask. Polishing fluid is also supplied separately which makes the record still more noiseless.

The hardening and polishing process takes about 5 minutes and may be hastened by applying warm air (hair dryer, resistance lamp, etc.).

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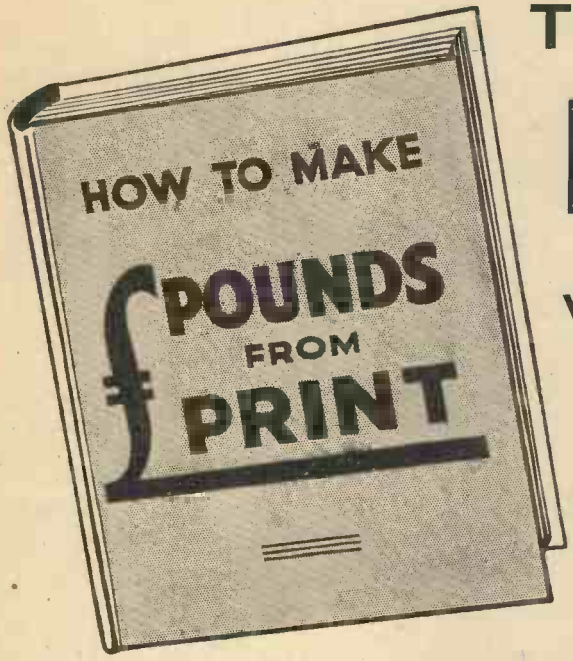

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Woodworking for Beginners

(Continued from page 252 of last month's issue)

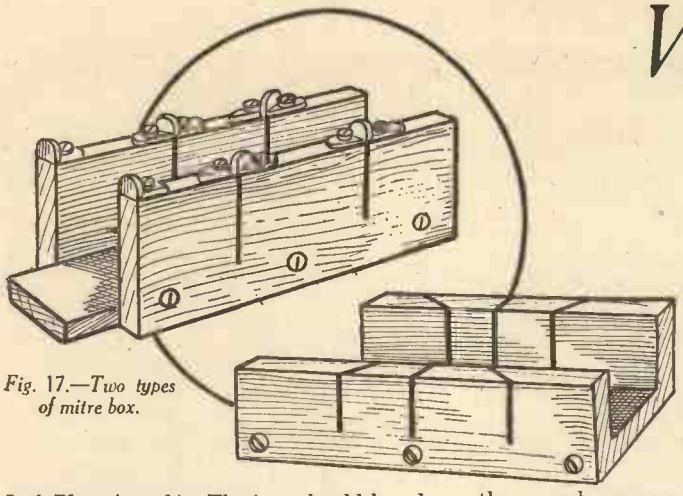


Fig. 17.—Two types of mitre box.

Jack Plane (*contd.*)—The iron should be adjusted so that it projects for a distance of from about $\frac{1}{64}$th to rather more than $\frac{1}{16}$th, depending upon the hardness of the wood being used. If the iron is found to project too far, it can be taken back by holding the plane in the left hand, the thumb being placed a little down the throat. The upper side of the toe should then be given a smart blow with a hammer or mallet. When the correct setting has been obtained the wedge must be driven tightly into position.

When the iron does not project far enough (or has not enough "set") it can be driven down by tapping its upper end with the hammer, holding the plane as before.

It is important that the cap iron should be correctly set, and the position for this is explained under the heading Cap Iron. With old planes the mouth is often too wide, due to the sole having been worn down by continual use. In that case the plane can be re-mouthed by fitting a piece of beech, cut to a triangular or rectangular shape, into a recess made about $\frac{1}{4}$ in. deep into the sole. The new piece of wood must be a tight fit and held in place with good glue. An indication of whether a plane requires to be re-mouthed can be gained by noticing how it works when it is closely set; if the wood appears to "tear" although the iron is sharp, re-mouthing is called for.

Keyhole Saw.—See Pad Saw.

Larch.—The best samples of this soft-wood are obtained from Russia, but it is also grown in many European countries, including Great Britain. The wood is dark yellow in colour and has clearly marked annual rings. It is chiefly useful for outdoor work and is employed for posts, railway sleepers, etc. It wears well and is durable, but is unsuitable for fine work, due to the fact that it warps and twists rather badly during the seasoning process.

Mahogany.—Of two main kinds, Spanish and Honduras, this wood has a rich red colour with chalk-like lines marking the grain. These lines are made up of a flinty substance which fills the pores; it also blunts a plane very quickly. Spanish mahogany is heavier than the Honduras variety and has a much better figure and more handsome appearance. It is extremely durable if kept quite dry and does not warp very badly. The Spanish mahogany is expensive both in prime cost and in working and is therefore only used for high-class work such as cabinet making, bank and shop fittings, etc.

Honduras mahogany is lighter coloured and much easier to work. It is often used for making small patterns, due to the fact that it warps and shrinks very little. In cabinet making it is often used as a base for decorative veneers. It can be obtained in planks up to a width as great as 7 ft. and is thus very suitable for making tops for tables, counters, and desks.

Marking Gauge.—Used for marking lines parallel to the side or edge of a piece of wood. It consists of a stock, with thumb screw, arm or slider, and a pointed piece of steel called the spur. (See Fig. 18.)

Matching Plane.—See Planes.

Matting Punch.—See Grounding Punch.

Mitre Box.—Used for holding lengths of timber whilst they are being mitred, or sawn off at an angle of 45 degrees. Mitre boxes are largely used in making frames for pictures and other similar purposes. They can be bought ready-made in two different types, both of which are illustrated in Fig. 15. The one shown to the left in this illustration is of a more accurate and expensive pattern, and has metal saw guides. That on the right is a simpler pattern which can easily be made from beech or other hardwood.

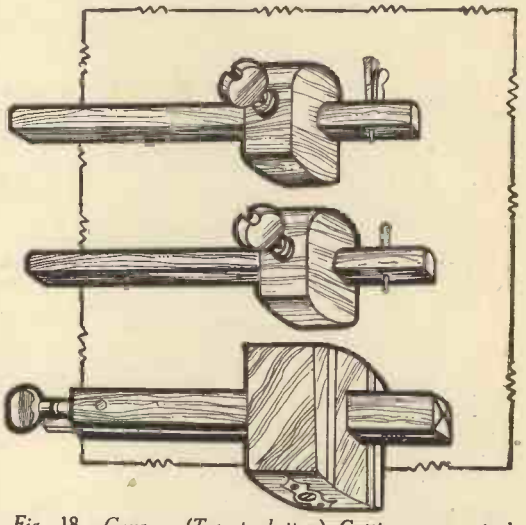


Fig. 18.—Gauges. (Top to bottom) Cutting gauge, single marking gauge, and mortise gauge.

Mitre Template.—This consists of a piece of hardwood L-shaped in section, which is shaped to fit various moulds. The end is cut off to an angle of 45 degrees, and the tool can therefore be used as a guide in sawing and chiselling.

Mortise.—One half of the frequently-employed mortise and tenon joint; the mortise is the rectangular hole or sinking into which the tenon fits. Mortise and tenon joints are very strong and can be used for fastening two pieces of wood of practically any dimensions together at an angle to each other. Common positions for such joints are at the junctions of the uprights and horizontal rails in doors; the joints are also used very frequently in both carpentry and joinery for making rigid frame-like structures.

The correct way to mark out a mortise is by means of a double marking gauge (also called a mortise gauge).

(To be continued)

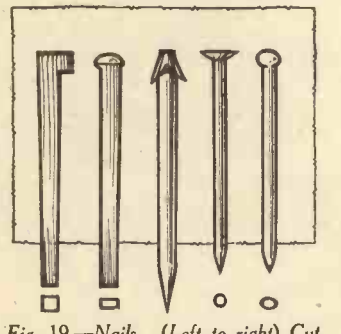


Fig. 19.—Nails. (Left to right) Cut brad, cut clasp nail, wrought nail, French or wire nail, and oval brad.

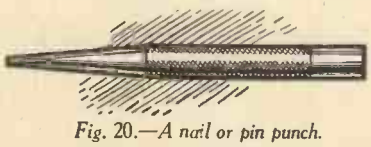


Fig. 20.—A nail or pin punch.

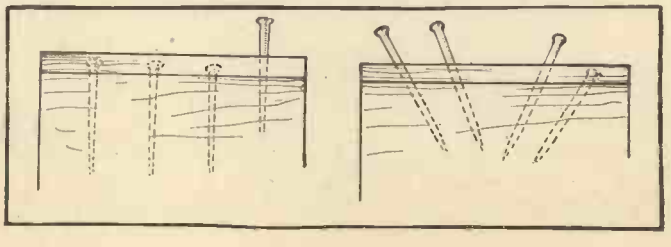
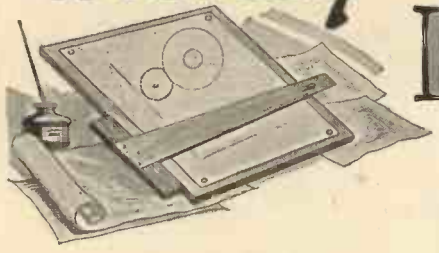


Fig. 22.—(Left) Two methods of nailing; that illustrated on the left does not give so rigid a joint as that on the right.

Fig. 21.—Sections showing different kinds of moulds. (Left to right) Ogee, scotia, hollow, and bead.

Money Making IDEAS



Advice by our Patent Expert

A MULTIPLE-CYLINDER ENGINE

"I WOULD like your advice, re the novelty, value, etc., of the petrol-engine design enclosed. The engine has not been made, and the sketch, of course, is subject to slight alterations, but the principle on which it works, will, I think, be quite clear to you. Although only one cylinder is shown, my intention is to make it a multiple-cylinder engine. Assuming the idea is novel, and I am granted a patent for it as a single-cylinder engine, would this cover any number of cylinders which I might desire to fit?" (T. H., Leeds.)

THE improved double-acting two-stroke engine is thought to be novel from personal knowledge, but in view of the vast number of patents granted for internal-combustion engines, a search should be made for novelty. Assuming the idea is novel, it should be possible to so draft a complete specification, as to cover either a single-cylinder or a multiple-cylinder engine. The inventor is advised to consult a reputable patent agent.

WOOL SPINNING

"I SHOULD be glad if you would let me have your opinion on the following idea, which has actually been put into practice and definitely works.

"The idea is designed to avoid waste, laps particularly, in the process of drawing, gilling, roving, and spinning worsted yarn from tops into the finished yarn.

"The principle may be described as follows:

"As the rovings, etc., go into the spinning frame, they pass over a balanced lever, which, when deflected by slubs, burrs, straws, etc., releases a small steel ball. This ball is run down a suitable channel or pipe to the driving pulley of the machine, and works a simple arrangement whereby the belt is moved from the fast to the loose pulley. The total time taken from the release of the steel ball to the stopping of the machinery, is not sufficient to allow the slubs, etc., to have caused the fibres to wrap around the rollers in the spinning frame." (E. M., Bradford.)

THE improvement in textile spinning machinery is fit subject matter for protection by patent. Provided the invention is novel it should have a distinct commercial value. You are advised to file an application for patent with a provisional specification, which will give you protection for about twelve months, during which time it should be possible to ascertain whether the invention is likely to be a commercial success.

IMPROVING A BUCKET

"I SHOULD be glad of your opinion of the domestic article shown in the accompanying drawing.

"It consists of a sprung wire device, covered at the points AB with thick rubber tubing, which can be attached to the bottoms of buckets and thus prevent the scraping of floors and polished surfaces on which the bucket is placed. The springing at the centre enables it to be fitted to buckets of varying sizes.

"I should like to know if the idea is original and if there are other devices on the market which serve the same purpose; also, if it is worth patenting, and your opinion of its commercial prospects, if any." (W. A., Kent.)

THE improved device for attachment to bottoms of buckets and like receptacles is fit subject matter for protection by letters patent. A certain measure of protection could also be obtained by registering the device as a design.

The broad idea of attaching rubber buffers to the bottoms of buckets, however, is not novel. It has already, more than once, been proposed to employ a detachable moulded rubber ring adapted to be attached, by stretching it over the bottom flange of a bucket.

In view of known constructions having the same object in view it is not thought that the invention holds out any prospect of being a commercial success.

AN IMPROVED ENGINE

"COULD you advise me on the enclosed specification of an improved engine." (J. H., Co. Limerick.)

THE improved engine, so far as can be gathered from the description, appears to form fit subject-matter for protection by patent. The invention is thought to be novel from personal knowledge, but it is considered extremely doubtful if it will be possible to construct an economical workable engine on the lines indicated.

AN INGENIOUS WEATHER BAROMETER

"I WOULD appreciate your advice on the weather barometer I have invented (drawing enclosed), with regards to taking out a patent for same.

"The whole is built on a wood base moulded at the edges. In the centre is an ordinary barometer, while on the left is a thermometer (rotor type). At the bottom of the barometer are four electric bulbs (3-volt type) with different coloured glass domes, N. E. S. W.

"When the push button on the right is pressed, one or two bulbs light according to the direction of the wind. This is operated by a wind vane on the roof (or any suitable position), constructed with special contacts connected to the barometer by five wires. The triangular piece at the top of the barometer is a piece of chemical paper, that changes colour according to the humidity of the atmosphere.

"I am uncertain, however, regarding the following: The thermometer is a special rotor type and is a patent in itself. Should I be infringing on the patent by using it on my instrument? Or how could I overcome same?" (J. B., Somerset.)

THE barometer which the applicant has invented forms fit subject matter for protection by letters patent. From personal knowledge, the invention is thought to be novel, but this can only be ascertained for certain by making a search through patent specifications and publications relating to the subject. The applicant is advised to first file an application for patent with a provisional specification, as being the least expensive way of obtaining protection, before marketing the apparatus or endeavouring to interest a manufacturer in marketing it. The invention is considered ingenious and likely to be commercially successful if properly marketed.

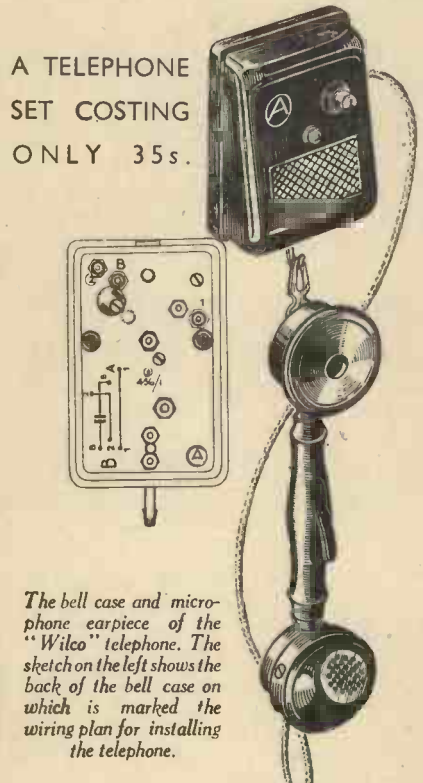
The special form of thermometer proposed to be used, if the subject of a patent, cannot be used by the inventor without infringing said patent, but if he buys the thermometer from the maker or patentee and simply uses it in combination with the other features of his invention, he will, of course, not infringe the patent.

The broad idea of using a material which changes colour, due to moisture in the air, is not novel or patentable. Some forty years ago there was marketed a weather prognosticator which comprised a printed card bearing the representation of a girl whose dress was of a material which turned pink when the weather was fine and blue when wet. The material of the dress was dipped in a cobalt salt (chloride of cobalt), which has the property of being pink in a hydrated state and blue when anhydrous.

ITEMS AND TOPICAL THOUGHTS CONCERNING MANUFACTURERS AND THEIR PRODUCTS.

An Efficient House Telephone

A TELEPHONE set costing only 35*s.* has now been placed on the market by L. Wilkinson, 8 City Road, London, E.C.1. The set is comprised of two units,



The bell case and microphone earpiece of the "Wilco" telephone. The sketch on the left shows the back of the bell case on which is marked the wiring plan for installing the telephone.

as shown in the sketch. Both units are efficiently and strongly made, and a wiring diagram is engraved on the back of each case. It is possible to ring and speak both ways. The telephone can be used as a means of communication between adjoining houses, the garage and house, kitchen and dining-room, bedrooms, etc. Attractively finished in black and chromium it is extremely simple to operate and wire up. To speak, remove the microphone earpiece from the hook and press the button fitted into the case containing the bell. Press down the lever in the handle of the microphone earpiece and you will then be in communication with the person at the other end of the line. The telephone is operated by a 4-volt battery.

Marklin 00-Gauge Railway

A VERY neat range of 00-gauge rolling stock and accessories is now being supplied by the well-known Marklin Company, and is designed for use in conjunction with the house-lighting mains. The locomotive is rated at 20 volts, and is of the 0-4-0 type with a built-in electric-light bulb. Solid nickel buffers are fitted, and the model is complete with nickelled connecting rod and valve gear. A separate tender is provided in the complete train sets and this hooks on to the locomotive, whereas all the rolling stock is provided with automatic couplings. These are of the type which link when the coaches or trucks are brought into contact, and they are uncoupled by slightly tilting the vehicle. The locomotives are obtainable in two distinct types, one being provided with a hand-reversing lever, and the other intended for use with a distant-control reverse, which is a separate line-side component costing 3*s.* 9*d.* With the aid of this, it is possible to carry out complete train control, as in the case of ordinary D.C.-operated mechanisms. A simple transformer is used in conjunction with the lighting mains, and a control rail is obtainable (and is supplied with the complete train sets) by means of which the speed may be regulated over a wide range.

One of these complete sets was tested with its full complement of three coaches and tender, and was found to run perfectly satisfactorily when the applied voltage was only 6 (A.C.). Even at this low value, the speed regulator enabled the train to be started and the speed gradually increased until quite a good speed was obtainable. When the full 20 volts is applied the locomotive will pull a dozen coaches and will attain a considerable speed. The automatic couplings function very satisfactorily, provided that it is remembered to employ them only on straight sections of rail, and this provision is, of course, necessary with the majority of automatic devices of this nature.

The equipment available for this particular model railway includes electrically-operated points, stations, goods depots, etc.—all of which may be illuminated by means of small bulbs obtainable for use with the 20-volt supply.

A complete train set consisting of locomotive, tender, and three passenger coaches costs 35*s.*, and with three goods wagons the price is 33*s.* In each case a length of track consisting of 11 curved rails, 1 connecting rail, and 4 straight rails, is included. A suitable transformer is obtainable for 11*s.* 6*d.*

THE ASTROGLOBE

Designed by K. N. Monro, M.A., and E. O. Tancock, B.A., this Ingenious piece of Apparatus will be Found Extremely Useful in the Study of Astronomy

AS its name conveys, this ingenious piece of apparatus is designed to enable one to locate the position and movements of celestial bodies in the heavens. It consists of a hollow glass sphere, partly filled with liquid to represent the horizon, which may be rotated on its support to represent the apparent motion of the celestial bodies around the earth. In addition to rotation the globe may be tilted in its supporting ring, and adjusted for any latitude in the northern hemisphere by means of a screw clamp sliding on a quadrant arm. The globe may also be set for latitude south of the equator, by withdrawing the rod from the clock dial and tilting to the required position. A line, graduated in degrees of time, is marked round the globe, equidistant from the two poles, to represent the celestial equator. Along this the Right Ascension of any required star can be measured from the first point of Aries, shown by the sign ♈.

The Scale

The declination of a star north or south of the equator may be measured by means of the scale provided with the apparatus. The ecliptic, the path of the sun (and approximately that of the moon) through the heavens, is marked by a broken line; and two small hemispheres, of which the flat sides are adhesive, are provided for affixing to the globe, to show the daily positions of the sun and moon respectively.

Some of the brighter stars of the principal constellations are marked on the surface of the globe in the respective positions in which they would appear in the heavens if seen by the eye of an observer situated at the centre. The rod passing through the stopper of the globe represents the axis of the celestial sphere, and points approximately to the Pole Star, about which all constellations stars appear to revolve. This apparent motion is, of course, due to the Earth's daily rotation about its axis.

Using the Apparatus

When the apparatus is in use it should be placed with the brass quadrant pointing south along the meridian of the place of observation. A magnetic compass is provided, to enable it to be set with considerable accuracy; allowance should be made for the annual variation if this is known, and the axis should point due north. The small red hemisphere representing the sun, should then be placed on the ecliptic, its position depending upon the date of observation, and the globe turned to bring the sun exactly on to the meridian in a southerly direction.

The pointer above the clock dial is then adjusted to indicate noon, and the slide on the quadrant is set to the latitude of the place.

The Adhesive Hemispheres

The apparatus is now ready for use, and by rotating to any required time of day the true direction of the stars and constellations can be observed. The small silvered hemisphere representing the moon should also be affixed in or very near the ecliptic in the correct position for the date under consideration. The Astroglobe is sold complete in a wooden case with an explanatory handbook, and costs £3 3*s*.

A front view of the Astroglobe with the quadrant arm shown on the right.

A LETTER-SORTING MACHINE

LETTER sorting in big towns is a task calling for considerable skill and careful organisation, and when sorted manually, each letter often has to be handled several times. A new machine has recently been installed at Brighton which can consign a letter to any one of 325 boxes whereas a manual sorter can only deal with 48 boxes. The new machine has a total capacity of 24,000 letters per hour and, so far as Brighton is concerned, the letter is disposed of in a single operation.

A Simple

By

A Novelty Which, Although

can Provide

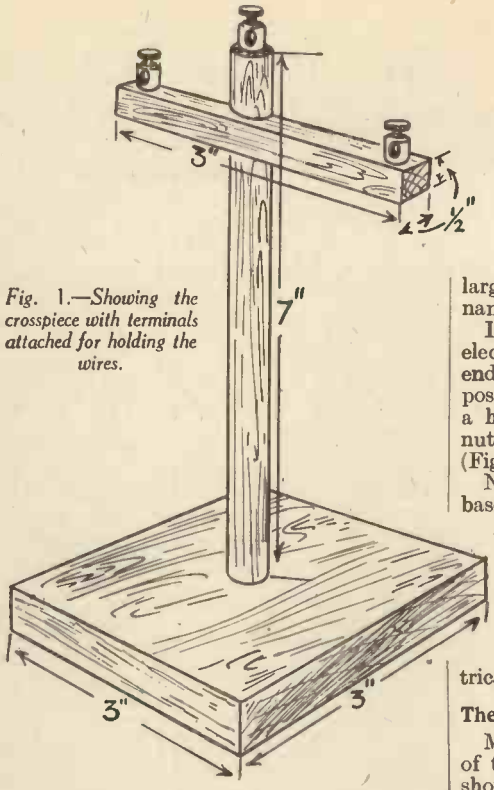


Fig. 1.—Showing the crosspiece with terminals attached for holding the wires.

WITH this telegraph instrument it is possible for two people to send messages to each other from one room to another.

To make this morse sounder, as the instrument is called, you will need a 2-in. soft iron nail or bolt, some tin, a piece of wood, and some thin insulated wire. If you have to buy the wire, which may be enamelled or cotton-covered, you should ask for Standard Wire Gauge No. 28 or some gauge near that. It is quite cheap and can usually be obtained from a wireless dealer.

The Electro-magnet

The electro-magnet must have in its centre, a piece of soft iron—the core. For this, use the nail or bolt. By means of sealing wax, fix a cardboard washer at the head and another about ½-in. from the pointed end (see Fig. 2). Cover the nail between the washers with a layer of paper to prevent any possibility of a short circuit. Now carefully wind the core with the insulated wire. Start at the head of the nail and leave a few inches of wire projecting in order to connect to a terminal. Wrap a few turns over part of the projecting piece to keep it in place. Wind each turn tightly and evenly. When you get to the other end of the core, wind a second layer of wire. Continue in this way until you have used about eight or ten yards of wire. Your magnet will work with less wire than this, but in that case your battery would run down quickly. Use as much wire as suggested, then your battery will last longer. Now knock the nail into the baseboard (Fig. 3). The latter should be about 2 in. × 3 in. There is no need to have one larger than this and a model of the size named, will look neater than a larger one.

If you have used a bolt for the core of the electro-magnet you must pass the threaded end through the baseboard and fix it in position by screwing a nut in place. Make a hollow underneath the base to take the nut so that the magnet will stand rigid (Fig 4).

Now fix two wood-screw terminals in the base and connect to these the ends of the wire from the electro-magnet. When in use, it will be more satisfactory to connect to these terminals than it would be to connect to loose wires. Several terminals of this kind can be bought for twopence and they are extremely useful when making electrical models.

The Armature

Make the armature by cutting a piece of tin about 3¾ in. × ⅝ in. Bend this as shown in Fig. 5, and fix it in position by a nail or screw. You must not use sheet brass for this as brass is non-magnetic.

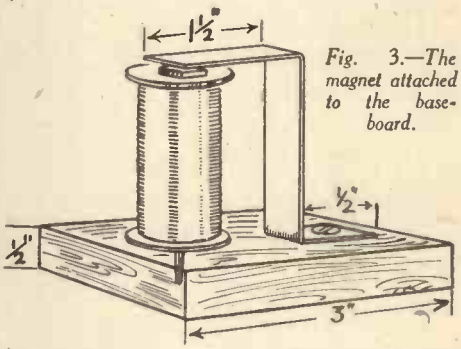


Fig. 3.—The magnet attached to the baseboard.

Now make a bracket by cutting a second piece of tin or a piece of sheet brass about 5½ in. × ⅝ in. or ½ in., and bend as shown in Fig. 5. These dimensions for the armature and the bracket are only suggestions, and, of course, will vary according to the size of the nail used for your magnet. Fix the bracket in position by nails or screws and arrange it so that the armature is touching it and is pressed down slightly.

When the current is passed, the armature is pulled down by the magnet, which it hits with a click. On switching off the current

Fig. 2.—Details of the electro-magnet.

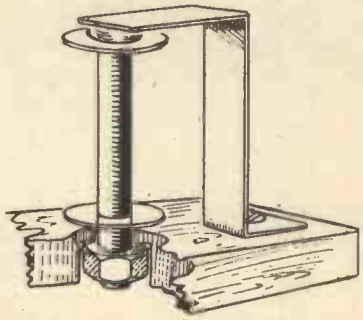


Fig. 4.—If a bolt has been used for the core of the magnet it can be attached to the baseboard as shown.

Morse Sounder

S. Boocock

Made from Odds and Ends, Fascinating Amusement

the magnet loses its power, and the armature springs back to hit the bracket with another click. A long interval between the two clicks is a dash and a short interval is a dot.

The Sending Key

The morse sounder is operated by an easily-made key. For a base, obtain a piece of wood about the same size as that which was used for the sounder. Cut a piece of tin or sheet brass 2½ in. × ½ in. and another piece about 2¾ in. × ½ in. Fix them to the wood as in Fig. 6. Use nails or screws if you intend to solder the connecting wires, but you will probably wish to be able to easily disconnect your apparatus, in which case use wood-screw terminals. First make the holes in the tin just large enough for the screws to pass through and screw down firmly. Use the shorter piece for the bottom contact plate, and the longer one for the key. Solder or screw an old terminal nut to the upper plate for a handle. When you press down the key so that it touches the contact plate, current will flow and the armature will be attracted by the magnet. Release the key and the circuit will be broken. This will allow the armature to spring back against the bracket. A little practice will enable you to send messages surprisingly quickly.

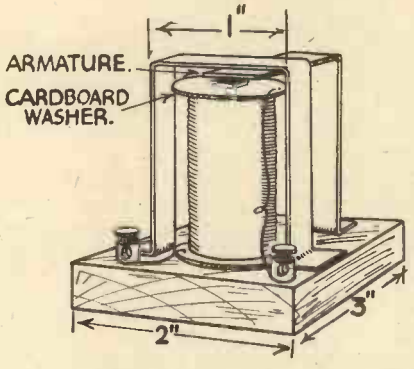


Fig. 5.—The armature fitted into place.

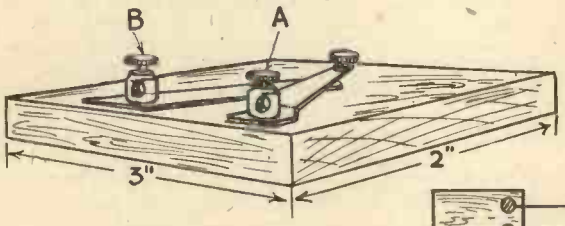
The Connections

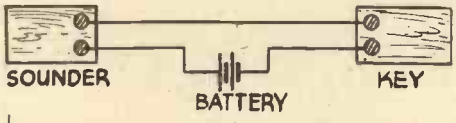
To get used to connecting electrical circuits, fit up one sounder, a battery, and key. Connect these as in Fig. 7, and connect to the key at points marked *A* and *B* shown in Fig. 6. If the sounder should fail to work, see that all your connections are correct and tight, and then adjust the armature by bending it a little. You should have no difficulty in finding the position in which it is most easily pulled down by the electro-magnet.

After you have tested the instrument, you may wish to fit up two complete telegraph stations so that you can communicate with a friend. The method of connecting is clearly shown in Fig. 8. You will see that instead of having two quite separate circuits, which would require four line wires, you may use three wires by making one wire serve both circuits. This wire, which must be connected to the battery, is marked *A* in the diagram.

If you merely wish to use the instruments in one room you will readily devise some way of making model telegraph poles. Pieces of dowel rod are very cheap and can be nailed to a piece of wood to make them stand upright. A crosspiece to carry the line wires is quickly fixed and nails or terminals will hold the wires in position (Fig. 1). Make the model carefully. See that the edges of the tin are straight and smooth. Take a little trouble over the wooden parts. You will find that a sheet of glasspaper makes a good deal of difference to the appearance of the model.

When you wish to dismantle the apparatus, it is only necessary to disconnect the keys and sounders. The line wires may be wrapped round the posts and you will easily be able to reassemble the set when you require it again.





Figs. 6 and 7.—(Left) The sending key, and (below) the wiring connections for a battery, sounder, and key.

THE MORSE CODE

A .–	H	O –––	U ..–
B –...	I ..	P .––.	V ...–
C –.–.	J .–––	Q ––.–	W .––
D –..	K –.–	R .–.	X –..–
E .	L .–..	S ...	Y –.––
F ..–.	M ––	T –	Z ––..
G ––.	N –.		

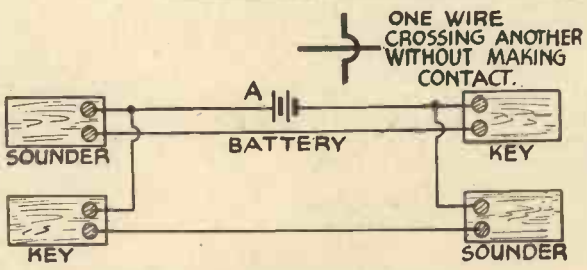


Fig. 8.—The complete wiring plan for the morse sounder.

"The Slide Rule," by Charles Hoare, C.E. Price 4s. net. 104 pages. Published by The Technical Press, Ltd., 5 Ave Maria Lane, Ludgate Hill, E.C.4.

IT is surprising how few people there are who understand the slide rule. With such an instrument it is possible to perform, easily and accurately, all ordinary business calculations. The laws which govern its operation are few and simple and easily understood, and even the uninitiated cannot fail to grasp its working from the above book which describes the instrument very thoroughly. The reader will also appreciate the fact that a neat, portable, and perfectly reliable slide rule, fitted inside a pocket in the front cover, is supplied with each copy of this instructive book. Thus, the reader is more easily able to understand the working of this fascinating instrument.

"Electrical Horology," by H. R. Langman and A. Ball. Price 7s. 6d. net. 200 pages. 93 illustrations. Published by The Technical Press, Ltd., 5 Ave Maria Lane, Ludgate Hill, E.C.4.

SINCE the introduction of public and domestic timepieces in the year 1370 numerous improvements have been made in the mechanism, until to-day electric clocks are used extensively throughout the world. The evolution of this type of clock and the various forms it has taken makes interesting reading in a book recently published under the above title. The authors have covered the subject very fully from the earliest electrically-driven clock mechanisms to the present day. Much ingenuity has been displayed in its construction, and it now seems to have arrived at a state bordering on perfection. The progress of the electric clock is described step by step with numerous illustrations showing how the clocks were made to function.

"The Elements of Practical Flying," by P. W. F. Mills. Price 4s. 6d. net. 130 pages. Published by The Technical Press, Ltd., 5 Ave Maria Lane, Ludgate Hill, E.C.4.

THIS interesting book should make a direct appeal to everyone interested in flying. It describes in simple language the following facts relating to aircraft: first principles, stability and control, the speed element, general performance, taking off, turning, landing, and the personal element. It covers the subject of modern flying extremely well, and each chapter is compact and lucid.

"Light and Sound." Price 2s. 3d. (Bound in full cloth, 2s. 6d.). By H. G. Lambeth, B.Sc., A.I.C., and P. E. Andrews, B.A., B.Sc. 180 pages. 150 illustrations. Published by University Tutorial Press, Ltd., High Street, New Oxford Street, London.

THIS interesting volume is intended as a first course in light and sound, for the lowest science forms of public and secondary schools. Written in simple language, it will give pupils a thorough grounding in the fundamentals of the subject. To this end the authors have carefully selected the experiments described, and they can be easily understood and performed by the average boy. To give reality to the subject and to maintain the interest of the reader, application of the scientific facts involved, to examples with which the pupil is familiar in everyday life, are discussed where possible. A three-page index is also given at the back of the book.

"Television Up-to-Date." Price 2s. 6d. By R. W. Hutchinson, M.Sc. 184 pages. 134 illustrations. Published by University Tutorial Press, Ltd., High Street, New Oxford Street, London.

AS a result of the tremendous advances which have recently been made in the science of Television, and of the fact that it is about to become an important public service, there is an urgent need for an unbiased account of what television is, what it can do a to-day, how it does it, and what are its possibilities for the future. In the above book this need is supplied in a simple and interesting way. No previous knowledge of electricity, wireless, or television on the part of the reader is assumed, yet all explanations are based on sound and modern scientific principles.

"The Book of Speed" (New and Revised Edition). Price 5s. 160 pages. 150 Full-page plates in photogravure. Published by B. T. Batsford, Ltd., 15 North Audley Street, London, W.1.

CONTAINING 150 illustrations depicting speed on land, sea, and air, and superbly reproduced in photogravure, this interesting volume will appeal to young and old alike. On the literary side the various chapters are written in simple language by the men responsible for these triumphs on land, sea and in the air, and provide not only an abundance of technical information, but an insight into the feelings and sensations of the speed kings through the hazards of their amazing enterprises.

"Squadrons of the Royal Air Force," by Major F. A. de V. Robertson, V.D., M.A. (Oxon), Lieut.-Commander C. N. Colson, R.N., and Flying Officer W. A. Cook. Price 7s. 6d. 132 pages. Well illustrated. Published by the Flight Publishing Co., Ltd., Dorset House, Stamford Street, London, S.E.1.

AS a considerable amount of interest is now being shown in the Royal Air Force, *Flight* have considered it an opportune moment, to republish in book form a series of articles on individual squadrons and other units of the Royal Air Force. Since the articles have appeared in *Flight* over a period of six years special notes have been added where squadrons have been re-equipped with aircraft of a more modern type.

Full-page plates in photogravure have also been added, and the book has been brought right up to date. An interesting foreword has been written by the Rt. Hon. Sir Philip Cuncliffe-Lister, G.B.E., M.C., Secretary of State for Air, and a six-page index is also given at the back of the book.

"Grand Prix," by Barré Lyndon. Price 7/6 net, 264 pages, 40 pages of plates. Published by Messrs. John Miles, Ltd., Amen Corner, E.C.4.

IN this fascinating volume, which is packed from cover to cover with thrills, the author relates the inside story of the greatest and fastest motor races in the world.

Lavishly illustrated with forty plates carrying over seventy action photographs—many now published for the first time—this is a book of absorbing interest. It is introduced in a foreword by The Rt. Hon. Earl Howe, P.C., C.B.E., V.D., President of the British Race Drivers' Club, and is completed by an epilogue from Cecil Kimber, famous designer of racing cars.

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Replies to Queries and Enquiries

If a postal reply is desired, a stamped addressed envelope must be enclosed. Every query and drawing which is sent must bear the name and address of the sender and be accompanied by the coupon appearing on page iii of cover. Send your queries to the Editor, PRACTICAL MECHANICS, Geo. Newnes Ltd., 8–11 Southampton Street, Strand, London, W.C.2.

THE INFLUENCE OF RAYS

"WHAT chemicals become luminous when subjected to the influence of X-rays. ultra-violet rays and infra-red rays respectively." (A. E. M., Folkestone.)

THE following substances become luminous when subjected to the action of X-rays :

Barium platinocyanide, potassium platinocyanide, magnesium, platinocyanide, calcium tungstate, calcium fluoride (fluospar), calcium sulphate, zinc sulphate, zinc sulphide, potassium-uranium sulphate, barium sulphate, barium sulphide, chlorophyll, many varieties of glass, quinine sulphate, mica, potassium acetate, stronium sulphate, strontium sulphide, uranium fluoride and uranium sulphate. Of these, the best are calcium tungstate or barium platinocyanide.

The following materials are self-luminous under the influence of ultra-violet rays, their luminescence being known as "fluorescence" :

Quinine sulphate (acid or alkaline solution of), solution of æsculin, solution of fluorescein, many varieties of mineral oil and solutions of uranium salts. Of these, solutions of quinine sulphate and æsculine give the brightest fluorescence.

No chemicals evolve light under the influence of infra-red rays, since the rays do not contain sufficient energy for this purpose. A surface painted with thallium iodide, however, possesses a selective reflecting power on infra-red rays. Also, a thin sheet of ebonite will transmit infra-red rays, whilst remaining perfectly opaque to ordinary light rays.

MAKING AN AIR PUMP

"I WISH to make an air pump to deliver a flow with a pressure of 15 lb. through an orifice of $\frac{1}{32}$-in. diameter. The piston stroke must not exceed 1½ in.

"Using a leather cup washer, what is the smallest barrel diameter I can use? Also, by what amount would the efficiency be increased by using (a) metal piston without rings, (b) metal piston with rings?" (L. D., Beds.)

IT is impossible to give the desired barrel diameter of your projected air pump from the data which you supply. In the first place, if an air flow of constant pressure is required, this will necessitate a container for the compressed air and the air flow from this will be governed by a number of conditions. The air flow at the nozzle or orifice of the pump itself will not be at the same pressure at any succeeding instant. Hence, it is not possible to provide the information which you require. The volume of air ejected at each stroke of the piston can be estimated from the formula :

$\pi r^2 h$, where :

$\pi = \frac{22}{7}$ or 3·1416.

r = Radius of air-pump barrel.

h = Stroke of piston.

The efficiency of your proposed air pump would not be increased by the use of a ringless metal piston, in view of the difficulty of machining such a piston accurately, and of providing a barrel with an absolutely true internal bore. A metal piston with suitable rings would increase the efficiency of the air pump—always provided that the rings were of suitable design and accurately fitted. Some type of lubrication would be called for, if the pump was intended for hard service.

ADDING PERFUME TO BATH SALTS

"WOULD you kindly describe the commercial process adopted for colouring and adding perfume to sodium carbonate crystals, for the manufacture of bath salts?

"What are the colouring agents generally used?

"Can you name a highly concentrated perfume and where it could be obtained?" (T. L., Edinburgh.)

IN the preparation of bath salts, good grade sodium carbonate is recrystallised from water containing 2 per cent. (approx.) of an aniline dye, such as methyl violet, and also a trace of some concentrated perfume dissolved in spirit.

Any aniline dye may be employed for the purpose and, also, almost any perfume. The perfume is dissolved in rectified spirit and the spirit is added to the crystal liquor. The crystals, after separation from the liquor are usually "whizzed," *i.e.* subjected to a centrifugal machine which rids them of water very efficiently. On a smaller scale, of course, they would have to be dried by very gentle heat.

Bath crystals must be bottled immediately they are ready, otherwise the crystals will slowly fall to powder in contact with the air.

Ionone is a liquid having a violet-like odour. This, together with oil of lavender, otto of rose, and many other strong-smelling oils, is quite suitable for bath salts preparation. Such oils may be obtained from Messrs. Goodwin Tidswell, Ltd., Cheetham, Manchester.

PLASTICS AND SYNTHETIC RESINS

"I AM interested in plastics and synthetic resins and I would appreciate the following information regarding them. My interest is purely experimental.

"Could you give me practical details for making viscose or plastic cellulose by the treatment of cotton with caustic soda and carbon disulphide? I believe 'cellophane' films can be made by spreading this on a flat surface.

"How can I separate pure casein from milk, and by the action of formaldehyde, convert this to galalith? How could I, if possible, make a tough, waterproof paper by treating it with casein and then formaldehyde? Would the formaldehyde need to be in a gaseous state for the latter? If so,

how could I evolve the gas from a formalin solution?

"Is it possible to make bakelite without the application of pressure, but merely by getting it to set in a mould. Could you give me proportions and concentrations of phenol and formaldehyde for this, if practical." (W. B., Dundee.)

VISCOSE is the sodium salt of cellulose xanthate. In order to prepare it on a small scale make up an approximately 17 per cent. solution of caustic soda and allow pieces of filter paper (blotting paper or cotton wool will do, but filter paper is best) to soak in this solution until they swell to about double their size. A 2–4 hours' immersion will usually be necessary. Remove the swollen cellulose from the caustic soda solution, allow it to drain completely, and when semi-dry, place it in a flask and shake it with carbon bisulphide. At least 33 per cent. by weight of carbon bisulphide will be necessary. This shaking process is known as "xanthation." On a small scale it will last for about half an hour. After completion of xanthation, remove the excess of carbon bisulphude, and allow the xanthated cellulose or viscose to dry after its removal from the flask. The xanthated cellulose should now be dissolved in a 5 per cent. solution of caustic soda (containing about 0·5 per cent. of sodium sulphite) and allowed to stand for a few days in order to "ripen." This ripening process enables the coagulation of the viscose, when drawn out into a thread, to be effected with greater ease, but it is not absolutely necessary. Cellophane films can be made (theoretically) by spreading thin films of plastic cellulose on flat surfaces, but practically, you will find their making very difficult, since some form of roller machine is required to turn out the film with constant thickness.

Casein can be separated from milk by the addition of rennet or of acid. To each fluid ounce of milk, add about 3 c.c. of a 10 per cent. solution of acetic acid and allow the product to stand for 15 minutes. The precipitated casein (mixed with fat) can now be filtered off. The yield will be about 3 per cent. of the weight of the milk. You cannot make "Galalith" (artificial horn) at home, since this is manufactured by compressing the casein material in hydraulic presses. Neither would it be practicable for you to make waterproof paper from casein. Vegetable parchment, which is tough and waterproof, can be made readily by immersing good quality paper in slightly diluted sulphuric acid for a few seconds and then by rapidly withdrawing it and plunging it into a bath of ammonia and subsequently washing the paper with an abundance of water.

It is impossible to make bakelite without the application of pressure because the characteristic properties of bakelite compound, are only formed when the bakelite moulding power is subjected to carefully controlled temperature and pressure.

A PETROL-DRIVEN MODEL BIPLANE

(*Continued from page* 281)

After stitching, the tops of the wings should be covered. The whole wing can then be doped with one coat of *clear full-sized aeroplane dope*, and allowed to set with weights upon it for 24 hours.

Flying the Model

First of all, check up that the engine is looking direct to its front. Draw a line down the fuselage in pencil on the top. See that a prolongation of this line would carry along the crankshaft of the engine. Next ascertain that the fin is also in line with this centre line. Neither right nor left rudder should be given. The model should glide straight and turn in circles owing to engine torque, whilst the engine is on. When the engine is switched off, by the self-timing apparatus, the model should glide down straight. In this way better landings are made.

Now check up that the tailplane has its leading and trailing edge in line with the thrust line, which should be drawn along the fuselage in pencil, as shown in Fig. 3. If not, pack up the rear or front of the tailplane with balsa wood. If you have constructed the model correctly this should not be necessary.

See that the leading and trailing edge of the tailplane and the mainplanes are true and not warped. Check up angles of incidence of the mainplanes and if not correct, pack up with balsa.

Place the top mainplane so that the leading edge is along the front end of the cabin. The leading edge of the lower plane should be 5½ in. farther back than the main plane leading edge. In this way the correct "positive stagger" is obtained.

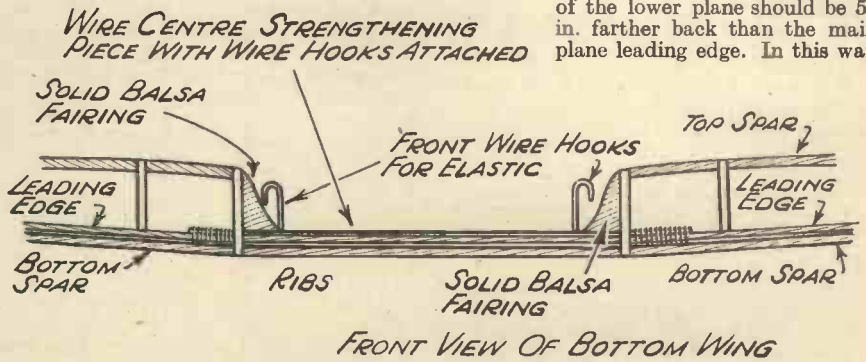

Fig. 17.—How the bottom wing is attached to the fuselage

Place the pocket flash-lamp battery below the fuselage, which should then be held up by elastic bands, between Nos. 1 and 2 formers.

Now try gliding the model directly into the wind. With a moderate throw forward and very slightly downward, the model should carry on in a good flat glide until it runs along the ground on its wheels, the tail gradually dropping.

REPLIES in BRIEF

F. J. M. (Rothwell).—Small electric motors are obtainable from Messrs. Economic Electric, Ltd., 64 London Road, Twickenham. Details for making a shocking coil are given in our handbook entitled *Simple Electrical Apparatus*, a copy of which is obtainable from us for 1*s.* 2*d.*, post paid.

W. A. P. (Co. Clare).—Details of synthetic rubber are obtainable from Mr. S. J. Odebach, 461, 8th Avenue, New York. You omitted to stamp your envelope.

L. W. (London, E.8).—As the poison gases to which you refer are on the War Office Secret List, we are not permitted to publish them. You will need to increase the voltage as well as the current. You should connect the secondary terminals to the pick-up terminals if these are fitted. If not, connect them between the grid of the detector valve and the grid-bias tapping.

J. B. T. (Orpington).—The sun-ray lamp must be used in connection with the mains resistance as described in the January issue. Aluminium or a chromium-plated reflector will suit. Nickel chromium wire would be suitable for rewinding purposes. For gauge and current-carrying capacity get into touch with the London Electric Wire Co., Church Road, E.10. All of the materials are obtainable from Economic Electric Co., 64 London Road, Twickenham.

J. E. W. (Eastbourne).—You omitted to enclose a stamped addressed envelope. Shall be glad to let you have the address of the makers through the post. The engine can, of course, be stopped and started in the manner you suggest. The safety valve is not necessary for the generator. The generator can only be fitted in a vertical position. We shall not publish designs until the engine is available on the English market.

SYNCHRONISED PHOTO FLASH - BULBS

(Concluded from page 276)

Higher shutter speeds than the above are not necessary for ordinary work, and they make synchronising unreliable. In any case, a little thought will show that the exposure is not governed by the slow shutter speed, *but by the speed of the flash while the shutter is open;* which, in the case of a flash-bulb, is in the region of $\frac{1}{50}$ second.

About the only disadvantage of a slow shutter speed, is a possible double image when the subject to be photographed is already illuminated by fairly bright lights. There may be a weak image from the lengthy shutter exposure, plus a strong one from the flash. Such occasions are rare however, and normal artificial lighting will not have this effect, except with very large apertures.

It is essential of course, to have some kind of reflector behind the flash-bulb to concentrate the light. The simplest arrangement is a wide-angled cone of white drawing paper (like a loud-speaker cone), clipped to the top of the torch by stiff wire. A better reflector is a cone made from sheet tin, but best of all are the highly-polished models obtainable for a few shillings from the leading photographic stores.

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