ESCALATORS & HOW THEY WORK

NEWNES

PRACTICAL MECHANICS

APRIL

6D.

INDUSTRIES UNDER THE SEA

TELEVISION MADE EASY • BUILDING A 15 c.c. MODEL TWO-STROKE PETROL ENGINE
CHEMICAL EXPERIMENTS WITH SELENIUM • BUILDING A FINE MODEL SPEEDBOAT •
A HOME-MADE RELAY • MODEL ELECTRIC RAILWAYS • THE MONARCH TWO-VALVER
ELECTRIC LIGHTING FOR MODELS • FACTS ABOUT AIRCRAFT • SCALE MODEL HIGH-SPEED
FURY • PLASTIC MOULDINGS • LATEST TOOLS • CLEVER IDEAS • PATENT ADVICE • ETC.

Practical Mechanics

Edited by F. J. CAMM

VOL. II. No. 19
APRIL
1935

SUBSCRIPTION RATES:
Inland and Abroad, 7s. 6d. per annum
Canada - 7s. per annum

Editorial and Advertisement Office: "Practical Mechanics," George Newnes Ltd., Southampton Street, Strand, W.C.2.
Registered at the G.P.O. for transmission by Canadian Magazine Post

Notes, News and Views

Oxy-Ferrolene

A CHEAP substitute for acetylene for use in oxy-acetylene steel-cutting blowpipes was demonstrated in London recently. The secret of this is a liquid called "Ferrolene," which is said to be a volatile petroleum product. Compressed coal-gas is bubbled through this liquid. The mixture of coal-gas and Ferrolene vapour is then fed to a special oxy-blowpipe. Oxy-Ferrolene will do the same amount of cutting as oxy-acetylene at about half the cost. It is said to give a cleaner cut. The Oxy-Ferrolene flame also gives no incandescent glare. The discovery should make the use of the blow-pipe in cutting thick steel even more popular than it already is. A Sheffield firm recently used the process for cutting through a propeller shaft 36 in. in diameter.

Temperature Changes

TINY changes in temperature caused by compression and expansion in the air as sound-waves pass through it are being measured by Ellis A. Johnson of the Massachusetts Institute of Technology. The instrument used can measure the "heat" of sounds too feeble for the ear to detect.

Testing Aviators for Altitude Flights

AT Monyecelio aerodrome in Rome a special room has been built where aviators can be examined by doctors before and after altitude flights to discover the state of their physical reactions to conditions. In this room, which is of 30 cubic metres, a special pump run by an engine of 16 h.p. creates a depression which can be equal to 16,000 metres of height. A cooling apparatus cools the temperature which can be lowered to about 70° below zero. The room is fitted with instruments of all kinds, and blood tests are made as well as tests of the organs.

A New French Rail Coach

AN oil-driven streamlined rail coach, which arrived in England from France, recently made a full-speed trial run on the L. M. S. railway between Willesden (London) and Tring (Hertfordshire). The new coach is equipped with rubber tyres and carries two spare wheels. It can be driven both backwards and forwards, and is said to be capable of a speed of ninety-five miles per hour.

The Largest Fish Port in the World

AT Grimsby a short time ago Sir Henry Betterton opened a £1,700,000 fish dock, the largest of its kind in the world. It has a total water area of 35 acres, and brings the total water area of the port up to 64 acres, making it the best equipped in the British Isles for landing fish. Twenty-three new trawlers are already under construction as a result of the new dock. Last year Grimsby marketed 186,000 tons of fish—one-quarter of the whole catch landed in England and Wales.

THE MONTH'S SCIENCE SIFTINGS

The new Cunarder "Queen Mary" is to be equipped with twenty-eight all-steel life-boats, each weighing 16 tons fully loaded. The boats, which will each accommodate 140 persons, will be propelled by high-speed Diesel engines.

A strange-looking aircraft, a tailless two-seater fighting 'plane, built for the Royal Air Force, was recently demonstrated at Yeovil. Pilot and observer have an uninterrupted view all round.

A new British colour-film process was recently demonstrated in London. The film shown was a travel-picture of Devonshire, in which reds and blues were rendered with considerable fidelity. The colour is produced entirely through the lens, and the problem of focus is eliminated.

The Loudest Sound

THE loudest sound ever heard by man was the eruption of Krakatoa, a volcano in the Dutch East Indies, in 1883. So violent was the explosion that air waves resulting from it travelled three times successively round the world.

A New Transparent Synthetic Resin

A NEW synthetic resin known as "Leukon" has recently been produced which is insoluble in water, alcohol, and aqueous media, and is unaffected by acids or alkalis up to concentrations of 40 per cent. in the case of sulphuric acid and of caustic soda at atmospheric temperatures. It is also unaffected by many high boiling organic esters. It is soluble in certain of its forms in a number of organic solvents, which include acetone, chlorinated hydrocarbons and benzene.

Leukon's low thermal conductivity and attractiveness to touch, especially when taken in conjunction with its mechanical and chemical excellence, suggest many possible uses in the field of medical and hospital equipment. It should be remembered that Leukon is more resistant to moisture and can have a higher softening point than ebonite, while it has the still further advantage of a wide range in colour as well as transparency. Closely linked with the medical field is the possible manufacture of Leukon spectacle frames by the injection moulding technique. This would give a frame which is kind to the wearer, tough, strong, light in weight, unlikely to split, warp, or be affected by moisture or perspiration.

World's Steam Locomotive Record

THE London and North-Eastern Railway locomotive, Papyrus, which set up a world's speed record for steam locomotives of 108 m.p.h., was lubricated with oil produced by the makers of Wakefield Castrol.

Making Glass Wool

SHREDDING glass into woolly fibres by centrifugal force is the unique process developed by a Swedish manufacturer of glass wool. Melted glass runs down upon a disc, which rotates with great velocity. By action of the centrifugal force, the glass is disintegrated into a mass of extremely fine threads. A current of air is blown downward around the edge of the rotating disc, carrying the formed glass wool down upon a cutting and transporting apparatus, by means of which the product is continuously carried away for further working. The fineness of the glass threads can be controlled within certain limits by regulating the temperature of the melted glass and the amount of glass fed upon the rotating disc per unit of time.

Industries under the Sea

Mysteries beneath the sea have been examined chiefly in the interests of science. This article explains some of the methods of overcoming the difficulties of penetrating into the depths of the ocean.

THE same love of adventure which through the ages has prompted man to explore the whole habitable surface of the earth exerts its influence still, and he is nowadays tempted to enter realms whose barriers, not many years ago, were to him utterly impregnable. He has recently conquered the air to an extent previously undreamt of, but no voyage to the stratosphere can compare in interest to exploration in the depths of the sea, with its myriad living things, beautiful or grotesque, timid or formidable, catalogued or unknown.

Unlike aviation, deep-sea diving has been carried on in a primitive way for centuries. Sir Robert H. Davis, in a recent series of lectures before the Royal Society of Arts, cited Pliny's "Historia Naturalis" (A.D. 77), in which are mentioned divers, employed in warfare, who drew air in through tubes, one end of which they held in their mouths, while the other was supported at the surface by a float. This practice is compared to that of an elephant which can breath through its uplifted trunk while its body remains submerged. The lecturer emphasised the fact that it would be possible only to use this system in a very few feet of water, since, on breathing the air through an open pipe, the lungs would be exposed to atmospheric pressure only, while the body would be subjected to increased pressure varying with the depth of the submerged diver. This would produce a dangerous compressive effect on the lungs, and result not only in great muscular effort in inhaling, but also in the production of hemorrhages in the diver's air-way.

Modern Diving Dress

Apparently Sir Robert, who is governing director of Messrs. Siebe Gorman & Co., Ltd., submarine engineers, regards the "open" diving dress of Augustus Siebe, introduced in 1819, as the foundation upon which modern diving dress has been developed.

Sightseers descending to the floor of the Pacific, 100 ft. below the surface, four miles off shore, and come up without even damping their shoes.

Captain C. B. Mayo broke all existing U.S. Navy diving records at Seattle when he descended 400 ft. into the waters of Puget Sound in a demonstration of the Romano diving bell which marine experts believe will revolutionise existing salvage methods. The bell is the invention of Gene Romano, a mechanical engineer. The inventor claims the bell to be especially adapted to raising sunken submarines and deep sea mine-laying, as well as to commercial diving purposes. It is seen poised at the end of the derrick which lowers and raises it from the water. It is a heavy metal pear-shaped globe capable of withstanding enormous under-water pressure. In the conning-tower-like top are glass port-holes, under which the occupants of the globe, two in number, may observe their manipulations of the articulated arms extending out from it. The dexterity of these is such that a small coin may be picked up with the finger-like claws at the end. Lines and couplings may be handled by them with ease as well as acetelyne blow torches. The bell carries a sufficient supply of air, supplemented with oxygen tubes, to maintain two men under water for fifty-four minutes. The bell is connected with the surface crew by two telephone lines, and a battery of four high-power lights attached to the mobile arms provides brilliant under-water illumination.

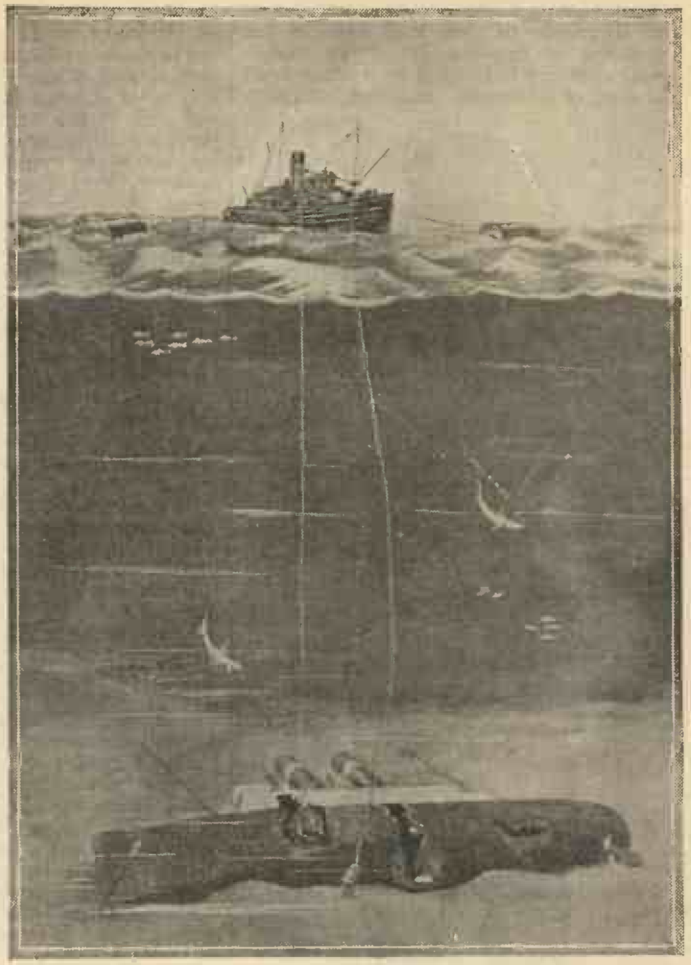
In this the wearer had to be circumspect in his movements, since, if he bent down, he ran considerable risk of filling his helmet with water. Still, much good work was done with it, and it was not long before Siebe introduced his closed dress and helmet. In this it was made possible for the diver to be supplied with compressed air, the appropriate density of which he could regulate himself by means of an adjustable spring valve, similar in operation to the well-known safety valves of steam engines. Towards the conclusion of this article further reference will be made to Sir Robert H. Davis, whose extensive knowledge of the subject enabled him to design the submarine escape apparatus which bears his name.

Salvage Operations

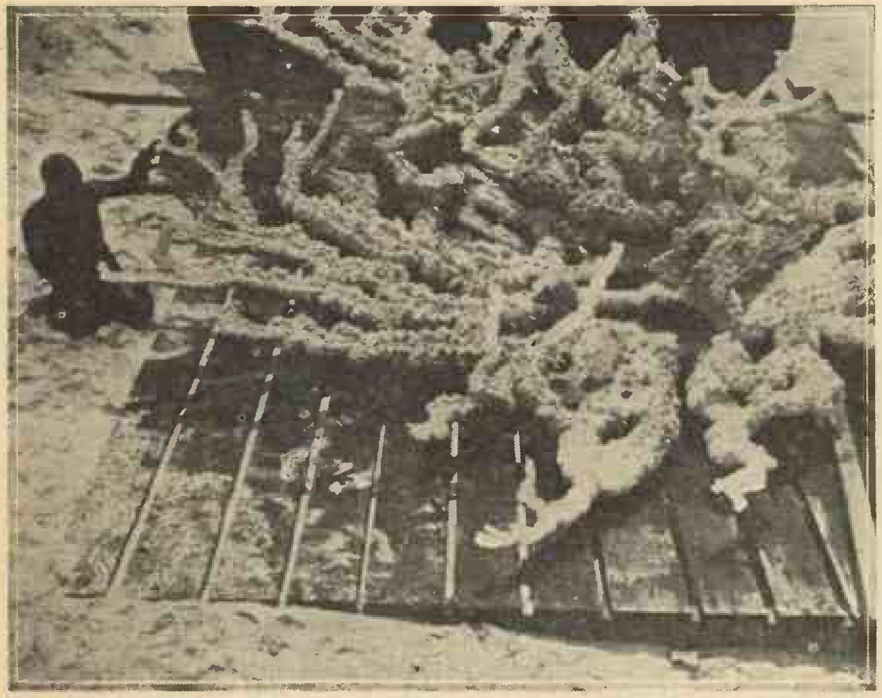
Modern diving dress mainly owes its being to the desirability of carrying out salvage operations on sunken shipping. An illustration accompanying this article shows diagrammatically the system employed by the salvage ship *Salvor* in its efforts to reclaim from the sea the fortune in gold, silver, and precious stones which sank with S.S. *Merida* when she was rammed by the *Admiral Farragut*. In this case the depth it was necessary to descend was 200 ft. Captain C. B. Mayo broke all existing U.S. Navy diving records at Seattle when he descended 400 ft. in a demonstration of the "Romano diving bell," also illustrated, which marine experts believe will revolutionise existing salvage methods. The bell is the invention of the mechanical engineer, whose name it bears. The inventor claims the bell to be especially well-adapted to raising sunken submarines and to deep-sea mine-laying, as well as to commercial diving purposes. It is shown poised at the end of the derrick, which lowers it and raises it again from the water. It is a heavy metal pear-shaped globe, capable of withstanding enormous under-water pressure. In the conning-tower-like top are glass port-holes, from behind which the two occupants may observe their manipulations of the articulated arms extending out from it. The dexterity of these is such that a small coin may be picked up with the finger-like claws at the end. Lines and couplings may be handled by them with ease as well as acetylene blow-torches. The bell carries a sufficient supply of air, supplemented with oxygen containers, to enable the two occupants to remain underwater for approximately an hour. The bell is connected with the surface crew by two telephone lines, and a battery of four high-power lights attached to the mobile arms, provides brilliant under-water illumination.

The Record Depth

Another interesting form of diving device was that in which Dr. William Beebe, the marine biologist, who has been described as the "Professor Piccard of the Ocean," recently made a descent of 2,500 ft.—more than half a mile—beneath the surface—the greatest depth ever attained by man under water. Only the fact that his oxygen supply was running short prevented Dr. Beebe from going lower into the unknown depths of the sea. As it was, Dr. Beebe made observations which enabled him to name five or six hitherto unknown fish, and collected scientific data of great importance. He was accompanied by Mr. Otis Barton, the inventor of the "Bathysphere," as the apparatus was named. This record descent under water was made at Bermuda.



Diving apparatus of various kinds owes its inception to the desirability of salvaging sunken freights which are valueless unless they can be reclaimed. The wrecked vessel here shown, the S.S. "Merida," *was laden with gold, silver and precious stones.*



The huge specimen of coral shown here was gathered under the direction of J. E. Williamson, whose under-sea photography is famous. It measures 16 ft. by 14 ft., and weighs 4 tons.

Often the devices which enable a number of persons to descend below the surface of the sea are erroneously called "diving bells." Strictly speaking, a diving bell is open at the bottom, the pressure of air within preventing the water from entering. If an inverted cup or glass tumbler is immersed and held under water, the imprisoned air within seeks to escape vertically upwards but is unable to do so. As soon, however, as the cup or tumbler is tilted to any marked extent from the vertical, the air will begin to escape from beneath, and will rise in large bubbles to the surface. This principle has been used to enable work to be carried out on shallow ocean beds by men above whose heads is suspended an air-tight dome-shaped structure containing a continually replenished amount of air. Hence the name "diving bell," since it resembles in essential shape the familiar church bell.

For Sightseers

One of the accompanying illustrations shows a "diving bell," (though not, for reasons just explained, strictly such) for deep-sea sightseers, in which they may descend 100 ft. or more below the surface, and come up, as it is explained to them, "without even damping their shoes." Thus are they able to peer into some of the mysteries of deep-sea life. The underwater chamber is lowered by a crane from the deck of a steamer. It is weighted with 1,500 lb. of ballast necessary to overcome its buoyancy, and reaches the limit of its run in about a minute. Each of the passengers aboard is able to look outwards into the water through thick-glass observation windows. An electrically-driven air-purifier is in operation all the time, and in case one of the windows should break under pressure, steel flaps can be tripped into place, hermetically sealing the breach before an appreciable amount of water can enter. There is sufficient oxygen within the "bell" to last the occupants from six to eight hours.

The closed diving dress introduced by Augustus Siebe in 1837. In this the diver was enabled for the first time to control the pressure of the air he breathed to suit the circumstances of his immersion.

"One-man Submarine"

A deep-sea explorer, aided by his experience in the construction of submarines, recently built a diving apparatus that holds one man in an adjustable case. This apparatus replaces a vessel requiring a crew of several men. The suit rather resembles a knight's armour and the turret-like body is like the conning tower of a submarine. This "one-man submarine," as it has been described, can dive to a depth of more than 800 ft. in ten minutes, the ascent from this depth only requiring about four minutes.

Many readers will remember having seen excellent cinematograph pictures taken under the sea. The originator of underseas photography was J. E. Williamson, who during six months spent under the waters surrounding the Bahama Islands in quest of specimens for the Chicago Field Museum, took many films, through glass many inches thick, of the mysterious floor of tropical seas. His "studio" was approached along a long flexible metal tube with a boat as its base. Probably the largest coral specimen ever taken from the bed of the sea was gathered by him, and is illustrated here. It measures 16 ft. by 14 ft., and weighs 4 tons.

Escaping from sunken submarines has always presented a considerable problem for many reasons, most of them bound up with an elementary principle of hydrostatics, whereby pressure increases according to depth reached. The pressure of air within a submarine must approximate to the pressure without, before hatches can be opened, and also some form of air lock must be incorporated in order that the opening of a hatch may be unaccompanied by any considerable entry of water. The Davis escape apparatus marks a considerable advance in permitting the members of crews of disabled submarines to reach the surface in safety, supplying in compact, portable form a means whereby a man may have a sufficiency of oxygen from the time of release from the opened hatch until he reaches the surface above.

Replacing a vessel requiring a crew of several men, this "one-man submarine," as it has been called, enables research work to be carried out on the bed of the sea that would otherwise be impossible.

ROYAL AIR FORCE

700 Aircraft Apprentices

and

Boy Entrants wanted

IT is announced by the Air Ministry that about 500 vacancies will occur in August, 1935, for well-educated boys to be trained as aircraft apprentices in the following skilled trades of the Royal Air Force: fitter, wireless operator, mechanic and instrument maker. Full particulars regarding entry and conditions of service may be obtained from the Secretary, Air Ministry (Apprentices Dept.), Gwydyr House, Whitehall, London, S.W.1. Applicants must have attained the age of fifteen years and be under the age of seventeen years on August 1st, 1935. A competitive examination will be conducted at numerous local centres early in June, 1935, the subjects being English and General Knowledge, Mathematics and Science. Applicants possessing an approved first school certificate with specified credits may be excused the entrance examination. No previous trade experience is required. The closing date for the receipt of nominations for the August entry, is Tuesday, May 7th.

Further Vacancies

About 200 boy entrants will also be required in September and candidates sitting at the aircraft apprentice examination for whom apprenticeships are not available, may, if of suitable age and educational attainment, be offered enlistment as boy entrants to be trained in the trades of armourer, photographer and wireless operator.

Excellent Opportunities

The Royal Air Force offers excellent opportunities to well-educated boys of securing an efficient training and of embarking on an interesting career with many possibilities of advancement. Aircraft apprentices and boy entrants are housed, fed and clothed free of cost and receive pay. The training is in the hands of well-qualified technical instructors, and boys entering as apprentices continue their general education throughout the apprenticeship period under a staff of graduate teachers.

Windmills and their Mechanisms

This article deals with numerous difficulties encountered by inventors in the development of the windmill, and also the ingenious mechanisms employed for grinding corn.

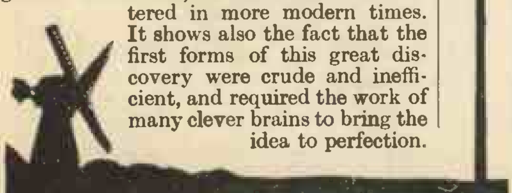
THE discovery of the water-wheel was the first, and most important, of the long series of inventions by which man has harnessed mechanical power to save himself from daily toil. But the use of the watermill was obviously restricted to places where rivers and streams of sufficient size and speed were available—since tide-mills have only rarely been used.

Thus in low-lying countries like Holland, though rivers are abundant, their flow is too sluggish to drive a mill; and in many of the drier countries there are no streams at all, except in winter.

Even in our own well-watered country, there are considerable areas where the rivers are too sluggish, too small, or too few, to drive the mills which were needed in many centres of population.

That is why we see windmills gracing the landscape through the vast lowlands of East Anglia, North-west Lancashire and Essex; as well as in hilly districts, such as the Weald of Kent and Sussex, the highlands of the Midlands, and many other districts.

The invention and development of the windmill makes a very interesting story of practical mechanical progress, and proves that the earliest inventors had the same, or greater difficulties, as have been encountered in more modern times. It shows also the fact that the first forms of this great discovery were crude and inefficient, and required the work of many clever brains to bring the idea to perfection.



The First Inventor

He was a clever old priest, one Dean Herbert, who lived at the end of the twelfth century.

By the custom of the time, all corn growers had to take their grain to the chief landlord's mill to be ground, which was expensive, and involved much unnecessary transport; in a few exceptional cases tenants were forced to convey the grain as far as fifteen miles.

Dean Herbert thought out the idea of a windmill, and employed a carpenter to build it for him. It worked very well. But when his landlord, a certain Abbot Samson, of Bury St. Edmunds, learned of it, he forthwith destroyed the mill on the ground that it interfered with the trade of his own watermill!

It was nearly a hundred years before windmills became common in England, and though none of these early structures exist to-day, we have sketches of them in old missals, and carvings in churches.

From this we know that the first windmill was a small wooden building, like a large dog kennel, placed upon a central peg or post; hence the name "peg mill." The disadvantages of this type were very great, winds changed constantly, and when this happened the miller had to turn the *whole structure* round by pushing on a long pole. This not only involved much heavy labour, but also risk of damage to the mill if the change were not made quickly enough.

Danger of High Winds

There was also the constant peril that the mill might "run away" in high winds, in which case the sails might be torn off, or the mill itself set on fire by the tremendous friction. At such times the miller's only chance of saving his property was to summon all the help he could, and keep the stones, or sets of stones, constantly supplied with grain. He could then do a month's work in a single day, and as long as the stones were grinding, the mill could not "run away."

(Above) A remarkable eight-sailed tower mill at Heckington, Lincs., and (right) the turret-post Mill, near King's Lynn, Norfolk. This mill revolves on a central peg, held in a concrete turret, and the structure beneath serves as a store for grain and flour.

A three-quarter smock mill at West Chiltington, Sussex, so called because the wooden casing goes over the mill like a smock for three-quarters of the height of the tower.

But the brains of the inventor soon discovered improvements. The first was to the sails, which originally were of tarred canvas, and so offered exactly the same resistant surface to a gentle breeze, and a hundred-mile gale. The *slatted* sail overcame this difficulty, as it was constructed of slats like a venetian blind. When the wind was moderate the slats were closed and offered full resistance to the breeze, but as it increased the slats gradually opened, and so let the excess power pass harmlessly by.

Brakes, too, were introduced to check the speed of the mill, but this was only a partial safeguard, as in great gales even the friction of the brakes might fire the mill.

The most important improvement was automatic gearing, by which the sweeps of the mill were always kept exactly in the wind, without any attention from the miller.

Automatic Gearing

At first this was effected by means of a flat vane, like the rudder of an aeroplane—which pointed in the direction of the wind like a weather-cock, and as the sails were at the correct angle to the vane, they were moved round as the wind changed. But this arrangement could only work with quite small mills (it is still used with the small circular modern mills) and the larger mills required a vane unmanageably large. This difficulty was overcome by a clever mechanical idea. A small wheel was furnished with sails, and set at right angles to the sweeps of the mill. It was so adjusted that when the main sails of the mill were correctly set to the wind and revolving, the adjusting vane was edgeways to the wind, and was out of action.

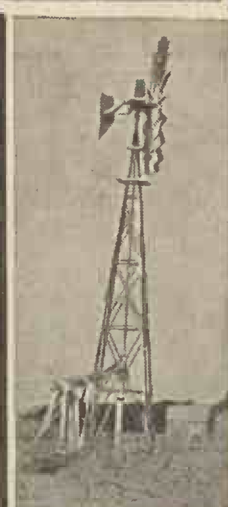
If, however, the wind changed, they started to revolve, and by means of a chain of gear wheels brought the mighty sails back into the wind. But there remained still another important improvement, which was the idea of a clever Dutchman. He fixed the sails of the mill to a

conical cap, so that *it* alone revolved to carry the sails into the wind, while *the mill itself stood still.*

This enormously reduced the labour—human or mechanical—required to turn the mill, and also made it possible to erect the mill of permanent materials, such as stone or brick, and far larger than heretofore. It is to this invention we owe the skyscrapers of milling, such as the gigantic mill at Yarmouth, with a brick tower 120 feet high, and the splendid eight-sailed mill at Heckington, in Lincolnshire. There are also some fine examples abroad, notably the giant mill on a hillock in the centre of Leyden (Holland), and another at Reykjavik (Iceland).

Small Mills

All modern mills up to about forty years ago were built on this principle; that is, brick tower, movable cap, and automatic gearing, but since then windmills have gone out of fashion for grinding corn. There is a fine windmill at Stretham, near Ely, which was built in 1880 and is still working. It claims to be the last of its type to be erected in this country, but in various districts there are many hundreds of these fine old veterans still busily working.



(Above) A tower mill which is hand operated for changes in the wind, at Barbados. The sails are moved round by a long pole. As the trade winds in Barbados blow steadily in the same direction for nine months in the year, it has not been necessary to fit automatic gearing; and (right) a modern circular mill at work in British West Indies.

A smock mill at Shipley, Sussex.

In more recent years only smaller mills have been built, but these are in regular use at home and abroad. They are built for cheapness, simplicity of construction, and ease of erection.

The tower is open ironwork of the lattice pattern, the sails are circular and slatted, and there is a vane which keeps the sails to the wind. The power impulse is conveyed by a long rod, working like a pump-handle. Such mills are light, inexpensive, and easy to erect, and so are widely used for pumping water, cutting mangels, and other light power purposes on small holdings.

Although one of the earliest forms of natural power, the windmill is still performing useful work, particularly in districts where a natural head of water does not supply an alternative and more satisfactory form of power. Houses remote from town electricity undertakings often use a small windmill for driving the dynamo of small house-lighting plants. Under the grid scheme, it is likely that this final connection with a picturesque and one of the earliest forms of power will vanish.

(Right) In windmill land. A scene near Schemerhoorn, Holland.

HOME-MADE RELAYS

An efficient and easily made piece of apparatus that can be constructed from an ordinary electric bell.

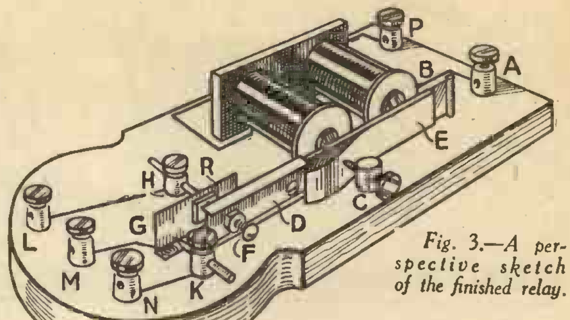


Fig. 3.—A perspective sketch of the finished relay.

THE object of a relay is to put into action (by means of a small current) a current of any magnitude in another circuit, and, for a very small outlay of time and money, such a relay may be constructed from an old electric bell, which, if not already possessed, can be purchased second-hand for a very small cost. As electric bells vary in size and shape, it is, of course, impossible in this article to give exact dimensions of most of the parts of the relay, but the accompanying diagrams will indicate to the reader the general lay-out, and very little ingenuity will be required to adapt the plan to his own particular bell.

The Electric Bell Used

Fig. 1 shows the most usual type of electric bell, which has a trembler and a "make-and-break" *C*. Remove the gong *S*, the hammer *T*, the wire which connects *C* and one terminal *A*, and the wire which connects *B* to the arm *E*. Do not remove the "make-and-break" screw from the base, as this will serve later as an adjustment—although it will no longer be in electrical contact with the rest of the apparatus. Connect the end *B* of the wire from the coils to the terminal *A*. The action of the bell is now that of a "striker." At this stage a battery should be attached to *P* and *A*, and if the work up to this point has been carried out efficiently, the arm *E* should be seen to move slightly towards the coils. If this is so, disconnect the battery.

The Insulator

Next obtain a thin strip of brass about 2 in. long and ½ in. wide. Near to one end drill a hole to allow a metal screw *F* to pass through it easily. This screw is secured in position by a lock nut on each side of *D*. Cut out a small insulator *R* from a piece of vulcanite or other similar material and screw it on to the end of *F*, being careful that the screw does not pass completely through the insulator. Remove the arm *E* and fix the brass strip *D* to *E* by means of small screws, filing the ends of the latter flush with the surface of *E*, and then replace *E* in its original position.

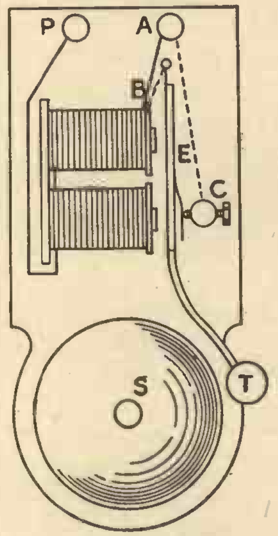


Fig. 1.—The most usual type of electric bell which has a trembler and a "make-and-break."

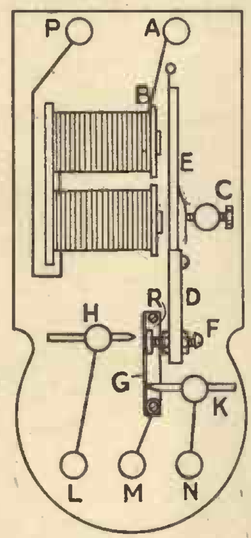


Fig. 2.—Showing the bell and hammer removed and the various alterations necessary to convert the bell into the relay.

G consists of a piece of brass foil about $\frac{3}{1000}$ in. in thickness, well hammered to make it tough and elastic. This foil must not be very thick or it will resist the movement of the relay and decrease its sensitivity. Cut *G* in the form of a rectangle and bend back a strip of it lengthwise at right angles, so that it can be fixed in an upright position by small screws in the baseboard. At a distance of about ½ in. on each side of *G* fix a battery terminal (No. 65) of the pattern shown in Fig. 3, and through each pass a piece of ⅛-in. brass rod, the contact end having been turned or filed to a point.

Final Wiring and Adjustment

Fix to the base three terminals *L*, *M* and *N*, and connect *L* to *H*, *M* to *G*, using a small waster under the screw in *G* to make a good contact with the wire, and *N* to *K*. In the diagrams the wiring is shown on the top of the baseboard. If strapping is used, this is to be preferred, but if ordinary copper-covered wire is used the job is much neater if the wires are run on the underside of the baseboard in the usual manner.

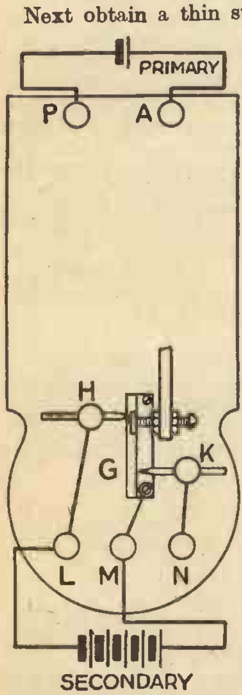


Fig. 4.—Details of the secondary circuit, showing the complete wiring.

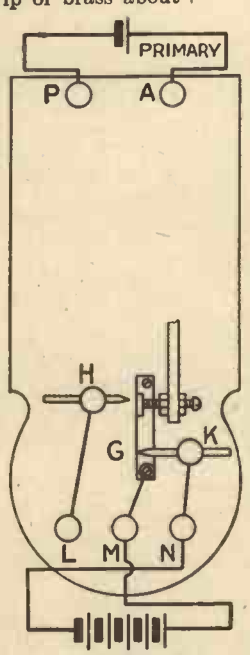


Fig. 5.—Sketch showing the method of operation.

The Adjustments Necessary

There are several adjustments to the relay which will allow it to be set so that its sensitivity may be great or small. The old "make-and-break" screw *C*, which is usually fixed with a locking screw, will enable the beam *E* to be set at varying distances from the coils. The screw *F* may be set in any position by the locking nuts, so that there is a suitable pressure on *G*, and the rods passing through *H* and *K* will allow of such fine adjustment that the slightest movement of *E* will be sufficient to close the circuit in the current when the relay is actuating.

How to use the Relay

To use the relay, connect the terminals *A* and *P* to the incoming, or primary, circuit, and the outgoing, or secondary, circuit to the terminal *M* and to *either L* or *N*, as required. When the circuit in the primary is completed, the beam *E* is attracted towards the coils. This causes *D* to move the contact *G*. If the secondary circuit is connected to *M* and *L*, the gap between *G* and *H* is closed, and the secondary circuit is completed (Fig. 4). The relay can thus be used for, say, an extension telephone call-bell. If the secondary circuit is connected to *M* and *N*, while the primary circuit is complete the contact *G* will be pushed away from *K*, but if the primary circuit is interrupted the gap between *G* and *K* will be closed, and the secondary circuit will be completed (Fig. 5), as in a burglar alarm. So one end of the secondary circuit is always connected to *M*, and if the other end is connected to *L* the relay will work in the "on" position, but if the other end is connected to *N* the relay will work in the "off" position.

Quite Simplified

Although the construction of this relay may at first sight appear to be complicated, the time taken to carry out the actual work is very little more than that taken to read about it, and the cost of the materials is almost negligible, as almost all of them can usually be found in the "junk-box" of the average amateur constructor.

Facts About Flying

The Townend Ring

THE Townend ring around a motor increases the speed of the plane, because it actually pulls the machine ahead during flight. If the ring were placed in a slipstream by itself, it would blow backward; but when it is placed around the motor it pulls ahead. The explanation lies in the fact that the metal ring is really a lifting surface with a cross section similar to an aeroplane's wing. The front of the ring has a smaller diameter than the rear, so the effect is that of having a lifting surface all around the motor, which is tilted forward. The air currents, hitting the flat surface of the motor, are deflected radially and strike the ring at such an angle that the resulting lift is forward. The stronger the currents, the greater the forward lift or pull exerted by the ring (Fig. 3).

Slipstreams

Contrary to common belief, the slipstream or blast, sent back by the propeller, does not spread out behind the whirling blades. Instead, it contracts, or funnels-in, behind the tips, so that the diameter of the slipstream is less than the diameter of the propeller. As the blades suck air from the front, other air rushes in from all sides to fill the hole. Thus it is drawn in from an area of greater diameter than the circle of the blades, and this side air, coming in at an angle, compresses the other air towards the centre of the slipstream. Strings tied to the frame of an electric fan illustrate this as they fly at an angle to the centre of the draught (Fig. 2).

Streamlining.

If you have ever shot an orange seed across a room by squeezing the pointed end, you have demonstrated why the body of a gull is better streamlined than that of a dragon fly. In a stubby, streamlined body, like a gull's, the bulging forward part deflects the air currents outward so that they come back, squeezing together near the rear. In the long "darning-needle" body of a dragon fly, the air currents come together nearer the head. The same principle holds true in aeroplanes.

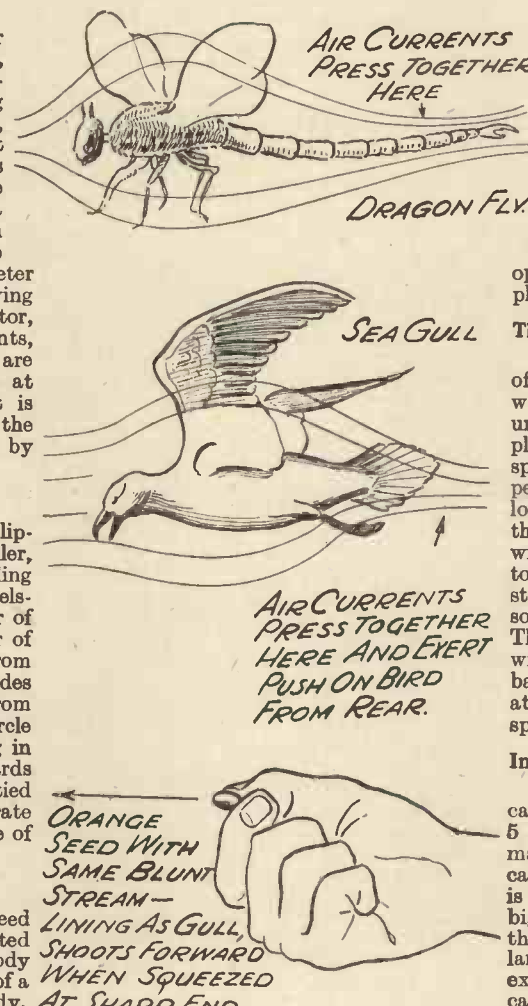


Fig. 1.—Illustrating that a gull's body is better streamlined than that of a dragon fly.

Draught in an Aeroplane Cabin Blows Forward

In the cabin of an aeroplane, although a gale rushes past to the rear at two miles a minute outside, there is usually a draught blowing forward against the wind. The explanation is that the airstream is deflected by the fat part of the streamlined fuselage, just behind the nose, so a suction is formed, similar to that which gives lift to the top of the wing. Farther back, these air currents press down again against the sides of the fuselage. Thus the suction in front and the pressure behind pump the air forward in an opposite direction to that in which the plane is travelling (Fig. 1).

The Pressure on the Front Spar of the Wing

During trial runs at top speed, the wings of a number of early planes broke downward in the air. The cause was a mystery, until tests revealed that when high-speed planes fly all out, the pressure on the front spar of the wings is often downward. At peak speeds, powerful planes, with lightly loaded wings, fly with the leading edge of the wing lower than the trailing edge. Most wings will lift at a negative angle of from 2 to 6 degrees. In this position, the wing is struck by the head-on wind on the top some distance back from the trailing edge. This pushes down the forward part of the wing and shifts the partial vacuum area back toward the rear spar. Consequently, at great speeds, the pressure on the front spar is actually down instead of up (Fig. 5).

In Aviation 1 lb. equals 21 oz.

For every pound added to the carrying capacity of an aeroplane, they must add 5 oz. to the weight of the structure to make it strong enough and large enough to carry the extra load. A little bigger wing is needed to support the extra pounds, a bigger engine to push the larger wing through the air, added petrol to feed the larger motor, bigger fuel tanks to hold the extra petrol. Consequently, when the carrying capacity of an aeroplane is increased 1 lb., the added load it must lift into the air will be, not 16 oz., but 21 oz. Inversely, cutting the weight of the machine 1 lb. saves 1¼ lb. (Fig. 7).

Two and Two equal Six in Aviation

If two streamlined struts, each having 2-lb. resistance in passing through the air, are placed near together, their combined resistance will not be 4 lb. It will sometimes be 6 lb. or more. The reason is the air flow around one strut interferes with

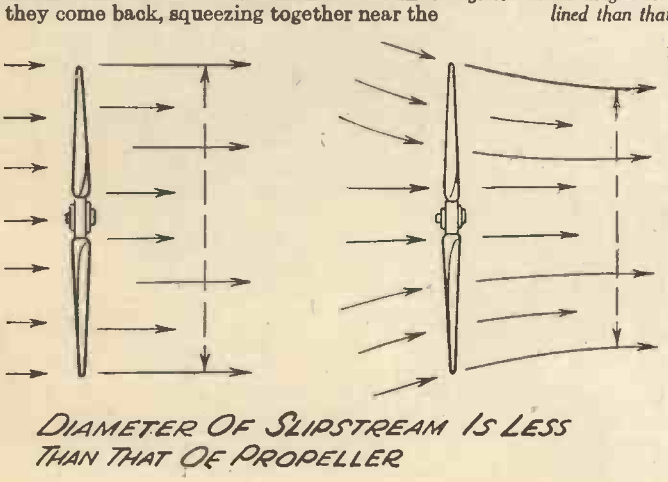
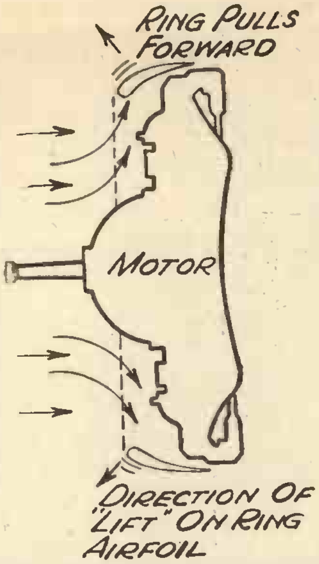


Fig. 2.—The slipstream sent back by the propeller does not spread out behind the whirling blade. (Right) Strings tied to an electric fan fly at an angle to the centre of the draught.

the air currents passing around the other. Eddies are formed between the two, thus increasing the drag. Planes with twin bodies or closely placed hulls have often proved inefficient due to such interference drag. Designers try to keep wings, struts and fuselages from interfering with each other as much as possible. In fact, a honeycomb radiator produces more resistance than a flat surface of the same area, because each little tube produces interference.

A Falling Plane would pass a Falling Body

If a stunt man, making a delayed parachute leap, jumped from a plane high in the air, the pilot, diving with the engine cut off, could drop faster than the jumper. On both subjects the pull of gravity would be the same, but the falling man would not be streamlined, while the plane would be. Consequently the aeroplane, with less resistance in proportion to its weight, would travel faster with the same pull of gravity.—(*Popular Science.*)



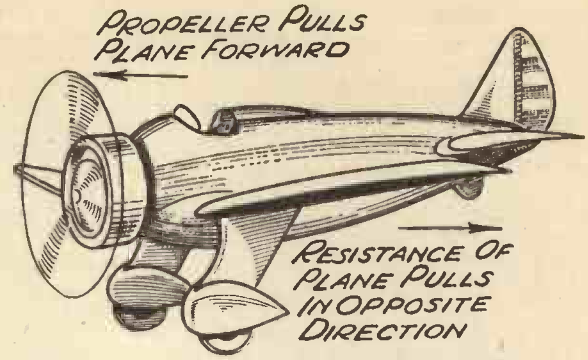


Fig. 3.—The Townend ring around the motor actually pulls the plane ahead during flight.

Airway and Aerodrome Lighting

In his paper on "Recent Developments in the Lighting of Airways and Aerodromes" at a London meeting of the Illuminating Engineering Society on March 12th, Mr. H. N. Green stated that the design of aviation lighting equipment has reached a stage when it is more difficult to state the requirements of lighting than to build apparatus to meet the requirements. His paper was mainly devoted to a description of recent developments in our knowledge of requirements, starting with a brief review of the visibility of light signals, covering threshold illumination, the practical threshold for recognition of a signal, foveal and paraveal vision, the effects of background brightness and of a flashing character. After explaining the principle of spacing airway beacons along a route, the author showed that low-power beacons close together mark a route less effectively than high-power beacons placed relatively far apart. British practice was compared with that abroad, and it was shown that we allow much more light for bad weather condition and incline to lower beam intensities and rapid signal repetition. The advantages of beacons giving over a million candles in the main beam were questioned and the performance of such a beacon in bad visibility conditions was analysed.

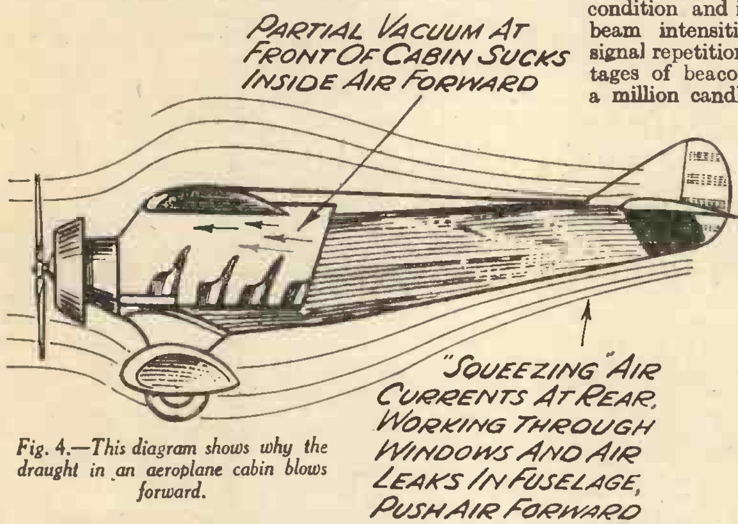


Fig. 4.—This diagram shows why the draught in an aeroplane cabin blows forward.

A New Type of Beacon

The latest design of beacon installed on the Croydon-Lympne airway was described by the author. An interesting feature was that two beams of light are emitted and two separate lenses are used to produce each beam; the inner lenses controlling the horizontal divergence, while the outer lenses give the required vertical distribution. By this arrangement the resultant beam has the same horizontal divergence at all angles of elevation, and consequently the duration of the flash exhibited is the same for any direction of observation. An oscillating beacon which exhibits a definite "on course" signal was also described. Although Neon light is still used for aerodrome beacons, the author maintained that it has no special fog-penetrating

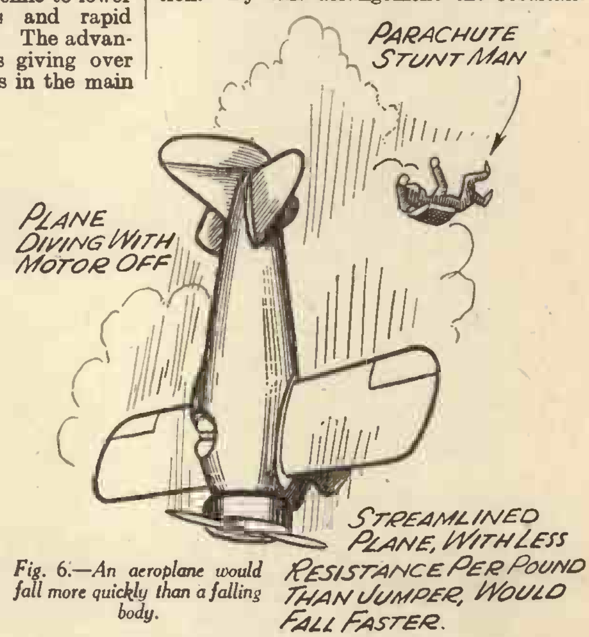
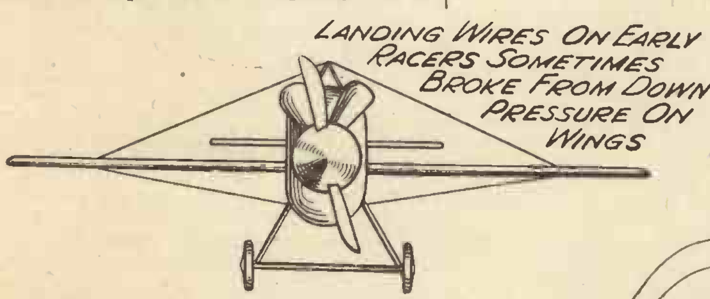


Fig. 6.—An aeroplane would fall more quickly than a falling body.



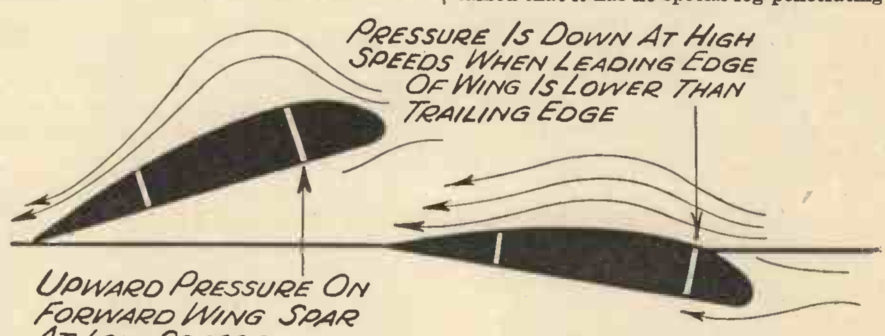


Fig. 5.—Showing the direction of pressure on the front spar of a wing when the aeroplane is travelling at a high speed.

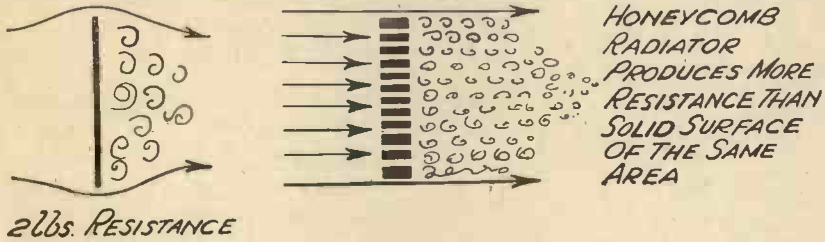
qualities. It was scattered and absorbed by the atmosphere in just the same way as any other red light, and, with visibility down to a mile or less, a Neon light could not be seen appreciably further than a white light of equal intensity.

Blind Flying

Blind flying, in the future, might necessitate the use of a more powerful aerodrome beacon than the Neon type. A pilot coming out of the clouds, somewhere in the vicinity of the aerodrome and with ground visibility poor, had no idea of the direction in which to look for the beacon, which must be picked out from other red signs by its flash period. It was therefore possible that a light which was recognisable by virtue of both intensity and character might in time become preferable to one which is recognisable by character alone.

Aerodrome Floodlights for Night Landing

The best and most convenient—and incidentally the most expensive—is to instal a number of fixed floodlights at intervals round the aerodrome boundary. One or more floodlights could be turned on, according to the direction of the wind, and as the whole installation could be remotely controlled, there need be no delay in bringing the lighting into action, or following changes in wind direction. The author described some interesting floodlighting developments in Germany and Holland, dioptric floodlight—with lamps with filaments shaped to increase the maximum luminous intensity, and reduce the foreground illumination. Figures were given showing the improvement in floodlighting performance during recent years. The latest designs of boundary lights used in Great Britain and Germany were described, and the use of sodium tubes in Holland was referred to. The light distribution of obstruction and boundary lights was also referred to.



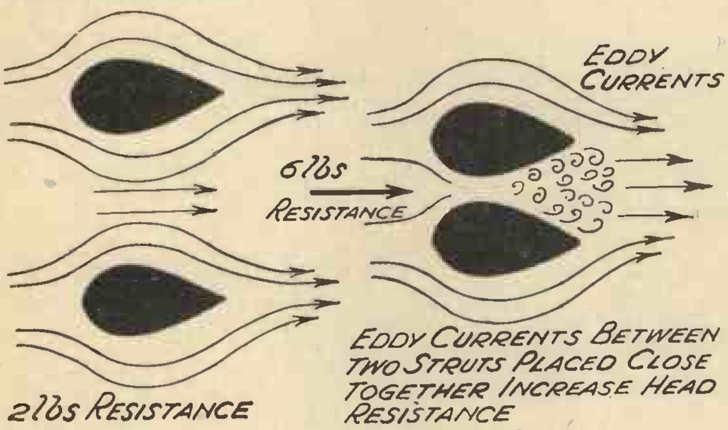
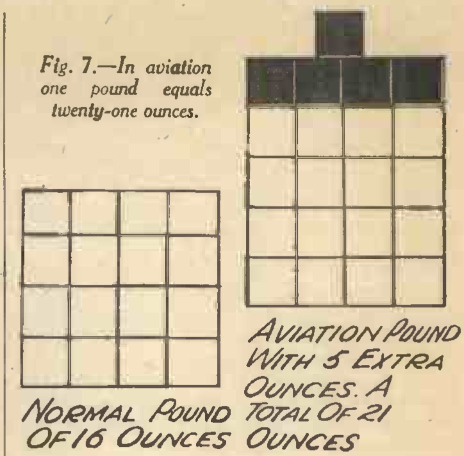


Fig. 8.—Planes with twin bodies on closely placed hulls have often proved inefficient, due to interference drag, as shown here.

Fig. 7.—In aviation one pound equals twenty-one ounces.



THE AIR-MAIL OF 1911 COMPARED WITH THAT OF 1935

More than 2,500,000 miles were flown by the air-liners of Imperial Airways during 1934. This figure, which has just become available, compares with approximately 2,300,000 miles for 1933. The progress of air transport is illustrated, strikingly, if one contrasts the statistics of our present-day air-mails with those of the first officially sanctioned aeroplane mail to be flown in England, the twenty-fifth anniversary of which is to be celebrated this summer. That pioneer Hendon-Windsor service of 1911 operated over a distance of only 20 miles, compared with the 20,000 miles of route flown over by Imperial Airways and its associated companies at the present time. The 'planes in use on that first service were driven by single engines of 50 h.p., and had a wing span of not more than 28 or 30 feet. To-day the big mail-planes are driven by four engines, developing a total of more than 2,000 h.p., and have a wing span of 130 ft. As for a comparison of the loads carried by air, then and now, the monoplane which actually inaugurated the Hendon-Windsor air-mail of 1911 carried just its pilot, Mr. Gustav Hamel, and a bag of letters weighing 23½ lb., whereas one of the big four-motored air-liners of to-day will lift into the air a useful load of just over three tons.

A Difference in Speed

As for the vital aspect of speed, whereas the first mail-carrying 'planes flew at from forty to fifty miles an hour, the four-engined aircraft of to-day, even when carrying considerable mail loads, can attain a speed of 175 miles an hour.

A study of the latest air traffic figures shows an increase of more than 20 per cent., recently, in freight dispatched by air from London to the Continent. And this augments the general story of progress, as revealed by current statistics for passengers and mails. Three of the main air routes to the Continent — London-Paris, London-Brussels and London-Germany—are all showing a substantial air-freight growth as compared with previous figures.

On the Imperial Airways line to Paris they have been having exceptionally large consignments of wireless apparatus recently, while on the service to Brussels a traffic feature just lately has been a continued increase in the quantity of wireless valves consigned by air. For delicate articles like these, the advantages of air transport, with its absence of jolting or vibration, are so great that the bulk of such goods are now being sent by air, the valves requiring no special packing, but travelling quite safely in ordinary cardboard containers.

The same applies to electrical appliances, scientific instruments, and fragile goods of all kinds. Handling is reduced to a minimum; and though speed naturally costs money in the air, as on land and sea, consignors reap a very considerable advantage from the fact that insurance rates for goods by air are, generally speaking, only about one-third those for surface transport; while packing costs are also reduced.

Heavy Consignments

The big air-liners in use to-day, and the roomy cargo spaces now available, enable freight consignments of a size and weight to be dealt with which it would have been impossible to handle not so long ago.

On a route to Germany, for example, a piece of machinery weighing over half a ton was air-borne recently, while not long ago a 'plane had among its cargo a small motor car. Motor cycles, urgently required on the Continent, are often dispatched by air, as are spare parts of all kinds for motor cars—these last-mentioned not only going over to the Continent, but being dispatched for thousands of miles along our Empire routes.

Should they prove too bulky for dispatch as a single unit, mechanical parts can, as a rule, be divided up into several separate consignments for air transit. In this way such things as urgently required drilling machinery, pump fittings and engine parts are carried by the Imperial Airways' services to points along the Africa and India routes, saving many days, and often weeks, as compared with surface transport.

Increase in Passenger Service

In addition to freight progress, passenger and mail traffic by air continues to increase substantially. During the past twelve months more than 50,000 travellers flew in and out of Croydon in the aircraft of Imperial Airways, while the mail loads sent by air from this country during 1934 were by far the largest ever recorded, totalling approximately 6,000,000 letters.

Fig. 1.—Indicating how the whole of the interior of the spot-light studio is completely lined with copper sheet to prevent radio-frequency interference.

TELEVISION MADE EASY

By H. J. BARTON CHAPPLE, Wh.Sch., B.Sc., A.M.I.E.E.

The second article of the series. This month we deal with the spot-light method of television.

LAST month two specific methods for producing the ordered scanning line requirements were dealt with in a general manner, so it is now necessary to give further details concerning the practical applications of these principles. Dealing first of all with the spot-light method of television, the initial requirement is a very intense source of light, and the most suitable arrangement is to use a high-powered arc lamp which is being rated at 150 to 200 amperes consumption. It has an automatic feed and is mounted on a rigid iron framework. In front of this, in the same projector room, is the large diameter scanning disc housed in a large braced casing from which the air is pumped continuously to maintain a reasonable degree of vacuum. The disc in this way runs truer, while there is less likelihood of the small scanning apertures becoming clogged, wholly or partially, with small dust particles and so spoiling the field of light. Any dirty hole gives a black horizontal line on the final picture, and this has to be guarded against in achieving the best results.

In the Studio

As shown in Fig. 3 of last month's issue the light from this arc lamp is made to fill the mask cut out, and in this way, together with the associated focusing lenses, a tiny moving beam of light is made to emerge from the final lens. A thick wall separates the projector room from the studio proper, and to allow a free passage for the scanning beam an aperture is let into the wall, this being sealed with thick plate glass. This is seen in Fig. 1, and no background noise can thus mar the acoustics of the studio, and be picked up by the microphone seen near the left-hand photo-electric cell in Fig. 2.

The subject being televised stands 2 or 3 ft. away from this wall aperture, and interposed between him and the dividing wall is a large framework accommodating five photo-electric cells. As will be gathered by referring to Fig. 2, these are very large, being housed in metal cases with a wire mesh front, while associated with these cells are the "A" or first stage amplifiers. They are arranged in such a manner that they can be influenced by the greatest amount of light reflected from the rapidly moving scanning spot as it explores the televised subject, natural high lights and depth being imparted to the human features by carefully positioning these cells.

Instant by instant during the continuous scanning process the cells "pick-up" the varying reflected light, and owing to their inherent photo-electric property the light changes are made to produce a corresponding voltage change in an electrical circuit in which these cells form a part. In spite of the large electrode surfaces the voltage signals are small in magnitude and require considerable amplification, but they represent a faithful replica in voltage amplitude of the degrees of light and shade constituting the subject being explored. After the final amplifiers the signals are fed to a central control before being passed to the radio transmitter to become a modulated electro-magnetic carrier wave in space.

Isolation

Every precaution must be taken in the studio to ensure that it is free from any form of high-frequency interference, and this is carried into effect by completely lining the whole studio interior with sheet copper. This is shown in Fig. 1, the thick sound-proof door being treated in the same way so that it makes a proper electrical contact when closed, the screening being effectively earthed. The walls are then padded and draped to produce the correct acoustics, the microphone picking up the speech, song or music which accompanies the "turn" being performed.

At the same time as the vision and sound signals are being generated, the scanning mechanism has associated with it apparatus for the purpose of producing both high- and low-frequency synchronising signals. The former corresponds to the scanning line sequence per second ($240 \times 25 = 6{,}000$ pulses per second in the proposed high definition service), while the latter is the picture repetition frequency now standardised as 25 per second for high definition work. To give twenty-five pictures per second (and so eliminate any trace of flicker in the final received picture, and also allow artist movement to be reproduced quite naturally in the observed image) the disc has to rotate at a speed of 1,500 revolu-

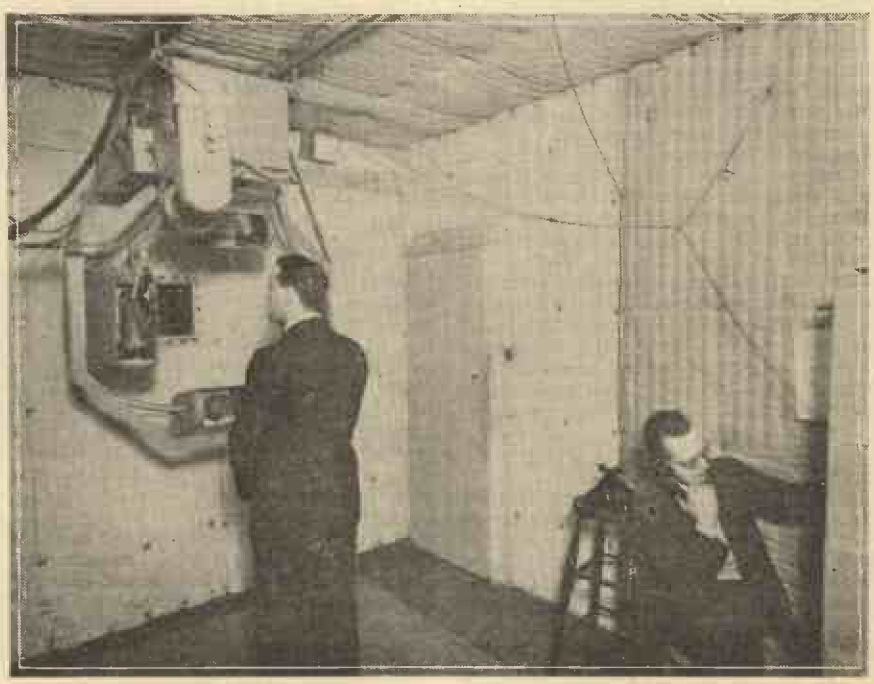


Fig. 2.—Showing the interior of the spot-light studio, with the dividing wall aperture and bank of photo-electric cells surrounding the subject to be televised.

tions per minute for a single spiral trace of scanning holes. It is also possible to have a double spiral trace of holes, each spiral having half the total number of holes and so being separated by twice the angular distance, and rotate this disc at a speed of 3,000 revolutions per minute. When this is done, however, two holes would normally appear simultaneously owing to the double turn spiral, and a geared chopper has to be included in the mechanism to mask off the hole which at that instant should not be scanning, and so let each hole do its work in turn.

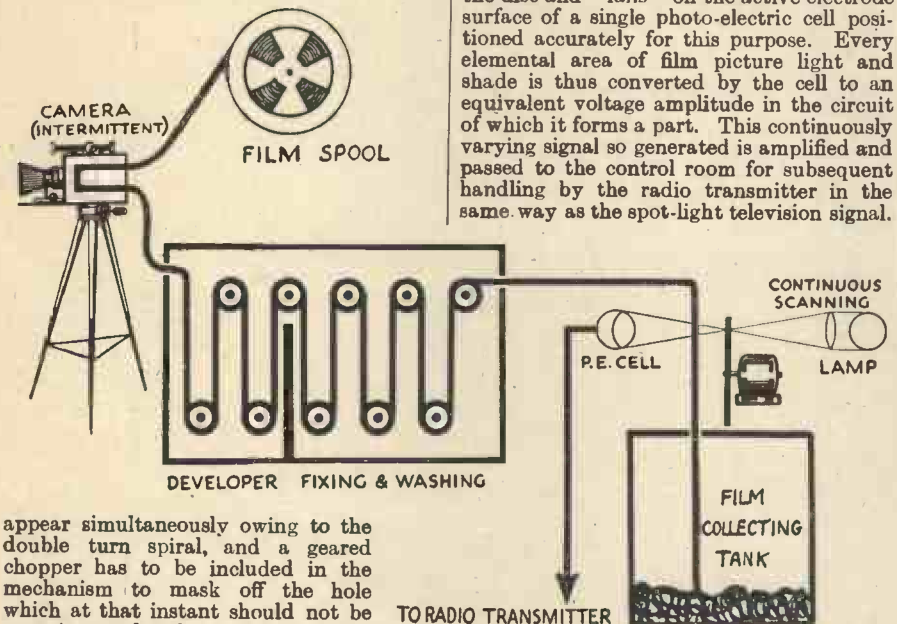


Fig. 3.—Showing how the intermediate film process works.

Televising Talking Films

Coming now to the tele-cine projector for producing television signals from standard talking films, a view of one of the Baird machines was given in Fig. 8 of last month's issue. This should be studied in conjunction with Fig. 3, which shows the bare essentials in simple pictorial fashion. A bright light source (in this case an arc lamp) fitted to the left of the projector machine has its beam of light focused on to a rectangular gate through which is driven the film by geared sprockets. No shutter mechanism is included in the equipment so that the resultant effect emerging from the second focusing lens is a series of still pictures moving downwards across a slot in a metal mask, one after the other, at a rate of twenty-five pictures per second.

Instead of "throwing" these pictures on to a screen they are focused on to the top rim of a scanning disc, which, for a 240-line picture, has a series of 120 minute holes located on a circular trace with an angular separation of three degrees. The disc is revolved at 3,000 revolutions per minute and each separate hole traces the same arc path (regarded as a straight horizontal line for all practical purposes) during the running of the disc. The width of the projected film pictures at the top of the disc is such that only one hole at a time is accommodated during the scanning process.

Double Motion

As the picture moves downwards at a constant speed, the disc holes move across at a constant speed, and although each hole traces the same path as every other hole, due to the downward movement of the film pictures, the line traced across by each hole is a hole width separated from its immediate neighbour. One complete film picture moves down the mask slot in one twenty-fifth of a second, but during that time the disc has made two complete revolutions, and hence the number of lines into which the picture has been dissected is twice the total disc apertures, which in the example quoted is $2 \times 120 = 240$ lines. The arrangement of relative motion has in this way given the scanning conditions required.

At any and every instant of the hole movement, the amount of film picture light exposed by the hole passes right through the disc and "falls" on the active electrode surface of a single photo-electric cell positioned accurately for this purpose. Every elemental area of film picture light and shade is thus converted by the cell to an equivalent voltage amplitude in the circuit of which it forms a part. This continuously varying signal so generated is amplified and passed to the control room for subsequent handling by the radio transmitter in the same way as the spot-light television signal.

While the television signals are being generated, the film passes through the standard type of talking film head. Here the sound recorded on the narrow film track between the sprocket holes and film edge by either the variable density or variable amplitude method is converted to an electrical signal through the medium of a small projection lamp and photo-electrical cell. In addition, associated with the picture scanning mechanism are double synchronising frequency pulse generators to give both the L.F. and H.F. signals required at the receiving end, as we shall see later on in the series.

A Form of Delayed Television

Since it employs identical methods of scanning as that used by the tele-cine machine, it is appropriate at this juncture to deal with yet another method for producing television pictures. This is the Baird intermediate film apparatus, a simple pictorial sketch of which is shown in Fig. 3. Using 17·5 mm. film a special camera takes pictures of the scene to be televised in a manner similar to an ordinary cinematograph camera. Both indoor and outdoor scenes can be photographed, and, as an example of the latter, reference can be made to Fig. 4, which shows part of the equipment used while "shots" are being recorded of horses exercising in the Crystal Palace grounds.

Fig. 4.—Using the intermediate film high-definition scanner to televise an open-air scene of horses at jumping practice.

After leaving the camera (an intermittent type) the film is fed through a series of tanks by sprocket wheels and rollers. In these tanks there are the appropriate photographic developers and fixing solutions, and after going through this process the film is washed. While still wet, the film now passes down through a "gate," on one side of which is an arc lamp and on the other side focusing lenses and an encased scanning disc, where the projected film pictures, moving in an uninterrupted path, are scanned by a circle trace of minute apertures in exactly the same way as the tele-cine apparatus just dealt with.

Applications

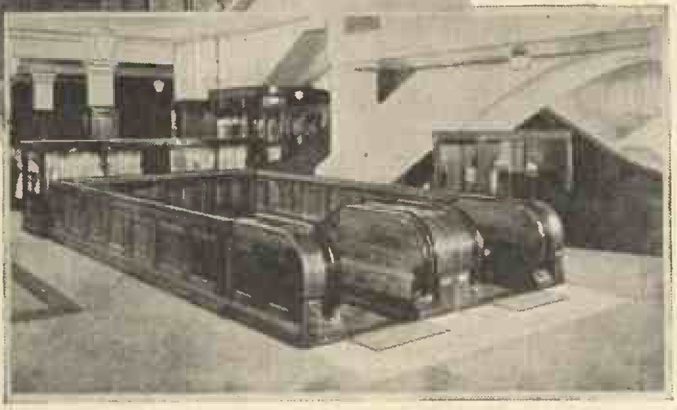
In addition, a sound-recording tube makes a variable density sound track down the film edge to be "taken off" at the other end of the film journey through the tanks as a sound signal. Finally, the double synchronising pulses are also generated as in the case of the tele-cine machine. The remarkable feature of the whole apparatus, however, is that the time which elapses between the photographing of the scene on to the film by the camera and its dissection into a "multi-lined" television image signal from the finished but wet film negative is only about half a minute.

This has only been made possible by a careful study of photographic and developing technique, but it enables the machine to be used for a wide variety of purposes. Accommodated on a lorry it can produce television pictures of any outdoor event of sporting or national interest, while indoor studio plays, sketches and so on all come within its scope. Not only can the transmission of these signals be effected with a delay measured in seconds, but the event, no matter of what nature, is stored in celluloid form for subsequent transmission at any other time when such a course is deemed desirable.

These three methods of producing television pictures for any public service, and using mechanical scanning, have been developed to a high degree of efficiency, but there is yet another important scheme for performing similar functions and which eliminates all forms of mechanical scanning. This is the electronic camera which is now being investigated and improved to take its place in the whole arrangements which ultimately will provide television for all. This side of the question will be dealt with next month.

HOW AN ESCALATOR WORKS

The external appearance and use of the escalator is no doubt familiar to a large proportion of the travelling public, but very few understand the "internal" mechanism, and this article will therefore prove interesting.



Two types of escalator in use at a departmental store.

BROADLY speaking, a passenger escalator is a mechanism which comprises a continuous number of steps, which can be made to move in a descending or ascending direction and which, although having a step formation on the inclined portion, gradually changes to flat platforms as the upper and lower fixed landings are approached.

Escalators are built at a standard angle of 30 degrees from the horizontal, and in three standard widths—namely, with an inside measurement of 2, 3 or 4 ft. between the balustrading, and operating at a speed of 90 ft. per minute.

There are two types in use for passenger service: the flat-step type with smooth treads, which involves the use of shunts at the landings; and the cleat-step type, which is provided with comb-type landings. On the flat-step type, the step appears from under the floor at the lower landing as a moving platform, and as it goes upward, it slowly breaks into a perfect series of steps, rising into a complete stairway. On each side there is a hand-rail of flexible material, which moves upward at the same speed as the stairs, thus affording the passengers a secure support as they ascend. At the top the steps again flatten out into a moving platform, from which the passenger steps to the stationary landing on the same level, with no appreciable sensation other than that experienced in walking on the level. At the upper landing one of the side balustrades turns inward, and the moving platform disappears under it.

The flat-step type is made either ascending, descending or reversible. The shunts for escalators operating in the ascending direction are placed at the upper landing; with the descending escalator they are at the lower landing, and with the reversible type they must be placed at both upper and lower landings.

The Cleat-step Type

The principal features of this type are the use of the perfect step formation of the flat-step type, and the use of the comb landings at the top and bottom, so as not to require the space on the floors needed for the shunts used on the flat-step type. The steps are of the same construction as the flat-step type, but have longitudinal cleats screwed to the steps, so as to permit of the use of the comb landings. The cleat-step type is always made reversible so that they can operate either up or down, depending upon the traffic conditions; or it can, of course, always be used in one direction.

> **INTERESTING FACTS ABOUT ESCALATORS**
>
> *The following details refer to the installation of eight escalators in various London Underground Stations:—*
>
> *The combined vertical rise of the escalators was* 3,500 *ft.*
>
> *The aggregate of the horse-power of the driving motors was* 6,000.
>
> *The number of steps required was over* 12,300.
>
> *The total length of the special step chain needed was over* 32,500 *ft.*
>
> *That of other roller chains used exceeded* 9,000 *ft.*
>
> *The special moulded wheels which carried the steps numbered nearly* 50,000.
>
> *There were six miles of travelling hand-rail.*

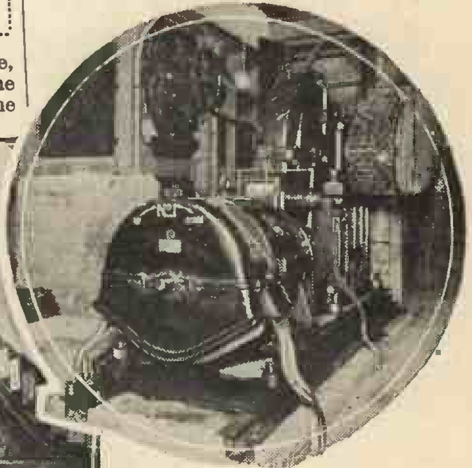
Safety Devices

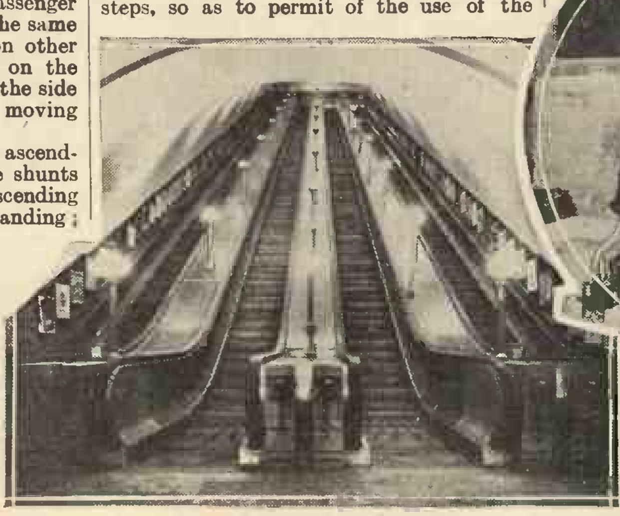
Both types of escalators are provided with all necessary safety devices, arranged to stop the escalator immediately upon any derangement of the apparatus. They are provided with full automatic push-button control—to start, stop or reverse the direction of travel. Buttons are conveniently located at the top and bottom landings of the escalator, the stop button being available as an emergency stop; the other buttons can only be operated by means of a key. This prevents the unauthorised use of the buttons and still makes it possible for anyone to stop the escalator in case of immediate necessity.

All types of escalators are driven by an electric motor placed underneath the floor at the top of the incline. This motor drives the gears and sprockets, which in turn operates the driving chain which carries the steps.

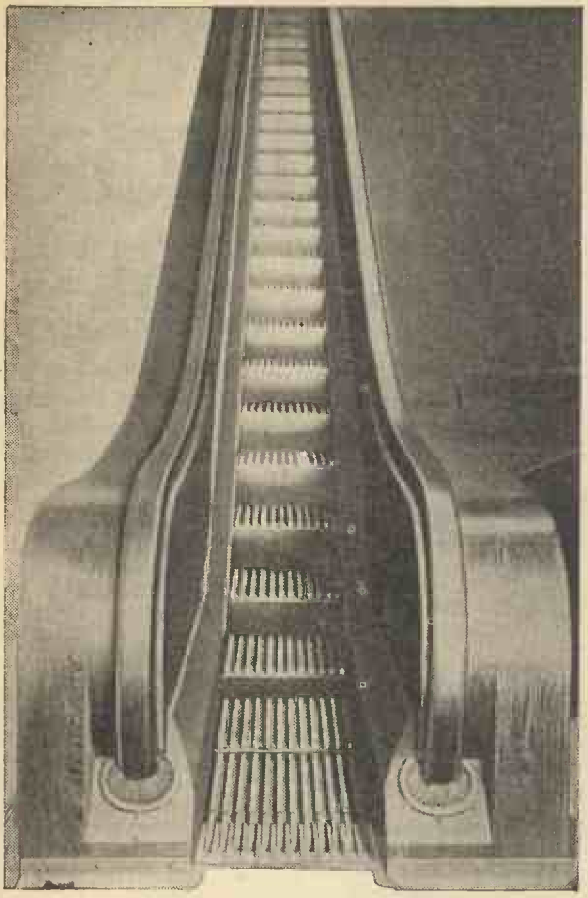
The Brake Drum

A great deal of attention is given to the design and operation of the main brake, to facilitate the safe-stopping of the esca-





(Above) The escalator machinery chamber and (left) the escalators which are in use at Holborn station.



The type " L " clear step escalator.

lator under varying loads. This drum, which is roughly 4 ft. in diameter, is acted upon by a pair of balanced shoes lined with ferodo and carried by steel arms, spring-applied, and magnetically held in position while the escalator is running. The force exerted by the brake gear is sufficient to stop a fully loaded, maximum rise, descending escalator moving at full speed, but at the same time it must not stop a lightly loaded descending one so suddenly as to cause undue shock to passengers who may be travelling thereon. To do this the brake magnets, which are of exceptionally powerful construction, and their coils, are fitted with variable discharge paths controlled by a device built into the controller, and also with voltage regulators.

Arrangement of Escalators

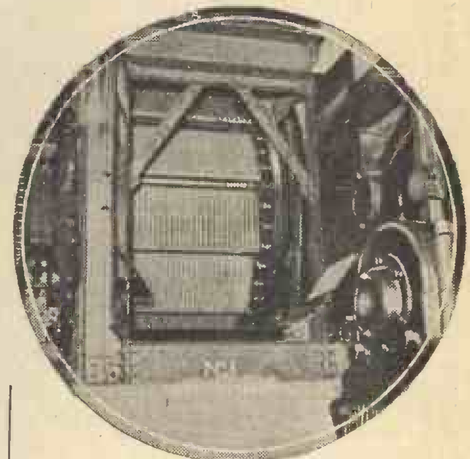
The arrangement most generally used in department stores are the parallel type and the criss-cross, or bucksaw, each with many modifications. In all cases, however, they can be arranged for both up and down service and to give a continuity of travel from one escalator to another at the various floors. The parallel type has two escalators adjacent to each other. This arrangement permits of taking and delivering the up-traffic into the same cross aisle where the traffic conditions warrant such an arrangement. With the criss-cross or bucksaw type, the up and down traffic is widely separated, being taken away from and discharged into separate cross aisles, thereby entirely separating the up and down traffic, which in some cases is highly desirable. Under some conditions a combination of both systems works out to advantage.

Cleaning the Escalator

The escalator steps are cleaned by a number of air-nozzles which are directed on to the surfaces of the steps in the vicinity of the lower landing sprockets. The dust and *débris* are caught in removable trays which are daily removed by the station staff. The air pressure is about 60 lb. per square inch and is turned on each morning for about ten minutes whilst the escalator is in motion.

The Step Chain

The step chain and wheels are also cleaned in the same manner, after which a further set of nozzles sprays them with oil, the air pressure for this latter purpose being reduced to about 9 lb. per square inch. The fixed landings at the top and bottom of the escalator are covered with steel plates filled with rubber flooring and provided with bronze mouldings. These are removable where they cover the machinery, to facilitate the replacement of large parts should same be needed at any future time. We are indebted to the Otis Elevator Company for the foregoing information.



The treads at the turning point at the top of the escalator.

A WORLD-FAMOUS STEAM ENGINE

PROGRESS has never before been swifter than in the last century, when the magic of science has wrought such overwhelming improvements.

To look at that now historic little steam engine " Locomotive No. 1 " is to see the beginning of the vast railway systems of the world—the thousands of miles of steel permanent way—the giant expresses—which to-day we look upon almost as a matter of course.

And yet Stephenson's little engine seemed a miracle to our grandfathers when, as " Active," the first public passenger train in the world, she attained the modest speed of 15 miles an hour at the opening of the Stockton and Darlington Railway in 1825. A huge crowd of nearly 50,000 came to gaze awestruck at this unbelievable performance, yet now a railway speed of 70 miles an hour passes without comment.

The First Man to run a Locomotive

Richard Trevithick was the first man to run a locomotive, closely followed by Blenkinsopp, and Hedley with his " Puffing Billy," but it was George Stephenson who set out to improve the locomotive and to lay the foundation stone of the railway system we have to-day.

" Locomotive No. 1 " was his third experiment—the first being the " Blucher " (1814) capable of hauling eight loaded wagons at 4 miles per hour, and the second improved locomotive was constructed a year later for the Killingworth Colliery.

" Locomotive No. 1 " was constructed at Forth Street Works, Newcastle-on-Tyne, and the model recently made by Bassett-Lowke Ltd. shows clearly its construction.

A Realistic Model

In the actual engine which weighed 6½ tons, the four coupled wheels were 4 ft. diameter, and the two vertical cylinders 24-in. stroke, 10-in. diameter. The water pressure was 25 lb. to the square inch, and the tender carried 15 cwt. of coal. Afterwards the water barrel on the tender was changed for the 240-gallon sheet iron tank.

The realistic model made by Bassett-Lowke measures 3 ft. × 11 in. wide × 23 in. to the top of the chimney, and has been built to the special scale of 1½ in. to the foot for Robert Stephenson & Co., of Darlington, from their own old model. It has the unique feature of being a working model. All the overhead motion—the intricate " grasshopper " gear—has been specially constructed for working conditions. The boiler is of copper with mahogany lagging; the motion parts are of nickel-plated steel, and the curiously patterned wheels of cast iron. The chimney of the model is 16 in. high, and the rails are made in the old style with imitation stone sleepers.

An Interesting History

" Locomotive No. 1 " itself, as it stands now on the stone pedestal in Darlington station, has had an interesting history.

For the first twenty-five years it was in service on the Stockton and Darlington Railway, then for seven years as a colliery pumping engine.

Since then it has been to Philadelphia and Paris for exhibitions, led some famous railway processions, and it came to life most appropriately at the railway centenary at Darlington in 1925.

BUILDING "STREAMLINIA"

This month we deal with the woodwork of this fine model speedboat. Previous articles on the construction of this model appeared in our issues for February and March.

Fig. 2.—The hull in course of construction, showing imaginary chine line.

SINCE our last issue several readers have found a little difficulty in shaping the hull of *Streamlinia*, and finding the correct chine line.

A simple method used at Northampton is shown on the sketch plan reproduced herewith. After marking off and carefully cutting through the profile, working down to the lines on both edges, it will be found that the ordinate lines previously marked are cut away. These are marked again on the top and the bottom of the block, and the centre line of the hull should now be marked at both top and bottom of the forward end, preferably with a joiners' marking gauge. The only tools absolutely necessary for the hull work are a joiner's paring chisel, a flat paring gauge, both about 1¼ in. wide, and a good outside gouge for projected to the bottom of the hull (see Fig. 1, line ABC). On ordinate No. 2, A represents the deck outline, B is the chine line, and C the chine line projected to the bottom of the hull. You can mark out these lines on the body plan. The sketch plan shows projected chine lines on ordinates 2, 3, 4 and 5.

In this manner you can start work on the forward end and cut straight through, from the top of hull outline to the projected chine line (see Fig. 2). The elevation of the chine is now marked on the side, and the forward part of the hull can be carved in accordance with the templates of the body plan.

These templates can be very simply made by placing thin pieces of plywood or cardboard under the body plan and pricking with a needle, afterwards cutting with a sharp knife or fretsaw.

In shaping the forward part a good flat gouge will be found to produce the best results. It pays to be careful in not taking off too much at a time, and testing with the appropriate template after each few cuts.

When the forward end is completed, the stern should present little difficulty, and you can then proceed with the hollowing out.

Hollowing out the Hull

A skilled craftsman, with the help of tools, generally takes about three hours to hollow out the hull, but when you are doing the work yourself, it may take up to a week, according to the time at your disposal. In fact, to hollow out the hull a little at a time is really the ideal way, as naturally more care is taken over the work. The thinner the hull is, the lighter it will be, drawing less water and consequently giving more speed and better performance. In the case of *Streamlinia*, we advise hollowing out to about ⅜ in. thick throughout the whole of the hull.

These further facts are given for the benefit of those who have not yet completed the hull, but I doubt if many of us, with scoured hulls covered with priming paint, have resisted the temptation to try out our masterpieces on water, even if it is in a spot no more adventurous than the bathroom.

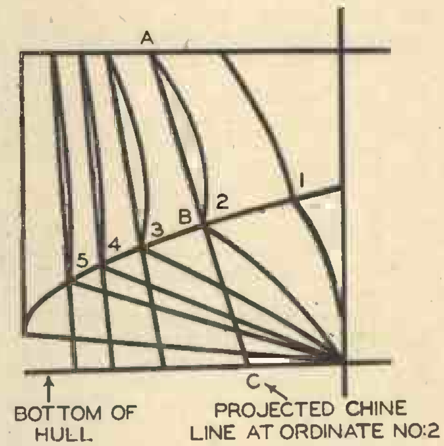


Fig. 1.—This sketch shows a simple method of obtaining the chine line.

I am sure those of us who have done so, have been agreeably surprised at the buoyancy and modernistic "racy" appearance of the hull. A good lead paint is necessary or the wood will be saturated.

Fig. 3.—(Left). Showing the method of drilling the stern tube. The operator is shown sighting the centre line of the hull.

Drilling the Stern Tube

The next operation on the hand-carved hull is drilling the stern tube—not such a difficult job as many would suppose, provided you have the assistance of someone with a true eye. Place the hull face downwards on the work table (see Fig. 3). Keep your eye on the centre line of the hull while hollowing out, but it is advisable also to use a marking gauge if you possess one, as a pencil line is so easily erased.

The Chine Line

The outline of the top of the hull is marked out on the top, and the after bottom outline on the bottom. To produce the correct chine easily, the chine line can be

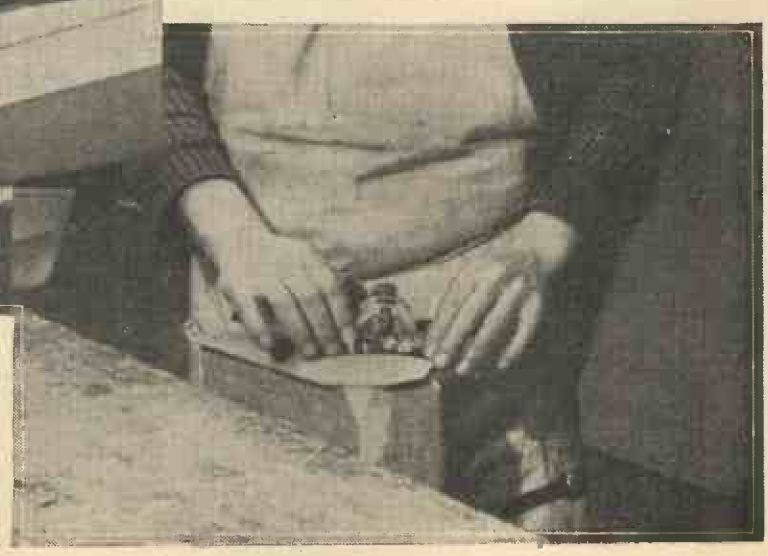


Fig. 4.—(Right). Shaping the top of the deck house on a wooden block fixed in a vice.

your assistant sights the angle at which you are drilling. It does not matter if the hole is drilled on the large side, as afterwards this can be filled in, around the tube, with plastic wood. It is almost impossible to drill a perfectly true hole, and it is certainly preferable to fit the tube loosely at first than to bend it, as often happens when the hole is tight. The hole in the wood block inside the hull should fit correctly.

Unscrew the gland from the end of the stern tube. Push it through from the outside, fix the skeg (shaft bracket) with $\frac{1}{2}$-in. *steel* screws (brass screws are liable to break if screwed tight), and fill in the hole in the hull with plastic wood. Let this dry thoroughly before cleaning off. It is advisable to leave it for twenty-four hours, and in the meantime continue with the upper structure, beginning with the deck, which is best cut from a piece of 5 mm. plywood. This can be marked out by placing the hull on the plywood, pencilling round, and cutting $\frac{3}{16}$ in. outside the line, afterwards carefully cleaning and rounding off with sandpaper.

The Top Deckhouse

Now begin on the construction of the top deckhouse, and here the fretsaw will be found very useful. On the full-size drawings, which can be obtained from Bassett-Lowke Ltd., of Northampton, the deckhouse sides are all marked out the actual size. Otherwise these parts must be scaled up from the drawings reproduced in the March issue.

Streamlinia has a white deckhouse, and if this is the colour decided on for your model, any hard close-grained wood $\frac{1}{4}$ in. thick, such as American white wood, would be suitable, but some may prefer a mahogany deckhouse or some other varnished wood. It is purely a question of taste. Varnished mahogany is certainly associated with cabin cruisers, and it requires very little finishing.

Trace out the deck sides in pencil on whatever wood you decide upon, with the grain running *along* the sides. Use a fine fretsaw to cut out the windows, as then these will not require so much cleaning. When cutting out these sides, do not forget the slot in the after transom for the tiller, as this is most difficult to cut in when the deckhouse is constructed.

The corner joints must be most carefully made and fixed with screws and good Scotch glue, or croid, which has reached such popularity in aeroplane construction. Fig. 5 shows the method of fixing these parts together. The completed deckhouse should now be left for at least twenty-four hours to dry, afterwards cleaning up the rough parts, and rounding up the corners smoothly. This streamline deckhouse is certainly most attractive, following the latest principles in aerodynamics, and it greatly adds to the beautiful lines of the boat.

The roof of the deckhouse is rather difficult to hold when shaping, so it is advisable to screw it down to the bench top at the places where the holes for the pressure gauge or steam valve are later to be drilled. Or alternatively, it may be fixed to a block of wood, held in a carpenter's wood vice. Shape it up with a spoke-shave and sandpaper to a good smooth finish, ready for painting (see Fig. 4).

Finished unpainted deckhouses may be obtained for *Streamlinia* from Bassett-Lowke Ltd., for those who prefer this part ready made.

Fig. 5.—Showing a side of the deckhouse in the course of construction.

SAFEGUARDING COMMERCIAL AVIATION

Testing the upper air conditions for the guidance of pilots.

MANY amazing scientific devices are used by the Ford Motor Company to safeguard the airways which radiate from the Ford Airport, at Dearborn, Mich. A wireless beacon flashes its signal, marking an invisible course over the airway, thus making it possible for pilots to fly in darkness, fog, or through areas of low visibility. The courses are marked between Detroit and Chicago, and Detroit and Toledo, O., where one route connects with the transcontinental airway. Both pilots and stations along these routes are given a half-hourly radio weather broadcast from station WQDW at the Ford aerodrome, the weather information being supplied from a station perched high on the roof of one of the aerodrome hangers. At twenty-five and fifty-five minutes after each hour, pilots may tune to the station wavelength, and be appraised of the weather at every station on the routes. Lastly, the small station which houses the wireless beacon transmitter at the far end of the aerodrome, is also equipped with a marker beacon, which can be heard at a maximum distance of two miles. This warns pilots flying in foggy weather, or darkness, of the proximity of the aerodrome, and permits them to find their way safely into port. The photograph on the left shows meteorologists of the U.S. Weather Bureau at the Ford aerodrome preparing to test the upper air conditions for the guidance of pilots. With the use of the hydrogen balloon and the theodolite, the meteorologists are able to measure the movements of the balloon as it rises, and thus gauge the velocities of the winds aloft. Such information enables pilots to choose the levels at which they will fly, and to take advantage of favouring winds.

CHEMICAL EXPERIMENTS WITH SELENIUM

An Interesting and Practical Article Dealing with the Light-sensitive Properties of Selenium

Jöns Jakob Berzelius (1779–1848), *the great Swedish chemist and analyst and the first discoverer of the element selenium.*

SELENIUM is one of the most interesting of all the elements. It was discovered as far back as 1817 by that great Swedish chemist and analyst, Jöns Jakob Berzelius. Previously, the element, tellurium, had been discovered and its name had been derived from the Latin word, *tellus*, signifying the earth. Berzelius found that his newly-discovered element had many properties in common with tellurium. Accordingly, he decided to call his new element, "selenium," a name which he coined from the Greek, *selene*, meaning "the moon." Thus has selenium, even to this day, been dubbed "the moon element," although, of course, it has nothing whatever to do with the moon.

As every experimenter knows, selenium's chief claim to fame lies in its extraordinary light-sensitivity, a property which was first disclosed by a Mr. May, a telegraphist employed at the Valentia Island Station of the old Trans-Atlantic Cable Service. The year of this discovery was 1873. Almost immediately a number of proposals for making use of selenium's light-sensitivity were forthcoming. The first germ of the technique of television had arisen in the minds of experimenters. Light-sensitive selenium cells, however, proved fruitless for practical television purposes. Nevertheless, they had and, for that matter, still have many important scientific applications. Hence, selenium cells are by no means the "back numbers" which frequently they are considered to be.

You cannot, of course, purchase selenium from your local druggist or pharmacy. Nevertheless, any firm of wholesale chemists will be able to supply the material on demand. The average price is about 2*s*. per oz. for powdered selenium and a little more for the lump variety.

Having obtained ½ oz. or so of the powdered or lump selenium, examine it closely. If the element has been obtained in lump form, the lumps will be seen to be brownish-black and glassy-looking, having, here and there, a greenish cast about them. The lumps are brittle and they can easily be powdered up into a black powder.

Powdered selenium is also black in colour. Some varieties of the element, however, are brick-red in colour. This is a different form of the element, and, as we shall see later on, it is the form in which selenium is precipitated from its solutions.

A Poor Conductor of Electricity

It is easy to see that selenium is not a metal. Quite apart from its sensitivity to light, it is a poor conductor of electricity. As a matter of fact, from a chemical standpoint, selenium is very closely allied to sulphur on the one side and to tellurium on the other. Now sulphur is obviously a non-metallic element, whilst tellurium is very decidedly a metal. The properties of selenium are nearly half-way between those of sulphur and tellurium, although not quite half-way between, for selenium is more similar to sulphur than it is to tellurium.

Melt a small quantity of selenium at the bottom of a test-tube and note one curious and well-defined characteristic of the element. When melted, selenium gives off a peculiar odour which has been described as having a resemblance to rotten horse-radish, though, truth to tell, this resemblance has been much over-stressed. All the same, selenium does give off this peculiar odour when it is melted in the pure state, and as the odour is by no means a pleasant one, care should be taken not to melt large quantities of the element indoors.

Like sulphur, selenium exists in a number of different varieties or "allotropic modifications," as they are termed.

Alpha-selenium (α-selenium) is the brick-red powder in which form selenium is precipitated from its chemical solutions. Beta-selenium (β-selenium) is the black crystalline powder which is obtained by passing sulphur dioxide gas into a heated solution of selenious acid. Gamma-selenium (γ-selenium) is the dark-red crystalline mass which is obtained by dissolving selenium in carbon disulphide. Delta-selenium (δ-selenium) is the lump or powdered selenium of commerce. Very probably it is not a pure form of the element, but is a mixture of various modifications of selenium. It is, however, the form of the element which becomes light-sensitive on being subjected to careful heat-treatment.

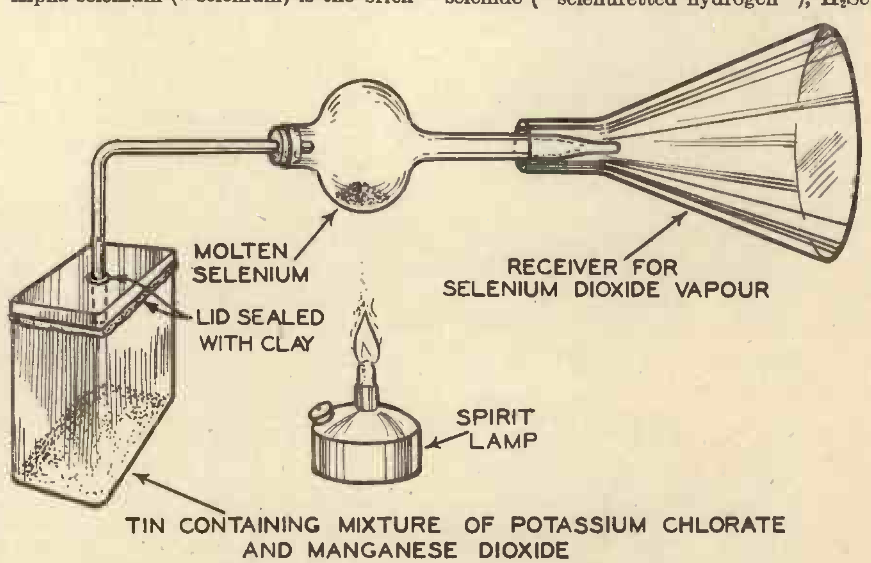
Selenium combines readily with many metals to form *selenides*, just as sulphur combines with metals to form sulphides. Mix intimately equal quantities of powdered selenium and fine iron filings. Place them in a test-tube or at the bottom of an old can and heat the mixture strongly. Just below red-heat a glow will spread through the mass. After this appears, heat a little more strongly and then allow the mass to cool down. It will now consist of iron selenide, mixed with more or less unchanged iron filings.

A Further Experiment

Now comes an experiment which MUST be performed out-of-doors owing to the bad odour of the generated gas. Place in a small flask fitted up with a delivery tube some of the iron selenide prepared in the foregoing experiment and pour into the flask a small quantity (sufficient to cover the iron selenide) of dilute sulphuric or hydrochloric acid. Have in readiness a vessel containing *cold* water and arrange matters so that the delivery tube of the flask dips below the water.

The action of the acid on the iron selenide will result in the liberation of hydrogen selenide ("selenuretted hydrogen"), H_2Se, a gas very similar to sulphuretted hydrogen in properties, but having, if possible, a still more unpleasant smell. It is for this reason, and also on account of the fact that some experimenters find hydrogen selenide gas somewhat irritating to the eyes, that the experiment should be carried out in an open space.

Hydrogen selenide is soluble in water. Its solution in water, however, is not very stable. Quickly it will begin to decompose and it will deposit brick-red selenium



An experiment with selenium showing the apparatus required for making selenium dioxide.

(a-selenium) on the bottom and sides of the containing vessel.

Ammonium Selenide

If instead of leading the hydrogen selenide gas into water, it is led into a dilute solution of ammonia, another compound—ammonium selenide—will be formed. But ammonium selenide, also, is not a very stable substance. Within a few minutes a proportion of it decomposes and liberates selenium. This time, however, the liberated selenium is in the form of a colloidal solution, which, as you will be aware, is not a true solution, but which in reality consists of a fine suspension of selenium in the water. The suspended particles of selenium are so fine that they cannot be seen except through an ultra-microscope. Nevertheless, their presence gives a magnificent ruby colour to the liquid.

Making hydrogen selenide H_2Se. Iron selenide and diluted sulphuric or hydrochloric acid are placed in the flask, the hydrogen selenide evolved being bubbled through water in the glass cylinder.

In this connection it is worth noting that if a trace of selenium is added to molten glass a similar colour is produced throughout the mass of glass. The principle is the same, the selenium being spread throughout the glass in a colloidal form.

If instead of ammonia or water, as in the above experiments, the hydrogen selenide gas is passed into a dilute solution of caustic soda, the resultant liquid will contain sodium selenide in solution. Like the water and dilute ammonia solutions of selenium, this solution also is unstable, and will precipitate brick-red selenium.

If dilute sulphuric or hydrochloric acid is added to any of the above three solutions, pure selenium in its brick-red form will be precipitated almost instantly. It can then be filtered off through a filter-paper, washed and dried for preservation or future experiments.

Before leaving the subject of hydrogen selenide, mention must be made of one very useful application which will be of interest to all amateur photographers. This is the making of selenium-toned photographs, about which little is heard at the present day.

In order to make these prints it is necessary to start with a black-and-white gaslight or bromide print. This should be immersed in the following "bleaching solution" until the black and white image is "bleached" to a faint brown colour:—

Potassium ferricyanide	.	100 gr.
Potassium bromide	.	150 „
Water . . .	.	2½ oz.
or 11 gm.		
16 „		
150 c.c.		

Rinse the bleached print in water and then transfer it to the solution obtained by passing hydrogen selenide gas into water, dilute ammonia or dilute caustic soda solution. A chocolate-brown image will develop upon the print immediately. The print should not be immersed in the hydrogen selenide solution for more than one minute, otherwise the whites of the photograph will be discoloured. It should then be thoroughly well washed and dried. Its image will now consist of silver selenide.

Selenium Dioxide

Selenium dioxide, SeO_2, is an interesting selenium compound to prepare. It is analogous to sulphur dioxide, SO_2, but unlike the latter, which is a pungent gas, selenium dioxide is a white crystalline substance. In order to prepare this material rig up the simple apparatus shown in the accompanying sketch. A mixture of potassium chlorate and manganese dioxide is heated in an old coffee or cocoa tin. This is better and cheaper than using a hard-glass test tube for the purpose. The lid of the tin and the area at which the delivery-tube passes through it should, of course, be well luted with clay in order to provide an efficient seal to prevent the escape of the pure oxygen gas which will be generated as a result of the heating. The oxygen gas from the chlorate mixture is led into a bulb tube, in the bulb of which a small quantity of selenium is gently melted. The exit from the bulb tube leads into a small conical flask or other suitable vessel. When the oxygen comes in contact with the selenium, the latter will take fire and it will burn gently with a peculiar lambent flame. White clouds of selenium dioxide, resulting from the combination of the oxygen with the selenium will be evolved and these will condense to long white crystals in the conical flask or other receptacle which acts as a "receiver." Some of these crystals ought to be collected and sealed up in a glass tube as permanent specimens.

To the remaining crystals a small quantity of hot water should be added. A solution of selenious acid will now be formed, the selenium dioxide having combined with the water in accordance with the following equation:—

$$SeO_2 + H_2O = H_2SeO_3.$$

Selenium dioxide. Water. Selenium acid.

This reaction, you will observe, is similar to that in virtue of which sulphur dioxide, SO_2, combines with water to form sulphurous acid, H_2SO_3. If oxides are dissolved in this acid, *selenites* are obtained. Selenious acid, however, is not very stable. If zinc, magnesium, mineral acids or even a stream of sulphur dioxide gas is allowed to act upon the solution, selenium will be precipitated.

Selenic acid, H_2SeO_4, which, as will be noted, is the selenium equivalent of the well-known sulphuric acid, H_2SO_4, is a much more stable acid. It is a strong acid also, and it carries the proud distinction of being the only single acid known which will dissolve gold.

Selenic Acid

To make selenic acid, one has to go a rather roundabout way. If silver nitrate solution is added to a solution of selenious acid, a precipitate of silver selenite, Ag_2SeO_3, will be obtained. If this salt is collected and suspended in water (it is insoluble in water) and a few drops of bromine added, the following reaction will occur:—

$$Ag_2SeO_3 + H_2O + Br_2 = 2AgBr + H_2SeO_4.$$

Silver selenite. Water. Bromine. Silver bromide. Selenic acid.

The insoluble silver bromide may be filtered off, leaving the aqueous solution of selenic acid to be concentrated by heat. This method of preparation, however, is not a very satisfactory one on account of the expense of silver nitrate.

A less expensive method of preparing selenic acid consists in fusing to red heat a mixture of about equal quantities of powdered selenium and saltpetre (potassium nitrate). A chemical reaction will proceed, resulting in the formation of potassium selenate. The fused mass is dissolved in water, and to the solution a solution of lead nitrate or acetate is added until all the selenium is precipitated as lead selenate. This insoluble compound is suspended in water and a stream of sulphuretted hydrogen gas is passed through the liquid. The lead is precipitated as lead sulphide, leaving the free selenic acid in solution. It should then be carefully concentrated by heat.

Selenic acid, like sulphuric acid, is a very strong acid. Metallic oxides, hydroxides and many metals themselves (including gold) dissolve in it to form salts known as selenates. These are easily crystallisable, and may be prepared in this manner.

Selenides

We now arrive at the large class of selenium compounds known as *selenides*. These are usually readily prepared by passing a stream of selenuretted hydrogen gas into a solution of the metallic salt. For instance, if a stream of hydrogen selenide is passed into a solution of silver nitrate or lead nitrate, silver and lead selenides respectively will be precipitated. These are absolutely insoluble in water.

Pure selenium in its glassy condition. This is the material from which the light-sensitive form of the element is prepared.

They may thus be filtered off, washed, dried and preserved in glass tubes. When acted upon by hydrochloric or sulphuric acids, selenides evolve pure hydrogen selenide gas. Herein, therefore, we have a method of preparing selenuretted hydrogen in its pure state.

When any compound containing selenium is fused by a hot flame on a block of charcoal, it invariably gives off a characteristic horse-radish odour. This constitutes a delicate test for the presence of selenium.

Selenium in its light-sensitive form is prepared by very carefully melting the lump variety of the element and then by cautiously allowing it to cool, thereby obtaining it in an annealed condition. Selenium, however, is given its light-sensitivity *after* being incorporated in electrical cells. It cannot be made light-sensitive by purely chemical methods alone.

If selenium is gently melted in a bulb tube and a slow stream of chlorine gas (generated by the action of hydrochloric acid on manganese dioxide) passed over it, selenium dichloride, Se_2Cl_2, will be formed.

The New Pelmanism

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"Take this Course—all of you," he says.

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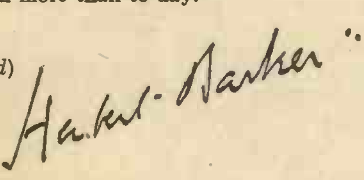
"Can we do this? I say most emphatically, We *can*, and by that simple, *alluringly* pleasant, and marvellous system which the denizens of the entire earth know as Pelmanism. No one who has investigated its methods can doubt this, and the imposing and impressive testimony of many of our greatest men constitutes, I should say, a *unique* record of praise.

"I always thought it quite impossible that the old 'Little Grey Books' could be improved upon, but the new ones have—if I may say so—achieved the impossible, and made the perfect more perfect.

"Take this Course—all of you—and life will have a new beginning whatever your age. You will, each day, more and more deeply realise the quiet but intense joy and satisfaction of knowing with *certainty* that your mind and character are steadily being built up, stone by stone; that your brain is being fortified and clarified; your will strengthened, and life becoming what it was surely intended to be, a glorious privilege—a blessing beyond all price.

"Mr. W. J. Ennever has indeed bestowed an inestimable boon upon mankind and richly deserves all that is best of his fellow-men. His name will be honoured in the history of progress, as it is respected to-day by the thousands of men and women who owe him a great, unpayable debt of gratitude. Never has the world needed Pelmanism more than to-day."

(Signed) 

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Increases Earning-Power

It enables those who follow it to master the art of Self-realisation and Self-expression. It shows them how to conquer any mental defects which may be troubling them and how to develop such useful qualities as Observation, Concentration, Initiative, Self-confidence, Self-reliance, Will-power, Organising Ability and Creative Imagination. It shows them how they can increase their all-round efficiency and earning-power and thus improve their positions in life. It is in fact a modern Course for the modern mind, and every reader who wishes to train his or her mental faculties to the highest efficiency by the most up-to-date scientific methods should write for full free particulars to-day.

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If therefore you are troubled with Indecision, Mind-Wandering, Procrastination, Timidity, Shyness, Forgetfulness, Lost Nerve, Morbid Thoughts and Fears, Depression, Want of Confidence, or False Feelings of Inferiority, or if you wish to develop :—

—Concentration	—Foresight
—Judgment	—Tenacity
—Self-Control	—Self-Confidence
—Imagination	—Strength of Will
—Initiative	—Self-Expression
—Observation	—Organising Power
—Resourcefulness	—Decision
—Courage	—Creative Imagination
—Perseverance	—Driving Force
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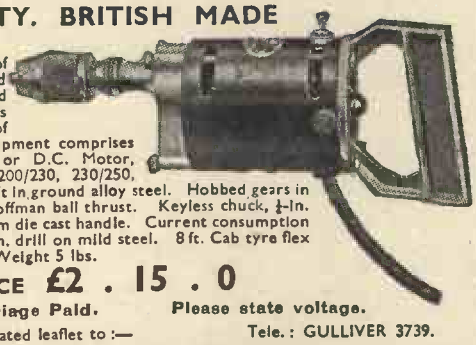

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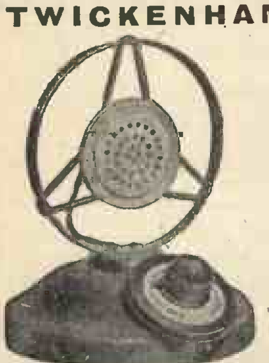

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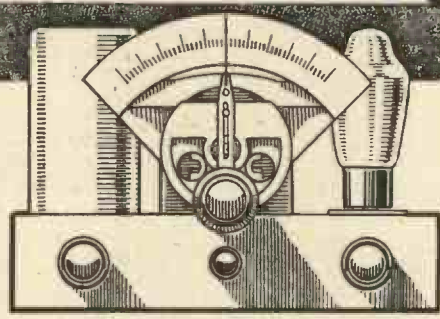
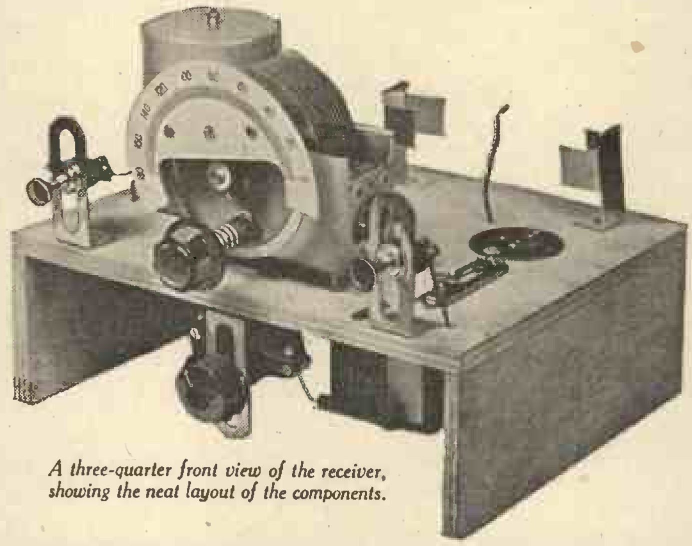


THE MONARCH TWO-VALVER

THE series of receivers formerly described in these pages have, without exception, dealt with receivers having three or more valves. The simple two-valver did not seem to call for space, since most readers are able to wire up a simple detector stage with one low-frequency amplifying stage. One is always, however, apt to lose sight of the fact that a new generation of wireless enthusiasts springs up every few months, as is proved by the many requests we receive for designs of crystal sets, one-valve sets and two-valvers, hence, this month we have designed a special two-valver, employing a well-known satisfactory circuit and modern components. We had in mind when preparing this design a receiver which could be used as a useful introduction to a more ambitious receiving set. After adjusting it, however, it developed into a fascinating piece of apparatus which in many respects is equivalent to some three-valvers.



A three-quarter front view of the receiver, showing the neat layout of the components.

Modern Appearance

To give it a modern appearance we have employed a wooden metallised chassis which gives the visible portion of the receiver a clean appearance and enables components not in need of adjustment to be conveniently tucked away underneath.

The receiver is certainly cheap, and it may be made in a couple of hours. Notwithstanding the economy of components and the few wires employed, it is a top-notcher from the point of view of quality and number of stations received. A modern screened coil is used which under test revealed itself to be entirely efficient, with no trace of break-through or restricted tuning range.

Careful adjustment of the pre-set condenser will improve selectivity and sharpen up the tuning.

The Construction

The first part to secure is the tuning coil, which is attached to the baseboard by means of two screws, then the variable condenser, which is fastened from the underside of the chassis by means of screws which pass into projecting sockets at the base of the condenser.

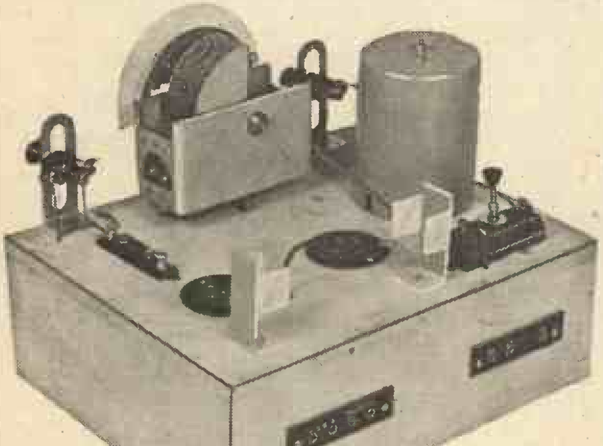
Next, drill 1-in. holes for the valve-holders, and fix these by means of four screws, noting the relative positions of the grids, that is to say, the grid of the detector valve is nearest the coil, whereas the grid of the pentode valve is nearest the right-hand side of the chassis. In other words, the two plate legs face one another. Next, screw down the pre-set condenser and the grid-bias battery clips.

The two brackets which carry the on-off switches and the wave-change switch should next be secured, as well as the small earthing tag to the left of the on-off switch. Now invert the chassis and secure in the exact centre of the front edge the bracket which carries the reaction condenser. Now screw the binocular choke, the L.F. transformer and the 2-mfd. fixed condenser to the chassis, and, finally, drill through the back of the chassis for the speaker and aerial and earth clip.

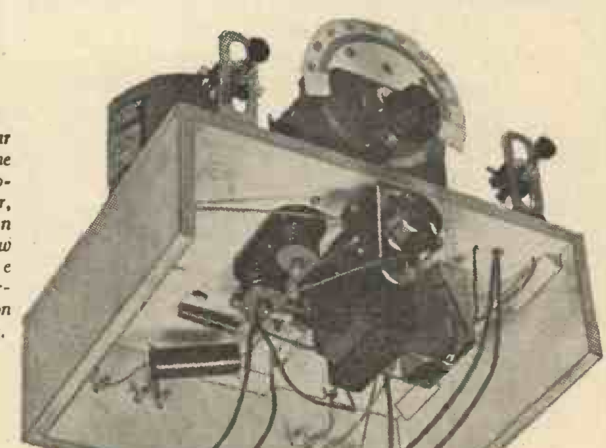
Wiring the Receiver

The Monarch Two-valver is now ready for wiring, which should be carried out in the following order:—

Connect the left-hand terminal of the wave-change switch to terminal 5 on the coil base (the coil should be mounted with terminals 5 and 2 at 9 o'clock and 3 o'clock, respectively); connect terminal 6 of the coil to the left-hand terminal of the pre-set condenser, solder a wire to the left-hand tag of the variable condenser to terminal 1 of the coil base, continuing this wire through a hole drilled in the baseboard to a ·0002-mfd. tubular condenser,



(Left) A rear view of the Monarch Two-valve receiver, and (Right) An underneath view showing the simplified wiring and position of components.



the other end of which is secured to the grid terminal of the detector valve. Also from this grid terminal connect one end of the 2-megohm grid-leak, and the other end of the grid-leak to the filament terminal nearest to the transformer. Turn the set the correct way up again and connect a wire from the left-hand terminal of the on-off switch to the nearest terminal on the fuse. The other side of the on-off switch is wired *viâ* a hole in the baseboard to the filament terminal nearest the 2-mfd. fixed condenser, this same wire continuing to the filament leg to which the grid-leak is attached.

The Earthing Connection

Now solder a wire to the earthing tab secured to the baseboard slightly to the left of the on-off switch and pass this wire through a hole in the baseboard to the front terminal of the 2-mfd. fixed condenser, to which it is soldered. Now wire up the two other filament legs; bare this wire mid-way and solder a wire to it, the other end being connected also to the front terminal of the 2-mfd. fixed condenser. The back terminal of the 2-mfd. condenser is wired to the H.T. positive terminal of the low-frequency transformer, this same wire being continued and connected to one side of the 25,000-ohm fixed resistance, the other side of the latter being connected to loudspeaker positive terminal of the speaker strip. This same terminal is also connected to the centre pin of the pentode valve-holder.

(*Continued on page* 320.)

LIST OF COMPONENTS FOR THE MONARCH TWO-VALVER

One Metaplex Chassis, 10 × 8 in., with 3-in. runners (Peto-Scott).

One Type GGR Tuning Coil (Ward & Goldstone).

Two Chassis-mounting Valveholders; one 4-pin and one 5-pin (Clix).

One ·0005-mfd. Tuning Condenser with Drive (J.B. "Nugang").

One ·0003-mfd. Reaction Condenser (Polar).

One 5 : 1 L.F. Transformer (B.R.G.).

Three Tubular Fixed Condensers; two ·0002 mfd. and one ·1 mfd. (T.M.C.).

Three 1-watt Resistances; 2 megohms, 20,000 ohms and 50,000 ohms (Dubilier).

One 2-mfd. Fixed Condenser (T.M.C., Type 25).

One H.F. Choke (Ward & Goldstone, Binocular).

Two Push-Pull Switches (Bulgin "Junior").

One 100-m.a. Fuse and Holder (Microfuse)

One ·0003-mfd. Pre-set Condenser (Ward & Goldstone).

Two Terminal Socket Strips; one A and E, and one L.S. (Clix).

One G.B. Battery Clip (Bulgin No. 1).

Four Wander Plugs; marked H.T. +, H.T. –, G.B. + and G.B. – (Clix).

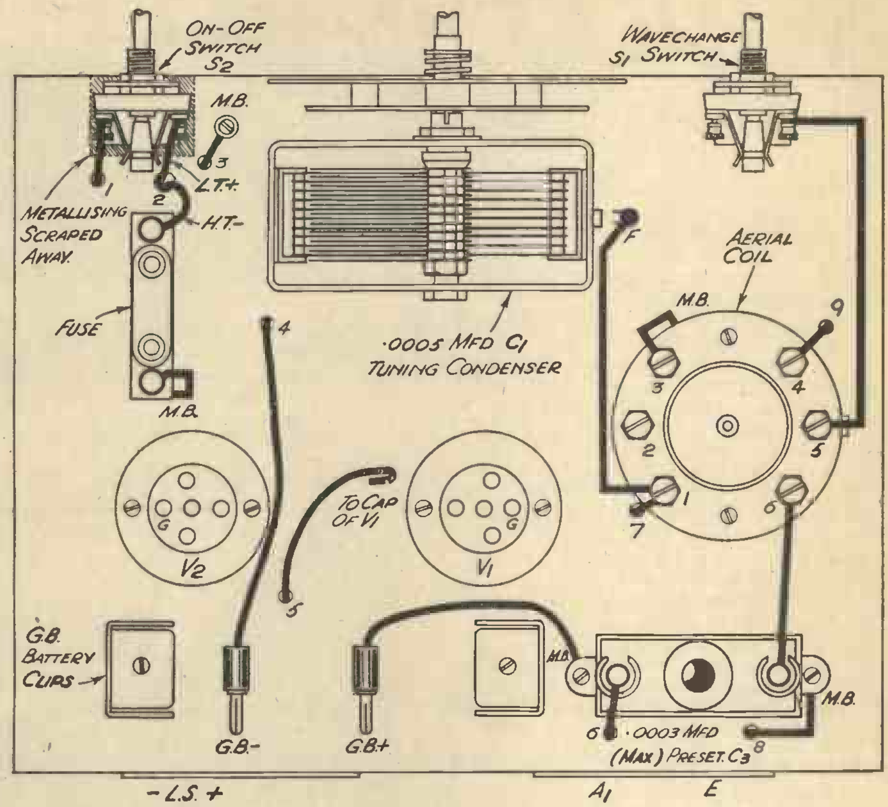
Two Spade Terminals; L.T. + and L.T. – (Clix).

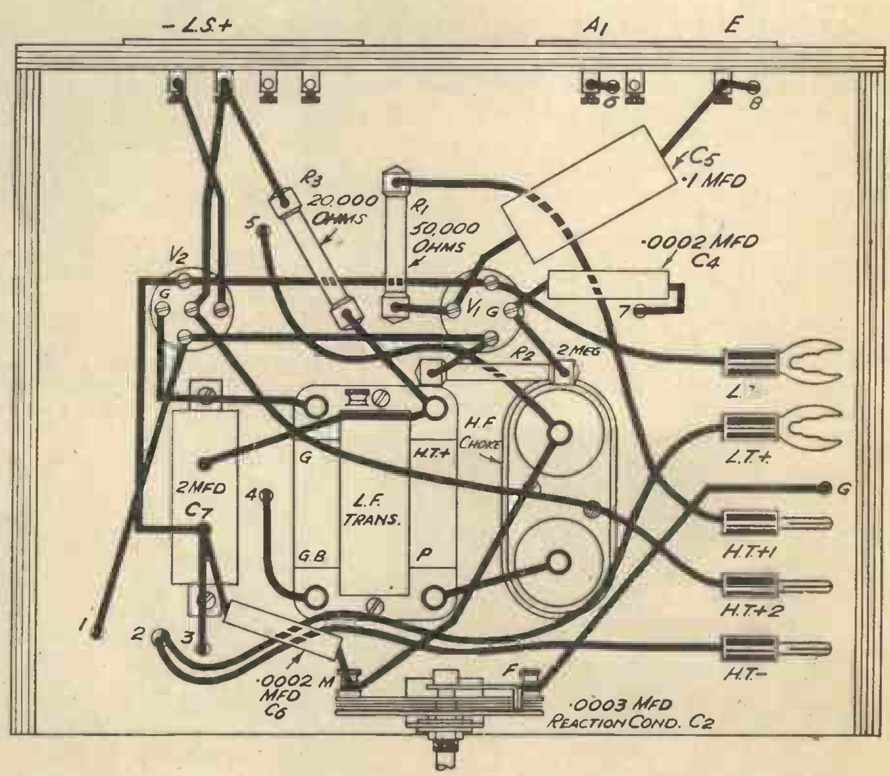
Connecting Wire, Flex, etc.

Two Valves; one V.P. 210 and one Y.220 (Hivac).

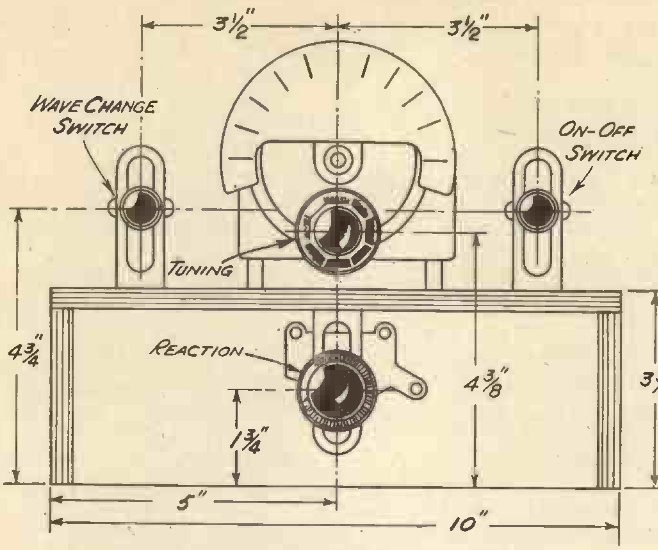
One Amplion Dragon Loudspeaker.

TOP- AND SUB-CHASSIS WIRING DIAGRAMS OF THE MONARCH TWO-VALVER





(*Continued from page* 318.)



The panel layout of the Monarch Two-valver.

Completing the Receiver

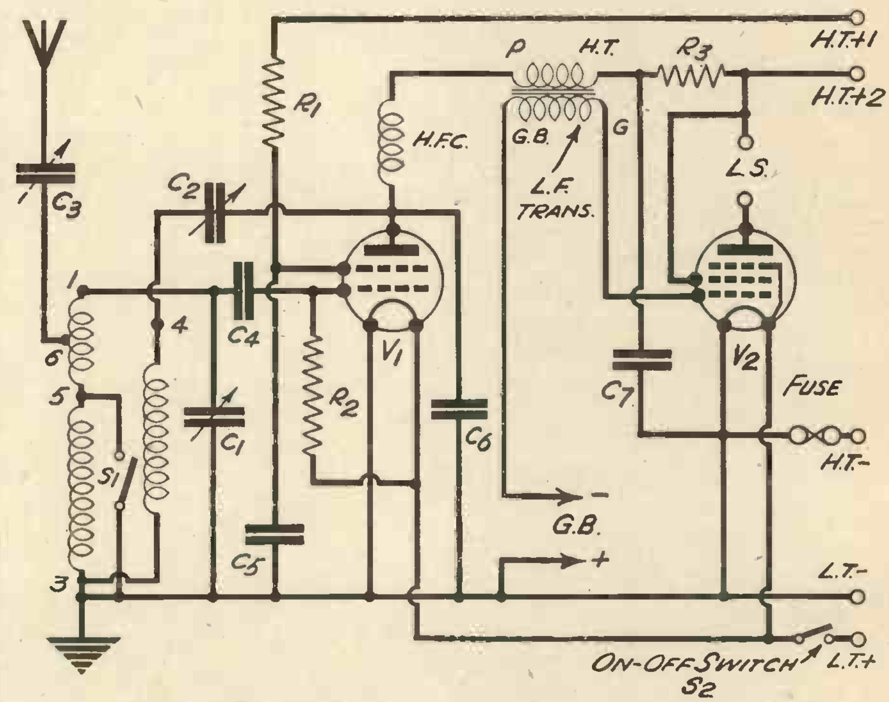
The loudspeaker negative socket is connected to the plate socket of the 5-pin valveholder. The low-frequency transformer, by the way, should be connected with the plate and grid-bias terminals nearest the reaction condenser. The plate terminal of the L.F. transformer is connected to the front terminal of the binocular choke and the grid-bias terminal of the transformer, the grid-bias battery lead being taken direct to the grid-bias terminal. The grid terminal of the transformer is connected to the grid of the pentode valveholder. The ·1-mfd. tubular condenser is wired between the plate socket of the detector valveholder and the earth terminal. A 50,000-ohm fixed resistance is connected to the plate socket of the detector valveholder, the other end of the resistance being connected to one of the leads of the battery cords, as later described. Now connect a wire from terminal 4 of the tuning coil through a hole in the baseboard to the nearest terminal on the reaction condenser, and connect a wire from the other terminal of the reaction condenser to the rearmost terminal of the binocular choke. Continue this wire in the form of a flexible lead through a hole in the baseboard to form a connection for the top terminal of the screen-grid valve. A tubular condenser of ·0002 mfd. capacity is also wired between the reaction condenser and the front soldering tag of the 2-mfd. fixed condenser. The right-hand terminal of the wave-change switch is connected by means of a wire passing through a hole in the baseboard to the nearest filament socket of the 5-pin valveholder.

It only remains to connect the battery cords to the various positions indicated in the wiring diagram on p. 318. Notice that the L.T.— lead goes to the filament valve-socket of the detector valve holder, the L.T.+ terminal passes through hole 2, and to the on-off switch, H.T.— passing through the same hole and being connected to one side of the fuse.

H.T.+ 1 is secured to the free end of the 50,000-ohm fixed resistance R1, and in order to relieve this of any strain it is suggested that the bunched battery cord leads should be firmly attached to a convenient part of the chassis by means of a leather strap fastened down by means of two screws.

The H.T.+ 2 lead goes to the fifth pin of the pentode valveholder. Notice that the G.B.— lead passes through hole 4 and is taken direct to the G.B. terminal of the L.F. transformer, whilst G.B.+ is connected to the metallised baseboard *viâ* the screw securing the pre-set condenser. Its bared ends must, of course, make good contact with the metallised baseboard.

A 2-volt accumulator will be required, a 120-volt H.T. battery, a 9-volt grid bias battery, and the Amplion Dragon loudspeaker. Suitable plugs for the terminal strips will also be needed.



The circuit diagram of the Monarch Two-valver.

Vacuum Cleaning a Ship's Oil Tanks

OIL sludge gradually collects in a ship's fuel tanks, which has to be cleaned out from time to time. This used to be done by blowing out with steam into the sea. When the Board of Trade stopped this objectionable practice, cleaning out by hand with bucket and shovel was resorted to. This messy proceeding has now been superseded by a vacuum-cleaning service at all the larger ports. When a ship wants to clean tanks, a service barge comes alongside, which is fitted with pumps, hose and receiver tanks. The 6-inch armoured hose is lowered into the hold perhaps 70 ft. down into the oil tanks in the double bottom. Any inflammable gas is first sucked off so that men can work in the tanks without respirators and then the sludge is softened with steam. Vacuum is turned on and the pumps start to suck up the sludge. As the pumps could not raise the sludge 70 ft. in a single lift, air is admitted along with the sludge so that it ascends as a fine spray. So powerful is the air draught that solid bodies, such as stray bolts and rivet heads are sometimes found in the receiver tanks.

ITEMS OF INTEREST

* * *

Gases from the Air

IN the air around us exist decimal percentages of the rarest of the chemical elements—the inert gases argon, krypton, xenon, neon and helium. In 1900 they were chemical curiosities. To-day they are used in millions of cubic feet for filling gas-filled electric light bulbs. To meet this demand, air is liquefied and fractionally distilled at temperatures 200° C. below freezing point. From 1,200 tons of air only 1 lb. of xenon is obtained and 70 lb. of krypton, although the quantities of neon and argon are 250 lb. and 11 tons respectively.

Electric light bulbs were originally "vacuum filled." But the vacuum allowed white-hot metal to evaporate off the filament which deposited on the glass and gave a dark film. To stop this the bulbs were filled with nitrogen. Nitrogen slowly attacked the filament, so argon, which is inert, was substituted. It is estimated that the use of argon has reduced the nation's electric light bulb by 20 per cent. If the gases xenon and krypton were substituted for argon another 25 per cent. could be knocked off, as they would insulate the filament from heat losses more effectively than argon. But the cost of working up the traces of these two gases from air would make the saving too expensive for the manufacturer. Besides it is probable that the filament type of lamp will be replaced by metallic vapour discharge lamps in the near future.

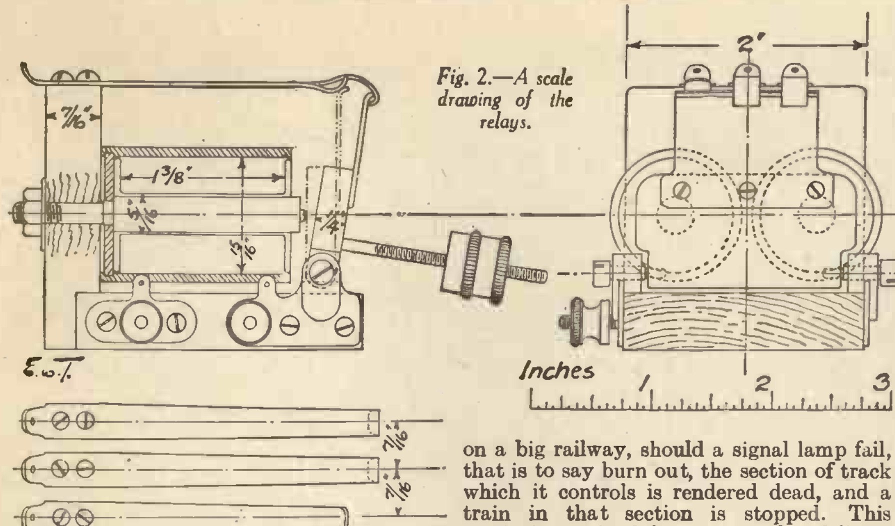


Fig. 2.—A scale drawing of the relays.

MODEL ELECTRIC RAILWAYS

AN AUTOMATIC CONTROL AND SIGNALLING SYSTEM

By E. W. TWINING

NOW that some of the Southern Railway Company's main lines, and many other suburban and metropolitan lines, are being completely electrified, a greater amount of interest seems to be growing in the minds of model railway enthusiasts. Although the majority do not go so far as to instal motor-driven coaches in place of locomotives with steam outlines, they are very much intrigued by such features as traffic type light signals in place of semaphores, and the automatic control of electrically propelled trains as they enter and leave the block sections of the tracks.

No Railway Accidents

There is a fascination in knowing that if one has two or three trains running on the same line on a circular railway, even though they do not all run at the same speed, one train can never overtake another, and that head- and rear-end collisions can never occur, because the fast train is automatically pulled up in the block section behind that occupied by the slower train, whilst the signal lights of the "dead" section go to *danger*.

It may be thought that the system or scheme must be a very elaborate one which can bring about such results, and in actual full-size practice it is rather complicated, but this is because a great number of refinements are called for which are not necessary in a model railway. For instance, on a big railway, should a signal lamp fail, that is to say burn out, the section of track which it controls is rendered dead, and a train in that section is stopped. This result is attained by means of a delicate thermostat attached to the lamp, the thermostat controlling a relay.

Fortunately, automatic control can be very much simplified for model working, and the system described here is one which involves the least amount of apparatus and wiring, and consequently avoids complication.

Control Independent of Signals

At first sight it may seem that as there can be no driver on the train, the system must of necessity be more, rather than less, intricate, but this is not the case. This is partly due to the fact that the control is independent of the signals. That is to say, the signals, instead of controlling the track, are themselves worked from the track relays, and so it would make no difference to the moving and stopping of the trains if there were no signals at all. Since there are no drivers on the trains to look at them, they are fitted for effect and not for use.

Actually, the intentional stopping of trains at stations, and the restarting of them is at the will of the operator of the railway, who controls them from a switchboard as he also does the points to branch and main lines, which points are set and locked electrically.

First, Second and Third Rails

The scheme is comparatively simple, and the simplicity is dependent upon the outstanding fact that not only the conductor rail, from which the motor on the locomotive picks up its current, but one of the running rails as well is divided up into block sections, and this running rail must be insulated from the corresponding rail in the sections ahead of and behind it. The other running rail is continuous and must be bonded together at all joints, so that it carries the main current. Besides the rails, there is an insulated feeder wire laid parallel with the track.

For convenience the three rails are referred to as follows:—First rail: the continuous running rail. Second rail: the sectioned or interrupted running rail. Third rail: the conductor of strip metal which is usually placed in the centre of the track and upon which the collector shoe, or brush, rubs.

It is not proposed to make any suggestions regarding layout for a complete railway, because so much has been most ably done by other writers in this direction as well as by manufacturing firms. The system suggested is applicable to any layout of either single or double track with or without branches, and all the needs of the permanent way and electrical departments are filled by giving two wiring diagrams only, one showing a single length of line, which in the case of double track can be considered as either the up line or the down line, and a complete set of points with crossover for double track.

Diagram of Circuits

Fig. 1 is a diagram showing a length of line covering six block sections, the length of each section being made just as short or as long as may be found convenient for the railway, and for the frequency of the train service. In full-size practice the lengths vary considerably, some of them extending for several miles. In a model they may also differ somewhat; the short sections being made not less than, say, one and a half times the length of a train. Each section is protected and controlled by a relay provided with three contacts, whilst a connection from the feeder wire is taken to

(*Continued on page* 323.)

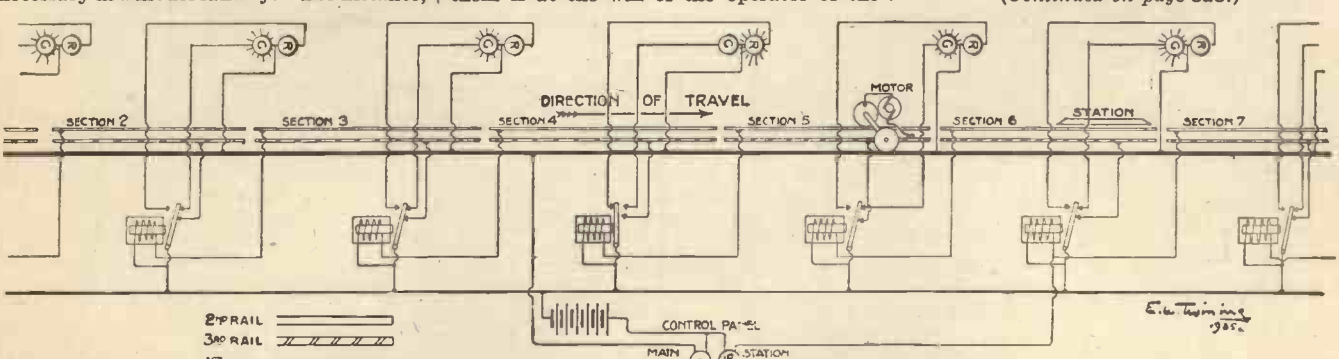


Fig. 1.—A wiring diagram, showing a length of line covering six block sections.

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MODEL ELECTRIC RAILWAYS

(*Continued from page* 321)

the movable armature of the relay. At the entrance to each section a signal lamp standard is placed having a red and a green light.

As will be seen from the diagram, the current supply (the sketch shows a 12-volt battery) is taken to the feeder wire and to the first rail. The circuit, when a motor of a train is on the track in, say, section 5, as shown in the diagram, is from the battery to the first rail, from the first rail through the frame of the engine to the brushes and armature windings of the motor, through the third rail, the lower contact point on the relay, the relay armature to the feeder wire, and so back to battery.

Lighting of Signal Lamps

Now the bridging over between the first rail and the sectioned second rail by the wheels and axles of the train closes another circuit, *i.e.*, from the first to second rails through axle, from the second rail to the windings of the coils of the relay in section 4, through the feeder and back to the battery. This relay is thus actuated, the contact leading to the third rail of section 4 is broken and this section is rendered dead. At the same time, the connection through the upper contact is interrupted, and the green light of section 5, which had previously been glowing, is extinguished. The closing of the relay passes current to the red lamp, and this is made to glow until the train passes out of section 5, when No. 4 relay falls back, and everything is restored to its original state ready for the next train.

From this it will be seen that should a fast following train be overtaking another, it will be repeatedly stopped in the section behind that occupied by the leading train.

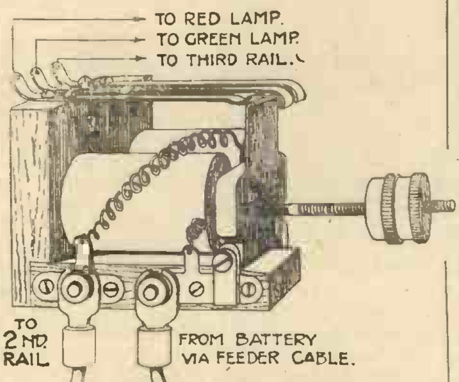


Fig. 3.—A perspective sketch of the relay.

Where stations occur, the trains, unless they are to run through, will be stopped by the operator, and to do this he will have a switch on his control panel with a wire run to the relay of the section in which the station is placed, say section 6. This will enable the operator to close the relay and so cut off current from section 6 at the precise moment when the train is in the station. Any following train will continue to run until it reaches section 5, where the signals for section 6 will be against it, and it will pull up.

Relays

A scale drawing of the relays is given in Fig. 2. In the foregoing, upper and lower contacts have been referred to, but actually these are side by side and all three are made of thin spring brass. The coils are on bobbins of thin sheet brass, each wound with about 5 oz. No. 28 enamelled copper wire. The two are connected up in series and encased in thin sheet-iron to increase the magnetic effect. The cores are of soft iron, as is also the armature. The pivots of the latter are formed by brass screws shouldered down.

To pull the armature off the cores when they cease to be polarised, an adjustable weight formed by two knurled nuts is shown—two are necessary for locking purposes. Large terminal heads of brass may be used for making up this weight. The rest of the details will be obvious from the drawing, aided by Fig. 3, which is a perspective view.

(*To be continued.*)

STORING ACCUMULATORS

THESE notes deal with the usual methods of accumulator storing as practised to-day, together with some information that has been acquired through experience. There are two common methods of storing, wet and dry, each of which is divided into two subsections depending on the exact technique involved.

The dry method seems the most enticing, since batteries so stored need not be touched for twelve months, but it is the least satisfactory, and cannot be recommended. The battery is given a full charge until voltage and specific gravity readings have been constant for a period of one hour, then an over-charge of one hour is given. The cells are then emptied and the battery acid stored for future use. When possible, remove the plates from the boxes, wash in distilled water and replace the separators, if of wood, with new ones. Wash out the containers with distilled water, leaving the plates in the water. Now replace the plates, seal the containers, fill up with distilled water, and leave for thirty hours, when it should be emptied. Allow it to drain for a minute and then seal the vent plugs. The battery should be stored in a cool dry place.

Doubtful Cells

This method may be varied, especially with cells whose condition is doubtful, by merely emptying out the acid and replacing with distilled water as before. Some authorities state that before cells are put into dry storage they should be fully discharged at the normal rate. This means that the battery must not be short-circuited through a length of thick wire or left standing until discharged before putting into storage. After fully discharging through a suitable lamp or other load, the cells are treated as under the charged method. After twelve months the battery must be refilled with its original acid, or acid of the same S.G., and given a long slow charge at half the normal rate. If the battery is left as long as twelve months, it is generally found that the negative plates have acquired a composition resembling hard slate, and will neither take nor hold a charge. This is the one big disadvantage with these methods, and they are not to be recommended except in those cases where it is impossible to keep the battery charged. However, before resorting to the above methods, the others should be first thoroughly investigated.

There is yet one other method of treating a battery before putting it into dry storage, which is considered the best, but it has the disadvantage of damaging the positive plates if these have seen much service. The cells are emptied and the acid replaced with distilled water, which is left for twelve hours. The cells are then given a charge until all gas freely, and the gravity remains constant, readings being taken every thirty minutes. The plates are now washed in distilled water and then left in water for twenty-four hours, when they are ready for dry storage as before.

Methods of Charging

Those who have faculties for charging should adopt one of the following methods; details of the actual charging methods are omitted, but if unfamiliar to the reader he is strongly advised to read "Accumulators," by F. J. Camm, obtainable from Messrs. Geo. Newnes Ltd., 8-11 Southampton Street, Strand, W.C.2.. Price 1*s*., or 1*s*. 2*d*. post free. Arrange the batteries on a suitable bench where they will not be disturbed, and where spanners and other tools are not likely to get left or dropped on them and cause "shorts." The trickle-charging rate will depend on the type of cell, but it may be best found by a little experiment. Connect the cells in series, examine and correct the acid level, and test the gravity. Start charging, test the gravity each day; if the cells gas, then too much current is passing, but if the gravity falls slowly, then the charging rate must be increased. When a satisfactory rate has been determined, the cells may be left undisturbed, but should have the acid level and gravity checked each month. Before storing cells on trickle charge, they should have had a full charge immediately beforehand.

The best method of storing cells is to give the battery a full charge once every two months. Arrange the cells so that leads from the charging panel may be easily connected, examine and correct acid level, etc., and then give the batteries a full charge. The cells may now be left for two months, but before charging again the acid level should be noted. If any cell is lower than the others, charge until it is again healthy, or, if this does not bring it up, examine carefully, and correct the mistake.

Useful Hints

To the above notes several hints must be added. Use only distilled water unless your tap water has been approved by the local Battery Service Station. Space all batteries, and, where possible, arrange them on standard porcelain insulators, or, failing this, on white porcelain tiles. After charging carefully, dry the tops of each cell and vaseline all connectors, terminals, etc., and see that the vent plugs are not blocked up. For the hydrometer reading to be of any real use, they must be tabulated as soon as taken, and then the performance of the cell can be told at a glance. Make up a table of a series of columns, and mount it over the battery bench on a loose board, so that the attendant may carry it round with him and enter up any readings of the particular cells.

An article of this type would not be complete without a few notes on storing nickel-iron accumulators. These cells can be left for years either charged or uncharged without being damaged in any way, but if charged they will maintain the full voltage on open circuit for periods of up to twelve months and over, and then deliver their full capacity. It should be noted that if the cells have been given a recent charge the vent plugs should be unscrewed to allow any gas to escape, and then tightened up again, vaseline all terminals and connectors, also see that the cells are placed on a dry bench away from lead-acid batteries. These notes apply specially to the Ni-Fe cells.

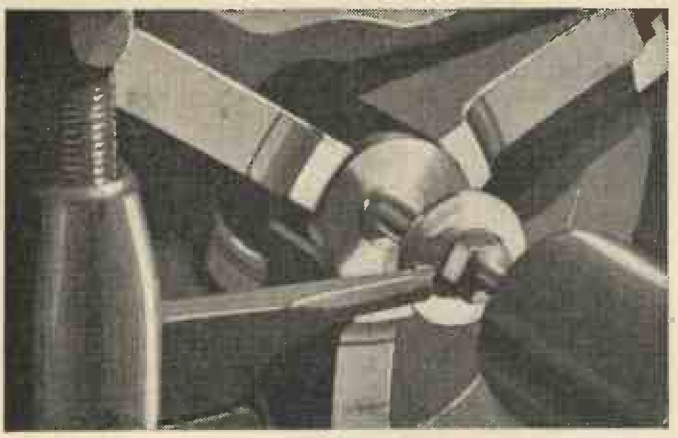


Fig. 1.—Lightly clean up the reversed face of the flange and, with an inside screw-cutting tool, scribe the $1\frac{1}{8}$-in. diameter pitch circle as shown.

LATHEWORK FOR AMATEURS

BUILDING A 15 c.c. STROKE PETROL

(*Continued from page 168 of the January 1935 issue*)

THE next parts to claim attention are those forming the moving unit. They are the crankshaft, part 5; connecting rod, part 7; piston, part 8; cam adapter, part 9, and sundry small parts connected with them.

Machining the Crankshaft

As the crankshaft is supplied in a "roughed-out" condition, the final machining can be straightway commenced. File off the parting pip (if any) from the tail end of the blank and hold in the 3-jaw chuck by the $1\frac{3}{4}$-in. diameter portion, allowing the face to project about $\frac{1}{8}$ in. clear of the jaws. Tap the end of the shaft true and tighten the jaws well on to the work. Centre-drill the end of the shaft, and support with the tail-centre.

Turn the shaft its entire length to within $\frac{1}{64}$ above $\frac{1}{2}$ in. diameter. Further reduce the shaft to a similar amount over $\frac{3}{8}$ in. diameter, stopping the cut $\frac{25}{32}$ in. away from the shoulder, and turn back for the thread to $\frac{5}{16}$ in. diameter so as to leave the $\frac{3}{8}$-in. diameter portion $\frac{3}{4}$ in. long. Take a light facing cut across the $1\frac{3}{4}$-in. diameter portion and a second cut $\frac{1}{32}$ in. deep, to form a boss $\frac{25}{32}$ in. in diameter. This provides clearance for the outer ring of the ball-race. The shaft before finishing is seen in Fig. 2. Screw the thread on to the lathe, carefully fitting it to a standard $\frac{5}{16}$-in. B.S.F. nut. Finish turning the $\frac{3}{8}$-in. and $\frac{1}{2}$-in. diameters, leaving a couple of thousandths for final finishing with a very smooth file. Ease the front end of both diameters slightly, so that the races push on easily to within $\frac{1}{4}$ in. of the shoulders as shown in Fig. 2.

Some provision will have to be made for holding the shaft before the crank-pin can be machined. Reference to the crankshaft drawing (part 5) reveals that the centre of the pin s $\frac{9}{16}$ off centre, and it will also be noticed that the bolt holes in the flange of the cam adapter (part 9) are arranged on a pitch circle of $1\frac{1}{8}$ in. diameter. This part will then form a very convenient throw-plate and enable the pin to be machined on the centres.

The centre hole in the cam adapter, if not already done, is reamed to $\frac{3}{8}$ in. diameter and passed over the end of the shaft, still in the lathe, and a nut passed on with the fingers, as seen in Fig. 3. Bring the tail centre to bear in the centre hole, and adjust for running, afterwards ocking the nut with a spanner. Take this precaution to prevent moving in the chuck whilst tightening. Turn the forward boss to $\frac{11}{16}$ in. diameter for a distance of $\frac{19}{32}$ in. (plus a few thou.), to the face of the flange, which must be cleaned up in any case. This boss must be smoothly finished to a good running fit in the $\frac{11}{16}$-in. diameter hole in part 3. Turn the flange over the top to exactly $1\frac{7}{16}$-in. diameter, and reverse the adapter on the shaft. Lightly clean up the reversed face of the flange and scribe a short line on it exactly $\frac{5}{32}$ in. from the edge. Bring the point of a finely ground inside screw-cutting tool against the mark and scribe the $1\frac{1}{8}$-in. diameter pitch circle with it by running the lathe, as is shown in Fig. 1.

Remove the adapter and divide the pitch circle into six equal parts and carefully spot up the hole positions. Drill the holes slightly under No. 6 B.A. tapping size, and lightly countersink the mouth of one hole to 60 degrees. The crankshaft can now be taken from the chuck, and with the shaft properly supported in a vee-block, find the centre and scribe a line $\frac{9}{16}$ in. above it on to the face of the crank-pin. Before scribing, the shaft must be rotated to bring the pin in the highest position. Bisect the line on the pin and spot up with care and drill with a centre drill.

Machining the Crank-pin

Select a suitable carrier to hold on the $\frac{11}{16}$ in. diameter of the adapter and pass on to the shaft, arranging it so that the long boss is nearest the crank end, lightly locking by means of a nut. The countersunk hole is arranged approximately in line with the centre hole in the pin. Place between the centres and get the back face of the crank plate running true, by slightly twisting the cam adapter on the shaft in the required

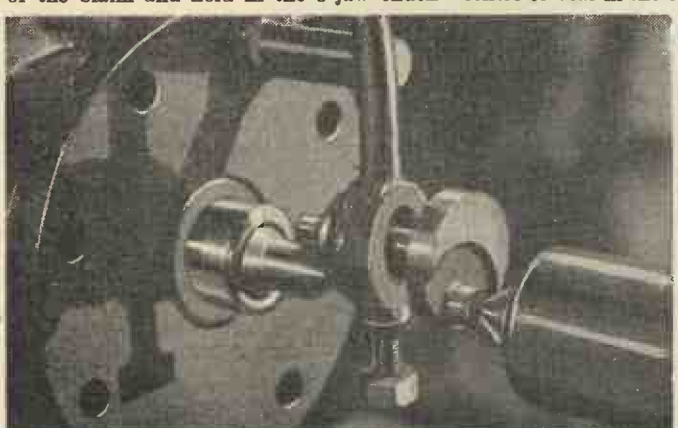


Fig. 2.—Showing the shaft mounted ready for turning the pin and finishing the front face.

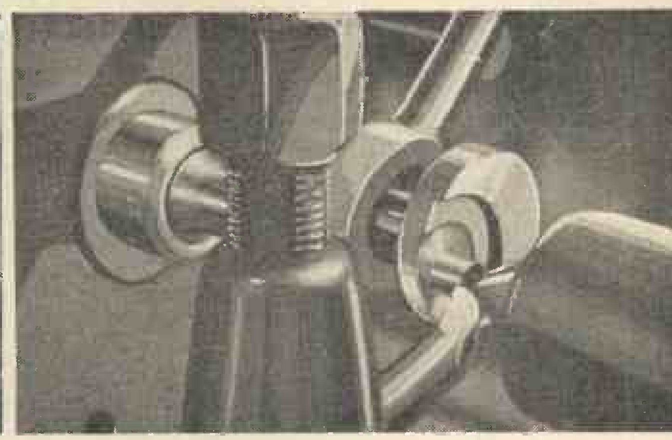


Fig. 3.—Taking a facing cut across the balance weight.

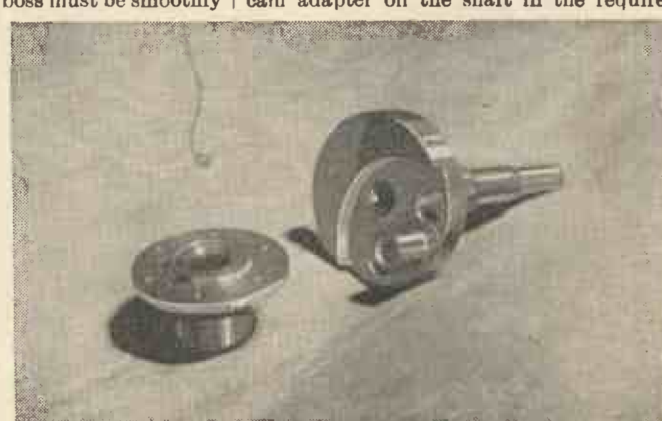


Fig. 4.—Showing the crankshaft and cam adapter.

MODEL TWO-ENGINE PART III

By W. H. DELLER

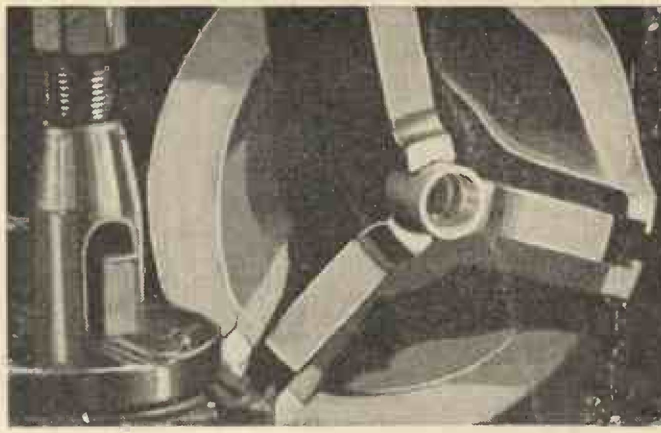


Fig. 5.—Scraping a small radius on the mouth of the piston before removing from the chuck.

direction, and afterwards lock in position. Insert a small brass pad between the end of the screw and the work before locking the carrier. Fig. 2 shows the shaft mounted ready for turning the pin and finishing the front face.

Take a facing out across the balance weight to leave it 3/8 in. in thickness and face out as far as possible round the pin to leave the web 1/4 in. thick. This is most conveniently carried out with a boring tool, as is also the turning of the crank-pin itself. Reference to Fig. 3 will make the method clear. Finely finish the pin to ·374 in. diameter, leaving a small radius in the corner. Continue the facing out with a square inside recessing tool and bore away the inside edge of the balance weight until it is 11/16 in. away from the inside edge of the crank-pin. This part of the machining is now complete, with the exception of turning the crank plate to size and drilling the lightening holes.

depth of 1⅝ in. is reached. Scribe a short line with odd legs on each side of the crank-pin 17/64 in. from the edge of the crank plate, and drill a 5/16-in. diameter hole on both sides at centre distances of 1/4 in. from the edges of the pin. A 13/64-in. (or No. 5) diameter hole is drilled right through the crank-pin and plate, and tapped halfway with a 1/4-in. B.S.F. thread. Chamfer the mouth of this hole on both sides, and also do the same to the other lightening holes.

Finishing the Cam Adapter

Finish the adapter by holding it in the three-jaw chuck on the 11/16 in. diameter so that it runs true. Face the front of the flange to 3/32 in., and turn the boss to 3/4 in.

better not to rely upon the small chucking boss to machine the piston, but to grip the body of the casting in the chuck for the purpose.

Catch in the chuck and face back the skirt until the piston is 1¼ in. long from the edge of the head. Bore out to 7/8 in. diameter with a slightly round-nosed tool, machining right up to the bottom edge of the internal bosses. For the purpose of the subsequent operation, see that a good finish is obtained in the hole, scraping a small radius on the mouth before removing from the chuck (see Fig. 5).

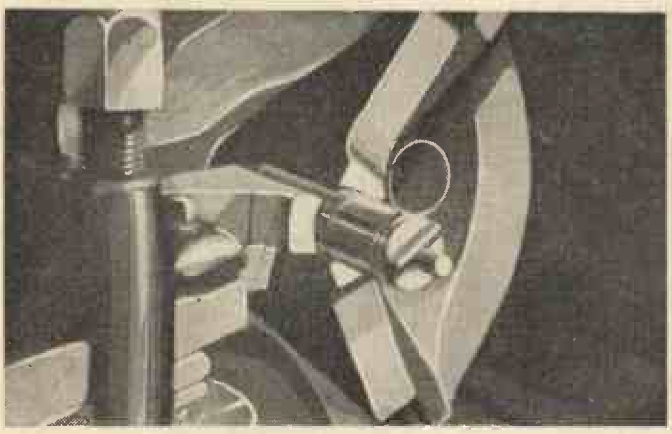


Fig. 6.—Adjusting the depth of the grooves.

Fig. 8.—Showing the partly assembled unit.

After removing the cam adapter, grip the shaft in the chuck by the 1/2-in. diameter and turn the plate over the top to 1 23/32 in. diameter.

Centre the plate and drill a 5/16-in. diameter hole down the shaft for a depth of 7/8 in. to the lip of the drill, and continue drilling with a 1/4-in. drill until a total

diameter and face. Mouth out the front of the hole to 5/8 in. diameter to a depth of 1/32 in. Chamfer the front of the hole by setting the tool slide to 45 degrees until the front measures 31/64 in. diameter. Leave this countersink with a good finish, as it provides a locking face for the special and coned locking nut. Open the holes in the flange with a No. 43 drill, slightly chamfer on both sides, and tap No. 6 B.A. Fig. 4 shows the crankshaft and cam adapter at this stage.

Machining the Piston and Connecting Rod

The "con-rod" and piston, parts 7 and 8 respectively, are comparatively simple jobs. It is

Fig. 7.—Showing the finished piston and connecting rod.

There is one little job to do now, before the piston is finished, namely, drilling and tapping the piston ring retaining the screw hole, which if left until later, cannot be successfully accomplished. Scribe a line on the side of the piston barely 1 5/64 in. up from the bottom edge and drill and tap a No. 6 B.A. hole through towards the centre. Turn a peg in the chuck and polish so that the piston will "wring" on to it, using a little oil to prevent seizure. Turn and polish the piston on the outside diameter to 1 in. and turn the ring grooves. This can best be done by grinding a parting tool to ·0015 in. wider than the rings and feeding straight in. The depth of the grooves should be such that when the ring is in the groove (see Fig. 6), and a rule laid along the piston, there is a clearance of 1/64 in. between the rule and inside edge of the ring. The tapped hole should come in the middle of the centre ring-land.

Saw off the chucking piece and file up the head of the piston. Mark off for the gudgeon-pin holes at a distance of 11/16 in. up from the bottom opposite to the internal bosses. Lay the piston on a vee-block, find the centre and set the baffle on the head level with the surface plate. Scribe across the lines previously made and make a centre dot where the lines intersect on both sides Centre-drill on each side and drill a 5/32-in. hole through the bosses. As these holes must be in line, the drilling is best carried out in the lathe with the piston supported on the tail centre. Follow through with a No. 19 drill, and open out to 11/64 in. diameter with a parallel reamer, but do not let the "lead" of the reamer go right through both bosses. Use the piece of steel supplied for the pin as a gauge, and make the fit of the hole such that the steel taps lightly into the back hole. Should a suitable reamer not be available, a drill may with care be used in the same manner.

The Gudgeon-Pin

The gudgeon-pin (part No. 11) is, according to the specification, made of case-hardened mild steel, but the material actually supplied is silver steel, so that if hardening is thought necessary, it must be quenched and tempered to a very dark straw. Pads (part No. 12) are fitted to the pin. Small snap head copper rivets may be used, but if turned from copper or brass rod, are best made on the end of a short piece and driven lightly into the pin, cut and faced off afterwards to make the total length over the pads measure slightly under 1 in., the ends being domed to 1/2 in. radius.

A small pin requires fitting in the tapped hole in the piston. This must fit tightly and therefore a portion of a standard screw is unsuitable. Ease a piece of 1/8-in. diameter brass rod down to ·110 in. diameter and run on 3/16 in. of No. 6 B.A. thread, adjusting the die to give a tight-fitting thread. Screw into the piston and cut off and file down flush with the surface, then with a fine safe-edged file, flat off the pin on each side where it projects in the ring grooves to leave it proud of the sides of the centre land by 1/64 in. The fitting of the piston rings is left for the moment.

The Con-Rod

The connecting rod (part No. 7) is made from 1/2-in. square Duralumin bar. Mark a centre line lengthwise on same and drill and ream a 3/8-in. diameter and an 11/64-in. diameter hole at a centre distance of 2 3/16 in. Machine up correctly the 1/2-in. bosses, as shown in Fig. 10, and treat the small end in a similar manner. Remove the metal between the bosses by sawing and filing, and adopt the same metho1 for shaping the rod. After facing the bosses down to 3/8 in. across, central with the web, radius one side of the 3/8-in. hole to suit the crank-pin. By the way, the pin must project slightly above the face of this boss. Provision is made for lubrication by drilling a hole through the bottom of the boss in the big-end and filing a 1/16 slot across the boss in the small end. Fig. 7 shows the finished piston and con-rod. A special 1/4-in. B.S.F. brass screw (part No. 10) retains the big end of the connecting rod, and as it is a simple part to make, no comment, beyond the fact that the thread should be a good fit and the head screwed down in close contact with the end of the crank-pin, is necessary.

Lapping the Cylinder

Take a short piece of 1-in. diameter bright mild steel about 4 in. or 5 in. long, face up one end and ease down if necessary with a fine file to the exact size. Cut a series of shallow annular grooves along the prepared portion, about 3/8 in. apart, with the nose of a front turning tool. File a small radius on the end of the bar. If the lap will not pass into the cylinder liner, ease it slightly until the front just pushes in. Charge the lap with very fine cutting compound such as rouge and oil, run the lathe slowly and push the cylinder backwards and forwards until the bore is polished. This operation requires care to prevent seizure.

Assemble the piston and connecting rod and lap the piston to the cylinder by hand.

Wash both parts in petrol and proceed with the fitting of the rings. Ease the ends of the ring if necessary, to permit them to pass into the mouth of the cylinder. The rings will, of course, go in without filing, but in all probability the adjacent ends will not lie flush. Carefully fit until they do, allowing the ends to butt together, without clearance. Next file a small notch in each ring to fit over the pin, fitted in the piston to prevent the rings from turning. These notches should be made in such relative positions that the gap in each ring will be spaced from the other at 180 degrees, also so that the ends of both rings do not travel over the ports. Lightly lap the rings to the cylinder by hand. After this has been done it will be noticed that there is sufficient clearance between the ends of the rings.

There is just one point regarding the coned retaining nut (part 19) for the cam adapter. See that the tapped hole is absolutely true with the coned surface. Fig. 8 shows the partly assembled unit. This brings the engine approaching the point where final assembling may be commenced.

COAL—Some Interesting Facts

THE world is slowly realising that there is more potential wealth and prosperity and happiness in a lump of coal than in an ingot of gold.

Fifty years ago or even less, coal was burnt in the ordinary grate without a thought of what was going up the chimney in smoke. Valuable chemicals which are now being collected and "bottled" went up into the skies and blackened our atmosphere.

To a certain extent this is still so, but we are being gradually educated to see how much of our national prosperity depends on the complete scientific exploitation of our natural resources.

Very few people have any idea of the vast number of entirely different substances which can be derived from coal. Take gas—21 1/2 tons of it can be extracted from 100 tons of coal. From the same 100 tons of coal we can get 1,000 gallons of tar, enough to make miles of road surface.

From the black tar also come a number of dyes. Coal tar, too, is the base of one of the effective remedies for diseases of the skin.

Main By-products

From what remains of the carbonised coal we get graphite, coke, ammonia and the residual flue dust. These are the main by-products, and once they have been extracted and isolated the scientist gets to work and starts to separate them to the last ounce.

Every time you burn coal in the domestic grate you lose 75 per cent. of the heat and every one of the above by-products go up the chimney. It is about as extravagant and foolish as burning furniture.

The coal industry of this country is in a bad state, and things do not look like improving for some time to come. Normally, vast quantities of coal are used for iron and steel production, but this has become greatly reduced in the last few years. Our coal magnates are at last realising that if prosperity is to be restored to the coal industry every single ounce of that coal must be utilised.

Every year we import over 2,000,000,000 gallons of foreign oil and petrol, partly for our ships and partly for our cars. If we were to utilise coal in the way it should be utilised, we could supply all our needs in this direction.

Nearly 200 substances have been isolated from coal at the present time, including the heavy oil with which nearly 1,000 of our ships are driven.

Coal Derivatives

Who would think that when we develop our snaps we are using coal-derived chemicals and that when we have a headache we can take a coal-derived aspirin tablet to cure it ?

But this is only a beginning. Our cars are driven by benzole, and the roads they run on are made with tar, both important coal by-products. We write with coal-derived graphite pencils, cook our meals and heat our rooms with coal-derived gas, we sit in the cinema and the image we watch on the screen is lit with coal-derived carbon arcs, the ice which cools us in summer is made by coal-derived ammonia, our dainty perfumes are made from coal-derived gas, the houses we live in are made from coal-derived blocks.

The dirt in our skies is another important aspect of this vital problem. More than half of the three-year-old children in this country have rickets because they are robbed of sunlight by the smoke pall which hangs over our cities.

Fogs

During heavy fogs caused by smoke traffic is disorganised. In twenty-seven days of fog during recent years the buses of London lost 400,000 working miles. We insist on clean food, clean water, bodily cleanliness, yet our breathing tubes and lungs are blackened and polluted with dust, soot and sulphuric acid.

We protest against the vandalism of writing on the sky—and allow industries to blot out the sky writing.

Consider for a moment the matter poured forth from coal-burning chimneys. It was said recently that the city of Manchester burns 3,000,000 tons of coal a year, only 750,000 tons of which are used for domestic purposes. There are 1,100 factory chimneys and 150,000 houses in that city continuously discharging into the air a product of the incomplete combustion of these millions of tons of coal. The result is that 20,000 tons of solid matter falls into the city area, with tar and acid, to the amount of 75,000 and 200,000 gallons respectively.

Because of this condition of soot, Manchester spends on the small matter of laundry bills a quarter of a million pounds a year more than it would spend if its air were as clean as that of Harrogate.

Many prominent industrialists are awakening to the urgent need for a scientific coal industry. The more extensive use of coa by-products will permit of more economic manufacture of the main products, gas and coke; and this, in turn, will benefit industry, particularly the iron and steel industry, which annually consumes large quantities of metallurgical coke. By burning raw coal millions of pounds worth of valuable by-products literally go up our chimneys in smoke.

"PLASTICS" AND THEIR USES

An account of the new synthetic resins. Progress in the next ten years will produce strong light materials which will influence many branches of engineering and construction.

A SPECIAL section of the exhibition of British Art in Industry is devoted to plastics mouldings. A whole room is panelled with cameos of these new materials. Yet ten years ago plastics were scarcely on the market. The rise to importance of this remarkable group of substances will go on rapidly. They are destined to have a very great influence on the course of every-day civilisation in the course of the next ten years.

As yet the most ambitious plastic product in familiar use is a wireless cabinet pressed out in one piece. But plastic manufacturers are already prepared to mould the complete interior furnishings of a house, from the doors and wall panellings to the furniture and bath-room fittings. The most remarkable development is the new crystal-clear plastic which is illustrated. This is assured of an immediate outlet in the replacement of present-day safety glass in motor cars. As it is at least as strong as cast-iron and can be moulded to any shape it should solve the problem of equipping stream-lined cars with large windows without interfering with the stream-lined curves. The strength, lightness and colourful durability of plastics have everything to recommend them to the car designer, and even to the aeronautical engineer, in their search for light materials which will give high performance at low horse-powers.

What are Plastics?

Speaking in the most general terms, a plastic is any sort of resinous or gummy material which on being cast, pressed or moulded, sets hard and firm. Thus shellac is classed as a plastic. So are artificial silk and celluloid. But to-day the term is reserved for certain types of artificial resins, the first example of which was bakelite. Bakelite was first made by a Belgian chemist, Baeker, in 1906, by heating together strong formalin and a substance obtained from coal tar, called phenol. He found that his resin became hard and firm when it was heated and pressed. The material had a limited use during the post-war years for making electrical apparatus. Its advantages were quickly realised, and soon chemists got on the track of other substances like it. The business really got under weigh in 1924. Since then one measure of its progress is the thousands of patents which have been taken out to protect the manufacture of newly discovered plastics.

A few of the groups of these substances are the formaldehyde-urea, the benzyl-cellulose, the vinyl-acetate and cellulose acetate plastics. These are names indicating the chemical origins of preparation. Rubber forms the starting-point of a group of plastics. Investigation goes rapidly along lines which are designed to find new plastics of greater strength, transparency and resistance to heat. A plastic has even been produced to replace the natural gum used for chewing gum.

A display of unbreakable table ware, made of "Beatl" urea-formaldehyde plastic.

How Plastics are Made

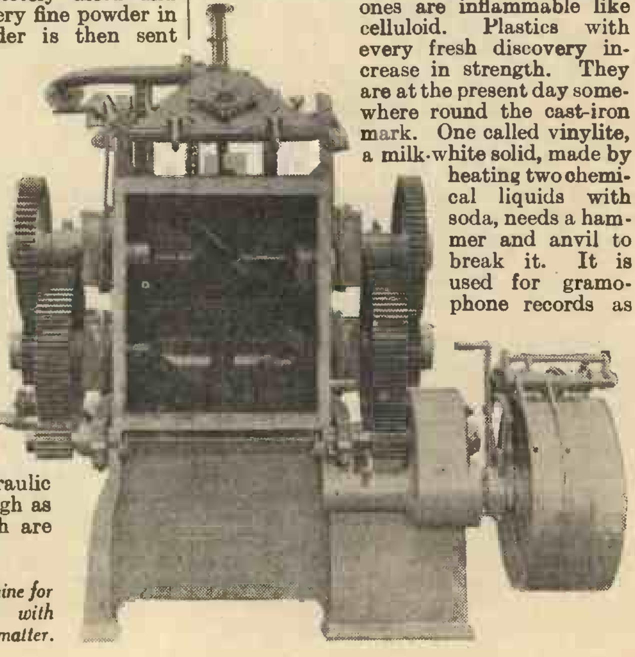
The first step in the manufacture of a plastic is to make the resin. This is a process of chemical synthesis in which liquid substances are mixed together and heated. The chemist calls it a condensation. The result is a thick, syrupy liquid. This is then evaporated under vacuum to give a stiff gum. At this point a "filler" is mixed in and colouring matter, if desired, is added. Fillers are usually either wood meal or cotton lint. The mixture of gum and filler is then completely dried and afterwards ground to a very fine powder in a ball mill. This powder is then sent forward to the moulding presses in powder form or as lightly pressed pellets.

The moulding process presses the resin powder into the form of the finished article, and sets it hard and firm at the same time. This setting is called the "cure." The powder or pellets are fed to a steel mould, and a die is closed on the mould. Between die and mould the shape of the finished article is formed. The moulds are steam-heated, and the die is forced home by hydraulic pressure. Pressures as high as 200 tons per square inch are sometimes used. Heavy pressure and steam heat cause the resin first to flow and then to change into a smooth hard tenacious substance. Pressure is left on for about a minute to effect the cure, and then the press is opened and there in the mould lies the brightly coloured article. A short annealing process may follow and feather edges from the "flash off" of the mould may have to be machined off. After that the article is quite ready for the market.

The control of the moulding needs a practised hand. The pressure on the press must be exactly controlled. The weight of the charge has to be just right otherwise the moulding is not clean. The mould and the die must be bright and clean otherwise the moulding is stained and marked. Stainless steel moulds and dies are therefore used. The temperature of the steam heating controls the polish and tenacity of the moulding. Finally, experience is required in mixing different coloured pellets and powders to get the right shades and runs of the mottlings and marbellings, which are a feature of plastic mouldings.

Features of Plastics

The behaviour of a plastic to heat depends on the resin from which it has been pressed. Some soften and run just above the boiling point of water. But others are not affected by heat until they become so hot that they char. None of the modern ones are inflammable like celluloid. Plastics with every fresh discovery increase in strength. They are at the present day somewhere round the cast-iron mark. One called vinylite, a milk-white solid, made by heating two chemical liquids with soda, needs a hammer and anvil to break it. It is used for gramophone records as



A blade mixing machine for mixing resin syrup with fillers and colouring matter.

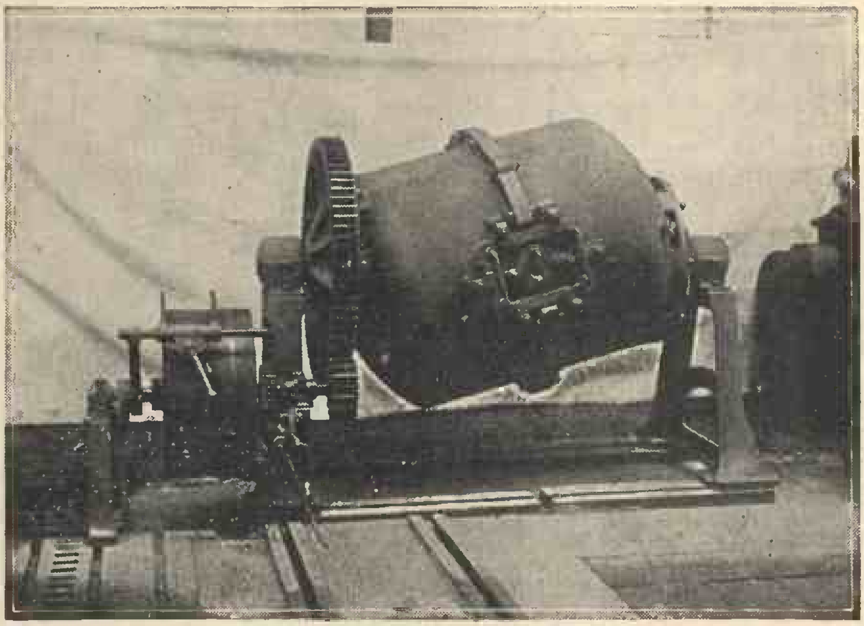
One of the most interesting examples of the beautiful effects which can be obtained by engraving the new transparent plastic material. This is a dodecahedron, with a hole in the top surface which is facing the camera. Through this hole is seen a pentagon facing in the opposite direction, with a star engraved upon it. The star is seen direct through the central hole, but the stars which appear to be engraved on the other facets are actually seen by reflection and refraction. There is only one star though six appear in the illustration.

its toughness gives an almost indefinite life to the fine grooves of modern electrical recordings. Others are extremely flexible, and can be produced in thin transparent sheets giving the better quality cellophanes. If the original resin is hot-rolled on to cotton fabric, brightly coloured transparent materials are produced, which are indistinguishable from oiled silk. Cellulosic paints and lacquers represent another large class of plastics, which are brilliant, hard-wearing and oilproof. You have only to notice the screw caps of bottles and tubes in a chemist's shop to realise how much plastics have replaced old-fashioned corks and therefore how cheap they are to produce. Wherever you see articles made of materials which you would vaguely call vulcanite, celluloid or bakelite you may be fairly certain that it is made of one of the more modern plastics.

Colour

Originally one of the troubles with plastic resins was that they turned brown or muddy with age. Research has overcome this difficulty. The picture of the plastic crystal shows that in this direction perfection has been reached. The colourlessness of the modern plastic and its stability to light permit the use of dyes and fillers which give such shades as clear jade and rose quartz. Effects running from opaque to translucent and transparent can be obtained with the utmost certainty. Even the high lights of opal and onyx can be imitated.

In plastics, science has sprung a group of materials on the world which are more wonderful than the most inventive of scientific prophets have dreamt about. By some, the near future is heralded as the Plastic Age.



A batch grinding ball mill. Dried, filled resin is rolled over and over inside this with hard steel balls which crush it to a fine powder.

HATCHING EGGS BY AIR FROM ENGLAND TO AUSTRALIA

An experiment never before attempted, that of sending a sitting of hatching eggs for 12,800 miles by air, was carried out in connection with the recent departure of the first air-mail service from this country to Australia.

The eggs were consigned by Captain the Hon. C. K. Greenway (now Lord Greenway) from his poultry-farm at Stanbridge Earls, Romsey (Hants.), to Mr. F. P. Finney, of the Rhode Island Red Club, Sydney, New South Wales. On their first stage the eggs were flown from London to Paris. Then came a train link to Brindisi, and after this an air voyage across the Mediterranean in one of the big Imperial Airways flying-boats. From Cairo the load went on above the desert to Baghdad, and on down the Persian Gulf to Karachi.

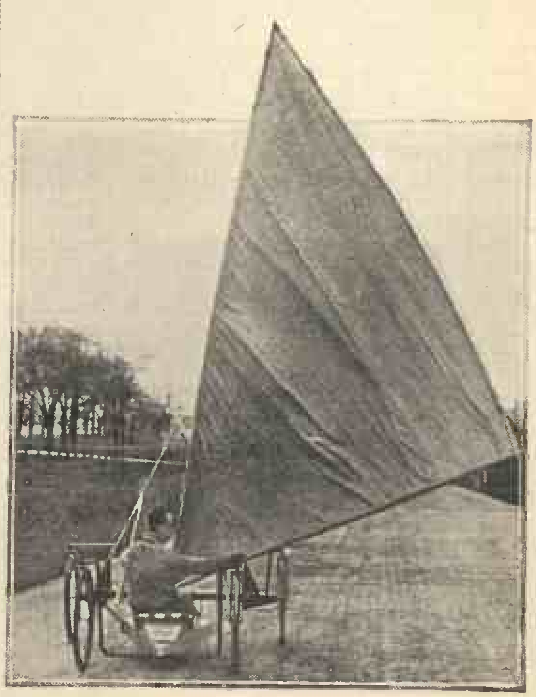
Across India

Across India the stages were flown in one of the monoplane air-liners operated by Indian Trans-Continental Airways, an associated Company of Imperial Airways.

From Calcutta the flight continued to Rangoon and Singapore; and then on eastward over fresh air links to Port Darwin and Brisbane—these new sections from Malaya to Australia being operated by Qantas Empire Airways, another associated company of Imperial Airways. The consignment of eggs reached Brisbane twelve and a half days after leaving London, as compared with a journey of forty-five days had they gone by land and sea transport, representing a saving of thirty-two and a half days. From Brisbane they continued to Sydney by rail, being delivered to Mr. Finney a few days later. He immediately examined the consignment and found it in perfect condition, not a single egg having been damaged in transit.

This first consignment of hatching eggs by air from England created immense interest in Australia. Photographs of the eggs, and of the box in which they travelled, appeared in the Press, with full accounts of the experiment.

Mr. Finney, the recipient of the eggs, has since communicated with Qantas Empire Airways, and also with Lord Greenway. In one letter, after promising to report further as to the results actually obtained in the hatching of the eggs, he says: "This experiment has created a 'stir' everywhere throughout Australia, and I feel personally that it will open up and develop the importing and exporting of hatching eggs to many parts of the world."



Experimenting with a new type of Land Yacht.

ELECTRIC LIGHTING FOR MODELS

How the appearance of models may be improved by properly applied lighting effects.

ALTHOUGH light is the most fundamental controlling factor in all human activity, the science of lighting has been for many years the most neglected of all. It is only recently that the importance of properly applied lighting has been realised and steps taken to ensure its provision. This tendency has been reflected not only in the more correct lighting of ordinary models, but in the widespread production of models designed solely to show lighting effects.

Model lighting may be divided broadly into three classes: firstly, exterior lighting, either to show up the model to its best advantage, or to represent natural lighting in the case of a scenic model; secondly, the reproduction in a model of the actual lighting systems present in the prototype; thirdly, the use of models definitely designed to show the effect of a new lighting system in a proposed building. Generally speaking, the first two applications alone concern the average model-maker, the third is the province of the architect and professional modelist.

A Model Locomotive

Few constructors realise the immense improvement that may be effected upon a well-finished model by means of properly applied lighting; to take a common instance, that of a locomotive. This is often housed in a glass case or upon a pedestal, and the owner usually relies upon the general room lighting for illuminating his model, with the result that the most impressive parts, the brightly polished motion work, are left in semi-darkness by the shadowing effect of the running boards. It is possible to obtain for a few shillings, tubular lamps about 10 in. long and less than 1 in. in diameter, complete with reflector for use on the house mains. One of these lamps mounted on either side of the model at the bottom of the case will cause the usually obscure parts of the locomotive to stand out with a clearness and sparkle that will astonish even its builder. This treatment, with variations, is applicable to most models with great success. Most standard high-voltage lamps are available with blue-tinted glass bulbs known as "daylight blue" finish these produce a very white light which shows up the white metals with a far greater brilliance than the more yellow light from the usual type of lamp.

Fig. 1.—A striking photograph of a scale model of Bournemouth, designed by one of our contributors, Mr. E. W. Twining. The model is constructed on the diorama principle.

Probably the greatest achievement in the way of scenic model lighting was the panoramic working model of the attack on Zeebrugge at the British Empire Exhibition in 1925. Here the representation of a sunset and the gradually appearing stars equalled anything to be produced by the lavish lighting equipment of a full-size theatre.

A Model of Bournemouth

A more modern instance is the large model of Bournemouth on view at Waterloo Railway Station. This model, which is probably the most magnificent of its kind ever produced, represents in two sections one and a half square miles reproduced in the completest detail. It is constructed on the diorama principle, that is, the scale diminishes from front to back in order to produce perspective until it merges into the backcloth. The lighting system is housed behind a pelmet in the roof of the case and consists of standard gas-filled lamps in a trough extending the length of the case; the trough aperture is covered with diffusing glass of a type known as muffled glass. Sixty-watt lamps are used in three sets of fifteen, comprising white, orange and blue bulbs to give effects of daylight, sunlight and moonlight. Change of effect is done by a motor-driven flasher which causes a gradual change-over by extinguishing the lamps of one colour one by one while those of the next colour are switched on one by one; this device obviates the need of a resistance dimmer. Fig. 1 gives some idea of the wealth of detail present in this model.

The branch of lighting which chiefly concerns the average modelist is the provision of scale lighting as a finishing touch for any type of model. Difficulty is often found here owing to unfamiliarity with this sort of work, lack of knowledge of the appropriate prototype fitting and the paucity of commercially obtainable light-sources of scale appearance. The cheapest and most easily obtainable small light-source is the so-called flash-lamp bulb; this unfortunately is difficult to work into any small scale on account of its large screw cap.

Interior Lighting

Lighting of interiors divides itself into three sections; direct lighting as is used for workshops and industrial purposes; general diffusing fittings used in offices, public buildings and domestic interiors; and what is known as architectural lighting. The first two of the above systems comprise definite hanging fittings, usually suspended on wire, chain or conduit, and present the greatest difficulty to the modelist.

For industrial interiors the usual type of fitting is that known as the Standard Dispersive Reflector. Fig. 2 shows the specific profile of this, and it may readily

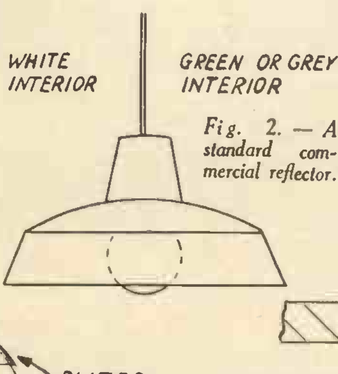


Fig. 2. — A standard commercial reflector.

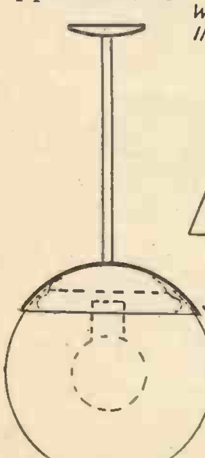


Fig. 5.—A cut-off opal bulb used as a hanging fitting.

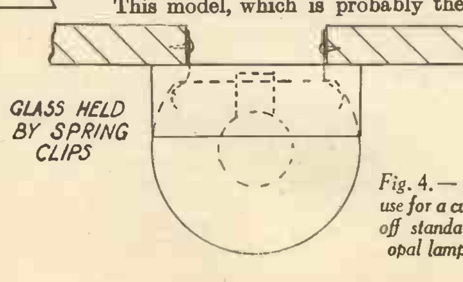


Fig. 4.— A use for a cut-off standard opal lamp.

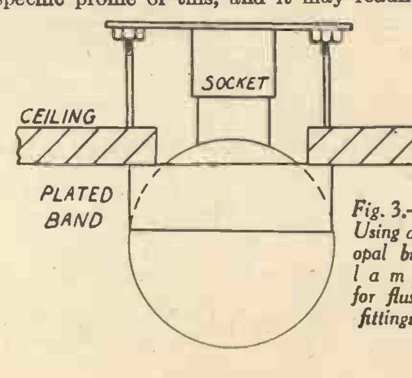


Fig. 3.—Using an opal bus lamp for flush fittings.

be made up from thin sheet metal. It is necessary for all model fittings of this nature to be designed around the intended type of lamp in order to accommodate its socket. To be strictly accurate a spherical bulb should be used in these industrial reflectors, and a lamp manufacturer's catalogue will reveal several kinds of spherical bulb lamps ranging from ⅜ in. diameter to 1 in.; the leading firms of model suppliers list lamps as small as ⅜ in. diameter.

The diffusing fittings present more difficulty as they are made of glass, a very intractable material to the engineer. It is therefore necessary to adapt standard forms of glassware, and there is scope for considerable ingenuity in this direction. Fortunately the modern tendency is towards extremely simple spherical forms of opal glass, and this considerably simplifies the model-maker's problem. In models of 1½ in. to the foot and larger, spherical opal 12-volt lamps, as used for interior lighting of vehicles, can be made directly into the most effective flush mounting fittings, as shown in Fig. 3. A simple alternative where the 12-volt supply is undesirable is to take a burnt-out 40-watt standard opal lamp and cut off the lower part of the bulb; this may be utilised as shown in Fig. 4, and lighted by any type of lamp thought desirable. These cut-off opal bulbs can also be made into a hanging fitting as in Fig. 5, which is self-explanatory. These full-size lamp-bulbs may be cut off by tying a length of string around the required plane of fracture, soaking in petrol and igniting; this method is only applicable to gas-filled lamps, but the vacuum type shatter dangerously.

Small Models

These adaptations of full-size lamps are only applicable, as was pointed out, to large-scale models; for smaller sizes it will be necessary to obtain smaller spheres. These may be found in the form of various beads or glass ornaments; alternatively,

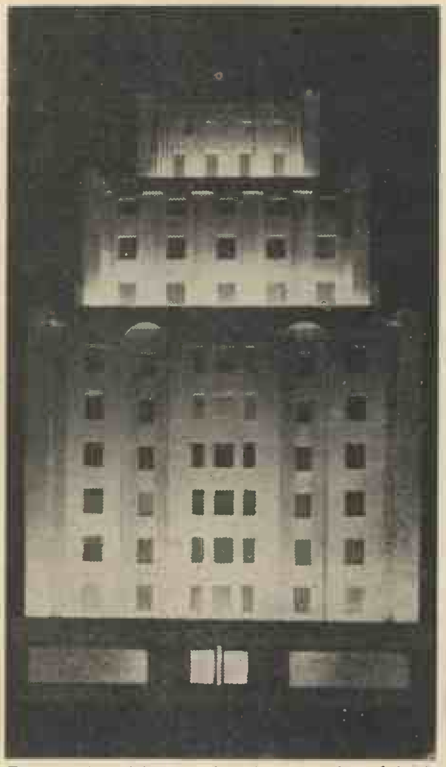


Fig. 6.—A model designed to show the effect of floodlighting.

there are a number of firms who will make opal glass spheres to any size for a very moderate sum. Another modern tendency is to make lighting fittings from flat glass panels set in metal frames. Nothing is simpler than to model these from small-section brass angle and strip. Either thin glass or celluloid may be used for the panels, and rendered obscure by means of the crystalline lacquers now available; it is difficult to obtain opal glass sufficiently thin for the purpose. Countless suggestions for the design of this type of fitting may be obtained from modern catalogues.

Architectural lighting is the term applied to lighting which is built into the structure in the form of wall panels, lintels, skylights, etc., and is capable of being reproduced to any scale as the size of lamp used is immaterial. So unlimited are the possibilities of architectural lighting that it may well be made the subject for a special branch of model-making; the major point to be observed is that the lamp spacing behind the glass should be adjusted to obviate any patchiness in the brightness thereof.

Pendant Fittings

The use of models designed to show lighting effects is illustrated in Fig. 6; this represents a building to a scale of ½ in. to the foot, and is designed to show seven different methods of floodlighting.

When pendant fittings are being modelled it is often the practice to hang them upon their wires in accordance with full size procedure. This should never be done, since the weight of model fittings is insufficient to keep the wires straight. The wires should always be run through small-section tube to simulate conduit, which is in accordance with the best recommendations, and makes a neat job.

Finally, it is not enough to think that a few flash-lamp bulbs scattered about a model represent model lighting; the exact method of illuminating the prototype should be ascertained, and that scaled down with as much care as the rest of the model. The result will inevitably repay the trouble taken.

MASTER-PILOTS OF THE AIR

An Imperial Airways pilot, Captain O. P. Jones, has recently completed 1,000,000 miles. He first entered aviation in 1917, when he underwent a course of flying instruction at Shoreham. Captain Jones then became a service pilot, and put in approximately 550 hours' flying in many different types of aircraft while with the R.F.C. and R.A.F. Then, resigning from the service, he started a joy-riding business of his own.

3,116 Passengers in Three Days

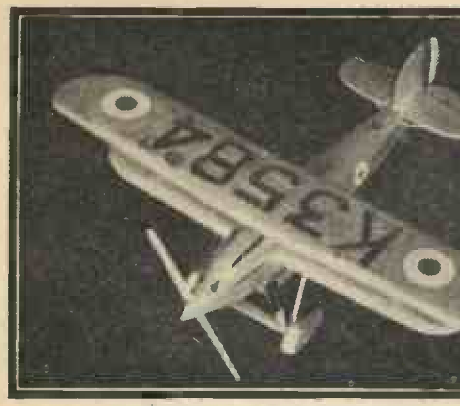
Subsequently, for some time, he was with Mr. A. J. (now Sir Alan) Cobham, and then flew as a pilot on the early Continental services, joining Imperial Airways on its establishment in 1924. Captain Jones has had the honour, several times, of piloting air-liners in which the Prince of Wales has been a passenger. On one occasion, while giving demonstration flights in Scotland, Captain Jones took up 3,116 passengers in three days. Another remarkable record as a pilot is that of Captain F. Dismore, of Imperial Airways, who has now been flying regularly for twenty-one years, his air experience dating back to before the war. He was also flying constantly during the war; while he has been engaged ever since hostilities ceased in piloting commercial aircraft. Captain Dismore gained his certificate of proficiency as a pilot as far back as 1913, and his air career since then is believed to have established a record for continuous flying over a long period of years.

Twenty-one years ago, when Captain Dismore first began to fly, he was piloting a crude, box-type biplane driven by a single 50-h.p. engine and carrying a pilot and one passenger. To-day, illustrating twenty-one years of progress, he flies as Commander of air-liners which are driven by four engines developing a total of more than 2,000 h.p. and which accommodate as many as forty-three people—thirty-nine passengers and a crew of four. Among the other veteran pilots of Imperial Airways a well-known figure is that of Captain A. S. Wilcockson. Joining the R.A.F. at the beginning of 1917, Captain Wilcockson completed 580 hours of flying before demobilisation in 1919. For some months after that he acted as pilot on the official air service which carried mails from Folkestone to our Army of Occupation at Cologne. Then he began flying on the pioneer commercial air lines between London and the Continent, subsequently joining Imperial Airways. Captain Wilcockson has gained distinction as a test-pilot as well as an air-liner Commander, having carried out much of the early test-work with slotted-wing aircraft. The number of hours he has spent in the air now total 8,991.

Another veteran of Imperial Airways is Captain W. Rogers, known to his many friends as "Rodge." After seeing war service with the R.A.F., Captain Rogers became an airway pilot in 1920, flying the twin-engined machines which were the forerunners of the giant four-engined craft of to-day. Now the number of hours he has spent in the air stand at 7,880.

Two Veterans

Two more of these veterans of the air are Captains H. H. Perry and H. J. Horsey. The former, after a large amount of flying in the early days of civil aviation, joined Imperial Airways in 1927, and his flying hours now reach a figure of 7,137. Captain Horsey, who is an expert in handling flying-boats as well as big multi-engined land-planes, has now spent 6,088 hours in the air. At the present time approximately seventy pilots, captains and First Officers, are in the regular service of Imperial Airways, flying on the European and Empire routes operated by the company. When commercial flying began, just over fifteen years ago, the first air-line pilots were recruited from the official Communication Squadron which, during the last stages of the war, had been flying with important officials between London and the Continent. Each of these airmen was a master of his art and, as the number of airway pilots grew, the wonderful spirit of those first men, and their fine attitude towards their calling, was handed on to those who followed them, the result being that the air-line pilot of to-day has a great tradition to live up to, and is doing so worthily.



A photograph of the finished model.

SCALE MODEL AIRCRAFT No. 3

A SCALE MODEL HIGH-SPEED FURY

The third article of a series dealing with scale models of most of the present-day aeroplanes

THE High-Speed Fury is a development of the ordinary Fury, and although the two machines are very similar, the High-Speed Fury has an even better performance than its predecessor. It has a speed in excess of 230 miles per hour at 15,000 ft. and a really phenomenal climb. Two Vickers guns are fitted under the fuselage and fire along the grooves in the engine cowling, and through the propeller, the Constantinesco gear controlling the fire to prevent the stream of bullets hitting the propeller.

The differences of the two Furies can be easily seen either on the ground or high in the air, the High-Speed Fury having wheel spats and also a smaller wing area, obtained by tapering the leading edge of the top plane and trailing edge of the lower. Models of the ordinary Fury can be made to the sketch dimensions, leaving off the spats and keeping the edges of the planes parallel.

The photograph shows the High-Speed Fury. The model can be supported in mid-air with black cotton and "shot" in any desired position. The propeller should, of course, be removed, replacing it with a disc of thin celluloid in order to get the effect of a revolving prop.

The List of Woods

Here is the list of the various parts and the sizes of the pieces of wood from which they are cut.

The dimensions in the panel include sufficient wood for insertion into holes where necessary.

Start off by making the spinner and propeller boss from ½-in. dowel rod. The taper can be cut with a chisel and then finished off with sandpaper. Pass an ordinary pin through the centre of the spinner and place it in position at one end of the piece of wood from which the fuselage can now be cut. The spinner acts as a guide for the correct shaping of the front of the nose. The pilot's cockpit can be cut out, the two gun slots filed out, and the six small holes on each side of the engine cowling should be drilled. Next fit the tail-piece and the rudder, which may be kept in one piece and a deep score made on each side to represent the hinge (as it can be separated and hinged with pins as described in No. 1 of this series). The rear plane and elevators should now be cut out and fitted, a pin passed through the fuselage, and its head cut off, and so into the ends of the rail-pieces, making a more satisfactory job than by gluing. The tail-piece struts (a pair on each side) should also be fitted, these helping to locate the rear wing on the level. The tail skid, which is fragile, may be left until later.

Next cut the lower wings and pin and glue them to the fuselage. Drive a hole in each wing for the reception of the rear interplane struts, but do not fit at the moment.

Now make the top plane, either carving out the underside slightly or by wetting the wood and bending it under pressure till dry. Note that the leading edge of the top plane tapers away to the tips, whereas the taper on the lower plane is on the trailing edge.

LIST OF PARTS

	Long. in.	Wide. in.	Thick. in.
Fuselage	5·5	0·75	1·05
Tail and rudder	1·2	1·3	0·125
Rear wings and elevators—two	1·2	0·95	0·125
Top plane	7·2	1·2	0·15
Bottom plane—two	2·7	1·1	0·15
Wheel spats—two	1·0	0·4	0·25
Shock absorbers (under-carriage)—two	1·1	0·25	0·125
Axle strut	2·2	0·1	0·05
Undercarriage rear struts—two	1·7	0·05	0·05
Centre inter-plane struts—four	1·0	0·1	0·05
Centre inter-plane struts—two	1·0	0·05	0·05
Inter-plane struts	1·6	0·1	0·05
Tail-plane struts—four	1·0	0·05	0·025
Radiator	1·1	0·55	0·35
Tail skid	0·75	0·05	0·05
Propeller—two	1·2	0·2	0·1
Prop-boss and spinner	0·5	½ in. diam. dowel	
Wheels—on disc	½ in. diam.		0·2

The Ailerons

The ailerons, which are on the top plane only, can be marked or separated as for the tail plane. Drill six holes through the plane for the two rear inter-plane struts and the four fuselage-cum-plane struts. Holes must be drilled in the fuselage for the reception of the struts. Then glue the four shorter struts into the fuselage and push the top wing over the ends, seeing that the glue makes a good joint. As the angle which these struts make to the wing and the fuselage is wide, care must be taken in fitting, but the wood, being thin, allows them to be bent. Slide the rear inter-plane struts through the holes in the upper and lower planes and glue them in. Now set the angle of the lower planes and see that the gap is correct and equal on both sides, whilst the glue is still wet, and then place aside to set hard. The front inter-plane struts and the two centre cross struts are carefully fitted and then glued in position, the other struts being ample to hold everything rigid.

The under-carriage can now be fitted. The two wheel spats are solid and the axle strut passes through both. The wheels are sections cut from one complete wheel and are glued to the underside of the spats. The two shock absorbers can be cut and shaped, or a thinner piece of wood used, the upper ends being wrapped with bands of gummed paper to obtain the necessary shape. The upper ends of the shock absorbers are sunk and glued into the fuselage, the lower ends being trimmed off to size after fitting. The spats and axle strut are then glued to the ends and the two rear under-carriage struts fitted.

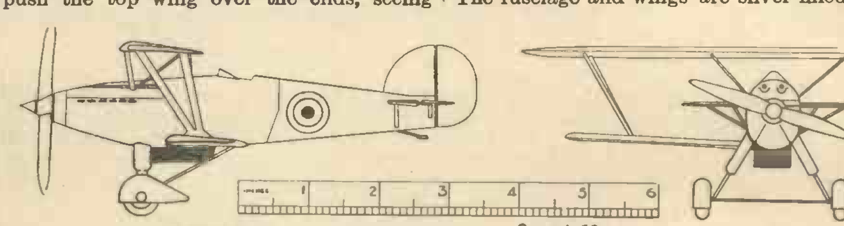
The Radiator

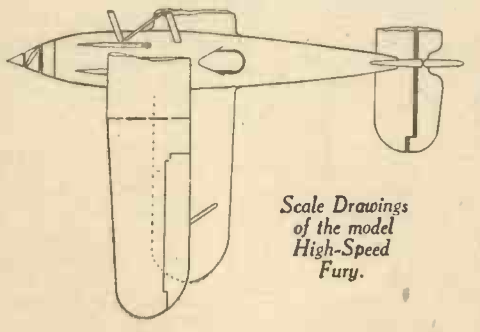
The radiator can now be cut to shape and its surfaces grooved to imitate the cooling tubes. This is glued to the under-surface of the fuselage, between the under-carriage struts.

The propeller is made in two halves, each piece being glued into a slot filed across the spinner.

The fastenings at the lower end of the inter-plane struts are built up with plastic wood or putty.

The model is now ready for painting. The fuselage and wings are silver lined out with blue, standard R.A.F. colours. Aluminium paint can be used all over, but that part to the rear of the cockpit can have a little colour added, quite a small amount to make a change from the front, which in the prototype is all metal, whilst the rear is fabric-covered. The identification discs are painted on the top of the upper plane, the under-sides of the lower plane and the sides of the fuselage, the blue ring being the outer, the centre red, and the magpie white.



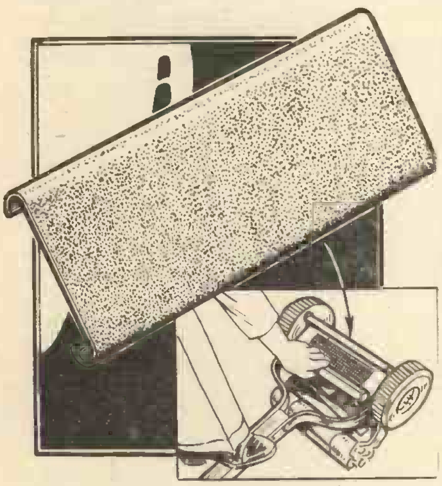


Scale Drawings of the model High-Speed Fury.

A Review of the Latest Devices for the Amateur Mechanic. *The address of the Makers of the items mentioned can be had on application to the Editor. Please quote the number at the end of the paragraph.*

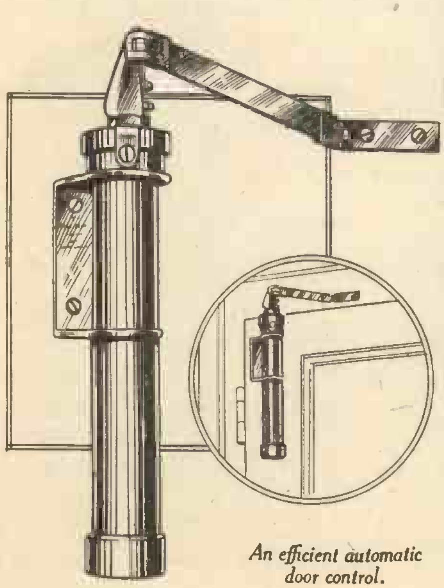
A Lawn Mower Sharpener

THE carborundum lawn mower sharpener shown herewith consists of a sturdy rust-proof steel, curved top and bottom, so as to fit over the cross bar of the mower. The sharpening side is faced with a sheet of



A carborundum lawn mower sharpener. No tools are required when using it, and there is no need to remove the mower wheels, reversing cogs, etc.

clean, fast-cutting, abrasive cloth. The hard, sharp, tough aluminous grains, with which the cloth is coated, quickly and easily cut a keen edge on the mower blades. By reversing the sharpener from time to time, you equalise the wear on the cloth. The sharpener is manufactured in one size only, and is suitable for sharpening mowers having 10-in. blades or wider. If your mower is wider than the sharpener, you simply put a drop or two of oil on the cross bar and slide the sharpener backwards and forwards across the bar, so as to contact the full width of each blade. The sharpener sells at the moderate price of only 2*s.* [119.]



An efficient automatic door control.

An Automatic Door Closer

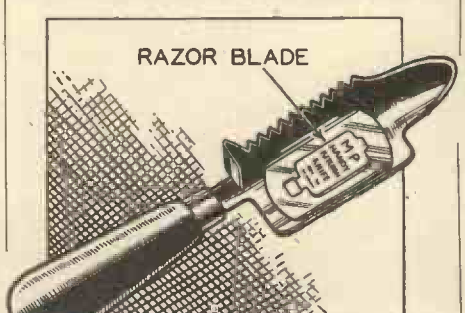
IF you desire your doors to close easily and quietly you should certainly fit the automatic door-closing device shown on this page. Inside the cylinder shown, is a spindle controlled by a spiral spring, whose tension is affected by the revolving of the spindle caused through opening and closing the door. The tension of the spiral spring increases when the door is open and actuates the door so as to close it. A checking effect is obtained by the oil in the fluid chamber, which works in conjunction with a valve to obtain a cushioning action in order to retard a too sudden motion, so as to prevent slamming. Should, however, the door be closed with excessive force so as to tend to shut the door more quickly than the checking means in the apparatus allow, the special resilient portion of the girder arm is so made that it will yield and prevent any damage or loosening of the working parts. The device costs 12*s.* 6*d.* [120.]

A Four-in-One Kitchen Knife

THE knife shown on this page is both novel and handy, and obtains its cutting edge from an old razor blade. It can be made to peel, core, scrape or slice fruit in a short space of time and is perfectly safe when in use. When the cutting edge becomes blunt, all you have to do is to fit a new razor blade. It sells at the low price of 6*d.* [121.]

An Ingenious Bench Fixture

A UNIQUE and ingenious bench fixture which enables articles (either held direct or in a vice or jig) to be swivelled or tilted to any position and rigidly held in



A four-in-one knife which obtains its cutting blade from used razor blades.

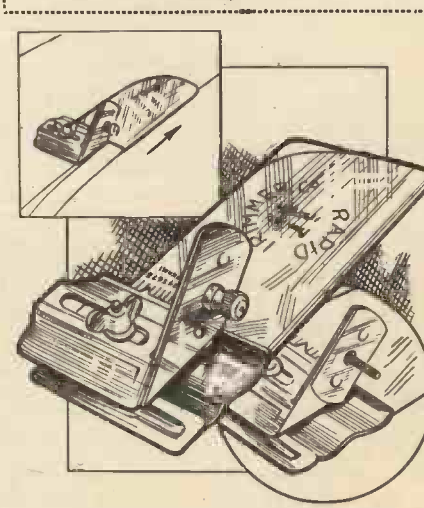
that position, is now on the market. It is obtainable in a small or large size, and the swivelling movement is through 360 degrees, the lock operating in any position. The canting movement is entirely independent of the swivelling movement and operates through 90 degrees. A fixed stop is fitted to prevent further movement. Thus an infinite number of positions is possible, so that the work, once held, can be turned to any desired position without re-gripping. Where used as a vice mounting, if choice of vice is available, it is recommended that the lighter types of vice be used, especially in the larger sizes. This is not only better for the mounting, but is infinitely better for the operator, as manipulation is so much easier and more rapid. The price of the small size is 17*s.* 6*d.* in grey iron, 22*s.* 6*d.* in semi-steel, and 27*s.* 6*d.* in malleable iron. The price of the larger size ranges from 32*s.* 6*d.* to 52*s.* 6*d.* [122.]

The Odd-Job Household Repair Outfit

TOOL sets vary tremendously. They may be nothing more than toys, or they may be complete enough for a carpenter—intended for people who want to make things. But neither of these meets the needs

A compact and portab e set of tools that will be appreciated by many handymen.

of an average householder. What he wants is an outfit adequate to deal with the hundred-and-one little jobs that crop up constantly in every house. The lost screw, the running tap, the loose terminal, or the broken picture wire. In fact, what is really needed is not only a small, carefully selected set of tools, but also a very complete assortment of nails, screws, staples, and similar small fittings. Here, then, is something quite new—something which every householder will find of invaluable assistance—The Odd-Job Household Repair Outfit. It has been produced for the man who, sensibly, attends to minor house repairs himself. The contents are sufficient for any little job likely to arise—yet it is as compact as anyone could wish. One of its very big advantages is this: all your tools are collected together in one handy box. You don't have to chase upstairs for the screwdriver—downstairs for the hammer. You know where everything is. You'll agree this ingenious little collection fulfils a long-felt want. It costs 21*s.* [123.]



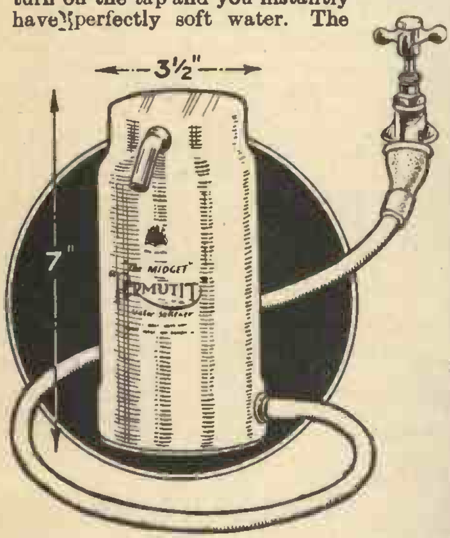
A novel and rapid paper trimmer. Simply loosen the wing nut and set the blade to the required width of cut, on the scale provided, each division being ⅛in. It costs 4/3

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.

A Midget Water Softener

THE neat water softener shown on this page consists of a white porcelain cylinder, 7 in. high and 3½ in. in diameter fitted with non-tarnishable fittings. Simply fit the rubber hose to any tap as shown—either hot or cold—gently turn on the tap and you instantly have perfectly soft water. The



A midget water softener that can be fitted to a tap in a few seconds.

device does not leak or drip, and is just as easily removed. A testing set is supplied free with the apparatus, and by adding a few drops of the special soap solution supplied, to the water and shaking it in a bottle, you can instantly tell whether you are receiving hard or soft water. Soft water will turn the solution into a creamy lather, but if the water is hard it will become cloudy with scum and there will be little or no lather. The water softener costs 25*s*., but a special non-tarnishable wall bracket, complete with screws and wall plugs, is supplied, if desired, at an extra cost of 5*s*. [110.]

A Set of Handy Measuring Spoons

THE spoons shown in the illustration on this page are graded in size from ¼ teaspoon to 1 tablespoon, and will be found useful for a variety of purposes. They are made in aluminium, and may be obtained for 1*s*. post free. [111.]

Interference Compensators for Wireless

THE certain way of curing interference is at the source. There are extreme cases when it is impossible to entirely remove the trouble, but it can be reduced to a minimum by using an interference compensator now being made by a well-known wireless firm. Sparking caused by contacts being broken causes noises to be radiated through the mains. It is the purpose of the interference compensator to block this radiation. To a large extent, the noises arise from H.F. currents, their characteristic sign being normally a continuous crackling or rustling, while L.F. currents are apparent by a humming sound. By connecting compensators at the source, these interfering currents are short-circuited and rendered ineffective, thus preventing radiation. The interference compensator costs 9*s*. 6*d*. [112.]

An Electric Gas Lighter

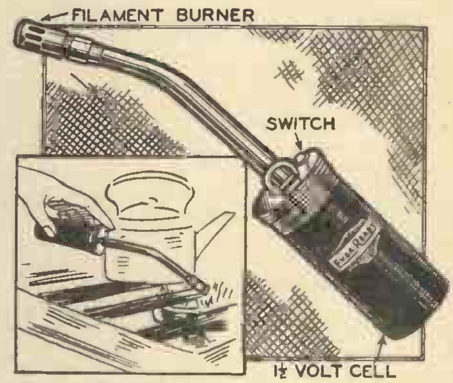
WE show on this page an electric gas lighter which is of simple construction and is entirely foolproof. As can be seen, it is worked off an ordinary dry battery, which is capable of lighting your gas some 7,000 times. It is safe, and there is no danger of sparks; just press the button and the gas is ignited. The ring shown in the sketch near the switch enables the gas-lighter to be hung where most convenient for use. It is certainly economi-

A set of measuring spoons that will be found useful for a variety of purposes.

cal, and costs 5*s*. complete. Dry battery refills cost 2*s*., and spare burners 1*s*. 3*d*. each. [113.]

Novel Edging Moulds

THE moulds shown on this page are both ingenious and novel, and they should certainly prove popular with gardeners. Each mould makes a tile 14 in. long and 7 in. deep, and by means of an inset supplied, three tiles 4½ in. long can be made in one mould, for curves. All you have to do is to mix the cement and pour it into the mould. These moulds also enable you to make crazy paving, as can be seen from the accompanying sketch. A set of six moulds to make 7 ft. of edging at a time costs 11*s*. 6*d*., or a half set can be obtained for 6*s*. A set of interlocking metal strips for making crazy paving costs

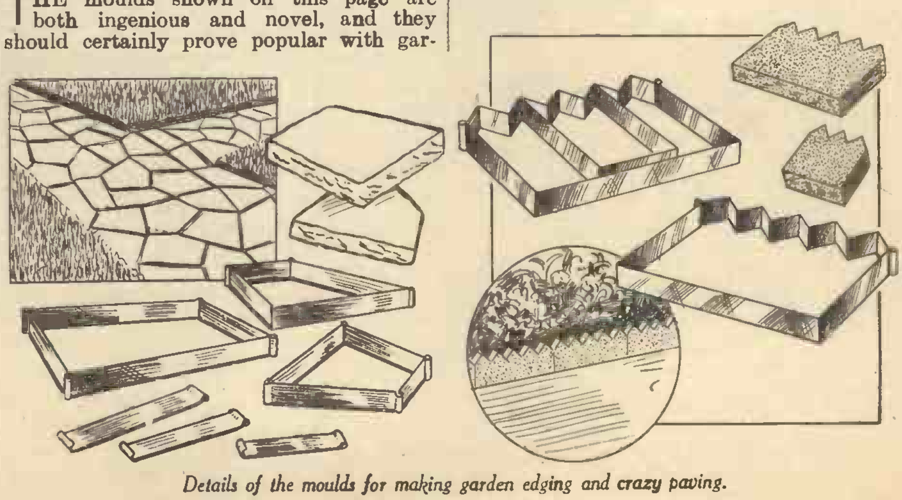


An ingenious electric gas lighter.

12*s*. 6*d*., or a half set is obtainable for 6*s*. 6*d*. [114.]

A Speedometer for Pedal Bicycles

A DEVICE which will certainly prove of particular interest to cyclists is a moderately priced speedometer, which can be attached to the handlebars of a bicycle by means of a clip and link. The driving sprocket supplied is attached to the spokes of the wheel by means of screws and spoke-nuts. If, however, it is found necessary to fit one of the spoke-nuts on to the lower spoke, a brass spacing collar, which is provided, should be used to prevent distortion of the driving sprocket. The speedometer is provided with a standard flexible shaft, 24 in. long, for machines with 26-in. wheels, and 29 in. long for 28-in. wheels. When fitting the device, care should be taken to obtain the correct meshing of the fibre pinion at the foot of the cable, with the driving sprocket, and also when connecting the top end of the inner flexible cable to the instrument. The bracket for supporting the bracket at the pinion end should be fitted to the hub spindle. The speedometer will register correctly whether fitted to the right or left side of the machine. It costs 12*s*. 6*d*. complete. [115.]



Details of the moulds for making garden edging and crazy paving.

AN A.B.C. OF ENGINEERING TOOLS

(*Concluded from page 285, March, 1935, issue*)

Surface Plate

A CAST-IRON plate resting on three feet, and having an upper surface scraped perfectly true. It is strengthened on the underside by ribs, the arrangement and size of which are carefully calculated to ensure the plate remaining true under varying conditions. A surface plate is used for testing the accuracy of the sliding surfaces of small machine parts where a true sliding contact is essential, such as lathe slide-rest parts, or the slide-valve of an engine cylinder. See also Scribing Block or Surface Gauge (Fig. 20).

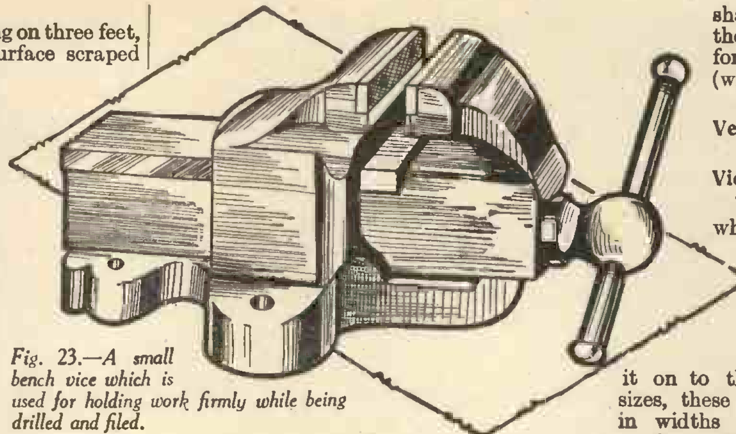


Fig. 23.—A small bench vice which is used for holding work firmly while being drilled and filed.

Taps

Used for cutting internal threads. Taps are made of cast steel, and have three or four grooves, or flutes, cut at equi-distant points round the tap forming cutting edges. For cutting threads in the larger sizes, it is the usual practice to employ three taps, viz., taper, the second, and the plug tap. The taper tap has its threaded end turned to a gradual taper, so that the end of the tap can easily enter the hole when starting the thread. The "second" tap is only slightly tapered at the entering end, the remaining threads being of the full diameter. The plug tap, which is used last for taking the finishing cut, has all its threads of the full diameter.

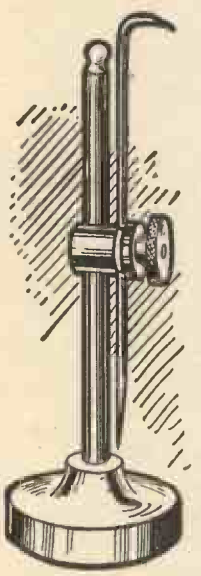


Fig. 20.—A scribing block which is used for marking the surface of a machine part, or casting, or for locating the position of holes to be drilled, and other purposes.

For gripping a tap when in use a tap wrench is employed. One pattern has an adjustable jaw arranged to grip the squared ends of taps of different sizes. There is a handle at each end, one of which acts as an adjusting screw for the movable jaw. Another pattern of smaller capacity has the clamping screw threaded through one of the handles, the end of the screw being knurled. A hole is made in the knurled end to take a tommy bar for tightening up the end of the screw against the squared end of a tap or any other small tool within its capacity.

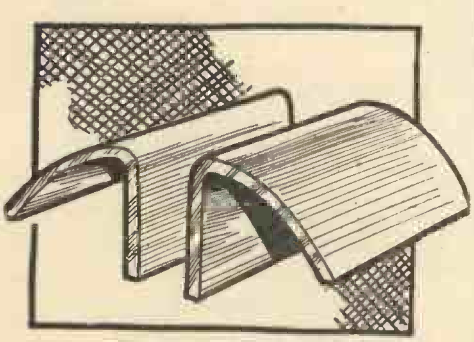


Fig. 24.—Vice clams are pieces of sheet metal, usually lead, bent to fit over the jaws of a vice.

Tinmen's Shears

Tool used for cutting thin sheet metal and wire. The long handles, in proportion to the length of the blades, enable a good cutting pressure to be applied (Fig. 22).

Twist Drill

A drill made of cast steel, and formed with a spiral flute which enables the metal shavings to easily get free when a hole is being drilled. Twist drills are made in varying diameters from 1/32 in. upwards, the smaller sizes having round shanks. The larger sizes are also obtainable with Morse taper shanks or square taper shanks, the latter pattern being intended for use with a ratchet brace (which see).

Vernier—See Caliper Gauge.

Vice

Used for holding work firmly while being drilled or filed. There are many patterns of vices suitable either for light or heavy work. A vice in common use is the bench vice, which is provided with side lugs for screwing it on to the bench. Made in various sizes, these vices have steel jaws ranging in widths from 2½ to 6 in. For light mechanical work a table vice is very useful. There are several patterns, one of which is shown in Fig. 23. A screw clamp is provided for holding it firmly on the bench or table, and there is also a small steel anvil, just behind the rear jaw, on which light hammering or riveting can be done. Some bench vices are fitted with an "instantaneous-grip" device operated by a trigger, which when pressed allows the movable jaw of the vice to slide freely in and out. The work is placed between the jaws in the ordinary way, the movable jaw is then pushed up against it, and the handle given half a turn which holds the work firmly in place. For holding small metal parts, and screws, for light filing and other purposes, a hand vice is used, the jaws being closed by screwing up a wing nut. For holding pipes, tubes and rods for cutting or screw threading, a tube vice is employed. This tool is largely used by gas-fitters, and can be bolted on to a bench or hand-cart. The V-shaped jaws, the upper one of which has a number of teeth on its gripping surface, hold the tube or rod firmly and prevent it from turning when screwing tackle is being used.

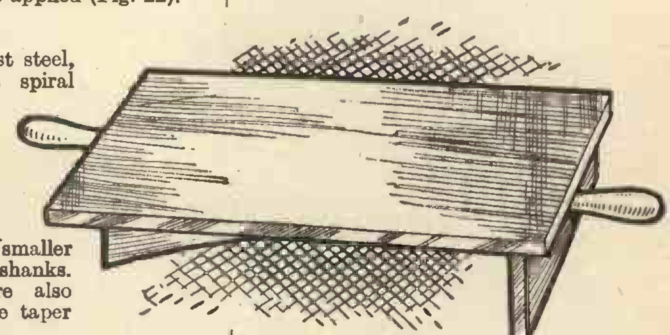
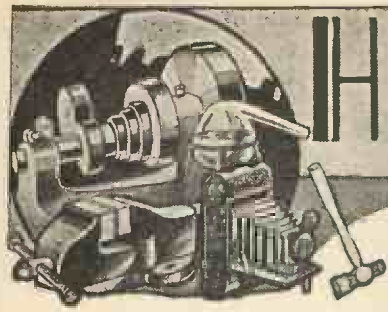


Fig. 21.—A surface plate, which consists of a cast-iron plate resting on three feet, and having an upper surface scraped perfectly true.

Vice Clams

Pieces of sheet metal, usually lead, bent to fit over the jaws of a vice to prevent finished work being scratched or marked by the teeth of the jaws (Fig. 24).

Fig. 22.—Tinmen's shears. A tool for cutting thin sheet metal and wire.



Hints about Hobbies

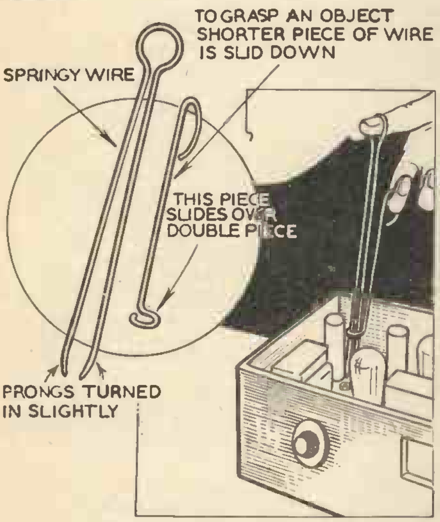
THAT HINT OF YOURS

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. No other correspondence whatever should be included.

A Handy Pair of Tongs

THESE handy wire tongs will be found very useful for recovering small objects, such as nuts, etc., from cramped places in wireless sets.

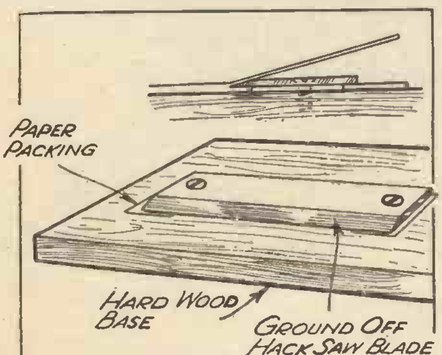
Two pieces of springy wire are shaped, as in the illustrations. To pick up an object, slide the shorter wire down on the tongs; the ends come together, grasping the object. This tool is easily worked with one hand.



Details of the tongs for recovering objects from awkward places.

Splitting Mica

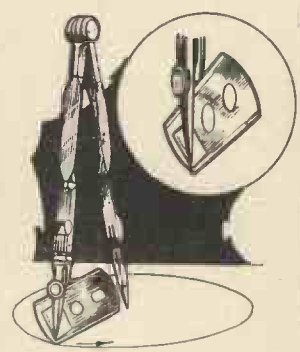
WHEN making fixed condensers it is often desirable to split up the mica sheet, as purchased, into much thinner sheets. By using the thinner sheets, not only is the capacity of the condenser increased, or, inversely, a fewer number of sheets required, but the complete condenser is, of course, very much cheaper. Mica is easily split with a knife, but some difficulty may be experienced in getting all the separated sheets of the same thickness unless some device is used for gauging them. An easy way of doing this is shown in the sketch. The blade is a piece of hacksaw blade ground off on one side to a knife edge, and drilled through (it will be necessary to soften the ends of the blade to do this) so that it can be fixed to a piece of hard flat wood with two wood screws. The blade is packed away from the wood with pieces of paper, the thickness of the paper deciding the thickness of the split mica sheet. As a guide, the thickness of an inside page of PRACTICAL MECHANICS is about ·003 in., and an outside cover ·005 in. The corner of a piece of thick mica is pressed against the edge of the blade and pushed through, by pressing the fingers on top, the lower piece emerging from the underside of the knife of the correct thickness.



A simple method of splitting mica sheets.

Another Use for a Compass

AN ordinary draughtsman's compass can quickly be converted into a tool for cutting circular holes in pieces of paper, card, etc., should the occasion arise.



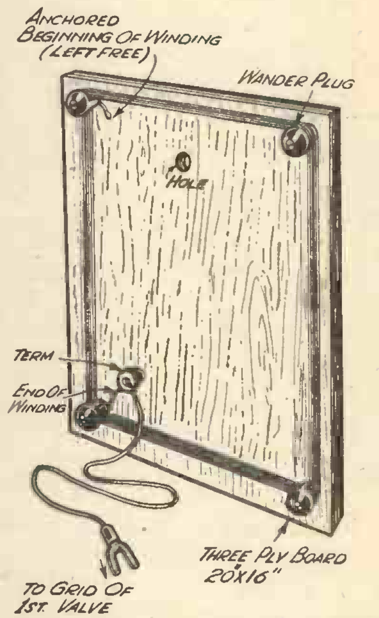
How a compass can be used for cutting circular holes.

Take an ordinary razor blade and place it between the blades of the compass pen at an angle, so that only one corner of blade is touching the material you intend to cut (as in sketch).

To prevent the blade slipping, place two pieces of card, one on either side of blade where the points come in contact with the blade, then tighten.

A Simple Frame Aerial

I FOUND that by using an aerial of the type shown in the accompanying sketch, and connecting it to the grid of the first valve direct, it enabled me to use a simple det.-2 L.F. set in any room as a portable set. To vary the amount of "capacity" to earth, and thereby control selectivity, I placed the aerial either on the floor or on a chair.



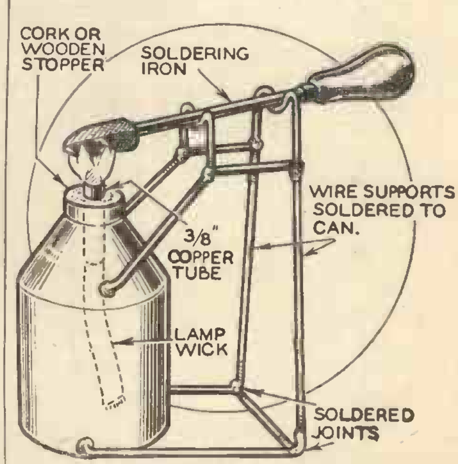
A handy and efficient frame aerial can be made as shown.

Soldering without Gas or Electricity

WHERE electricity or gas is not available this soldering stand and heater will be found very useful. Obtain a tin, one which does not leak, and solder wire supports to the tin, which are then bent into position, as shown in the sketch. Now obtain a piece of ⅜-in. copper tubing and push it through a hole in a cork or stopper, which projects about 2 in. into the tin. Push through enough wick so as to nearly reach the bottom of the can, and then fill with methylated spirit.

Earthing to a Water Tap

THE following idea may prove of use to readers interested in wireless, for a good earth connection to a water tap. After turning off the water, unscrew the top part of the tap. Now from a piece of thin brass, cut out a washer to fit over the thread of the tap. Firmly solder your earth wire to the washer by means of the holes drilled in the tag and rescrew the tap. This will prove much better than a clip.



A useful soldering iron stand and heater.

USES FOR WATER-GLASS

Thousands of tons of Water-Glass are sold annually for trades varying from oil-refining to paper-making

THE modern chemist specialises in finding new uses for old materials. With none has he had greater success than with water-glass. A hundred uses could be quoted for this material, and thousands of tons of it are sold annually for trades which vary from oil-refining to paper-making; for the potters' trade to the builders', from gold-mining to bottle-washing, so that it is superfluous to mention that the same material is used in egg-preserving.

Water-glass possesses a remarkable affinity for oil and grease. The manufacturer of lubricating oils uses water-glass to separate those last traces of paraffin wax which could do so much harm if they stayed in the oil and carbonised on hot bearings. The oil man at the well-head, when faced with a heavy "crude" which contains too much wax and bitumen, separates the oil with water-glass in the same way so that he can pump it along his pipe-lines. There are firms which do a thriving business in recovering oil from machine swabs and cotton waste, again by using a water-glass solution.

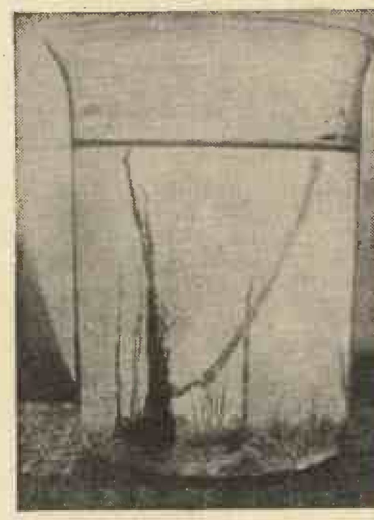
A "Detergent"

Breweries and dairy companies use water-glass in solving the problem of immense daily "wash-ups" of thousands of milk and beer bottles. Chemists who have raised the business of washing-up to the science of "detergency" find that a solution of water-glass spreads over dirty surfaces and cleans away dirt and grease in a remarkable manner. A solution of 1 oz. in a gallon of water will be found to be most effective as a cleaning solution in the workshop.

It is most unique, because it is the only alkaline washing material which does not harm aluminium. It is well known that washing soda corrodes the surface of aluminium. To illustrate this difference, you have only to boil a piece of aluminium with soda. Hydrogen is generated from the surface of the aluminium in a cloud of bubbles, which immediately disappears if a drop of water-glass is added. This property is not only used in washing the large aluminium vats which are common in industry; it also enables shaving creams and tooth-pastes to be packed in aluminium tubes. These materials are faintly but sufficiently alkaline to attack and destroy their containers. They are rendered innocuous by the addition of a trace of water-glass to the pack.

An Adhesive

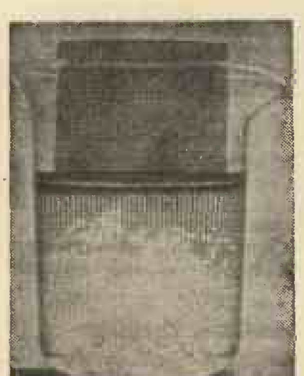
If water-glass is dried it sets with rock-like firmness. It is thus used as a rapid-setting adhesive in making mill-board. A mill-board-making machine is exacting in its demands. It takes thin sheets of paper, sticks them together and rolls up the finished cardboard at the rate of 300 ft. per minute. The bond between the layers of paper has to be made and set in the space of a few seconds. A carefully made-up water-glass solution is the only adhesive which stands up to this service. It gives an instantaneous bond which is stronger than the fibre of the paper itself.



A silica garden made by pouring a water-glass solution into a tumbler and then introducing crystals of copper sulphate, iron sulphate, etc.

A De-Flocculant

Water-glass has the property of making clays plastic and fluid. It deflocculates them, and so another wide range of uses is opened up. The paper-maker uses it to thin the filling clays he uses to surface writing and printing papers, so that the clay will flow smoothly to the paper-making machines and will still have plenty of body. In mining the same clay in the Cornish china-clay pits, water-glass is used to float off the clay from the grit of mica and quartz. A similar use is in the cleaning of gold and zinc, copper and tin ores from rocky gangue. The potter finds that water-glass makes his potting-clays mould more easily.



"Oil-break" off a wire gauze in water-glass solution.

Oi. will not break off the gauze in a soda solution.

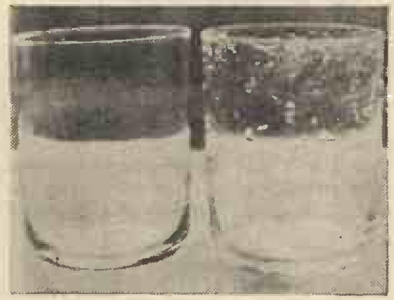
A Water-Glass Paint

Then water-glass is used in the final glazing and decoration of crockery. It is the base of many distempers and water-paints. A simple fire- and water-proof paint for colouring electric light bulbs and glassware can easily be made as follows :—

A solution of 1 part of water-glass in 6 parts of water is made up. A second solution of sulphate of ammonia is made up to full strength, as much as will dissolve. The two solutions are mixed to form the base of the paint. Into the base, any fire-proof colouring material, such as jewellers' rouge, ultramarine blue, brilliant green or chrome yellow is mixed to give a thin slurry. The surface to be painted is washed with water-glass and the paint is applied and allowed to dry. It is then "fired" by putting it in an oven at 300° F.—an ordinary gas-oven at full heat is just about right. The colour sets firmly, or if the colouring matter is omitted the base sets with a white frosted finish.

A Silica Garden

No account of the uses of water-glass would be complete without describing the fascinating experiment known as the "Silica Garden.' A 1 in 6 water-glass solution is made up and poured into a tumbler. Into this crystals are dropped of such substances as copper sulphate, iron



The glassware on the left is washed with water-glass, and on the right with washing soda. It will be seen that water-glass runs off cleanly.

sulphate, cobalt and nickel nitrates, even ordinary Epsom salts. Overnight the crystals begin to sprout and daily grow up into coloured stalagmites, which eventually fill the glass with feathery spires.

THE THOMAS GRAY MEMORIAL TRUST

Prizes offered in 1935 for the Improvement and Encouragement of Navigation

UNDER the will of the late Thomas L. Gray, the Royal Society of Arts has been appointed residuary legatee of his estate for the purpose of founding a memorial to his father, the late Thomas Gray, C.B., who was for many years Assistant Secretary to the Board of Trade (Marine Department).

The objects of the Trust are "The advancement of the Science of Navigation and the Scientific and Educational interests of the British Mercantile Marine."

The Council now offer the following prizes :—

Prize for an Invention

A prize of £100 to any person who may bring to their notice an invention, publication, diagram, etc., which, in the opinion of the judges appointed by the Council, is considered to be an advancement in the Science or Practice of Navigation, proposed or invented by himself in the period January 1st, 1930, to December 31st, 1935. Entries which have already been considered by the judges in the years 1930–34 are not eligible for further consideration unless they have since been materially modified.

In the event of more than one such improvement being approved, the Council reserve the right of dividing the amount into two or more prizes at their discretion. Competitors must forward their proofs of claim on or before December 31st, 1935, to the Secretary, Royal Society of Arts, John Street, Adelphi, London, W.C.2.

Prize for an Essay

A prize of £100 for an essay on the following subject: "Modern Navigational Appliances."

(1) Appliances made possible by electricity on board, *e.g.*, Wireless D.F., Echo Sounding, Gyroscope, etc.

(2) Appliances not depending on electricity, *e.g.*, Range Finding, Sounding Machine, Compass, etc.

Candidates are expected to deal with both sections. They should write from a practical point of view and give their views on the advantages and disadvantages or failures (if any) of modern electrical aids to navigation, based if possible on personal experience.

Competitors must send in their essays not later than December 31st, 1935, to the Secretary, Royal Society of Arts, at the above address.

The essays must be typed in English. They must be sent in under a motto, accompanied by a sealed envelope enclosing the author's name, which must on no account be written on the essay. A breach of this regulation will result in disqualification.

Both competitions are open to persons of any nationality, but, in the case of the Essay Competition only, competitors must be past or present members of the seafaring profession.

The judges will be appointed by the Council.

The Council reserve the right of withholding a prize or of awarding a smaller prize or prizes, if in the opinion of the judges no suitable invention or essay is submitted.

The Council also reserve an option on the copyright of the successful essay or essays, but do not claim any rights in respect of any invention to which a prize may be awarded.

PECULIARITIES OF SPINNING BODIES

ANY body, when spinning or rotating, possesses certain marked peculiarities which are entirely absent when it is at rest.

For one thing it acquires an extraordinary *rigidity*.

Obtain a disc of quite thin paper and fix its centre so that it can be rotated *rapidly*. When spinning, it resists, in a very marked manner, the blow of a stick or even of your fist, as if it were a disc of steel. Its flexibility has entirely disappeared.

Fig. 1.—The chain held in the drill chuck ready for spinning.

Fig. 2.—The second operation showing the chain commencing to spin.

The Rigidity of Smoke Rings

Many readers have no doubt experimented with smoke rings and noted their peculiar rigidity whilst travelling through the air. See what happens, however, when you try and cut it in two with a knife.

It will be found that if a body is supported below its centre of gravity it has one axis (the longer) about which it prefers to spin—but when supported above its centre of gravity it prefers another axis (the shorter). Now every body has three principal axes, and according to circumstances there is always one axis about which it prefers to spin.

Fig. 3.—The chain at the height of its spin.

The Spinning Chain

Obtain a flexible chain, and support it from above by means of a piece of string held in the chuck of a small hand drill (see Figs. 1, 2 and 3). Upon turning the drill, the chain will open itself in the form of an oval, gradually rising and finally spinning quite steadily as shown in Fig. 3. A high rate of spin is not necessary, because if the spin is too great, the motion may become unstable.

MODERN ARCHITECTURE

A multitude of mechanical appliances, water services, plumbing and ventilation are incorporated in a new Sanatorium which has recently been designed by Mr. W. T. Brown, B.A.

AN interesting and original design for a sanatorium has been completed by Mr. William Tatton Brown, B.A., of 6 Bedford Square, W.C.1, in which the demands of hygiene and economy of upkeep have been combined with a pleasing exterior.

The multitude of mechanical appliances, water services, plumbing and ventilation systems required for the sanatorium of to-day have been assembled to form an integral part of the design.

On the first floor, overlooking a lake, is a series of private wards, in which privacy has been maintained, even with balconies. The architect has taken advantage of these to relieve the rigidity of the design. At the east end of the block is an entrance and access tower which give a strong vertical accent to the composition.

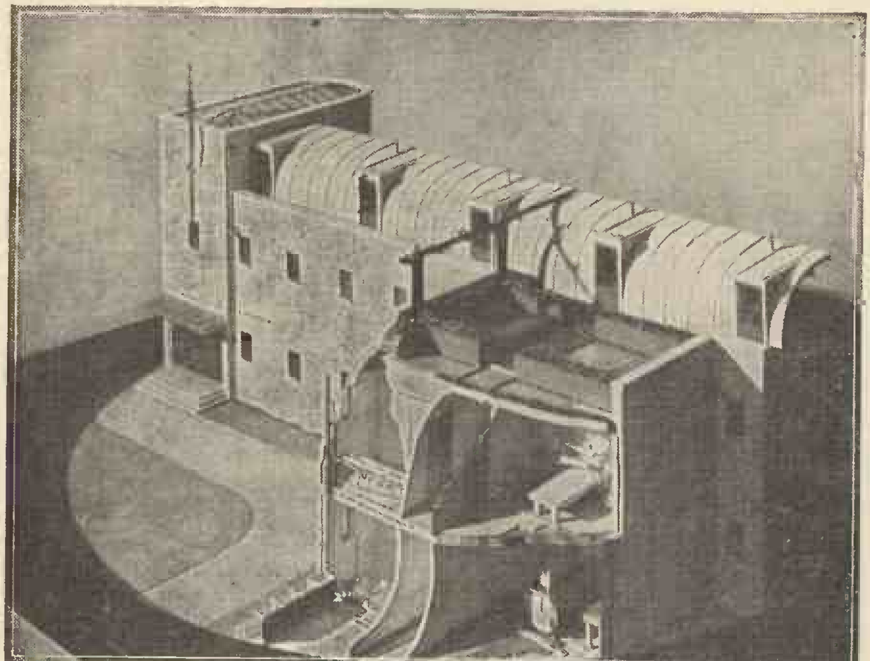
Demonstration to the Building Industry of the Uses of Lead

The plans were called for by the Lead Sheet and Pipe Development Council to demonstrate the uses of various forms of lead in the building industries, and many applications—familiar and unfamiliar—are exemplified in the building.

This metal has been used decoratively as well as functionally in the rain-water heads and down pipes, and also on the moulded canopy to the main entrance. On the first floor each sanitary unit of the private wards is equipped with tellurium lead soil and vent pipes, waste and anti-syphonage pipes; and the supply services and shower-lining are also in lead. An electric cable sheathed with British non-ferrous ternary alloy is carried across from the lake to the machine room in the farther wing, where it operates a heavy mechanical installation mounted on a lead mattress, which effectively insulates the rest of the building from vibrations set up by the machine. There is also a lead-covered table and sink.

On the floor above, an X-ray room is installed, the walls and doors of which are lined with lead in order to prevent the dangerous rays from penetrating beyond.

On the other side of the corridor is the sanitary accommodation for the staff of the sanatorium. The "one pipe system" has been installed, and all the plumbing is in B.N.F. ternary alloy and lead.



The service departments of the Sanatorium show many uses of lead both on the exterior and interior.

Roofing Difficulties Countered

It has been impossible previously to use lead for a flat roof intended for promenade, owing to the necessity for the construction of rolls at frequent intervals. This the architect has ingeniously overcome by laying Solchek tiles between the rolls, providing at the same time a flush walking surface and efficient heat insulating for the building and protection for the lead. On the north side roof, tellurium sheet lead has been stuck to the roofing surface with bitumen emulsion, and the rolls and gutters have been concealed with flower boxes.

MONEY MAKING IDEAS REVIEWED BY OUR PATENT EXPERT

NON-SKID TYRES

"I should esteem it a favour if you would kindly advise me upon the undermentioned proposition:—

"The idea is to affix a thin spring steel pattern round the periphery of motor tyres and any other tyres, such as cycles, etc. They are fitted in the first place when the tyre is deflated, and when fully inflated the pattern fits snugly into the tyre, making same quite non-skid, unpuncturable, and practically making it impossible for the tyre to wear out. The pattern does not interfere with the resiliency of the tyre, and can be attached to a tyre which has no tread, thereby rendering same as good as new.

"I estimate that twelve will be needed for each tyre, and the method of attaching the pattern to the tyres has been adopted for simplicity, but it could be made a permanent fixture to the spoke.

"The idea works well, but I am wondering whether I am up against legislation in any way; if not, would you advise as to method of exploitation, and whether patentable." (F. C., Brixton.)

This invention is novel so far as is known from personal knowledge, and forms fit subject-matter for protection by Letters Patent. The inventor is advised to file an Application for Patent with a Provisional Specification, as being the least expensive method of obtaining protection. By such means he will obtain about twelve months' protection, during which time he can test out the invention and endeavour either to market the invention, obtain financial assistance to do so, or try and interest tyre companies or other manufacturers to place the invention on the market.

Unless the inventor has actually tested the invention in practice, he is advised to do so, as there appears to be some doubt as to whether it will effectually prevent skidding of a wheel to which it is fitted. It should certainly minimise the chances of tyre punctures. It is not thought that there is any legislation to prevent the use of such a device, in view of the fact that "Parson's" non-skid chains have long been used, which would appear to be more likely to injure the surface of a road than the applicant's invention.

A GREYHOUND TRAP

"I am forwarding you plans of two ideas that I have thought out, and would be pleased if you would look them over and let me know if you think they are at all practical, as I am not an engineer. The first is a 'greyhound trap,' and the second is an air current chamber to be used for the vertical rise of aircraft. I would also be obliged (if these ideas are not practical), if you would point out to me where they are at fault." (J. C., Isle of Man.)

(1) The suggested improvement in greyhound traps is not considered to be an improvement on existing traps, but this opinion might be modified on consulting an expert in greyhound racing, about which we must confess very little interest. The idea doubtless could be so designed as to work effectively, but even if such a device had no serious drawbacks, it is not considered a commercial proposition in view of the cost of present traps. Provided it is novel, it could be protected by Patent, which is apparently the only means by which it could be protected, and unless protection is obtained it is not possible to make money from the idea.

(2) The suggested arrangement for causing aircraft to rise vertically is not very clear from the description and sketches. Apparently the idea is to rotate a paddle-wheel within a semi-circular casing; if so, the invention is based on a fallacy; the only result will be air disturbance without producing any lifting effort.

ELIMINATING SOAP WASTAGE

"I have designed a device for bathrooms or sinks, which will absolutely eliminate soap wastage.

"The appliance is attached loosely to the faucet of the tap, thus allowing it to be swung aside when not in use.

"It can be inexpensively manufactured, and should prove a success if placed with a suitable firm.

"The device is unpatented as yet, but I am now attempting to do so.

"Please give me your advice and opinion." (J. G., Forest Gate, E.7.)

The improved device for preventing waste of toilet soap is novel so far as is known from personal knowledge, and forms fit subject-matter for protection by Letters Patent. The inventor is warned that by submitting the device to manufacturers before filing an Application for Patent he runs a certain risk, since publication or showing the invention before protection is ground for invalidating any Patent subsequently granted for the invention. Although the invention may be novel and patentable, it is considered doubtful whether it would meet with commercial success. It is thought that the person who would be sufficiently careless to leave soap to soak in water would not be likely to take the trouble to manipulate the clip to attach the soap tablet.

A SPRUNG SADDLE ARM

"I have designed a sprung saddle arm, or pillar, for a cycle, and I would be very pleased to have your advice. Being only a youth of nineteen, my knowledge of patent laws, etc., is very limited. I shall therefore be very pleased if you will enlighten me on the following question:—

"How can I find out if the idea is novel?

"I think that you will agree that my idea would add greatly to the comfort of cycling, especially if fitted to the very popular racing machines, which are fitted with small non-sprung saddles." (A. G., Forest Gate.)

The proposed spring pillar for cycle saddles is, from personal knowledge, known to be old. Similar spring saddle pillars were in use, and probably patented, some thirty years ago.

PRACTICAL MECHANICS 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.

RE-SILVERING A MIRROR

"Can you kindly advise me what material to use for replating a mirror, and how to apply same to the glass?" (W. M., Chelmsford.)

According to the "Handyman's 1,000 Practical Receipts" the back of the mirror will no doubt be painted, and this paint should be removed with a strong caustic soda solution. The glass should then be treated with strong nitric acid, which will dissolve off the silver. The glass should be made chemically clean with the soda and nitric acid, and then rinsed several times with distilled water and laid on its edges. It must on no account be handled on the face or dried, as the least particle of dust or grease will entirely spoil the deposit of silver. For silvering the mirror prepare the following solutions: (1) 90 gr. of nitrate of silver, 4 oz. of distilled water; (2) 1 oz. of pure caustic potash, 25 oz. of distilled water; (3) ½ oz. of milk of sugar in powder, 5 oz. of distilled water. Take 2 oz. of solution (1), add ammonia drop by drop until the precipitate first formed is just dissolved, add 4 oz. of solution (2), and then ammonia again until the solution just becomes clear; make up to 15 oz. with distilled water, then add solution (1) drop by drop until a slight grey precipitate appears, which does not redissolve, allow to settle, add 2 oz. of solution (3), and stir well. The glass plate should now be carefully levelled until it is exactly horizontal, and the solution prepared as above should be poured gently on the glass, so that the whole of it is covered and none of the solution is lost. Allow to stand several hours in a warm room free from dust. At the end of that time pour off the liquid, replace the plate, and pour on it a second quantity of liquid. When the silver has deposited from this, rinse the plate in distilled water, allow to dry spontaneously, and then give a coat of good paint to form a protection.

OBTAINING AN OXYGEN SUPPLY

"Will you please tell me how to make a supply of oxygen uncontaminated by any other gas, at a minimum of expense? I have in mind electrolysis. In this method, is it essential for the wires to be of platinum and also in the interests of purity, would it be better for the water to be slightly briny instead of acidulated?

"Again, would a 6-volt motor-cycle battery be O.K. for the current supply?

"The main requirements are purity and economy." (A. C., Rochester.)

Although electrolytic oxygen fulfils the requirement of purity, querist would find it a tedious job to produce any quantity by means of a 6-volt accumulator. Such a process would never be used commercially. Surely for economy nothing can beat Brin's method. Barium oxide is heated in air to about 500°. The heating is then continued in a chamber to 1,000°, when oxygen is liberated and may be collected. The oxide is allowed to cool in air to about 500°, when it again absorbs oxygen, which in turn may be liberated by repeating the heating to 1,000°. The process may be repeated indefinitely.

If the heating presents difficulties, a quick, cheap method of obtaining oxygen is to obtain a quantity of "20 volume" hydrogen peroxide solution, acidulate it with a few drops of sulphuric acid, and add a little potassium permanganate solution. Oxygen is abundantly liberated.

A quick, convenient method is to use an acetylene generator and sodium peroxide. A little of the latter is placed in the compartment usually occupied by the carbide, and water allowed to drip through on to it. Oxygen is delivered at the outlet pipe.

A FILTER FOR RAIN WATER

"I wish to make a filter for rain water, so as to make it fit for drinking. I have been told animal charcoal powder is suitable, and would like your advice on how to use this. I have thought of sinking a well, but understand that the water contains a lot of iron. Can anything be done about this?" (W. B., Devon.)

Efficient filtration, unless operated by mechanical means (that is, pressure filtration) is necessarily slow; animal charcoal in powder is extensively used in filter charges on account of its adsorptive properties. Such charges can be purchased at any laboratory fitters, and can be readily dropped into place in the filter chamber. We cannot vouch that filtration through charcoal would free rainwater of acquired bacteria, although it would remove absorbed gases and *débris*. We consider that the pasteur filter would be far more effective, although slower.

Regarding the proposed well—any iron present in the water as hydrated carbonate must be removed if the water is to be used for washing clothes; this is accomplished by the addition of washing soda and borax stirred until dissolved and left for a few hours in order that precipitation of the iron may be complete before either the soap or goods are introduced; if the soap is dissolved before or with the alkali, it will take part in the precipitation and give sticky particles containing iron and calcium salts of the soap acids. These sticky particles would subsequently oxidise and create iron-mould in the fabric.

PHOTO-ELECTRICS

"With reference to your article on photo-electrics, I have made, as instructed, a wet cell, with the two copper plates well cleaned.

"On connecting it in series with a pair of 'phones and an accumulator, I obtained no result.

"I took a voltmeter reading and it read 1 volt. Putting a 50-watt lamp an inch away made no difference.

"Why should it read 1 volt?

"Could you tell me my mistake"? I tried it with an amplifier and a 60-volt polarising battery.

"Please could you also tell me the best material for making loudspeaker cones?

"Is a screen-grid input to an amplifier advisable? and is it better than an ordinary L.F. valve? Would an H.F. screened grid do (Mullard PM12)?" (W. M. L., Bishop's Waltham.)

Many experimenters have difficulties with the working of simple photo-cells of the liquid type at first, but, after experience has been gained, these troubles pass away.

Your difficulty with the copper cell which you have constructed may be due to several causes:—

(1) Are you sure that your solution of copper sulphate in which you "formed" the copper plates was not stronger than 1 per cent. copper sulphate?

(2) Are you sure, also, that the two copper plates forming the cell are not touching each other but are kept apart by the plate of ebonite between them?

(3) Are you sure that the "window" in the box in which the cell is placed is an effective one? That is to say, are you sure that the window does not allow light to obtain access to both sides of the cell at the same time, instead of only to the one side?

The above points must be carefully attended to, otherwise the cell may probably not function.

You do not require an accumulator in the circuit. It is obvious that if you include an accumulator in the circuit, current will leak through the liquid in the cell, thus giving a very appreciable voltage reading, as you yourself have discovered.

What you want to do, having first of all attended to the above three points, is to connect a pair of headphones directly to the output leads of the cell, that is to say, without the interposition of any battery or accumulator.

You ought then to get a result, using a 50-watt lamp. If the cell is but poorly formed, however, it will require the intense illumination of burning magnesium to give a result.

You can, of course, employ a radio amplifier in place of the 'phones. This will enable the "clicks" resulting from the intermittent illumination of the cell to be heard at loudspeaker strength.

The best material for loudspeaker cones is coarse linen cloth. This should be well dried in a warm oven and then varnished with any convenient varnish in order to render it more rigid and, also, moisture-proof.

For the simplest working in an ordinary amplifier, the usual L.F. valve is to be recommended, on account of its relative cheapness and efficiency. In certain circumstances a screen-grid valve may be preferable, but without further details it is quite impossible to give any definite opinion.

PLOTTING A GRAPH

"In your June issue you published a graph of the flow of water over a V notch of 90 degrees. Would you please send me the formula for plotting the graph, as I have just come in contact with a measuring notch of 60 degrees which formula seems to carry a lot more gallons per minute than the 90 degree notch published?" (P. C., Norfolk.)

Regarding the flow of water over a "V" notch, the graph given in our article in the June, 1934, issue of PRACTICAL MECHANICS was based on information given in "Molesworth's Pocket Book of Engineering Formulæ."

THE SECOND ANNUAL SKYBIRD LEAGUE RALLY AND MODEL COMPETITION

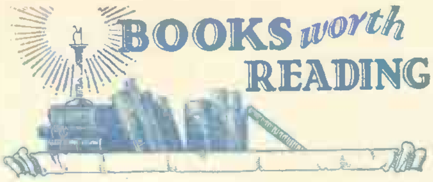
THIS interesting event open to all members of the Skybird League will be held from April 11th to the 20th. In addition to the Club competition for the Challenge Cups there will be an open competition for individual members, both Club and Associate. Captain W. E. Johns, Editor of *Popular Flying*, has kindly consented to make the final decision in judging the competition. Full particulars and conditions are published in *The Skybird* magazine, February and April issues. The latest date for dispatch of models will be April 5th. The winning models will be exhibited at Hamleys, Regent Street, from April 11th to the 20th. The Presentation of Trophies and prizes will take place at the Polytechnic, Regent Street, on Tuesday, April 16th, 2.30 for 3 p.m. Sir Harry Brittain, K.B.E., C.M.G., etc., President of the Skybird League, will make the presentations.

Captain J. Lawrence Pritchard, Secretary of The Royal Aeronautical Society, will give a lecture on "The Aeroplane and its Uses" (illustrated with slides). Admission will be by ticket on application to Skybird League Headquarters.

A. J. HOLLADAY & CO., LTD.

FREE ADVICE BUREAU COUPON

This coupon is available until April 30th, 1935, and must be attached to all letters containing queries.
PRACTICAL MECHANICS, APRIL, 1935



The Styles of English Architecture

BY ARTHUR STRATTON. *Published by B. T. Batsford Ltd. A series of wall diagrams for schools, etc., with explanatory handbooks. Series I.: The Middle Ages, 13s. net (paper); £1 12s. net (mounted). Series II.: The Renaissance, 12s. net (paper); £1 10s. net (mounted).* Students of architecture have here at their disposal two excellent series of wall diagrams to guide them in their studies of English styles. Those who study alone may consider that the explanatory handbooks containing small-scale reproductions of the wall diagrams may be sufficient for their purpose. These may be obtained separately, price 1s. 6d. net (paper wrapper), or 2s. 6d. net (bound in cloth) each. There must be many otherwise well-educated people who would like to feel a little more sure of their ground as regards the differences between, for instance, Anglo-Saxon, Norman and Perpendicular styles of architecture, and to them particularly these well-illustrated booklets may be recommended.

Design in Woodwork

By PERCY A. WELLS. *Published by B. T. Batsford Ltd. 6s. net.* Now that there is a persistent demand for better design in industry and commerce, the foundations for it should be laid at the offset, during the period of training. "All things made for use should do their job well," says the author of this readable book, "as with a saucepan, a spade, or a typewriter . . . but in things of permanent human interest fitness should combine beauty—that is, good design—with utility. A chair may be comfortable and still be ugly in form, in which case it does not completely suit its purpose, for it should add its quota of beauty and dignity in a room." The second principle is sound construction, which includes the right use of material. In this well-illustrated book will be found a sound guide to woodwork construction for all who appreciate simple beauty in everyday things. The construction of articles in wood at every stage, from the simple and elementary to the far advanced, is admirably dealt with.

Drawing, Design and Craftwork

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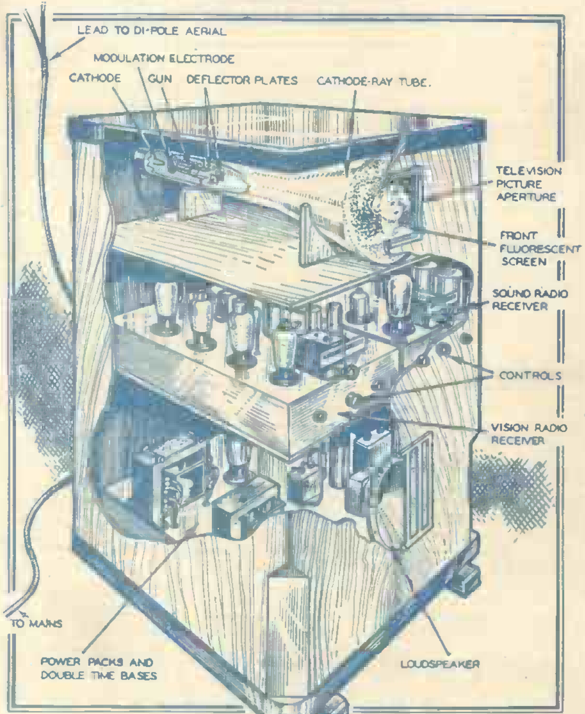

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