INTO THE DEPTHS IN THE BATHYSPHERE

NEWNES

PRACTICAL MECHANICS

SEPTEMBER

6D.

LECTROPLATING AT HOME · TRAPS FOR INSECTS · TELEVISION SIMPLY EXPLAINED
IARVELS OF MODERN IRRIGATION · A PETROL-DRIVEN MODEL
IONOPLANE · MAKING PHOTOGRAPHIC ACCESSORIES · PATENT
DVICE · RARE GASES · MODEL BOATS · RAILWAYS & AEROPLANES · LATHEWORK ETC. ETC.

Practical Mechanics

Edited by F. J. CAMM

VOL. II. No. 24
SEPTEMBER
1935

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

Editorial and Advertisement Offices: "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

Electronically-controlled Photography

BY the use of electronic apparatus for controlling a special camera, a clear photograph of a bullet travelling at 250 m.p.h. was made recently by engineers of the Westinghouse Electrical and Manufacturing Co. A glow tube furnished the light for making the picture.

Crash-proof Aeroplane Tanks

STATED to be an R.A.F. invention, new crash-proof, unbreakable tanks for aeroplanes are to be investigated for possible use in the Dutch civil air fleet. They are considered to be highly important in view of the danger of fire when a machine crashes.

The Smallest Wireless Set

AN inventor, of Vinnetsa, has built what is claimed to be the smallest wireless receiver in the world. It is $\frac{2}{5}$ in. high, $\frac{3}{10}$ in. in diameter, and weighs one-twentieth of an ounce. The reception is said to be perfect.

A New Seaplane Record

WE learn that Antonio Stoppani has broken the world long-distance record for hydroplanes with a 3,104-mile non-stop flight in a straight line from Trieste to British Somaliland.

For the Motorist

A DEVICE which buzzes a warning to motorists when they are approaching 30 m.p.h. in top gear has been invented. It consists of a small electro-magnetic buzzer which is clipped to the steering column and connected to the ignition coil.

First Motorless Directed Flight

IT is stated that Peter Riedel, aviator, has made the first motorless directed flight over a distance of 170 miles in six hours forty minutes, following the course of regular air liners.

A New Glider Record

A WORLD record for gliding is claimed by Ludwig Hoffmann, a German, who landed near Oskovice, Czecho-Slovakia, after travelling 310 miles in the air. Hoffmann started from Wasser Kuppe, Hessen. The previous record was 235 miles set up in July 1934 by Herr Ditmar, who flew from the Wasser Kuppe to Liban, Czecho-Slovakia.

A Robot "Town Crier"

WHAT is considered to be the first robot "town crier" has been successfully tested at Chesterfield. The apparatus includes a special gramophone disc, on which the announcement is recorded, and two loud speakers.

New American Liner

A NEW 30,000-ton liner, the largest and fastest ever built in the United States, will probably be running between New York and Europe in 1937.

Exhibition of Electro-deposition

A SPECIAL exhibition to illustrate the numerous branches of electro-deposition was opened recently at the Science Museum, South Kensington. The exhibition, which will remain open until the end of October, is of interest both to the layman and to the technical visitor.

The Science Museum is open between 10 a.m. and 6 p.m. on weekdays and 2.30 p.m. to 6 p.m. on Sundays. Admission is always free.

An American "Death Ray"

REGARDED as one of the greatest military inventions since the Great War, a "death ray" has been discovered by an American. With the aid of this ray, guns can be accurately trained on any target up to a distance of 30 miles. Several tests have already been made, using a searchlight instead of a gun. In these tests, a coastguard cutter, several miles out at sea in darkness, was "hit" by the beam of light no less than nineteen times out of twenty.

"Midget" Coins for America

WE learn that there is a possibility of the United States putting into circulation "midget coins," worth half a cent (approximately one farthing) and one mill (one-tenth of one cent, or 20 to a penny). Half-cent pieces have not been coined since 1857, and there are none of them in circulation to-day. There has not previously been a one-mill piece.

A Treasure-seeking Device

IT is stated that a new portable geophysical instrument called the "Terrometer" has been designed for detecting the presence of electrically-conductive ore beds and metallic deposits which are buried at moderate depths beneath the surface of the earth. The instrument consists essentially of a high-frequency oscillator and a sensitive detector, maintained in rigid alignment by supporting arms and provided with carrying handles for manual transportation.

New Development in Headphones

THE Brush Development Co., manufacturers of the piezo-electric microphone, are now producing piezo-electric (crystal) headphones for wireless reception. The new 'phones are of high impedance, and feature unusually good tone quality, and the ability to stand strong signals without blasting

Self-vulcanising Rubber

A LIQUID form of rubber latex which is self-vulcanising is now being produced. It can be applied with a brush like paint, and dries very quickly, taking the form of a durable, elastic, vulcanised rubber surface.

A Radio-telephone Service

A RADIO-telephone service between this country and Iceland is now in operation.

A New Railway Record

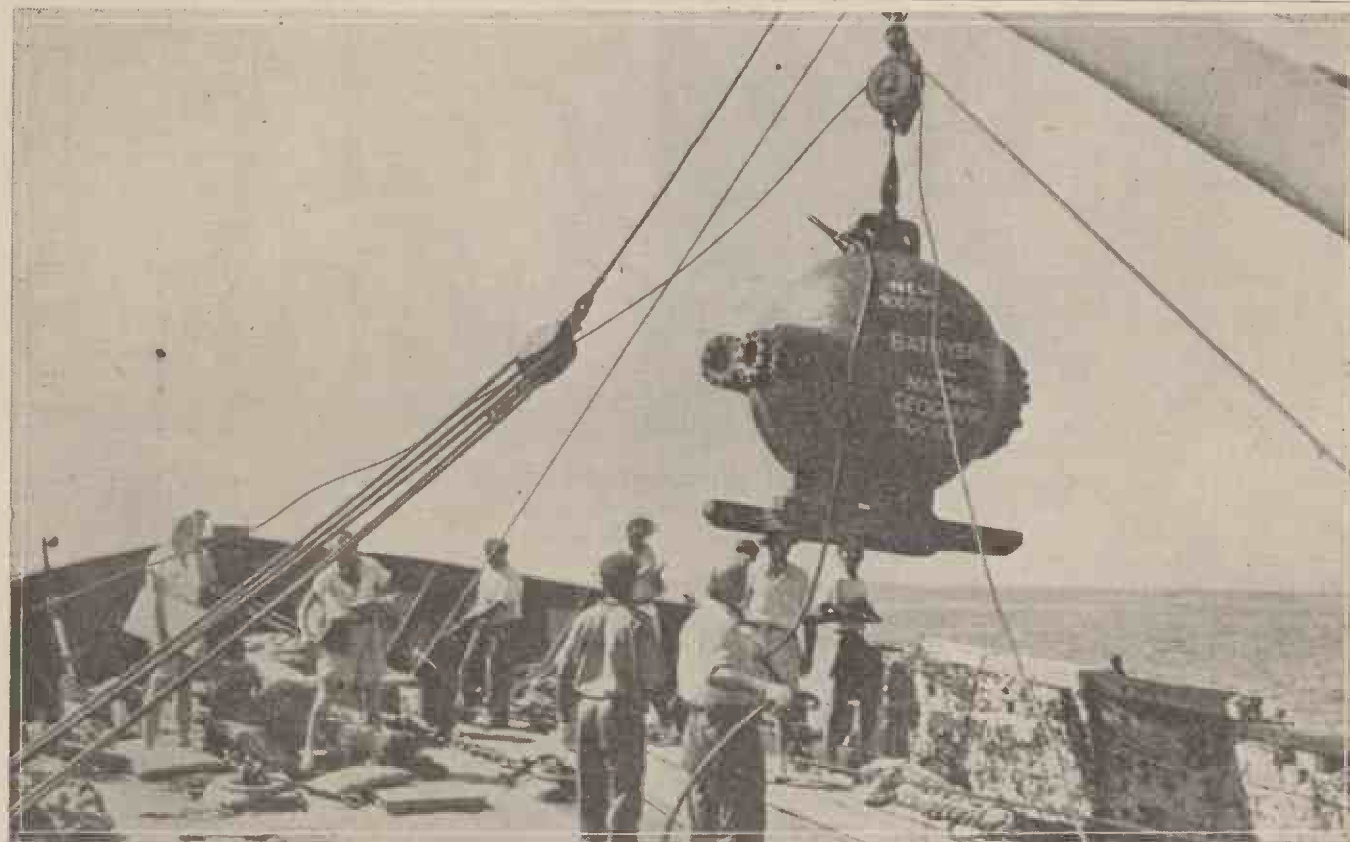
THE L.M.S. Railway have established a new record for the longest through engine-working in Britain, with a locomotive of the Royal Scot type. The journey was from London to Aberdeen and back—539 miles each way—and was accomplished in 36 hours.

Aerial Photography

A NEW camera, capable of photographing an area of 780 square miles at a height of 30,000 ft., has been produced in the United States.

Wired Wireless

A NEW type of cable, which will carry 200 different telephone conversations, is to be laid between London and Birmingham. It consists of a long continuous tube with a single wire inside. A Post Office invention, it adopts the principle of wireless by superimposing frequencies upon the wire. It is a system of carrier waves that can be called wired wireless.



Workmen busily at work on the Bathysphere prior to lowering it into the sea.

DEEP-SEA EXPLORATION IN THE BATHYSPHERE

Interesting Facts Regarding Dr. Beebe's Ingenious Device for Exploring the Bed of the Ocean.

SCIENTIFIC knowledge not infrequently advances in opposite directions by almost simultaneous stages, but, allowing for the absence of any connection, it is of interest to note that the pioneer balloon flights into the stratosphere and the attainment of new height records by Professor Picard, of Belgium, in the course of his cosmic-ray researches, have taken place during almost the same period as has occupied Dr. William Beebe, in his deep-sea explorations, off the Bermuda Islands, during the course of which he has descended to a depth of more than 3,000 ft. below the surface. But if the objects of each enterprise were different, much of the methods and apparatus employed by each are dissimilar only in degree; both employed hermetically-sealed gondolas, both employed oxygen apparatus for breathing purposes, but while Professor Picard's balloon was free to drift in whatever direction the wind decided, Dr. Beebe had the advantage of being securely attached to his depot ship.

Dr. William Beebe making the last turn of the main bolt of his Bathysphere immediately after being hauled up 2,000 ft. from the bottom of the sea

Study of Marine Life

The object of Dr. Beebe's explorations was the study of marine life in the depths of the ocean, and the fact that he descended to depths far greater than any previously attained, was only an incidental factor. His experiments, however, necessitated the construction of a very special chamber to withstand the enormous pressures encountered at such depths.

It is impossible to study deep-sea life by means of trawling nets, which raise their captures to the surface, because the reduction of the pressure from nearly three-quarters of a ton per square inch at a depth of 3,000 ft., to a pressure of only 15 lb. per square inch at the surface, nearly always results in the death and frequent destruction of any specimen which is brought to the surface. The construction of a suitable chamber, however, to withstand such pressures is not an easy matter. It must obviously have a water-tight door through which the observers and their apparatus may enter, and it must also have transparent windows.

For various reasons, glass cannot be used for the windows. It would require to be not less than 4 in. thick, and its transparency would be very poor. The only suitable material is fused quartz, optically ground to a thickness of 3 in.

The diving chamber, or Bathysphere, as it has been termed, is a cast-iron hollow ball nearly six feet in diameter and weighing more than two tons. It is fitted with a strong circular door, which covers an entry port only 14 in. in diameter, and in order that no possible leaks can occur under the terrific pressure of sea water, the door has to be clamped down by ten strong steel bolts.

A Test Dive

On one occasion, Dr. Beebe was conducting a rehearsal of a dive to test the organisation and apparatus and, as it was not intended to go to any depth, only four of the ten bolts over the door were screwed down. The Bathysphere, however, had scarcely been launched over the side and into the water when a frantic signal to ascend was sent up. At a depth of only a few feet, a leak had occurred around the edges of the door, thus showing how necessary it is never for one moment to relax precautions.

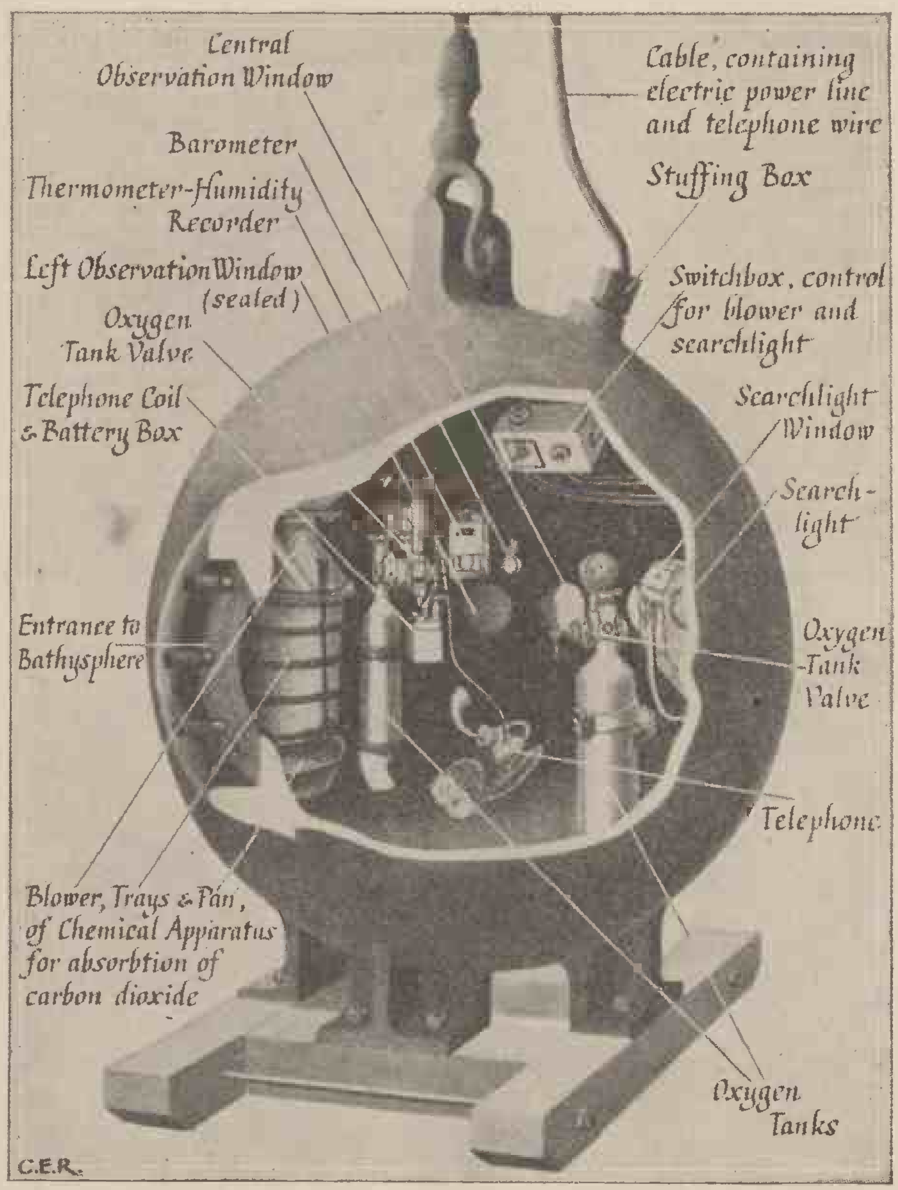
Opposite the entrance port, the Bathysphere is fitted with three observation windows of fused quartz through which it is possible to direct a 1,500-candle-power searchlight, and to take photographs of deep-sea life. One of the windows was nearly the cause of a serious accident on one occasion; a new quartz window had been fitted, and, in order to make sure that all was well, the Bathysphere was lowered over the side to a great depth and left suspended for some time before hauling it up. As soon as it was clear of the water, it became obvious that it was weighing far more than it should and closer inspection through the windows showed that it was more than half full of water! Somewhat gingerly, the centre bolt of the door was gradually unscrewed, and as it loosened, a fine jet of water shot out with terrific velocity, accompanied by a high-pitched singing noise. As the bolt was slacked off, the jet of water grew in volume and, soaked in spray and realising what might happen, Dr. Beebe ordered all hands away from the possible line of fire when the last turn of the bolt was reached. Suddenly, the massive bolt was wrenched from his hands and shot thirty feet across the deck, half wrecking a massive winch on the way! The bolt was followed by a solid jet of water which slackened after a while as the tremendous pressure inside was released, but it was clear that had Dr. Beebe not taken careful precautions, he might easily have been decapitated. Examination afterwards showed that the quartz windows were still in perfect condition, but the packing around the edges had leaked and permitted the inside to fill with water under tremendous pressure.

The Risks of Deep-sea Diving

Fortunately, no serious accidents have ever occurred, but when one considers the possible dangers and accidents which might occur, the risks of deep-sea exploration appear just as great as those undertaken by any aeronautical pioneer. A breakdown of the oxygen equipment, for example, would almost certainly have fatal results, for although death would not be immediate, it is probable that the failure of the oxygen supply would pass unnoticed in the general excitement and interest of the dive. Unconsciousness develops suddenly with shortage of oxygen, no warning or discomfort being experienced, and death by suffocation would quickly follow unless those on the boat above became alarmed by the silence of the observers and could raise and unfasten the Bathysphere before death could intervene.

supply of oxygen compensates for the removal of the carbon dioxide, an ordinary barometer is carried to ensure that the internal pressure remains roughly constant.

Dr. Beebe's explorations have all taken place within a small area roughly eight miles south-east of Bermuda, in the Gulf of Mexico—a spot where the ocean is more than one mile deep, and although the work has been in progress for some years, it was only during August of last year that dives to a depth of half a mile were attempted. Diving can only be conducted in the smoothest of seas, for otherwise the strain on the hawsers, supporting a total weight of over four tons, might well prove disastrous.



A cut-away view of the Bathysphere showing the apparatus for supplying the oxygen, also the telephone searchlight, etc.

In the confined space of the interior, it is impossible to use a continual supply of oxygen without simultaneously removing some of the carbon dioxide from the air, as otherwise the internal pressure would rise to dangerous limits. In order to remove the carbon dioxide, a special chemical apparatus is employed, which incorporates an electric fan. The air is circulated by the fan over a series of trays which contain soda lime and calcium chloride, for the absorption of carbon dioxide and moisture respectively, and in order to ensure that the

A Dive of 3,000 ft.

It was on August 7th, 1934, that the first test dive to a depth of 3,000 ft. was accomplished. Leaving harbour about 6 a.m. embarked on their steamer, the *Ready*, Dr. Beebe and his colleague, Mr. Otis Barton, with their staff, prepared to lower the Bathysphere on its test dive. All the instruments had been removed except a temperature recorder; the door was closed, and after being gently raised from the deck, the Bathysphere was lowered over the side on its long descent. The descent was accomplished in little over an hour, and two hours later the Bathysphere was safe again on deck. Examination showed that the test had been perfectly satisfactory—not a drop of water had leaked in and the temperature chart showed a temperature of 50° F. at the lowest depth.

Four days later, on August 11th, Dr. Beebe himself decided to descend. The preliminary operations for a "live" descent take a considerable time, and all the apparatus must be checked and the oxygen gear tested. The explorers themselves must wriggle their way uncomfortably over the sharp steel bolts which line the narrow door, and they must then patiently wait while those outside fasten them securely in. At last everything is complete and they are hoisted up and gently lowered over the side and into the water.

The first sensation as the Bathysphere descends beneath the waves is the sudden change from a world illuminated by golden yellow sunshine to a world in which all light is green—from a world in which light and shade alternate according to the sun to a world in which the light never varies except to get darker as the descent proceeds.

Only a few feet beneath the surface, the descent has to be stopped while the cable is swung in towards the ships side. This is necessary because besides the hoisting cable, there is a second cable, heavily coated in rubber, which carries the power supply for the searchlight and also the telephone wires, and this second cable has to be attached at frequent intervals to the hoisting cable to prevent it from being damaged or torn apart by its own weight.

Deep-sea Life

At a depth of 200 ft. the water appears to be a blue-green, and innumerable small fry, copepods, and others may be clearly seen. Between 300 ft. and 500 ft. a whole host of so-called tropical surface fish are seen: siphonophores, yellow-tails, and blue-banded jacks.

By the time a depth of 600 ft. is reached the light seems a dark, but faintly luminous blue, and green has totally disappeared. Gone, too, are all forms of plant life which appear not to be able to withstand the increased pressure at these depths. The light at this depth is a difficult one for observations; the power of the sun has not quite gone, and yet the light from the searchlight seems of little use—rather like that period of late dusk when it is too dark to drive a car without lights, yet when one's headlights are of little assistance.

By the time a depth of 1,000 ft. is reached, very little daylight penetrates, and luminous fish become more and more common, many of them of the most beautiful and most fantastic forms. Photography cannot at present record any of the beauty of deep-sea life because it is incapable of recording all the glorious and self-luminous colouring and all the phosphorescent sparkle with which this life abounds.

Except on rare occasions a specimen never remains stationary within the field of view and only too often it is found that by the time the eyes have accommodated and focused on the object, it has passed from view. The only satisfactory means of recording the form and colouring of the specimens is to make lightning sketches of size and shape and, simultaneously, to dictate an accurate description of colouring and other details to a trained stenographer on the boat above. The notes thus made enable reasonably accurate sketches and paintings to be made, but it is of course essential that the task of transcribing the notes into drawings and paintings should be accomplished while the impressions are still fresh in the minds of the observers.

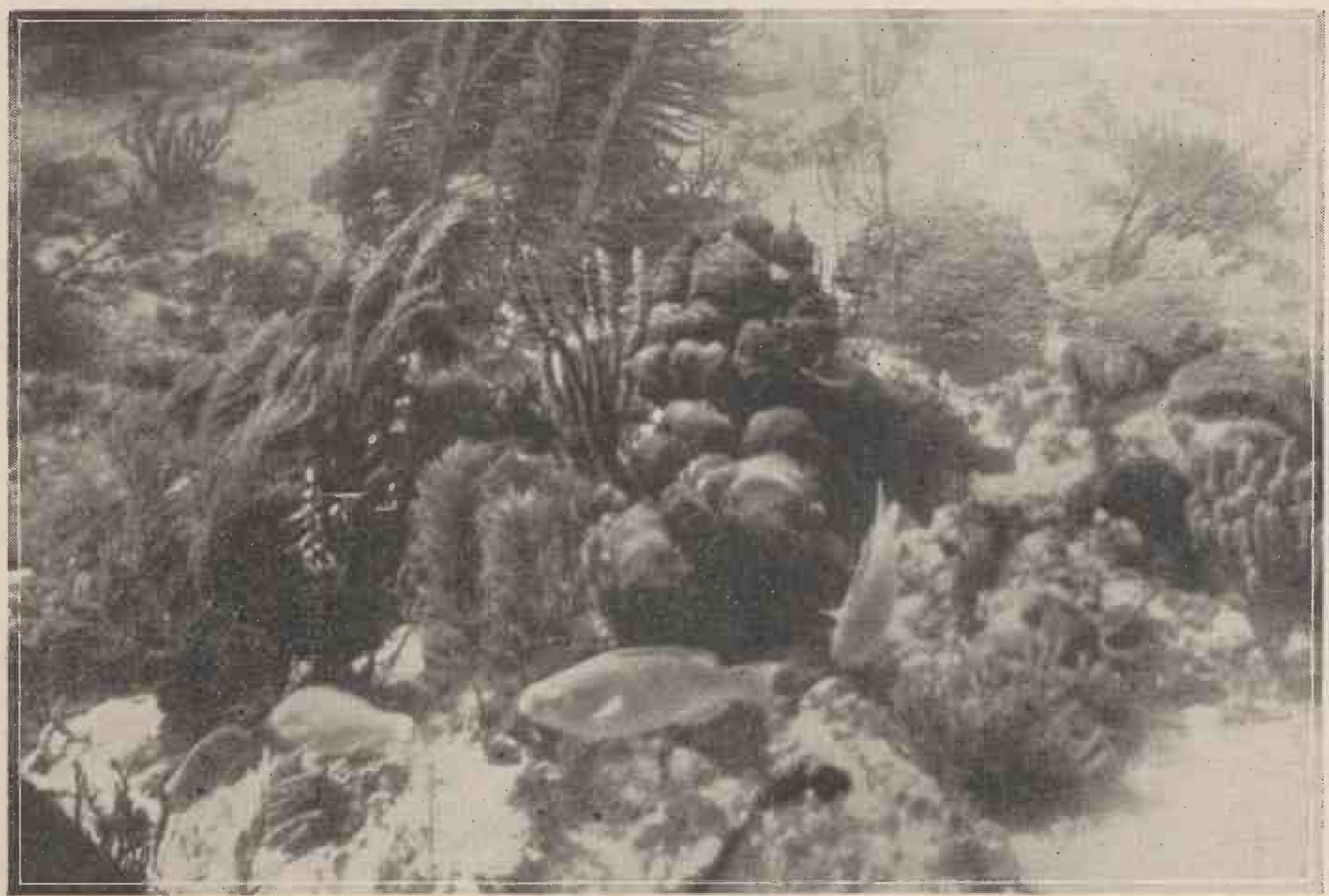
Queer Fish

At a depth of 1,500 ft. the observers have the delight of observing a fish hitherto unknown to science. About two feet in length, it appears entirely non-luminous and of an unpleasant buff appearance as it swims gradually through the beam of light. It possesses exceedingly large vertical fins and a very small tail, a small eye, and what appears to be a toothless mouth.

Below a depth of 2,000 ft. no light from above ever penetrates. The world above is gone entirely and an absolute blackness which defies description reigns throughout, only relieved by the flashing lights of luminous fish.

The descent is continued to a depth of 2,510 ft., at which level the Bathysphere remains for more than half an hour, sketches being made and descriptions telephoned to the surface all the while. As the ascent is commenced, a further important discovery is made—a fish of oval shape, perhaps six inches in length, with three slender tentacles each tipped with a brightly luminous bud which protrude like tiny masts from the back behind the eyes. The fish only remains in sight for less than two seconds, but the impression made upon the observers is so vivid that an accurate description is possible.

(*Continued on page* 556)



A clever under-sea picture, showing the beauty of the ocean bed.

France has followed in the footsteps of Great Britain and America with her adoption of the wind tunnel. The photograph shows the new French wind tunnel for testing aeroplanes.

Testing Aircraft in Wind Tunnels

By Means of the Tunnel Which Forms the Subject of This Article a Jet of Air may be Fanned to a Speed of 115 m.p.h. by a 30-ft. Fan-collector Driven by a 2,000-h.p. Electric Motor. It is Capable of Testing Aircraft 8,000 lb. in Weight.

SINCE very early days the development of the aeroplane has been greatly assisted by the testing of small-scale models in a stream of air; indeed, it is probable that in no other branch of engineering has the study of the behaviour of models played such an important part as in aeronautical engineering. During recent years, however, it has become increasingly evident that certain data obtained from small-scale models may not be applicable with sufficient accuracy to the detail design of the full-size aeroplane and may, at times, even be misleading. Full-scale experiments on actual aeroplanes in flight are laborious and costly, and there are inherent difficulties in controlling the conditions and analysing the results of such tests. It is for these reasons that it has been considered that a wind tunnel, in which tests on an actual aeroplane or parts of an actual aeroplane can be made, is a vital item of equipment for the furtherance of aeronautical research and development. Tunnels of this nature have already been erected, and are in operation in Great Britain and America, are being built in several European countries.

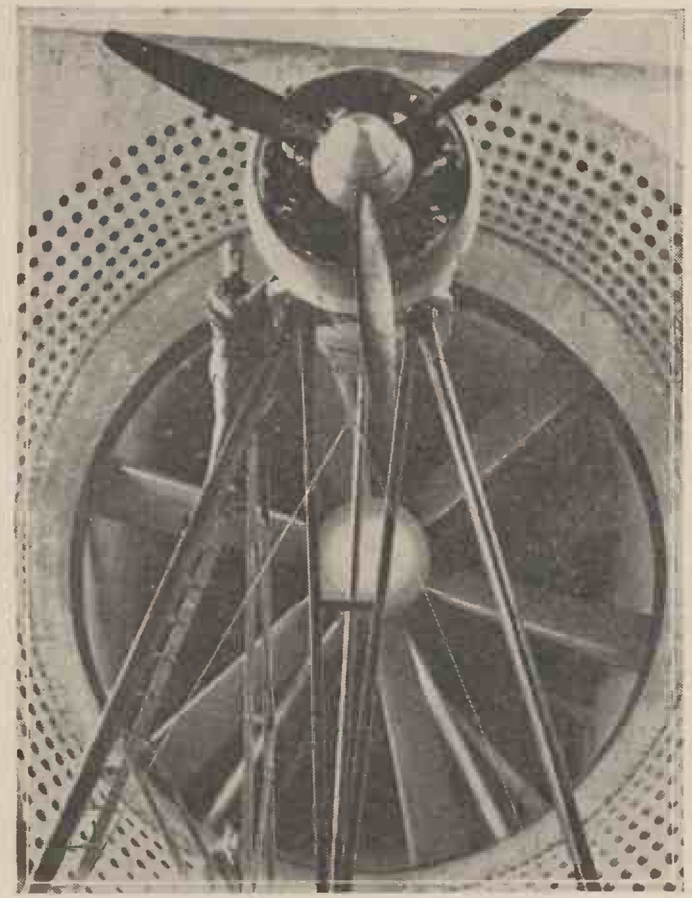
The New R.A.F. Wind Tunnel

The building is of steel and ferro-concrete construction. The tunnel itself is an open-jet return circuit type: that is to say, air is drawn from the nozzle across the working section and into a collector and thence through the return passage back to the nozzle. A 30-ft. fan in the collector is used to force the air through the circuit. The rotary motion of the air caused by the fan is taken out of the airstream by a system of straighteners behind the airscrew, and the air is assisted round the corners of the return passage by a series of guide vanes designed to reduce to a minimum the loss of energy in the air stream. The diameter of the working jet is 24 ft.; during preliminary discussions on the design it was decided that a large proportion of the more important problems could be solved if the working section were large enough to contain the centre section, airscrew, and fuselage, and that a jet 24 ft. in diameter was large enough for the experiments contemplated. The tunnel is capable of dealing with aircraft of up to 56 ft. in span and 8,000 lb. in weight.

The Layout

The layout has been designed so that the aeroplanes to be tested, with all the necessary apparatus, can be transferred to and from the testing section with little loss of time. A balance to measure the forces on the aeroplane when in the airstream is installed beneath the jet, and in the adjacent erecting shed two aeroplanes can be prepared for tests. The crane system allows either aeroplane to be transferred rapidly to the balance. Aeroplanes can be tested with their airscrews driven by their actual engines, and in order to measure the power supplied by the engine during the tests, a special dynamometer hub has been designed, fitting between airscrew and engine. When aeroplanes are tested with engines running, the exhaust discharges into the airstream and a special ventilating system has been installed to change the air continuously, and prevent the concentration of exhaust gas rising to a dangerous value.

Full-scale tests in the tunnel include such investigations as cleanness of design of the entire centre portion of the aircraft,



An engine ready for testing in the wind tunnel described in the text. The photograph also shows the huge 2,000-h.p. electric motor turning a 250-revolution fan to drive the wind at 115 m.p.h. on to the engine.

effect on performance of possible improvements, and alternative detail arrangements, drag and cooling of air-cooled engines, tests of radiator systems, and schemes to improve the comfort of the crew. Besides tests on actual aeroplanes, provision has been made for testing large-scale models up to about 18-ft. span. For model testing, two overhead cars are provided to which are attached balances. The cars are housed in the portion of the building above the test section, and the models are prepared and fitted to the balances in special erecting bays. The models can then be lowered by an electrically-operated lift into the jet for the measurements.

Equipment

The balances mentioned above for measuring the forces on the aeroplane or model under test, use a form of parallel-motion linkage, whereby simultaneous readings of lift and drag are obtained; the final portion of each measurement is self-indicating.

The tunnel fan is driven by a 2,000-h.p. direct-current electric motor, housed in a motor room at one end of the tunnel. The maximum speed of the air jet is approximately 115 m.p.h.; the speed is controlled automatically.

Torque Dynamometer

In many experiments in the large tunnel, it is necessary to know accurately the power absorbed by the airscrew. The corresponding problem in marine engineering of ascertaining the power absorbed by the propeller, is solved by measuring by an electrical method the very small twist in the propeller shaft when it is transmitting power. In the aircraft engine the problem is a more difficult one, principally because there are only very short lengths of shaft available. Many attempts have been made in the past, in this and other countries, to devise light and compact apparatus which would enable the power to be measured, but the necessary accuracy has not hitherto been achieved.

The apparatus in the small tunnel building, which was developed in collaboration with the Admiralty Research Laboratory, appears to have solved the problem. The length of flexible shaft of marine practice is now replaced by a steel wheel having flexible spokes through which the drive is transmitted.

5-ft. Open-jet Tunnel

This tunnel is approximately a ½ scale model of the large wind tunnel, although with its relatively high-powered motor a much higher wind speed can be obtained. The tunnel is of particular interest because it is probably the first open-jet tunnel in this country of the single-flow return type. The 500-h.p. motor enables wind speeds up to 218 m.p.h. to be obtained, and the tunnel is devoted to work where especially high speeds are required. Investigations into wing-flutter problems, and experiments with high-tip-speed airscrews are two typical examples of the work dealt with in the tunnel.

Sphere Turbulence Indicator

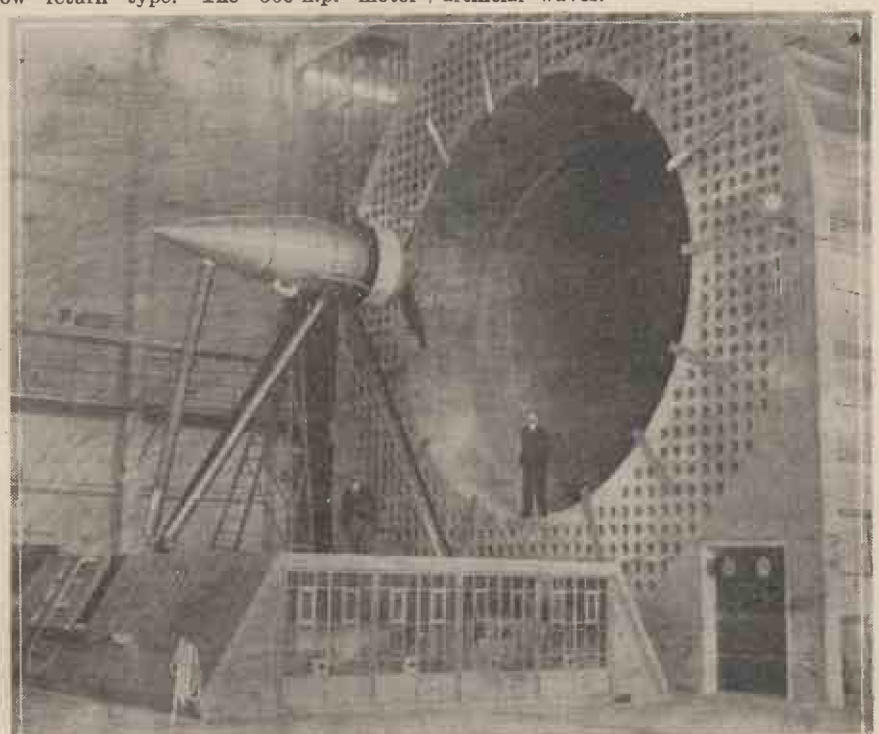
When air flows over a body the forces it exerts are partly dependent on the turbulence of the airstream. An estimate of the degree of turbulence can be obtained by observing how the drag of a sphere varies with speed. In the present apparatus, the drag of the sphere is opposed by the drag of a disc through a simple lever system, and the speed at which the two drags balance gives an indication of the turbulence.

High-speed Airscrew Test Apparatus

There is a serious reduction in the efficiency of an airscrew as the tip speed approaches the velocity of sound (1,120 ft./sec. at sea-level). Wind tunnel experiments have shown that this loss is minimised if thin, low-camber, aerofoil sections are used. A further series of experiments on coarser-pitch airscrews is to be made which will give results applicable to high-speed aircraft. The apparatus is designed to measure thrust and torque, and a fan is used to recover the slipstream energy and so minimise the power required.

The Froude Tank for Seaplanes

Seaplanes are also tested by means of a special tank. The waterway is 650 ft. square and deep enough to test models 9 ft. long. The carriage can travel at 40 ft./sec., so that model seaplanes can be tested up to take-off speed. The carriage accelerates, maintains any selected speed, and brakes itself automatically. Wave suppressors are fitted so that the waves caused by towing the model are quickly damped out, enabling runs to be made in rapid succession; they are folded up when tests in waves are required. A mechanical device is fitted for making artificial waves.



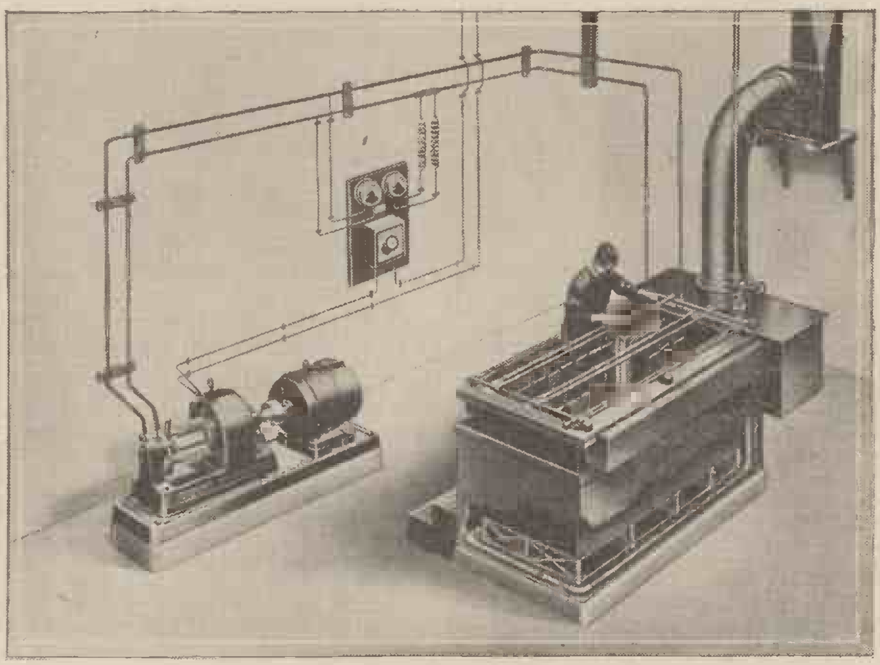
An aeroplane engine placed on the balance in the wind tunnel ready for testing.

Electro-Plating at Home

Sufficient Practical Details are Given Below to Enable any Amateur to Experiment with Electro-Plating and to Produce Results Equally as Efficient as Commercial Work

THE science of electro-deposition is almost as old as the discovery, in 1800, of the electric battery itself. In fact the metals sodium and potassium were first isolated by Davy in 1805 by electrolysis of their molten salts, and these metals, together with many others, are obtained exclusively by this type of process to-day. Electro-deposition soon became of considerable scientific interest, but commercial electro-plating may be said to have begun in 1838, when an Englishman named Elkington took out the first patent.

Electro-plating on a small scale is a very simple process which can be carried out by any amateur. A solution of some salt of the metal which it is desired to deposit is placed in a suitably shaped container, across the top of which is placed a pair or sometimes three metal rods. From one of these rods the article to be plated is suspended by means of a piece of wire, while a plate of the same metal as that in the solution is suspended from the other. If an electric battery is then connected to the two rods, so that the positive terminal is connected to the plate and the negative to the article to be plated, then the chemical action caused by the passage of the current through the solution deposits a coating of the metal on the article.



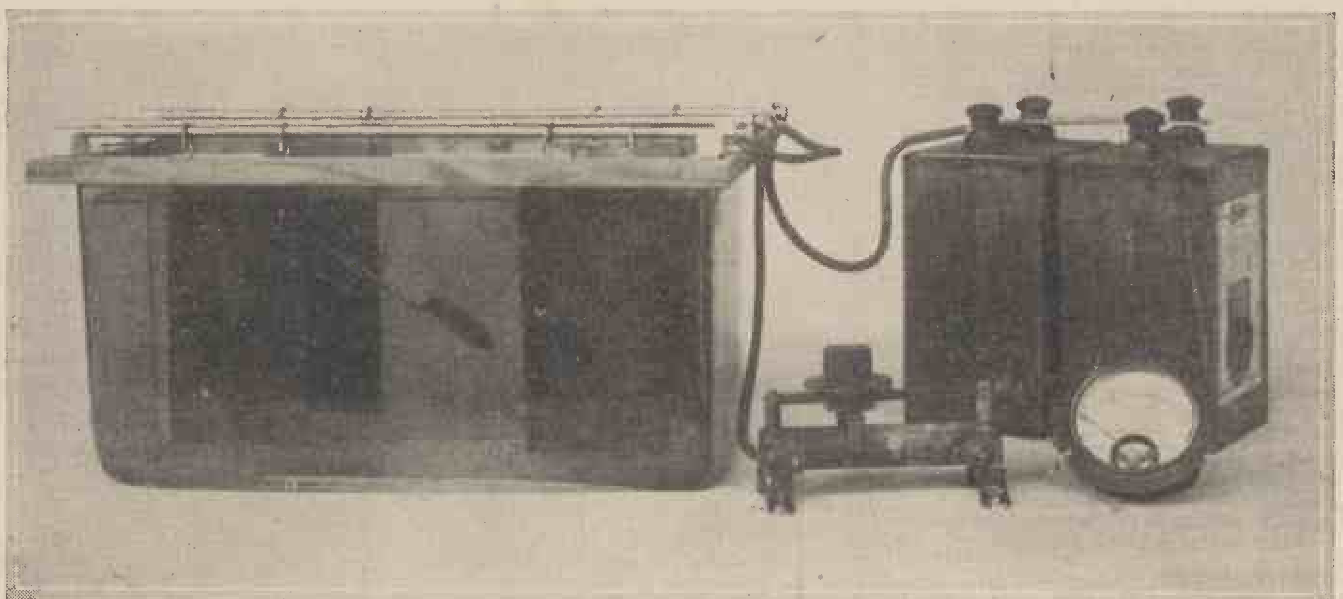
A small commercial chromium-plating plant.

Copper-plating a Spoon

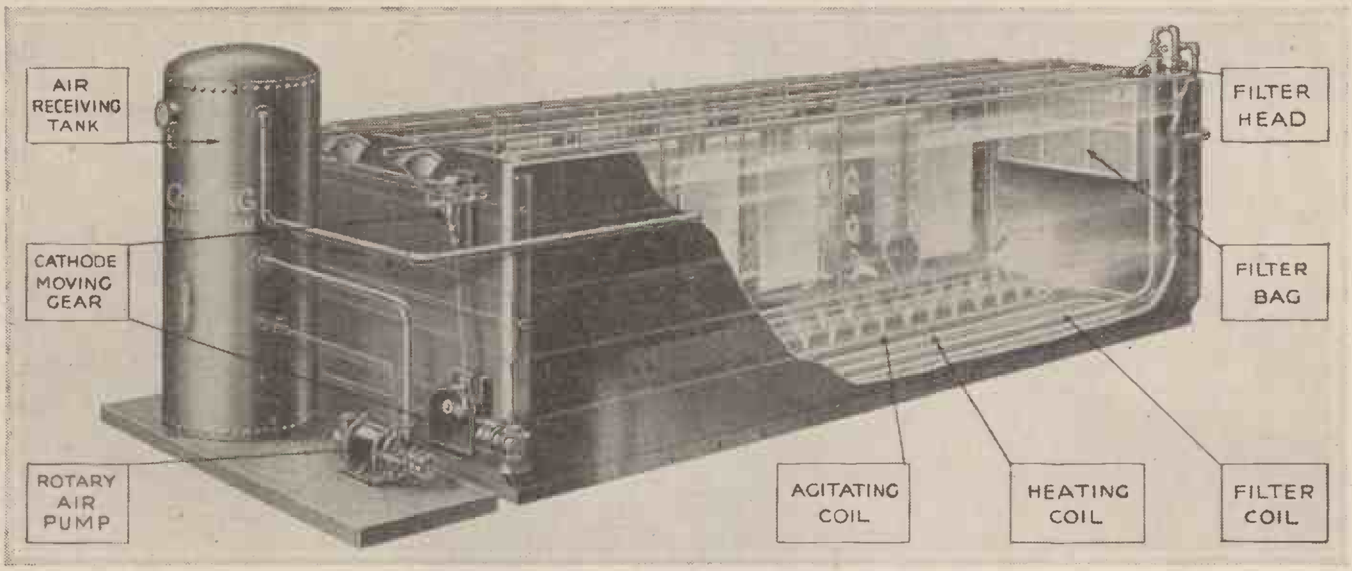
As an experiment, let it be supposed that it is desired to copper-plate an old spoon. Make up a solution of copper sulphate in the proportion of 1 lb. of sulphate to half a gallon of water. Add 4 ozs. of sulphuric acid to the solution, and suspend the spoon from the negative rod. A small plate of copper must then be suspended from the other rod and a 4-volt battery connected.

The passage of the current through the solution breaks up the copper sulphate into pure copper and sulphuric acid and deposits the copper on the spoon which, within a few minutes, becomes coated with a "blush" of copper. The coating of copper becomes thicker and thicker as long as the current is permitted to flow.

The sulphuric acid which is formed by the decomposition of the copper sulphate attacks the copper plate and combines with it to form fresh copper sulphate. In this manner the composition of the solution remains unaltered throughout the process, but, of course, the copper plate is gradually eaten away.



Details of the apparatus used for electro-plating by the amateur in his own home.



A sectional view of a commercial electro-plating vat and associated equipment.

It is not in the least necessary that the copper plate, or " anode " as it is termed, should be pure copper, because any impurities will be precipitated to the bottom of the solution as sludge, only pure copper being deposited on the spoon.

In order to deposit nickel on the spoon, we should require to use a nickel solution and a nickel anode; to deposit silver we should use a silver salt and a silver anode, and so on.

Cleaning Process

It is very important that the object to be plated should be thoroughly cleaned before the plating process, as otherwise the plating will not be durable, and will not adhere firmly. Cleanliness in the ordinary domestic sense is not sufficient—the article must be absolutely and chemically clean. Some idea of the care required in cleaning may be gained from the fact that if the article is touched by hand before plating, the coating will not adhere to those parts which have been touched.

Commercial electro-plating is a more complicated process than the simple one outlined above, although the principle is identical. The process is complicated by the number of cleaning and washing baths through which the article must pass if the plating is to be a sound and satisfactory job.

First of all, the article must be mechanically cleaned, either by emery or by sandblasting. It is then cleaned by immersion in various acid or alkaline solutions according to the particular metal.

If the article is required to have a highly polished surface after plating, it must be highly polished before any attempt is made to plate it, because it is most difficult to get a really good finish if the plating is done on an unpolished base, and if the polishing is left until afterwards. An amateur will have to prepare and polish the article by hand, but commercially the polishing is accomplished by holding the article against a rapidly revolving buff, made of many thicknesses of cotton cloth. The buffs receive frequent applications of polishing compositions, which generally consist of a thick grease mixed with Tripoli, emery, or rouge, according to the nature of the metals and the degree of polish required.

Removing Grease

In order to remove any grease on the surface the article passes through a hot potash bath which is worked at about 200° F. This bath converts any animal or vegetable fats which may be on the surface into soap which rises to the surface. After being washed in cold water, the article is ready for the next bath, the constitution of which depends on the plating process to be used.

Nickel-plating is probably the most important commercial process, and to illustrate the general practice of commercial electro-plating, the nickel process will be described in detail.

Where the quantity of plating to be carried out is small, the articles are usually transferred from one bath to the other by hand, but where a very large number of similar objects require to be plated, as is usually the case in a commercial works, then large automatic machines are used to facilitate mass production. The automatic plant has the advantage that all operations are correctly carried out with consequent uniformity in the thickness of the deposit and improved quality of plating.

The various vats are generally placed in line, one behind the other in their proper sequence. Conveyor chains are arranged to move slowly along the line of vats, the articles to be plated being suspended from cross rods.

The suspended articles pass successively through all the preparatory cleaning and swilling vats before entering the plating vat, and they are then finally washed after plating.

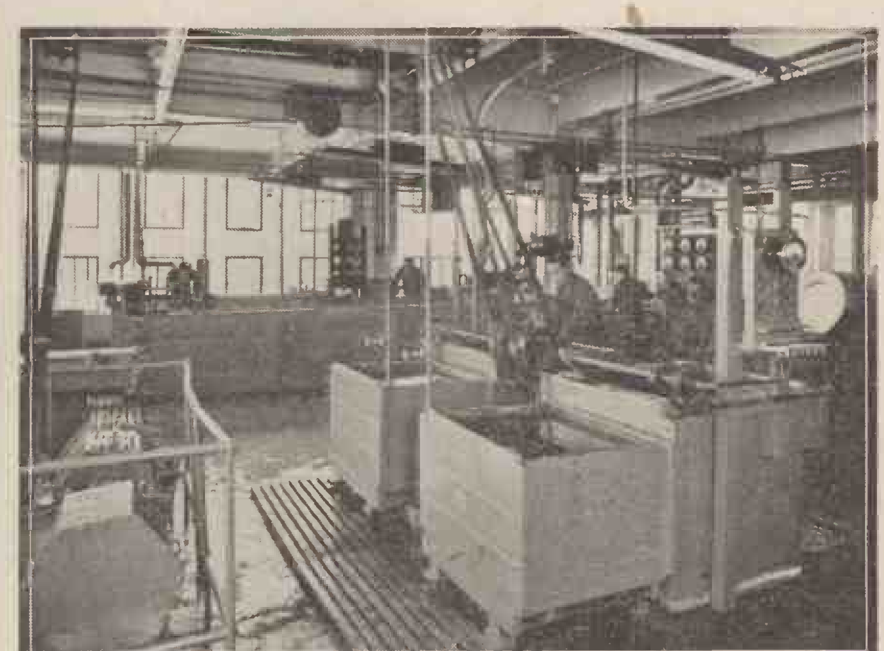
At the end of each vat, the articles are lifted automatically by an auxiliary chain, carried forward, and deposited again in the next vat. The various vats are designed to allow the articles to remain in a particular vat for a predetermined time, which cannot be altered without altering the plant.

The Various Processes

A commercial nickel-plating plant comprises the following processes:

Vat No. 1.—*Degreasing.* After the articles have been mechanically cleaned and

(*Continued on page* 579.)



A view of a plating shop where the parts of vacuum cleaners are plated.

MAKING AN AIR PUMP

Converting a Small Motor-cycle Engine to perform the Duty of an Air Compresser for Tyre Inflation and Paint Spraying

By S. J. GARRATT

A SMALL motor-cycle engine can be converted to perform the duty of an air compresser for tyre inflation and paint spraying without extensive alteration, and either a two-stroke or four-stroke engine may be used. The exact details of modification will naturally depend upon the engine available in the first case, and this article must therefore be regarded as a general guide, which may require reconsideration in some cases.

In general, however, the smallest available engine should be chosen, and, as in many cases such an engine may be reclaimed from scrap, care should be taken to see that the main working parts, that is to say the crankshaft, connecting rod, cylinder, piston, the main bearings, and both connecting rod bearings, are all in good condition. The valve gear does not matter as it is to be removed. If it is found necessary to rebore the cylinder, a new piston should be obtained which reduces the compression space as far as possible.

Reducing Compression Space

In any case, it is important to adopt some method of reducing the compression space, such as turning down the cylinder flange, or the cylinder head joint, or else bolting a block of aluminium on to the top of the piston. The compresser will probably give useful results if the compression ratio of the engine is about 5 to 1 without such alteration, but it will be more efficient if it is altered.

Piston rings should be examined and renewed if necessary, as, although their duties will not be as heavy as when used in an engine, they may be a source of serious leakage if not in good order.

Having overhauled the main parts of the pump, attention may be given to the valves. All the gear may be discarded entirely, including timing gears, cams, and tappets, but the valves themselves must be retained. The exhaust valve should be ground in and fitted in the usual manner; it is not to be used as a valve, but is the most convenient means of stopping up the exhaust port.

The inlet valve should also be fitted in the ordinary manner, but with a much lighter spring than usual, so that it can be lifted from its seat by a light pressure of the finger. If it opens with a pressure of about 6 oz., it will probably work all right, and in any case springs of various strengths can be tried when the job is running.

In the case of a petrol engine, nothing need be done beyond altering the compression ratio, if it is possible to do so without altering the port timing, and stopping up the transfer passage, as explained later.

A Delivery Valve

The compresser will require a delivery valve, and it will be better to make a special fitment for this instead of trying to make use of the engine valves. The illustration (Fig. 2) shows a suitable design for this valve, which is intended to be screwed into the sparking-plug hole. It is a straightforward job for a metal turner; the body should be made of mild steel, and the "banjo union" of brass or gunmetal. The ball itself should be of stainless steel if obtainable, or else of phosphor bronze, though an ordinary bearing ball would probably give quite good service.

The spring should be fairly light—just enough to make the valve return smartly on to its seat.

Only the main dimensions are given, because it may be necessary in some cases to modify the arrangement to clear other parts of the engine. One point to watch when making the body is to see that the radial holes come immediately above the valve seat without breaking into the seat, and that the outer ends open clearly into the recess of the "banjo" ring.

After completing the compresser there is the question of drive to be considered. An electric motor—when power is available—is by far the most convenient, and it is best to have one of about ¼ h.p., which should suit most circumstances. It should be borne in mind that the power required does not depend only on the size of the pump, but the load is largely dependent upon the volume of air delivered.

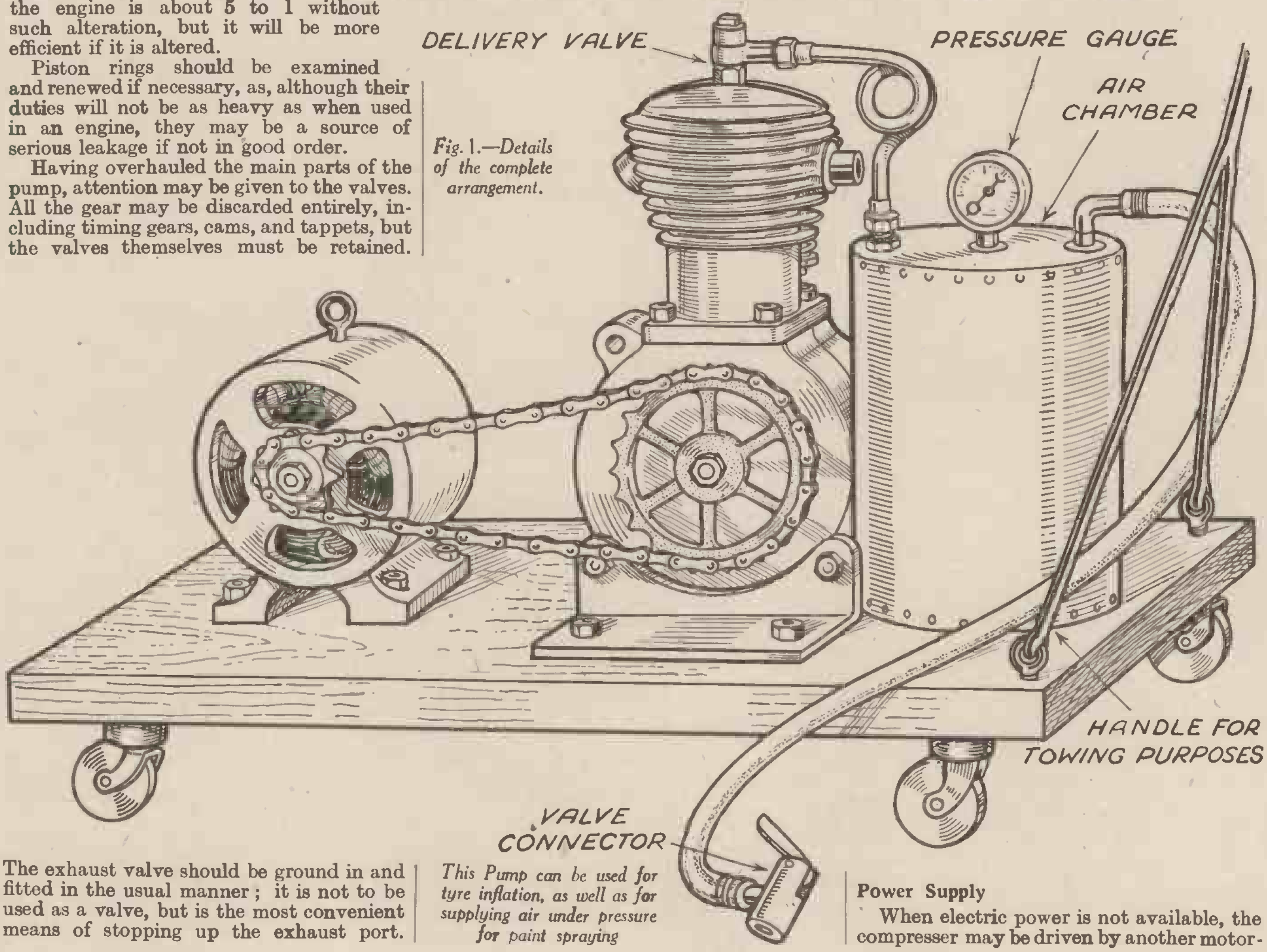


Fig. 1.—Details of the complete arrangement.

This Pump can be used for tyre inflation, as well as for supplying air under pressure for paint spraying

Power Supply

When electric power is not available, the compresser may be driven by another motor-cycle engine, both being arranged on a stout wooden base on small wheels—preferably with caster action—and a handle to pull the whole outfit about. A similar arrangement can also be adopted for an electric drive (see Fig. 1), but in this case a long flexible electric lead would be required.

In either case, the motor, whether petrol or electric, should not be directly coupled to the compresser, but a chain or belt drive with a reduction ratio of about 4 or 5 to 1 should be used, so that the compresser runs at a slower speed than the motor.

An Air-Pressure Chamber

It is advisable to arrange an air-pressure chamber on the delivery pipe to even out the intermittent delivery from the compresser. A small, stout cylindrical tank, say 9 in. long and about 6 in. diameter, would be suitable. It should be about $\frac{1}{16}$ in. thick and well riveted together, an ordinary soldered tin can would probably burst sooner or later. This chamber could conveniently be arranged on the same baseboard and fitted with a pressure gauge. The delivery from the pump is connected to the air chamber, while a flexible tube of suitable length leads from another connection in the air chamber to the tyre valve. This flexible connection should be about $\frac{1}{4}$-in. bore and capable of standing pressures up to, say, 50 lb. per square inch for ordinary touring cars, or 100 lb. per square inch for lorries, etc.

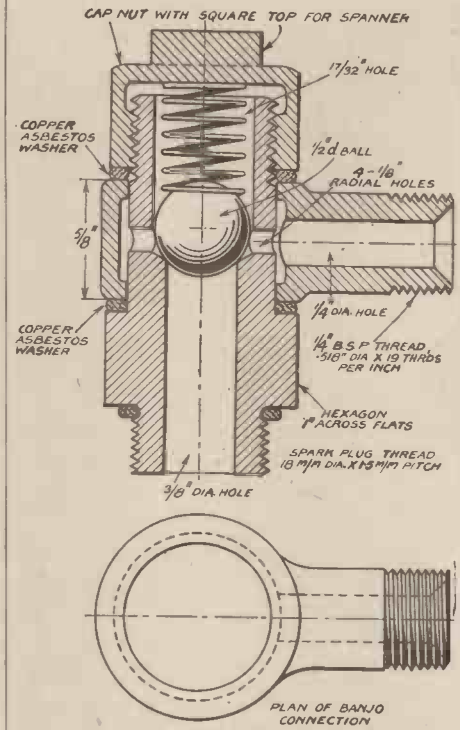


Fig. 2.—A suitable design for the delivery valve.

For High Pressures

If the unit is to be used for high pressures, such as are used on large lorry tyres, particular attention should be paid to reducing the compression space in the compressor cylinder, and it will be advisable to use a greater reduction on the drive, say 8 to 1 or 10 to 1. In any case, the flywheel should be retained on the compresser.

The lubrication of the compresser must not be overlooked, but provided that a small quantity of oil is kept in the crank chamber, no elaborate lubrication system is necessary. Care should be taken, however, to see that the piston rings are in good condition so that oil does not get by, otherwise it might get into the tyre, with detrimental results. In the case of a two-stroke engine, the crank chamber should be sealed off by stopping up the connection to the transfer port, an air inlet being provided by drilling as many holes as possible in the outer walls of the transfer port, so that air can be drawn direct into the cylinder instead of *via* the crankcase; the latter can then be used for lubrication on the " splash " principle.

Some Facts about Synthetic Products

How Coal is Obtained from Cabbages, Sugar from Sawdust, and Cotton from Banana Stalks

EVERY day the scientists are "going one better" than Nature, with the result that synthetic products, whose place of origin has been the laboratory or workshop, are superseding the natural products on which, previously, we have relied.

Take silk, for example. In the old days silk was produced by silkworms. It was a slow and elaborate business of producing a fabric, and thus it was expensive. Then along came the scientists and found that they could produce silk synthetically and much more cheaply. Artificial silk is now produced in vast quantities, and millions of people all over the world would never have been able to wear silky clothes if we had had to rely on the silkworm for our supplies.

Pearls were produced only from oysters. The pearl fishers had to await the pleasure of the oyster. Only a very small number of bivalves produced pearls, so that pearls were scarce and therefore expensive. Then the scientists had an idea. The pearl is a growth in the oyster, and it is formed by injecting an irritant which produces the pearl. As a result, cultured pearls are plentiful and cheap. Thousands of women can now wear pearls which would otherwise have been beyond their reach.

The Production of Coal

A short while ago a professor of Heidelberg University, Dr. Friedrich Bergius, announced that he had taken eleven pounds of cellulose, a chemical derived from cabbages and cornstalks, mixed it thoroughly with water and placed his solution in an air-tight vessel. Then he heated it to 640 deg. Fahr. He allowed this sealed cooking to continue for twenty-four hours, after which he shut off the terrific heat, let the accumulated gas escape from the vessel and waited for the liquid to solidify. Result: Eleven pounds of coal!

But Dr. Bergius had done much more than that. He had leaped across the chasm of the ages and in twenty-four hours produced a substance which it takes Nature 24 hundred centuries to create! In other fields of research, too, chemists are producing equally-remarkable results. Fuel oil and synthetic petrol are being obtained in large quantities from the soft coal of Germany, while in this country we are making ourselves independent of foreign motor fuel supplies by extracting it from shale, and even from the coal used in our gasworks.

This synthetic motor spirit is seen by many as the solution to possible emergencies if this country were cut off from foreign sources of the essential fuel for our motor vehicles. Already millions of gallons are being produced every year. Think of the deeper significance of this, and its effect upon international relations and the peace and prosperity of mankind. What the chemists in their laboratories have done is to take the germs of another world war, put them into a test tube and dissolve them out of existence. The conflict they have averted is the giant struggle for the diminishing supply of the world's natural petroleum, which the great Powers were supposed, by some observers, to be preparing.

Not only oil from coal and coal from oil, coal from cabbages, rubber from coal, but burnable gas from water, alcohol from coal, edible fats from coal and even the day of synthetic bacon may soon be upon us. These are all among the completed achievements or promising potentialities that scientists have added to the wonders of the modern chemical industry.

A Substitute for Cotton

A young Philippine scientist not long ago invented a substitute for cotton, which he produced from hitherto worthless banana stalks. The process, resembling mercerisation, consists of " cracking " off the cellulose binding of the fibre, which leaves it pure white and ready for weaving without anything to be spun.

In other fields a lemonade has been made out of peanut shells and bran. One of the details that await further perfection in this product is the name of the beverage. At present, for want of something shorter and prettier, it is " xylotrihydroxyglutaric acid." But what's in a name?

Not long ago two German chemists triumphantly informed the world that after years of fruitless attempts they had succeeded in making food out of wood, or to be specific, sugar out of sawdust. Other foods, too, are being created out of apparently useless products. Seaweed is being transmuted into edible foods, for which marvellous health-giving properties are claimed.

The chemist has not only inherited the cloak and improved upon the arts of the alchemist of medieval times, but he is the modern counterpart of the magician of the Dark Ages—the Merlin at the court of the Average Man.

The day is coming—has in fact arrived—when the chemist feeds us, clothes us, heats and lights our houses, and supplies essential fuel for machines that transport us and make our daily necessities.


(Left) A reservoir at Arucas, Grand Canary, and (right) dry torrent bed, Bou Saada. The water of this torrent, instead of wasting in the desert sands, is stored up, and keeps the oasis alive.

THE WONDERS OF IRRIGATION

There are Numerous Irrigation Schemes throughout the British Empire. Below we Give but a Few of the Ingenious Schemes.
By GEORGE LONG, F.R.G.S.

IRRIGATION is both the oldest and the newest of the methods by which man has learned to control the forces of nature to his advantage. It was extensively practised in the valleys of the Tigris, the Euphrates and the Nile thousands of years ago (the first was Hammurabi, King of Babylon, 4,000 years ago), and new works are constantly being started in our own days. Among President Roosevelt's recovery plans are several irrigation schemes, and the great Arizona Dam which has been recently completed is one of the mightiest engineering achievements in the world. The dam is built across a narrow rocky ravine on the Arizona-Colorado borders which has been subject to disastrous floods in the rains, though it shrinks to a mere trickle in the dry season. The dam is over 600 ft. high, and when the water has filled up behind it, there will be a new lake 115 miles long and 600 ft. deep, the waters of which will cause many square miles of desert to become fertile.

Oasis of Sidi Akbar (Sahara) showing the palm trees receiving their water, which is led to them by means of ditches.

The British Empire has many mighty irrigation schemes. The Aswan Dam has a head of about 100 ft., and in 1913, when the Nile was exceptionally low, it undoubtedly saved Egypt from famine.

Earliest Forms of Irrigation

Australia has the Murrumbidgee Dam 240 ft. high, and the Dawson, 140 ft., which is claimed to be the second largest in the world. There are many important works in India which have saved millions of native lives from famine. The earliest form of irrigation can still be seen working in Egypt—the shadoof. This is merely a bucket slung on a pivoted beam, having a weight at the other end. The bucket is dipped into the river, and emptied into the trench which carries the water to the crops. One shadoof, which is worked by man-power, can water four acres; but one sakia which is propelled by oxen can irrigate from five to twelve acres. This is a simple waterwheel of buckets, which dip

"The Edge of the Desert," Bou Saada (Sahara). The wall is to keep out the desert sand and it forms a line between desert and fertility.

into the stream and are emptied at the top of the revolution into channels which convey the water to the crops. A better arrangement, however, when the lay of the ground permits, is to build a simple dam across the stream, and thereby form a lake large enough to maintain a supply of water through the rainless months, and high enough to flow over the fields by simple gravity. Many of these were constructed two or three thousand years ago in Asia and Africa, and some are still working. This type of irrigation is very common in the Sahara Desert, and nearly every oasis is watered in this way. Contrary to popular belief, the Sahara is *not* rainless; its northern side has a short season of heavy rain which, however, runs off the baked soil and is wasted in the desert sands. If, however, it is stored in artificial lakes, it can maintain crops throughout the whole year. Egypt is an example of a country which, though practically rainless, raises splendid crops, because the Nile brings down rain which has originally fallen more than a thousand miles away.

The oasis of Biskra, showing a lane and water conduit through the palms.

A windmill waters the desert at St. Vincent, Cape Verde Isles.

Flood Waters

Large areas of India are rainless through many months of the year, but have been rendered fertile through irrigation works, which employ the flood water brought down by rivers from the melting snow in the mountains, and which is most abundant in the hottest seasons.

Although huge engineering works, like the Aswan Dam, are of most interest to the public, and receive most of the newspaper mention, it is yet a fact that more cultivation depends on a huge number of much smaller dams and works. Our own British food supplies depend largely on these small irrigation works. Tomatoes, new potatoes, and bananas come here in great quantity from the Canary Islands, which would be practically uninhabitable but for irrigation. It is true that there is a considerable rainfall during the winter months, but the islands are so steep and mountainous that almost all this water would run off into the sea. There are no rivers, but only ravines which are torrents for a few weeks in the year, and dry for the remainder. Owing to the fact that the rain runs off—instead of sinking in—even wells cannot be relied upon. But there are an enormous number of reservoirs in use, which collect the water from every tiny torrent and save it up. It is then distributed to the crops in little channels of stone or concrete. Sometimes there is a small gulley on top of the wall that separates the road from the fields and a constant stream of clear water runs along it.

Imported Drinking Water

In the Cape Verde Islands rain is so scarce, and continues for so short a perod, that even drinking water is imported by ship to the capital city (St. Vincent), and the fountain in the town from which domestic washing water is obtained is *salt*—not fresh.

No doubt something could be done here by the formation of dams across the lines of the torrent beds, but at present most of the islands are barren. There are, however, several interesting examples of irrigation on a small scale by means of deep wells—sunk in the dry beds of the rainy-season torrents. These are pumped by windmills and one of these can fertilise a large area. Bananas, yams, coconuts, paw-paws, and many other tropical fruits are grown.

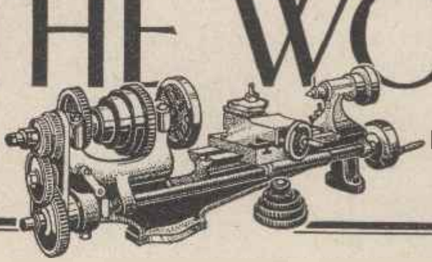
Artesian Wells

In some of the deserts of the world it is possible to obtain water by means of deep artesian wells, consisting of tubes driven into the earth to a depth of four thousand feet or so. Some think that these deserts may be the dry beds of former seas, the water of which has percolated through the soil, and has formed deep underground lakes from which the salt has been removed by filtration in passing through thousands of feet of sand or soil. In certain cases this underground reservoir is subjected to great pressure by the overlying strata, and when the bore-tube reaches it the water rises up like a fountain and forms a perpetual spring, which fertilises the desert and needs no pumping. There are many examples of this type of irrigation in Australia, and some in the Sahara Desert.

The water supply for this banana plantation is supplied by means of the concrete conduit shown on the right.

LATHE WORK

FOR AMATEURS



By "HOME MECHANIC"

USING carbon-steel tools, brass can be cut at a surface speed of 80 to 100 ft. per minute, cast-iron 40 to 60 ft., mild steel 30 to 40 ft. The newer high-speed and super high-speed permit rates to be increased enormously. Rotational speeds for three surface rates are:

Diameter Inches.	Feet per minute. 30	60	100
	Revolutions per minute.		
¼	458	917	1,520
5/16	367	733	1,222
⅜	306	611	1,019
½	228	458	764
¾	153	306	509
1	115	229	382
1¼	91	183	306
1½	76	153	255
2	57	114	191
2½	46	91	153
3	38	76	127
3½	33	65	109
4	28	57	95
4½	25	50	85
5	22	46	76
5½	20	42	69
6	19	38	64

Apron.—The front of a saddle containing gears and controls for the screw-cutting and feeds.

Attachments.—Extra fittings put on to enable special operations to be performed.

Back-gears.—Used to gain power in a headstock when belt drive is inadequate.

Bed.—On which the heads are mounted, and the saddle slides.

Bellchuck.—A hollow chuck to hold wood or to take bars which are pinched with radial screws.

Box Tool.—Employed in capstan and turret lathes for turning to uniform diameters. Vee or roller steadies support the bar opposite the tools.

Cam.—An irregular-shaped rotating member for controlling the movement of automatic feeds.

Capstan.—A revolvable tool holder, with index to locate the various tools in line with the lathe spindle.

Carrier or Dog.—A device which, when fixed on a shaft, enables it to be rotated on the centres by the catch-plate.

Catch-plate.—A disc on the spindle nose, driving a carrier screwed to the work.

Centres.—Usually made to standard angle of 60°, to run work on between the heads.

Chaser.—A tool having several threads on its end, to cut or finish screws.

Chasing Saddle.—Applied to certain lathes; it cuts threads by the control of a leader or hob screw.

Change-gears.—Vary the speed ratio between spindle and lead-screw, to enable screws of various pitches to be cut.

Chuck.—A work-holding device, having jaws that slide or rock or spring to hold concentrically or irregularly.

Compound Rest.—Mounted on the bed to impart movement of the tool in two directions.

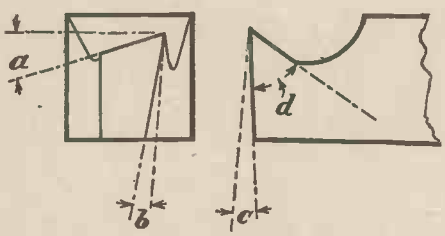
Cutting Off.—Or parting, effected with a narrow tool, after components have been machined from bar.

Collet Chuck.—Split chuck for repetition work; holds one size, but adaptable for other sizes and shapes by substitution of different collets or gripping pads.

Coolant.—Suds or oily emulsion flooded on work to cool, and give smooth finish.

Dividing-plate.—Drilled with rings of holes for pitching round work-pieces for certain precision operations.

Draw-in Chuck.—Has spring or hinged jaws, actuated from the rear of the spindle.



Cutting tool angles (see Table below).

	Bronze.	Cast-Iron.	Steel.	Wrought Iron.	Brass.
(a)	5°	15°	20°	25°	10°
(b)	3°	3°	3°	3°	3°
(a)	3°	3°	3°	3°	3°
(b)	85°	70°	60°	56°	80°

Driver.—Rotates shafts, etc., set between centres.

Faceplate.—Put on spindle nose and holds articles by clamps or dogs.

Feed-shaft.—Lies along the bed, and actuates the saddle and cross-slide feeds.

Follow-rest.—Attached to the rear of the saddle, and steadies a shaft against the cutting pressure.

Fork-centre.—Has a point to centre wood, and two prongs to rotate it.

Form-tool.—Has a contour corresponding to the one desired to be turned, hence will finish thousands of pieces uniformly.

Gap-bed.—Is cast with an opening before the headstock to receive wheels, etc.

Hand-rest.—Employed in wood-turning, and light metal-turning to steady hand tools.

Headstock.—The driving element of a lathe. The slidable head is termed loose headstock, tailstock, or poppet.

Knurling Tool.—Operates a hard steel roller cut with pattern which impresses the work.

Lead-screw.—Moves the saddle at a specified rate in relation to the spindle speed, for screw-cutting.

Mandrel or Arbor.—An accurate shaft which centres and drives an object by its bore. Is either solid or adjustable to fit various sizes.

Magazine Feed.—Carries a batch of components and supplies them singly to the chuck of an automatic.

Micrometer Dial.—Fitted to slide-rest screws, to enable fine settings to be made accurately.

Pilot.—Guides a tool or tool-bar centrally; the pilot slides through a bushing in the spindle, or a hole in the work-piece.

Quick-change Gear Box.—Provides instant means of varying feeds or screw-cutting ratio by a nest of gears and handle.

Quick Withdraw.—Jerks a cross-slide back instantaneously with a quick-pitch screw, to withdraw a screw-cutting tool at the termination of the traverse.

Saddle.—Moves along the bed and carries the compound rest, or a turret.

Set-over Head.—A loose head possessing a cross adjustment to permit long tapers to be turned.

Sliding.—The operation of longitudinal turning.

Steady or Stay.—Device which bears on the back of shaft and sustains it against the cutting pressure.

Stops.—Solid abutments which determine travel of tools, for repetition turning.

Surfacing or Facing.—Effected by the cross traverse, as distinct from Sliding.

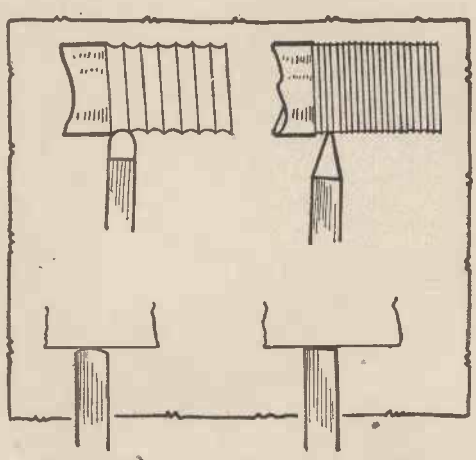
Spring Tool.—One having slight elasticity, to impart very smooth finish.

Taper Attachment.—Fitted to the back of a saddle, moves the cross-slide to turn tapers.

Tool-holder.—Carries a tool, or bit to avoid the cost of a complete tool of expensive steel.

Turret.—The same as a capstan, but this feeds through an intermediary slide attached to the bed, whereas a turret moves direct thereon.

Wire-feed or Bar-feed.—Hand or automatic mechanism which feeds and grips stock intermittently in a spindle as units are machined and cut off.



The effects of coarse and fine feeds and tool shapes.

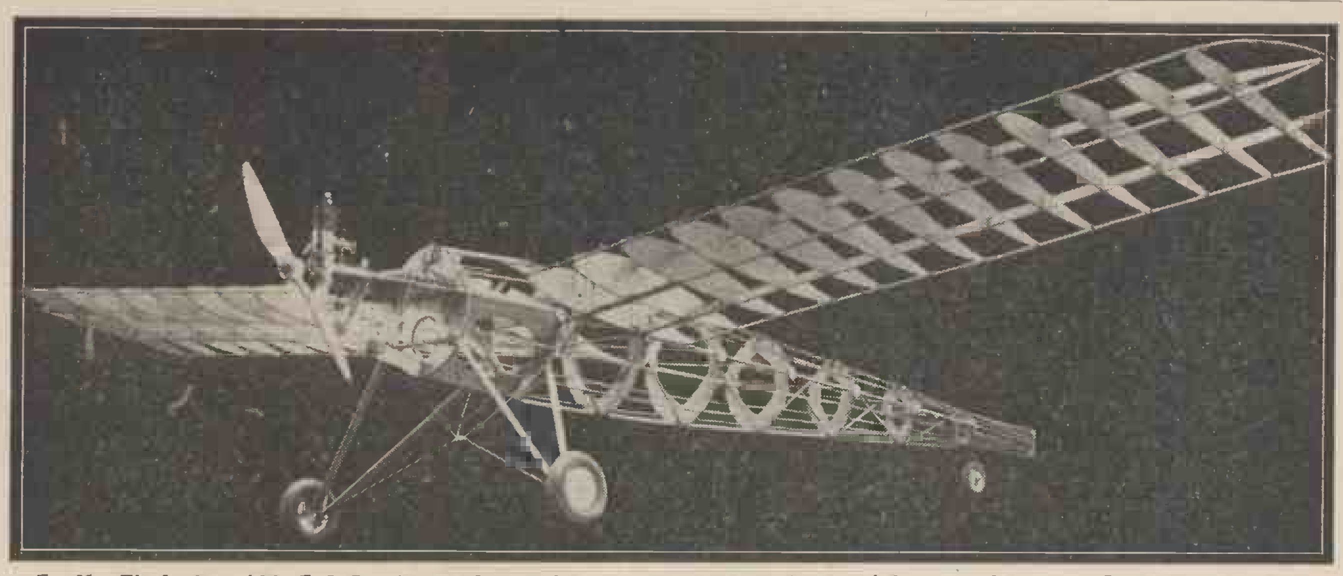


Fig. 25.—The fine lines of Mr. F. J. Camm's petrol-driven model monoplane can be seen in this view of the uncovered structure. Further up-to-the-minute designs appear in his "Power-driven Model Aircraft."

A Petrol-driven Model Monoplane

Making the Main Planes, Tail, and Rudder

By F. J. Camm.

The Main Planes

I HAVE selected the R.A.F.34 wing section for the main planes. This, as is shown in Fig. 42, has a reflex trailing edge, the purpose of which is to provide a more constant centre of pressure. On my actual model I have employed a gradual wash-out on the wing section. This involves a certain amount of labour in cutting pairs of ribs of gradually diminishing camber. (These can be purchased from advertisers accurately cut.) The reader may, therefore, elect to make each rib of the form shown in Fig. 42. There is really no reason why he should not do so, the main point in favour of the taper wing section being that it provides a stronger structure. No special difficulty will be encountered in assembling the wing. The ribs, which are of alternate $\frac{1}{16}$-in. three-ply and $\frac{3}{32}$-in. balsa (each end rib being of three-ply) are slotted, as will be shown later, to receive the various spars, which are glued into the slots, no other form of fixing being provided. Contrary to usual practice, I have not employed a longer trailing edge than leading edge. I am well aware that this latter form is chiefly employed to eliminate end-losses, but as these do not occur to any noticeable extent at speeds below 40 miles an hour, it is better to employ a short trailing edge since this avoids whip, and the tendency of the wing to flex and take on a negative angle when flying, usually with disastrous results. The leading edge is bent by steam to the form shown, and the trailing edge is half cut through and folded to meet it. Notice that the two main spars are planed off so that the camber entirely vanishes.

The main spars are attached to the wing tip members by suitable fish plates, lashed into position with thread. The wing roots are further strengthened in the manner shown in the photographs to receive the piano-wire prongs, which plug into pieces of brass tube soldered to U-shaped lugs which embrace the two horizontal longerons. Details of this fixture will be illustrated later.

The reader may save a little weight on the ribs by suitably fretting them out, as shown by the dotted lines, but I do not recommend this. Notice that both leading and trailing edges are of birch, whilst the two main wing members are of spruce, $\frac{3}{8}$ in. deep by $\frac{1}{8}$ in. wide. When completed and the glue is thoroughly dry, give the whole framework a thin coat of gold size and put aside until ready for covering.

The Tail and Rudder

The frameworks of the tail and rudder are built from 14 S.W.G. piano wire to the plan forms illustrated in Figs. 32 and 36. The various ribs of the tail are cambered, and fixed underneath each are pieces of wood strutted to the wire ribs as shown, to act as fabric supports. The bottom of the tail is thus quite flat, the whole being of the lifting variety.

Between these wooden pieces lateral strips are also secured to prevent the ribs from rocking sideways. The tail is made in two pieces, bridged at the rear with a piece of piano wire to which three pieces of brass tube are soldered—one to secure the tail to the sternpost, and the two others to receive the prongs which secure the rudder and permit of its adjustment. A separate detail of this idea is shown in Fig. 34. The rudder itself has a wire yoke piece attached at the front, prongs on which pass into pieces of tube bound and soldered to the front edge of the tail, which is fixed,

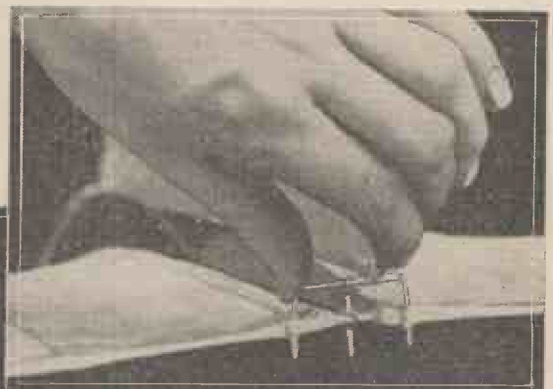


Fig. 27.—The rear rudder clip, which permits the rudder to be adjusted. See Fig. 34 for details.

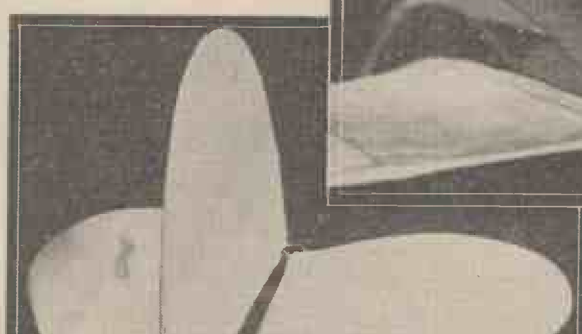


Fig. 26.—The finished tail and rudder.

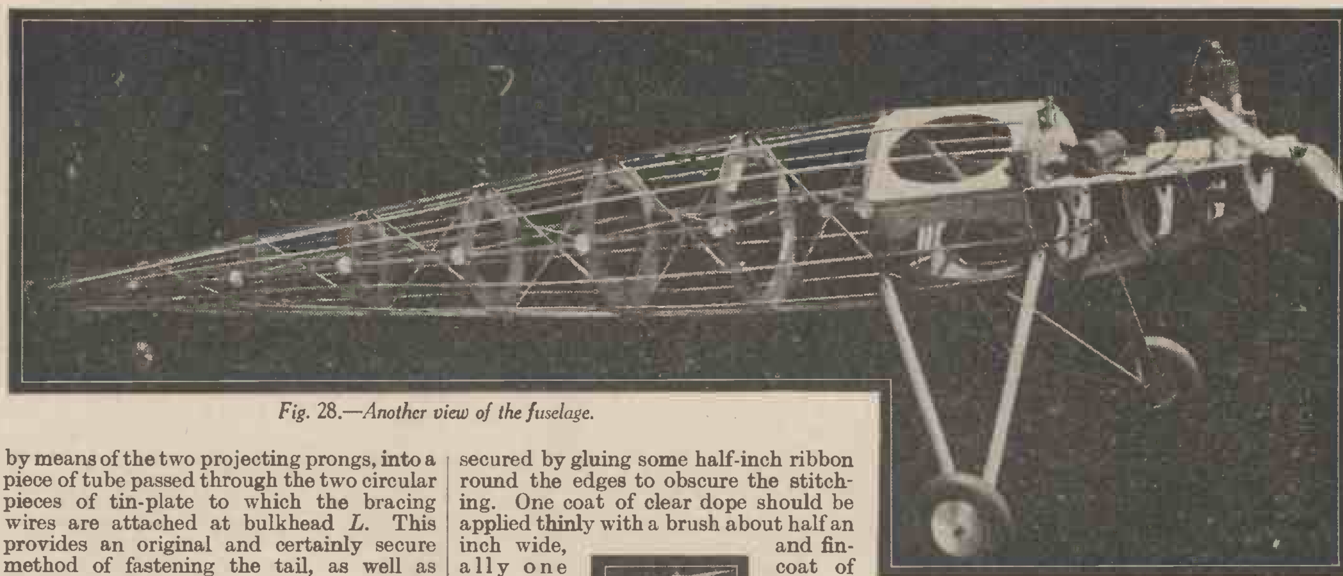


Fig. 28.—Another view of the fuselage.

by means of the two projecting prongs, into a piece of tube passed through the two circular pieces of tin-plate to which the bracing wires are attached at bulkhead *L*. This provides an original and certainly secure method of fastening the tail, as well as permitting it quickly to be removed for transport purposes. Construction of the rudder is shown in Fig. 37. This may be covered flat or made to streamline form by binding wooden ribs (about three) at equal intervals. The details at *x* and *y* show the method of securing the rudder to the tail previously referred to. The fabric is stitched to the tail and the rudder with an over-and-over stitch, four pieces of fabric being required for the tail and two for the rudder. Unproofed Jap silk is used and applied damp. A neater finish can be secured by gluing some half-inch ribbon round the edges to obscure the stitching. One coat of clear dope should be applied thinly with a brush about half an inch wide, and finally one coat of aluminium dope.

The Chassis

Returning to the chassis, the rear members or limbs are secured to the fuselage in the manner illustrated in Figs. 20 and 22, which were given last month. The axle, which should be ⅛-in. diameter steel rod, is bent to a wide inverted V form, and has pieces of tube soldered on each side of the riser plates which were illustrated in Fig. 24 last month. Further V pieces secure the centre of the axle to the limb connections, being secured by wire binding and soldering.

Suspension

The chassis is sprung by means of short springs consisting of about eight coils $\frac{3}{16}$-in. diameter 22-gauge piano wire, one end being hooked over the axle and soldered to it, and the other hooking into a hole at the bottom of the riser plate.

I failed to find on the market any ignition throw-over switch sufficiently light for my purpose. I therefore constructed one of my

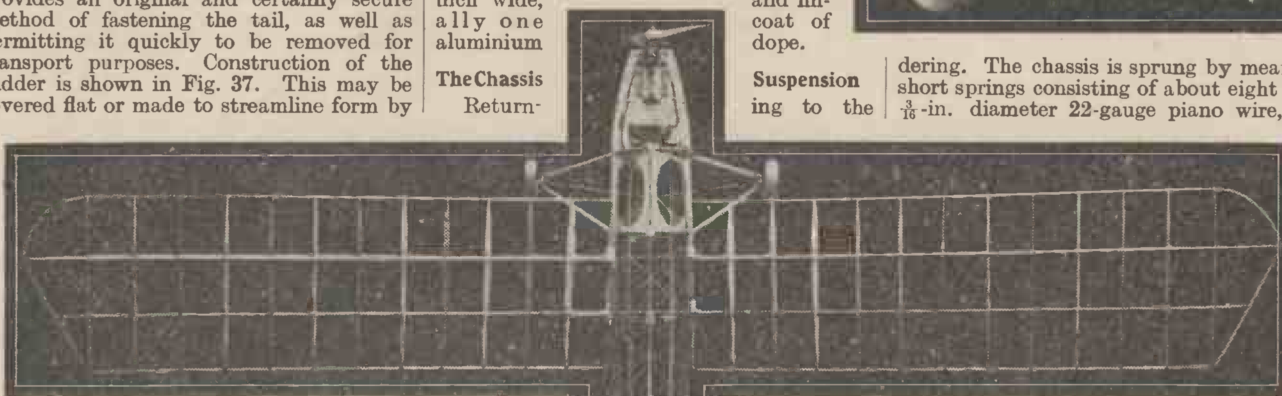


Fig. 29.—Plan view.

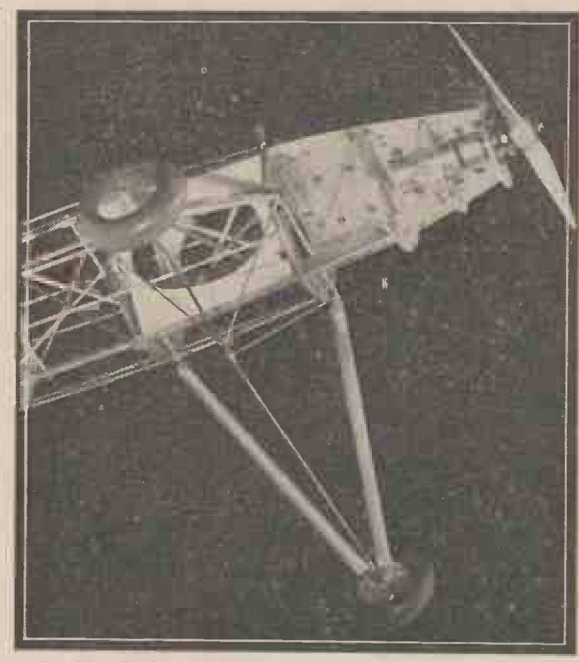


Fig. 30.—Underneath view of the chassis and engine mounting.

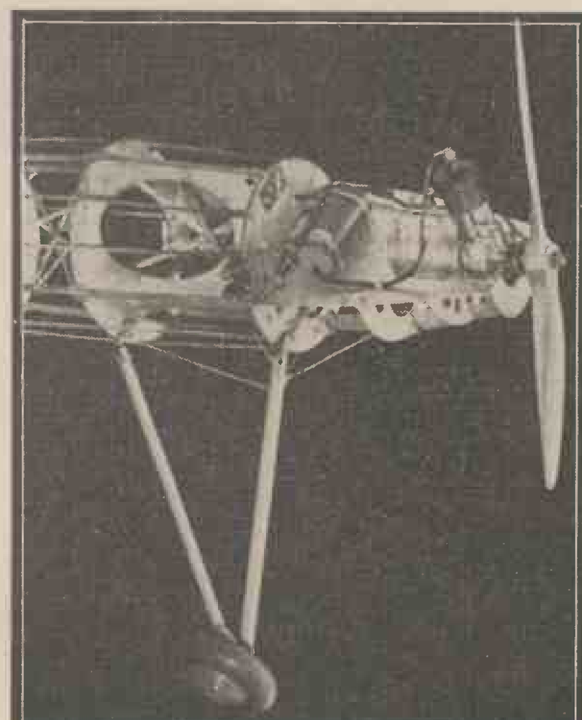
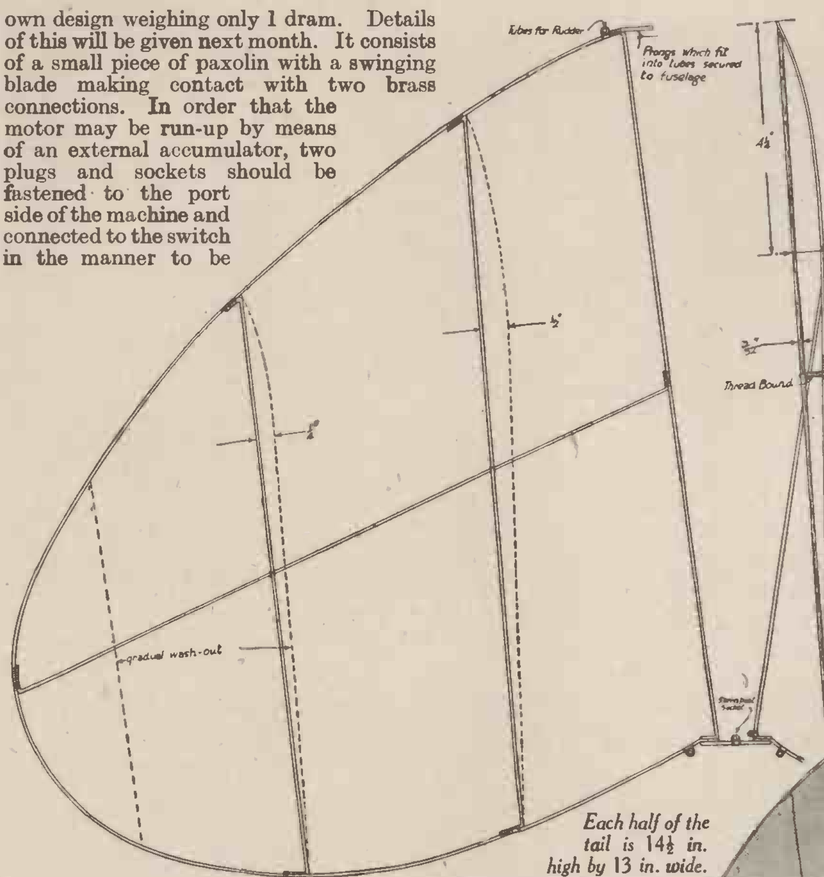


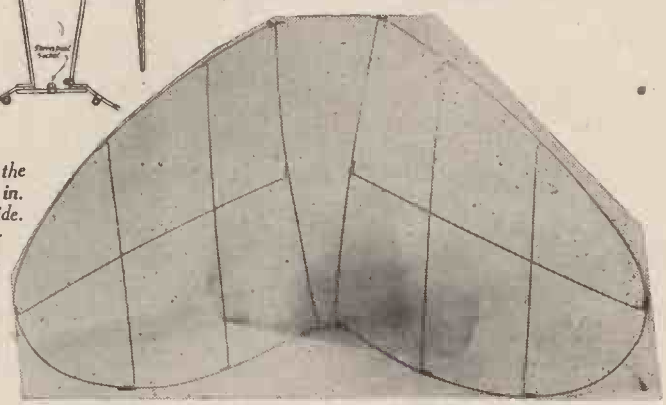
Fig. 31.—Top view of the engine mounting.

own design weighing only 1 dram. Details of this will be given next month. It consists of a small piece of paxolin with a swinging blade making contact with two brass connections. **In order that the** motor may be run-up by means of an external accumulator, two plugs and sockets should be fastened to the port side of the machine and connected to the switch in the manner to be given later, which will illustrate the complete ignition system. Once the motor has started, the switch is thrown over to the second contact, which immediately cuts out the accumulator and cuts in the small micro-cell reposing in the bottom of the first fuselage bay.

I have used the special Dunlop wheels which they make for model aircraft purposes, although the reader may decide to make his own on the lines first designed and described by me and now illustrated in my *Power-driven Model Aircraft* and suggested by me many years ago. I mention this fact because so many seem anxious nowadays to claim the idea. The method consists of using a rubber ball, piercing it through its diameter, passing a piece of threaded tube through the two holes so made, placing a washer over each side and finally a nut. When each nut is tightened the ball will gradually lose its spherical shape and take on the form of a balloon wheel.

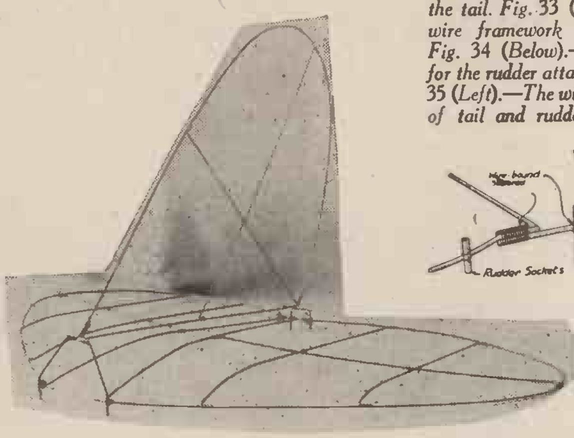
A specially light ball for this purpose is now made by Messrs. Dunlop Ltd., at the special request of Capt. Bowden. The wheels should be at least 5 in. in diameter because these roll more easily over rough ground and tend to bridge small potholes rather than to follow their contour. What-

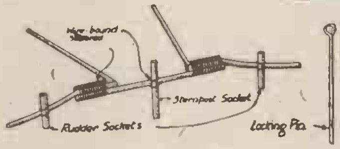




Each half of the tail is 14½ in. high by 13 in. wide.

Fig. 32 (Above).—Half-plan of the tail. Fig. 33 (Right).—The wire framework of the tail. Fig. 34 (Below).—The sockets for the rudder attachment. Fig. 35 (Left).—The wire framework of tail and rudder assembled.





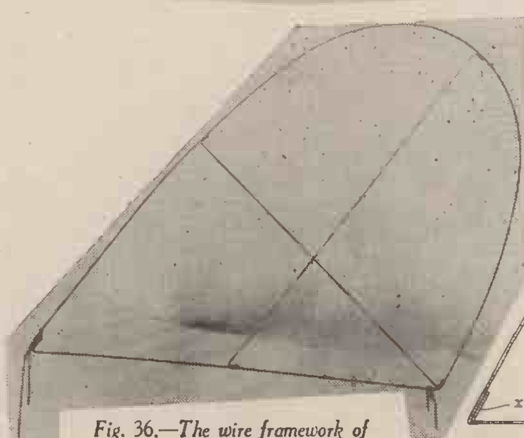


Fig. 36.—The wire framework of the rudder.

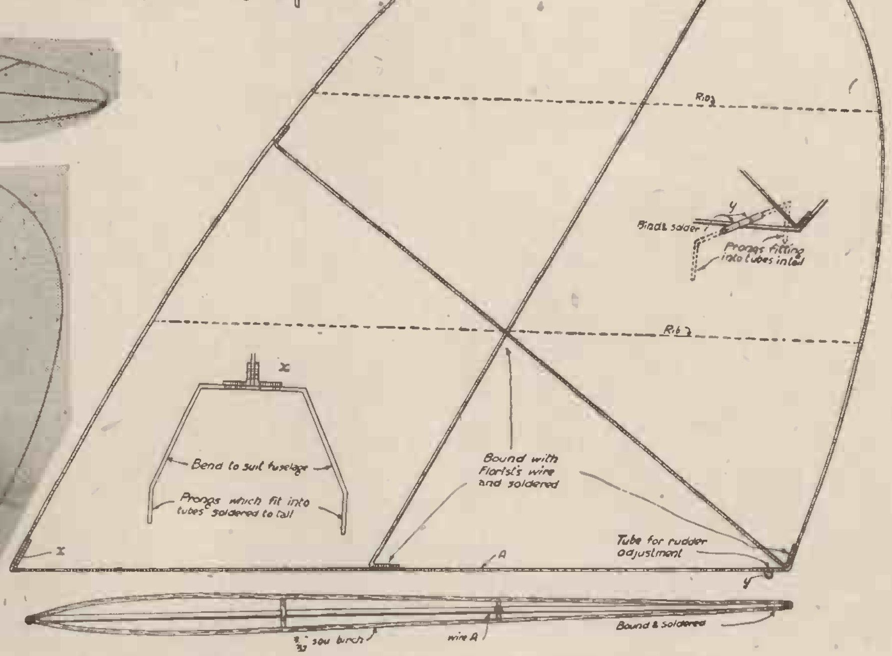


Fig. 37.—Details of the rudder framework. It is 15 in. high by 12½ in. wide.

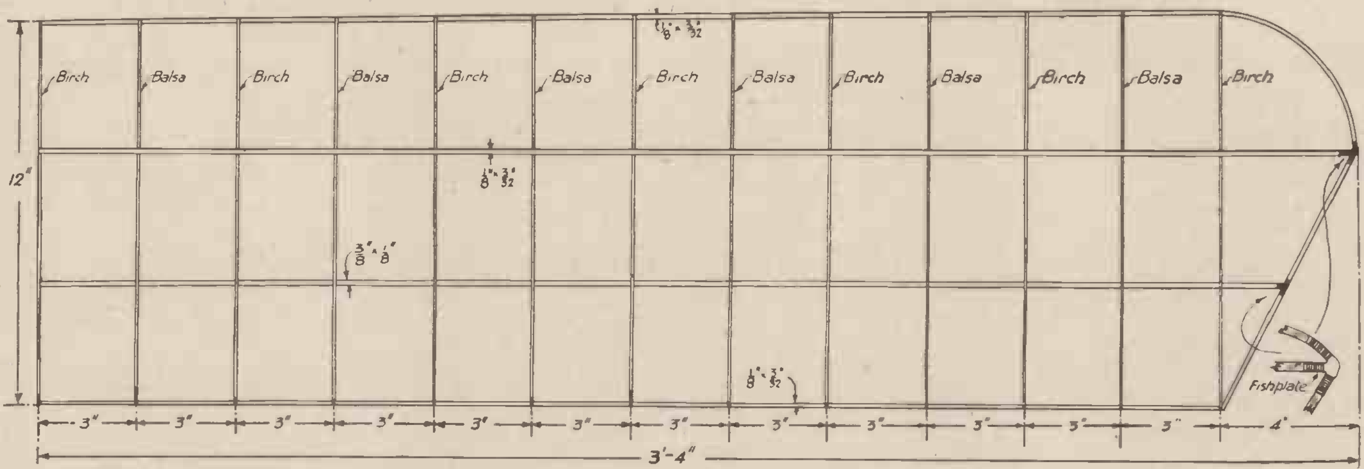


Fig. 38.—Plan of one of the main planes. Do not forget to make one right-hand, and one left-hand, as shown in the photographs below.

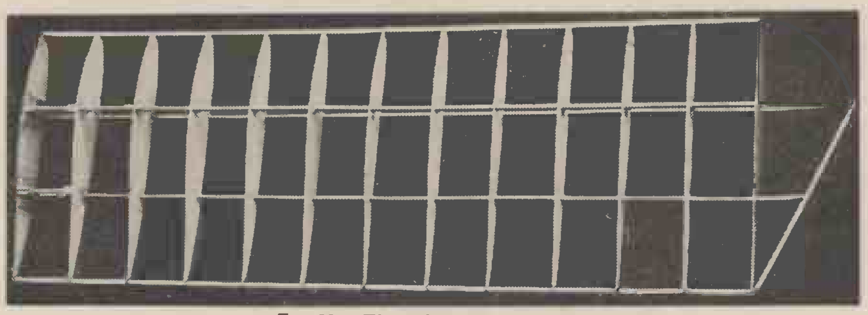


Fig. 39.—The right-hand main plane.

Fig. 40.—The left-hand main plane.

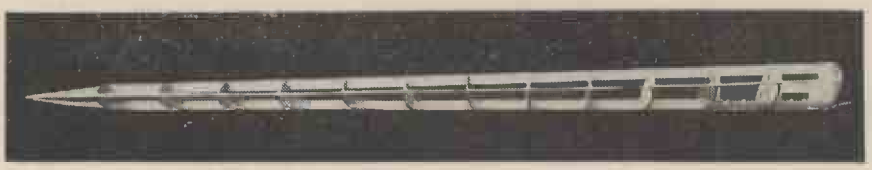


Fig. 41.—End view of the right-hand main plane.

Fig. 42.—The form of the ribs. Fret away portion within the dotted lines. This section is the well-known R.A.F.34.

ever form of wheel is used, they must have a hub at least 1 in. long, and a ⅛-in. hole through them for the axle.

Special wheels for the purpose are obtainable from A. E. Jones Ltd., Model Aircraft Supplies Ltd., and E. Gray & Sons, Ltd., all of whom supply complete kits of material for the rest of the model. Next month I shall describe how to make an engine adapter for the Atom Minor, as I have received many requests from readers for this.

The engine cradle and engine unit will be enclosed finally by a metal spinning, and those readers who prefer to buy these should get into touch with me so that I can arrange for the necessary supply.

In order that you may check your construction against the drawings, I give the following table of the weights:

The tail and rudder together	6½ oz.
Aluminium cowl for engine and fuselage front	2¾ oz.
Tail alone	4½ oz.
Rudder	2 oz.
Fuselage, complete with engine and chassis	2 lb. 12½ oz.
Wings	5½ oz. each.

I do not anticipate that any difficulty will be experienced in following the instructions here given. The photographs indicate the really attractive lines of the model and that it does not follow the crude structures built piecemeal on unsound principles, which pass under the name of petrol-driven models, and which make such fantastic gyrations at some of the London flying meetings. This is a model designed on correct principles according to full-size practice and without resort to empirical formulæ laid down by nonentities and learners. Many of the critics of model aircraft have that most dangerous possession, a little knowledge, which they use on the principle of teaching while they are learning.

Next month I shall conclude this series with details of the main plane fixtures and photographs of the model in flight.

CLOCKS AND PAST

An Interesting Article Describing the of Sundials, Water Clocks, Sand Glasses, Timepiece was Invented and

Fig. 1.—An Egyptian Water Clock found at Karnak and dating from 1400 B.C.

WHAT is " time " ? I suppose most people have some hazy idea that time has something to do with the rotation of the earth, but no such definition would satisfy a philosopher. According to Newton, time flows on universally by itself without respect to any other phenomenon, and he conceived time as something which would continue for ever, even if there were no material bodies or human beings in existence. One could devise no means of measuring such absolute time, however, and consequently we have to fall back on common physical occurrences.

The oldest method of time measurement was by the use of the shadow cast by the sun. The use and construction of sun-dials, however, is a separate subject, and we will, therefore, deal with the primitive water clock or " Clepsydræ " of Egypt.

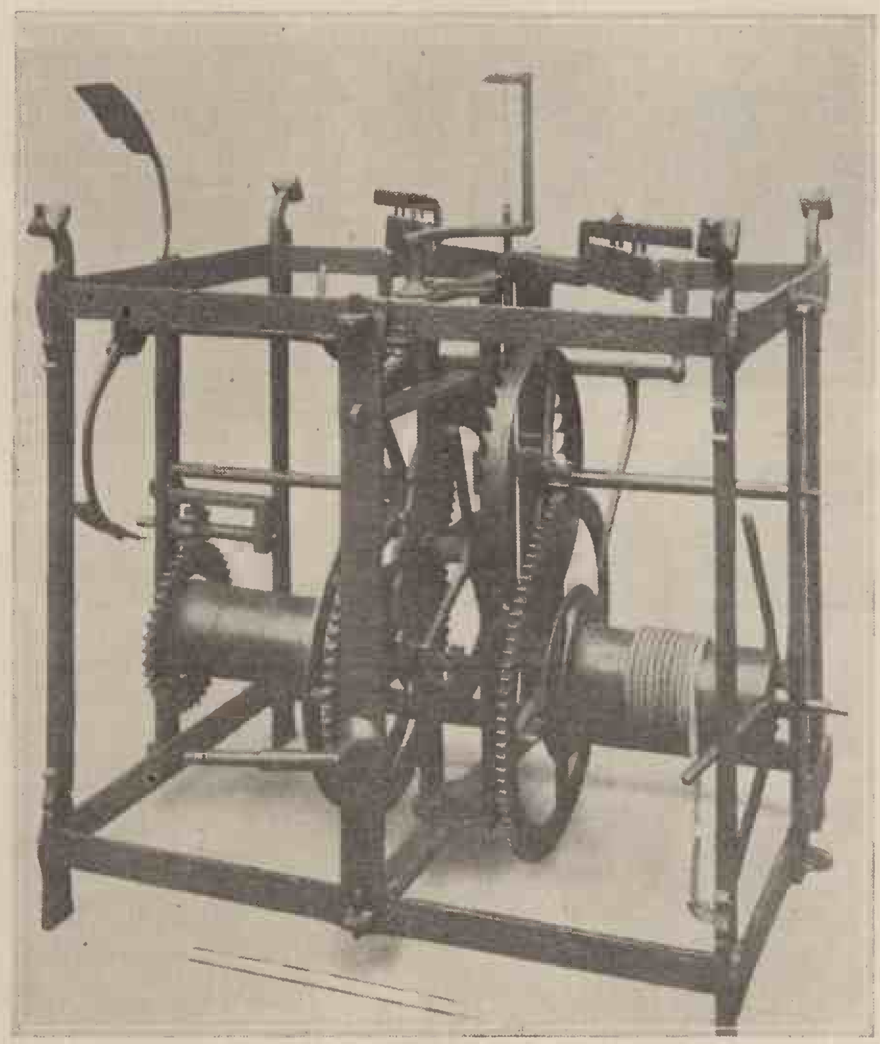


Fig. 2.—The Dover Castle Clock which is still in working order at the Science Museum, South Kensington.

The Egyptian Water Clock

This usually consisted of a large stone vessel, conical in shape, which had a very small hole in one side near the base. The vessel was filled with water, and as the water escaped through the orifice, the level inside fell, indicating on vertical scales, the time which had elapsed since refilling.

The ancient day and night were each divided into twelve equal divisions or hours, and as the relative lengths of the day and night varied according to the season of the year, so the length of each hour varied according to the season. This was easily allowed for in the water clock, by using different scales for different months. A

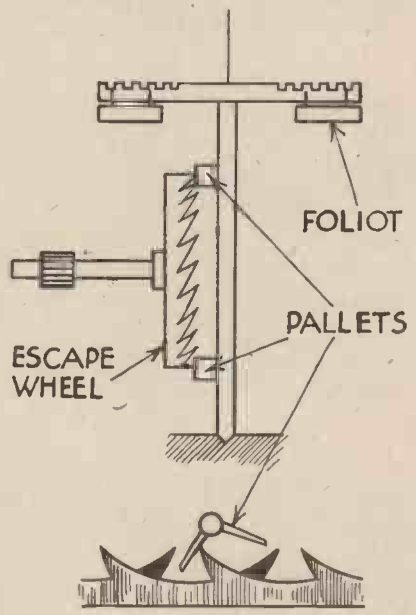


Fig. 3.—A diagram of the verge escapement.

photograph of a water clock which was found at the Temple of Karnak in 1901, is shown in Fig. 1. It dates from the reign of King Amenhotep III, 1415–1380 B.C.

For nearly three thousand years the water clock, the sun-shadow clock, the sand glass, and a burning candle were the only devices known for time measurement, and it was not until the fourteenth century that the earliest known mechanical clock was constructed. The name of the first inventor and even his clock are unknown—there are several claimants for the honour—but it is certain that the clock which, until 1872 was in the tower of Dover Castle, is one of the earliest practical clocks, and it is certainly the earliest still in working order. It is known to have existed in 1405 and was probably made about 1395, and it may still be seen working at the Science Museum.

WATCHES OF THE

By G. M. Garratt, M.A.

Earliest Methods of Time Measurement by the Use etc., and How the Ingenious Mechanism of a Present-day Made to Keep Accurate Time

Fig. 6.—A Lantern Clock of 1688.

The Dover Castle Clock

The construction of the Dover Castle clock is of considerable interest. There are no screws, nuts, or bolts; they were not used in clocks in England until nearly two centuries later. The framework and other such parts as could be permanently fixed together were riveted, while those parts which had to be dismountable were held by taper wedges.

The weight drum rotates once every hour and the hand was driven from its shaft by gearing, which has since been lost. No minute hand was fitted, in fact scarcely any clocks had minute hands until the end of the seventeeth century, because they were not sufficiently accurate.

The escapement is of special interest, because all the early clocks and all watches, until about 1750, were fitted with this type of escapement, which is known as the verge. The balance arm or "foliot" is not fitted with a spring, but carries two heavy lead blocks which swing through an angle of about 90 degrees under the action of the escape wheel. The verge escapement is shown diagramatically in Fig. 3, and it will be seen that the pointed teeth of the escape wheel engage with two pallets on the shaft of the foliot. The pallets are placed at right angles to each other, and the whole effort of swinging the foliot, stopping and reversing the swing, is transmitted through the pallets. Variations in the individual teeth and variations in friction and in the driving force cause the time of vibration to vary considerably, and accurate time-keeping was almost impossible.

The Pendulum

In spite of this, it was not until about 1670 that Huygens adapted the pendulum to the control of a clock. The properties of a pendulum had been discovered more than half a century earlier, by Galileo while comparing the swinging of a lamp pendant with the beating of his pulse during a service in Pisa Cathedral, but Galileo never applied his discovery and died without appreciating its importance.

Huygens found that the isochronism (or "equal time-periods") of Galileo's pendulum was approximate only, and is only exact when the arc remains constant. As the verge escapement was still the only one known, and as this demanded an arc of at least 60 degrees, the timekeeping still left a great deal to be desired.

The invention of the anchor escapement by Dr. Robert Hooke, in 1675, made it possible to use a pendulum which swung through a small arc only, and thus enabled far better accuracy to be obtained. This was the same Hooke who discovered the law relating the action of forces with the deflection of springs, and he also discovered an ingenious coupling for shafts which are not in line—two dis-

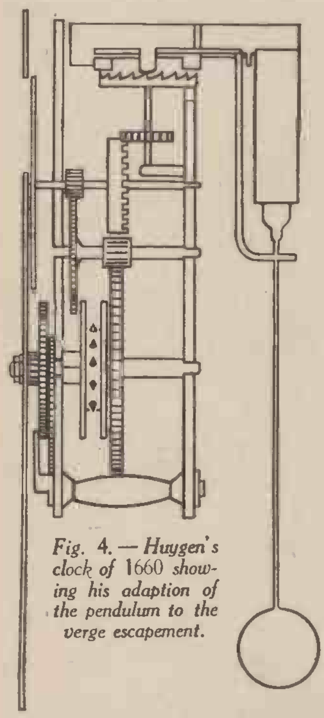


Fig. 4. — Huygen's clock of 1660 showing his adaption of the pendulum to the verge escapement.

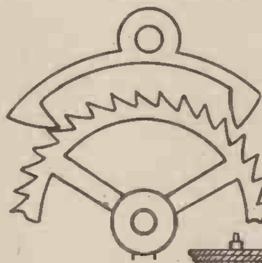


Fig. 5.—A diagram of Hooke's anchor escapement.

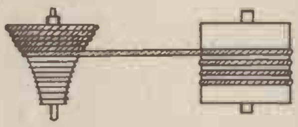


Fig. 7.—A sketch of the fusee.

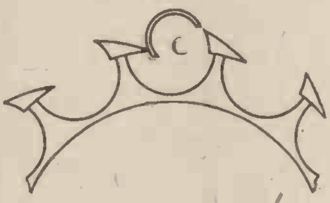


Fig. 8.—Showing the cylinder escapement.

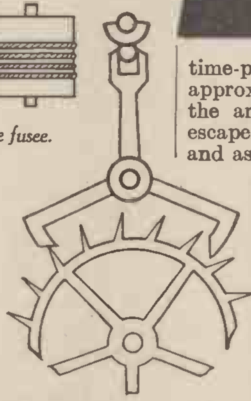


Fig. 9.—A diagram of Mudge's detached lever escapement now known as the "English Lever."

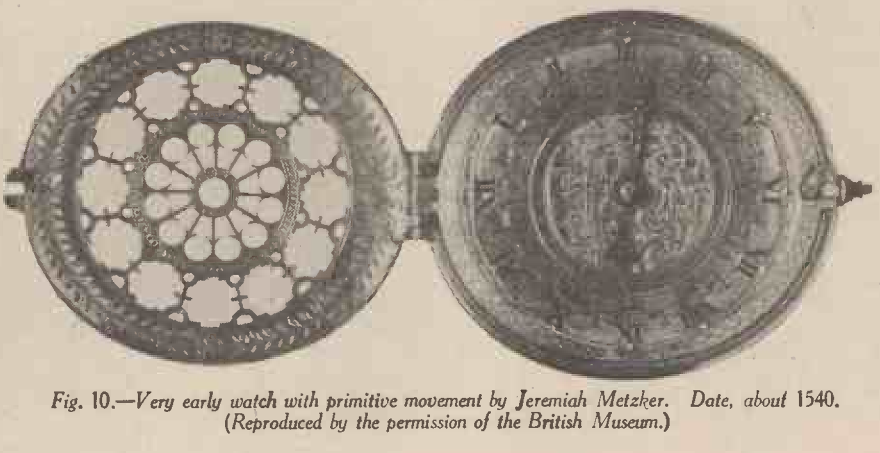


Fig. 10.—Very early watch with primitive movement by Jeremiah Metzker. Date, about 1540. (Reproduced by the permission of the British Museum.)

coveries which have since become a joy to every examiner and a terror to every engineering student! Hooke's anchor escapement is shown in Fig. 5, and this escapement, only slightly modified, is used to this day in clocks where a high standard of accuracy is not required.

The very early clocks were nearly always large ones for mounting in a tower or other public place, and for this reason they were known as turret clocks. Household clocks did not come into use until the end of the sixteenth century, when the lantern clock was first made. The first lantern clocks had the usual verge escapement, but they were soon fitted with a short pendulum known as a "bob." Fig. 6 shows a lantern clock which was made in 1688.


Fig 11.—(Left) The back of a watch by Jan Bockelts Van Aacken, about 1640. This watch contains a compass, a sundial with movable gnomon and astronomical indications besides the ordinary movement. (Right) A French watch, probably by I. Mornand, of Paris, about 1690. (Reproduced by the permission of the British Museum.)

Weight-driven Clocks

The early clocks were invariably driven by means of a weight, and it was only the invention of the mainspring by Peter Hele, Nuremburg, at the end of the fifteenth century, that made possible the construction of a watch. The first watch escapements were of the verge type, and the amount of space occupied by this escapement caused the watch to be approximately spherical in shape—a fact which resulted in their being termed "Nuremburg Eggs."

The uncontrolled verge escapement, however, was entirely unsuited to the varying driving torque exerted by the mainspring, and it is to be feared that the first watches were toys rather than timekeepers. When the spring was fully wound, the powerful torque would cause the balance arm to swing through a much larger angle than when the spring was almost unwound, and consequently the watch would lose time.

In order to attain a constant driving torque, and so improve the timekeeping, a device known as the "fusee" was invented about 1525. This device may still be seen in many clocks to-day, and it is invariably used in all marine chronometers. The principle may be clearly understood from Fig. 7. The mainspring is contained in a cylindrical drum, or barrel, on which is wound a piece of catgut, or a slender chain. The other end of the catgut is wound on a spiral drum, so contrived that as the spring runs down and becomes weaker, the leverage on the axis of the spiral increases, thus giving a practically constant torque throughout the range of the spring.

Even the invention of the fusee did not make the verge watch into a reliable timekeeper, and little improvement was made for nearly 150 years until the balance spring or "hair-spring" was invented by Hooke in 1660. The balance spring did for the watch what the pendulum had done for the clock, for the addition of the hair-spring gave the balance wheel a definite period of oscillation, and although the shortcomings of the verge escapement interfered and prevented perfect isochronism, yet a vast improvement was achieved, and it now only required an improved escapement to make the watch a reliable instrument. The less the escapement interferes with the free swinging of the balance, the closer is the approximation to isochronism, and the best escapements are those which release the escape wheel, and give the impulse to the balance or pendulum, as nearly as possible to the middle of the swing.

Improved Escapements

The first big improvement in escapements was made by George Graham, in 1725, with his cylinder escapement shown in Fig. 8. This was followed in 1755 by the detached lever escapement invented by Mudge. The latter, except for a few cylinder watches, is the only escapement now used. Such was the conservatism of watch-makers, however, that the verge continued in use until the middle of the last century.

The detached lever escapement is now made in a variety of forms, but the principle of all is the same as that shown in Fig. 9.

Although many improvements in detail construction have been made during the last 100 years, it must be frankly admitted that the watch of to-day is an invention of the eighteenth century. No important changes have taken place since then and, in fact, the only triumph of recent years has been the marvellous development of watch-making machinery which renders possible the purchase of an excellent watch for a few shillings and a really accurate chronometer for £10.

DEEP-SEA EXPLORATION IN THE BATHYSPHERE

(Continued from page 540)

On the return journey to the surface, at 1,900 ft. another discovery is made—a brilliantly coloured creature almost round in shape. Its length is about six inches and down its sides it carried five distinct and crescent-shaped lines of sparkling lights. Dr. Beebe has described it as one of the most beautiful creatures he has ever seen and has named it "The Five Constellation Fish." The ascent is completed without further discovery and the brave observers climb out to stretch their legs after over three hours beneath the surface—only to be reminded that had they descended a further 150 ft. they would have reached the half-mile mark!

A Further Descent

Four days later—on August 15th, 1934—it was decided to undertake a further deep-sea dive as the weather had held good and suitable days were all too infrequent. The descent was made at almost the same spot as the previous one, the weather conditions were almost identical, but the marine life observed was quite different, thus showing the immense variety which is available for scientific observation.

Below a depth of about 500 ft. no plant or vegetable life of any sort can exist, and it therefore follows that every creature which exists only at lower depths must be carnivorous, but it by no means follows that it is always the larger fish that eats the lesser. For example, there is the Black Swallower—*Chiasmodon Niger*—which is actually capable of swallowing a fish of three times its own size! The victim is swallowed whole and lies coiled in the grossly distended stomach of its greedy host, there to be dissolved and digested if, in the meantime, the pair are not themselves caught up in the vicious mouth of some yet more powerful enemy. Life must indeed be short in these depths, where almost every creature is fair game for another, and one cannot but remain surprised that any can survive to reach maturity.

On this descent, an explanation was found of a phenomenon which had puzzled the observers on previous occasions—the ability of certain creatures apparently to "explode" at will. Previously, small "explosions" had been observed close to the windows of the Bathysphere which had puzzled the observers who had not been able to explain the happening because the event happened so close and so suddenly that they could not focus their eyes before it was all over. This time, however, Dr. Beebe was observing a large Scarlet Shrimp, several inches in length, when it rolled over and shot forth a cloud of brightly luminous fluid, so bright as to illuminate his face and the frame of the window of the Bathysphere. This characteristic appears to be used as a form of defence—a sort of luminous smoke cloud with which to blind and baffle some nearby assailant.

3,000 Feet Below the Surface

Between 2,000 ft. and 2,500 ft. on this dive several large fish were observed—one was at least twenty feet in length and broad in proportion, but it remained within view for such a brief instant that identification was impossible. At these depths no light whatever penetrates from above and the only moving lights which can be seen are the individual luminous spots on many of the fish themselves.

The Bathysphere finally came to rest at a depth of 3,028 ft., but in spite of the depth, the water seemed clearer and more free from sediment than nearer the surface. In fact, Dr. Beebe has said that it appeared so pure and harmless from within the Bathysphere that there seemed no reason why they should not be outside! They had only to recall, however, that there was a pressure of nearly 20 tons on each of the windows and more than 7,000 tons on the shell of the Bathysphere to cause them to change their minds!

Fig. 1.—As some form of rigid mounting is necessary for the engine, it should be mounted as shown.

A 15-c.c. MODEL TWO-STROKE PETROL ENGINE

Details for Fitting-up and Running the Two-Stroke Engine

By W. H. Deller

REFERRING to the instructions given for setting the cam operating the contact breaker in the concluding article dealing with the building of a 15-c.c. petrol engine on page 423 of our June issue, it should be mentioned they are correct where a fixed coil is to be employed to produce the H.T. current. Where, however, a trembler coil is to be used for the purpose, with the piston in the stated position, the contacts should be just "making." Further than this, it will also be necessary to modify the cam adapter somewhat, to cut down the duration of the spark at the plug points. This is done by increasing the length of the groove sufficiently to keep the contacts closed through the same angle of rotation that they previously remained open.

Making Ready for Running

Before the engine can be run, the following additional parts are required: petrol tank and piping, coil, condenser, and a switch and battery together with the necessary connecting wires. The design of the tank, unless a temporary one be used, will probably be dictated by the space available for its accommodation in the model which the engine is to drive. For an aeroplane or boat, a tank having a total capacity of 6 cubic in. will be large enough. The tank should be fitted with means for shutting off the petrol supply, and a needle valve, as shown in Fig. 5, is preferable to a miniature plug-cock for this purpose.

Some form of rigid mounting is necessary for the engine, and it is suggested that for testing purposes, the best method is to mount the engine, tank, etc., on one piece of board as seen in the photograph, Fig. 1. Four holes are drilled near the right-hand top corner to take the long studs at the back of the crankcase. Before bolting up the engine, pass a steel washer over each stud, and also one under each nut on the reverse side to prevent the nuts from sinking into the wood.

The petrol tank is mounted alongside the engine, and supported from the wood by means of a suitable clip and stay. Arrange the outlet of the tank at such a height that it comes above the carburettor. The tank and carburettor union nipples are sweated on to either end of a suitable length of annealed ⅛-in. diameter copper tubing, and the connections made.

Fig. 2.—Once the engine has warmed up, try the effect of the throttle.

Fix the condenser under one of the nuts holding the engine, by means of the lug provided. Clip the coil to the board in the position shown.

Wiring Up

Using insulated flexible wire, connect the contact breaker to the top condenser terminal, and continue the same lead to the terminal on the core of the coil. Connect the centre terminal of the coil to the terminal of the sparking plug, preferably with stiff insulated wire, so that it will remain at a distance from the cylinder head. Take a lead from the top or end terminal on the coil to the positive terminal of a 6-volt battery. Connect the negative side to one of the bolts holding the crankcase, with a switch in circuit. If a wooden propeller is to be fitted to the engine, a washer plate of the same diameter as the boss on the cam adapter should be made, being drilled with No. 6 B.A. clearance holes to match up with the tapped holes and a ⅜-in. hole drilled in the centre. Drill the prop. boss for the bolts in such a position that the blades are making an angle of 45 degrees with the vertical centre line of the engine, just before the contacts are due to break, as in Fig. 4.

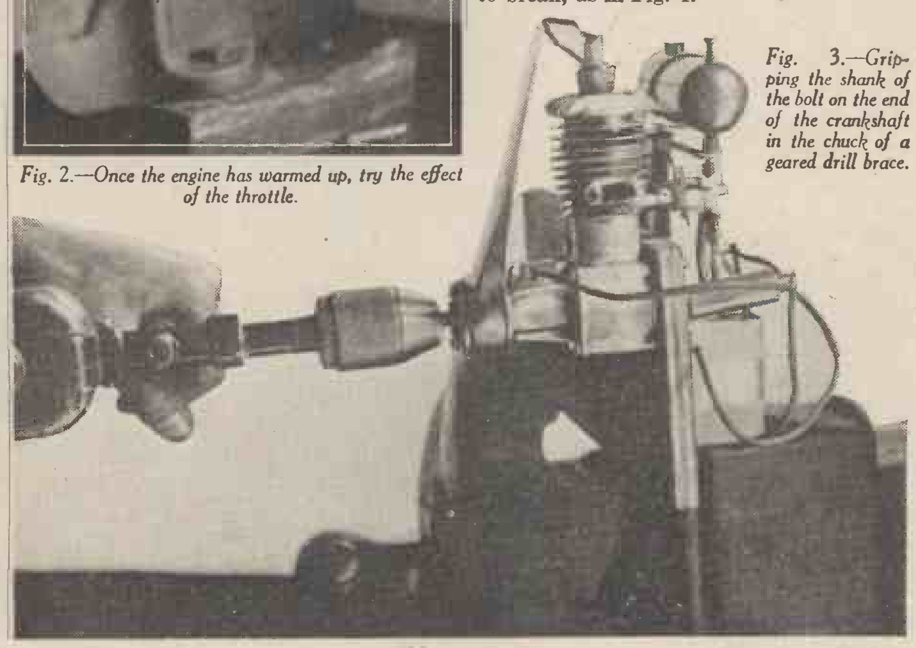


Fig. 3.—Gripping the shank of the bolt on the end of the crankshaft in the chuck of a geared drill brace.

A Necessary Detail

Now is an opportune time for fitting a small detail which will ultimately save much time in getting the engine to make an initial run, in fact it might even be left to provide the regular and certainly safe method of starting the engine, at all events when it is to be used for aircraft work. This fitting is in reality a deep locking-nut which is screwed up tight against the head of the cone nut and overlaps the end of the crankshaft to leave about $\frac{1}{16}$ in. of clear female thread. Where a propeller is fitted, this nut should be made from smaller hexagonal steel, and turned down cylindrical for the greater part of its length, as shown in Fig. 7. By taking this precaution, only a comparatively small hole need be drilled in the centre of the propeller boss.

Running

Remove the drain plug in the bottom of the engine and inject lubricating oil to the big-end bearing, letting some run down the con. rod to the gudgeon pin. Remove the sparking plug, and in a similar manner thoroughly oil the cylinder walls, rotating the engine whilst so doing. Leave the piston at the bottom of the stroke for the surplus oil to drain away out of the exhaust port, and re-insert the drain plug in the crankcase.

Screw down the petrol stop valve and pour a little high-grade motor spirit into the tank. The engine runs of course on a petroil mixture, and must not be run on the neat petrol for more than a few revs.

Fix the board on which the engine is securely mounted to the front of the bench, or hold it in a strong vice. Cut the head off a $\frac{1}{16}$ in. B.S.F. bolt, and make sure that the thread fits easily into the special nut on the end of the crankshaft. This being so, grip the shank of the bolt in the chuck of a geared drill brace (Fig. 3).

The setting for the carburettor is very critical, and to find the correct position by swinging the engine is apt to prove a rather tedious process. It is suggested that the following method will save much time in this direction.

First screw the jet down on to its seating, and open the throttle about half-way. Remove the sparking plug and arrange it, with the lead connected, laying down on the cylinder head with the points over the mouth of the hole. Put a drop of oil on the thread of the bolt held in the brace, close the switch, and turn the engine by means of the brace, observing that the plug is sparking properly. Turn on the petrol and open the jet screw by about half a turn. Now turn the engine rapidly as before, and a flame should shoot out of the top of the cylinder every time the plug fires (Fig. 8). If it does not function, see that the suction valve lifts at each revolution. If so, make sure that the petrol flow is not restricted by an obstruction in the pipe. If everything is clear, open the jet screw a few more notches and try again. The flame should be a blue colour; if not, the petrol must be cut down until it is so.

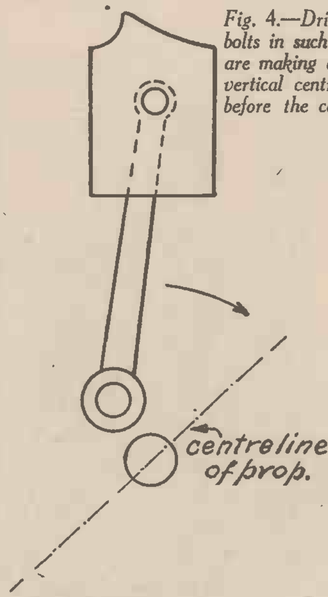


Fig. 4.—Drill the prop. boss for the bolts in such a position that the blades are making an angle of 45° with the vertical centre line of the engine, just before the contacts are due to break.

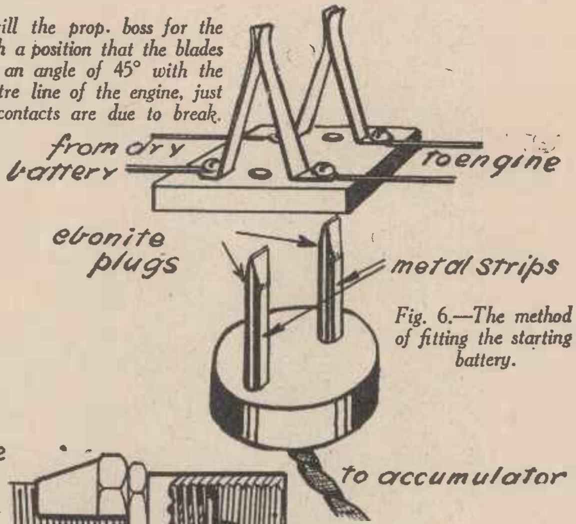


Fig. 6.—The method of fitting the starting battery.

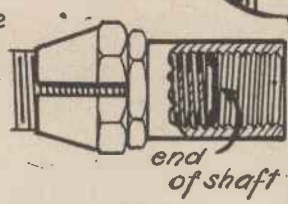


Fig. 7.—(Left) Where a propeller is fitted, the locking nut should be made as shown.

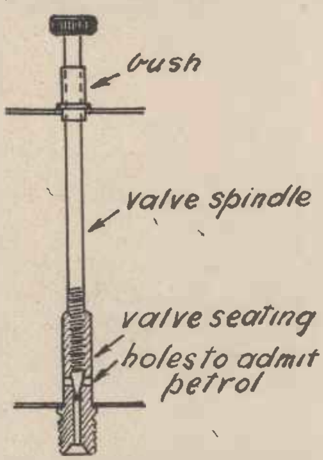


Fig. 5.—The needle valve for shutting off the petrol supply.

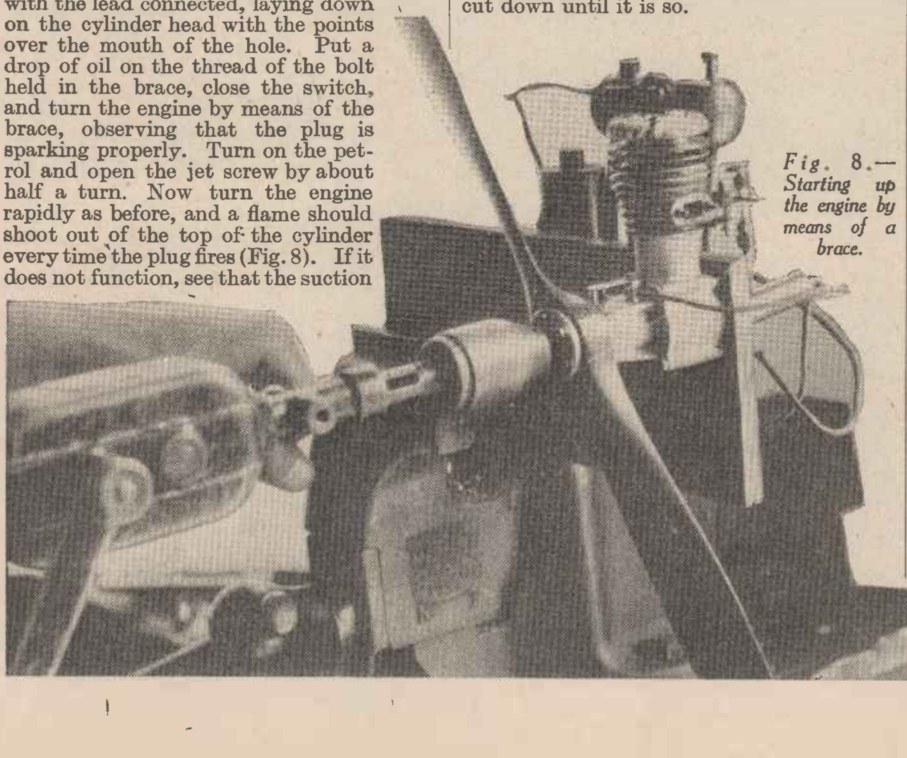


Fig. 8.—Starting up the engine by means of a brace.

The Correct Mixture

Screw in the plug at this juncture, and "lightly" tighten. With the setting as it is, the engine should start. As soon as it does so it will race the drill brace and disengage itself from the thread. Shut the engine off almost immediately, and drain the petrol tank. Refill with a mixture of petrol and engine oil in the ratio of 5 or 6 to 1. This must be well mixed beforehand.

Pour a little more oil into the cylinder and restart the engine (see Fig. 2). It may be now, that the jet will want opening a shade more, but do not alter it in a haphazard manner. Once the engine has warmed up, try the effect of throttle adjustment. Note the exact starting position of the throttle and jet, and allow the engine to make runs of comparatively short duration until it is "run-in" properly. After starting, it may be possible to cut the petrol down with advantage to the running. In any case, the failure to two-stroke will probably be due to a mixture that is too rich. Where the engine is fitted with a flywheel, provision should be made for the application of a light load once it has started, otherwise it will run "anyhow."

Failure to Start

Providing that the engine has been accurately made, it should run. Failure to fire at all may mean that the spark is too weak, or that the presence of an explosive mixture in the cylinder is lacking. Test for this by injecting a couple of drops, not more, of petrol into the cylinder through the plug hole, and after replacing the plug, see if the dope will fire. If it does not, look to the battery. Continual back-firing points to the ignition being too far advanced, whilst a dull pop, without starting at every revolution, indicates too rich a mixture or that the ignition is retarded. Where the mixture is at fault, drain the crankcase and lubricate the piston before making another trial start.

Once the engine has started, the ignition system will function from a $4\frac{1}{2}$-volt pocket-lamp battery, but for easy starting a 6-volt accumulator should be introduced into the circuit. For this reason, therefore, provision should be made on the model for plugging in a starting battery, and a way of doing this, so that the pocket-lamp battery is put into circuit as the plug is withdrawn, is seen in Fig. 6.

TELEVISION MADE EASY

A Simple Explanation of How the Time Base Builds up the Line-dissected Area on the Screen of the Cathode-ray Tube.

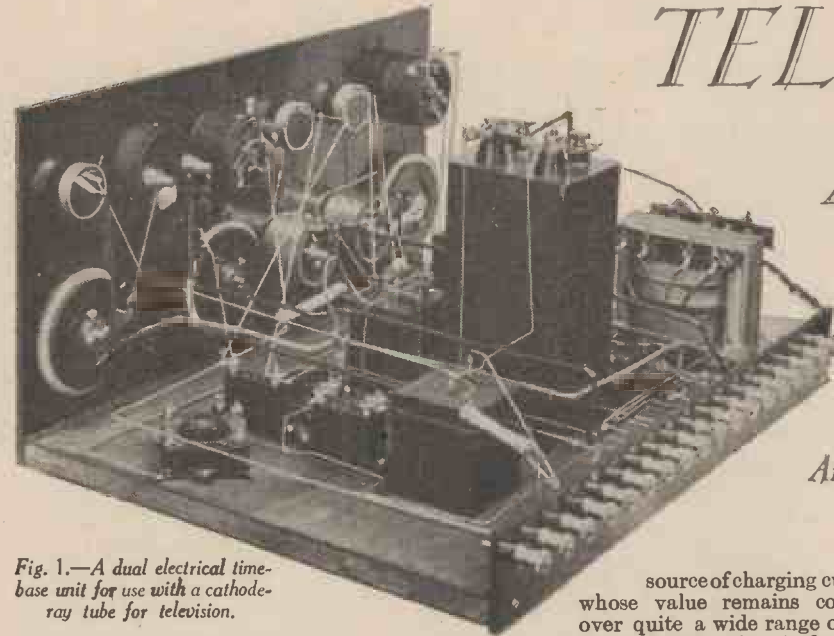


Fig. 1.—A dual electrical time-base unit for use with a cathode-ray tube for television.

WHEREAS in mechanical methods of television reception the light field trace is a function of scanning-disc apertures, mirrors on a drum, etc., with a cathode-ray tube as the picture-reproducing device, the line-dissected area is built up through the medium of wholly electrical equipment. This light-field structure was explained last month, and to produce the electro-magnetic or electro-static fields for this purpose, and be in a position to govern the frequency of their action, make them truly linear in their relationships, and have enough voltage available to give the full screen sweep, is the task allotted to the time base. It constitutes a most important part of the whole equipment of the television receiver, for without a correct line trace on the tube screen, the picture reproduced falls lamentably below the high standards which one now associates with modern television technique. The schemes which have been employed and the modifications introduced from time to time to ensure a correct action are many and varied, but it will suffice, for explanatory purposes, if attention is confined to a straightforward method enabling electrostatic deflection to take place.

The First Requirement

The scheme is made clear by referring to Fig. 3, which shows a high-frequency pentode valve, gas-filled relay, fixed condenser, and limiting resistance coupled together in such a manner that they become a saw-tooth pulse generator. The first requirement is a source of charging current, whose value remains constant over quite a wide range of voltage variation. This is furnished by the pentode valve, for if the static characteristics of such a valve are examined, they will be found to exhibit a steady anode current for a wide anode voltage variation. The magnitude of this current is a function of the filament current, the current naturally being low at low filament temperatures and high at the normal current rating. As the filament temperature is increased to its limit, however, the range of voltage variation for maintaining the anode current constancy is correspondingly reduced.

With this arrangement, it is possible to secure the required linearity of action which is so essential for the spot sweep across the screen, and also for the picture repetition. The linear charging action is in reference to the fixed condenser *C* of Fig. 3, and any failure in this connection evidences itself as a bunching together of the scanning lines at the end of the picture trace, together with a compression of the television image at the end of the line trace. Any undue non-linearity mars the pictures very considerably, and must be avoided at all costs.

A Charging Action

Returning again to Fig. 3, the steady current flowing from the pentode valve charges up the condenser *C* so that the voltage across it rises uniformly with time—this is the saw-tooth effect to which reference was made last month. This steady rise of voltage produces the electro-static field across one pair of the deflector plates of the cathode-ray tube—say the pair producing the horizontal line trace. The beam of electrons, and in consequence the fluorescent spot on the screen, travels horizontally at a steady velocity, and the charging action must continue until the spot reaches the end of its trace. Insufficient acquired voltage charge by the condenser shortens the line trace and so reduces the total light area over which the pictures can be built up.

At the crucial moment, the charging action must cease, and so cause an almost instantaneous collapse of the electro-static deflecting field, and it is here that the gas-filled relay performs its useful function.

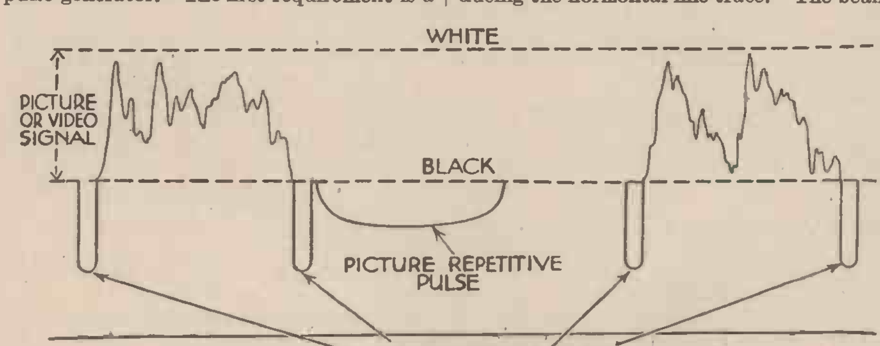


Fig. 2.—Showing how a composite picture signal would be formed when the double synchronising pulses are added.

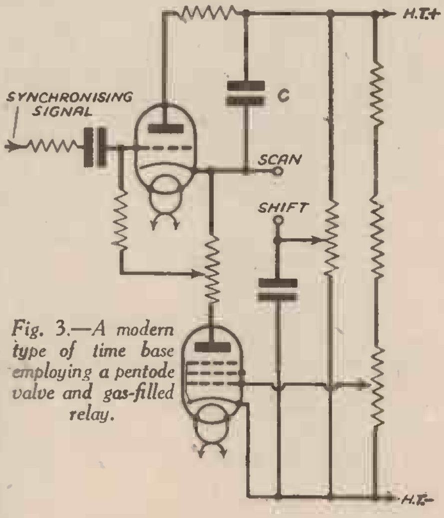


Fig. 3.—A modern type of time base employing a pentode valve and gas-filled relay.

The relay resembles a three-electrode receiving valve, inasmuch as it has a cathode (filament), grid, and anode, but due to the presence of gas within the glass envelope and the electrode structure, the behaviour of the relay is quite different from that of a thermionic valve.

Grid Control in Relay

An actual arc discharge takes place between the positively charged anode and heated cathode through the mercury vapour or helium vapour gas filling. This condition of ionisation, as it is called, happens when a definite minimum voltage is exceeded and this latter is dependent on the magnitude of the negative bias applied to the grid. The control exercised by the grid electrode in this way is termed the grid control ratio, an average value for this being

25. Expressed in another way this is the same as saying that with a negative grid bias of 10 volts the minimum ionising anode voltage is $25 \times 10 = 250$ volts. Once ionisation commences within the relay the grid exercises no further control until starting conditions are restored, and furthermore the internal resistance of the relay drops to a very low figure. It is for this reason that the makers state that a limiting resistance must be included in the load circuit to ensure that the anode current does not exceed a predetermined value.

Having assimilated the simple principles of the gas-filled relay it is easy now to complete the description of the time-base action. The condenser *C* in parallel with the anode and cathode of the relay produces the ionisation condition when the charging voltage just exceeds the limiting value set by the grid bias applied to the relay. The large current surge discharges the condenser *C* and so causes the collapse of the electrostatic deflecting field between the cathode-ray tube plates joined in circuit in the manner shown in Fig. 3.

A Triggering Action

If left entirely to itself, this circuit would not be absolutely regular in its action, although the electrical constants may be designed with extreme care so that the pulsing should occur at some definite frequency (the line repetition frequency in the case under review). It is for this reason that both H.F. and L.F. synchronising signals are included in the picture modulation signal as shown by the waveform of Fig. 2. At the receiving end, selector valves filter out the three separate and distinct portions of the radiated signal.

The line-synchronising pulse (actually rectangular in shape and of definite time duration) is then fed to the grid of the H.F. time-base gas-filled relay via the resistance and condenser shown in Fig. 3. This triggers the action of the relay at the exact time, and ensures a picture line trace of the correct length and proper frequency. The same remarks apply to the picture-synchronising impulse which, of course, is fed to the grid of the L.F. time-base relay, while the remaining vision signal modulation passes to the control cylinder of the cathode-ray tube electrode assembly.

Fig. 4.—A combined vision and sound receiver employing a cathode-ray tube.

"Shift" Control

By operating two time bases in this way—a dual unit built up for this purpose is shown in Fig. 1, and in actual practice can be made quite compact—it is possible to ensure a line field trace on the fluorescent screen which will conform to the requirements of the transmitting end. Due to slight irregularities in lining up the electrode assembly, the actual light field may not be disposed centrally on the screen. This is the reason for including the "shift" control shown in Fig 3. By having one plate connected to the moving arm of a potentiometer shunted across the main H.T. supply, it is possible to shift or move the field to the desired position. Naturally, there is a separate shift control for each time base.

Whereas in a mechanically reconstituted television picture the ratio of height to depth is fixed by the dimensions or configuration of the scanning unit, with electrical methods of scanning, this has to be adjusted by the user. This is a simple matter, however, and is brought about by altering the depth and the width of the picture and line traces respectively (assuming a horizontally scanned picture in this case), so that they not only fill economically the screen space available at the tube end, but have the right proportional ratio for the particular television transmission which has been tuned in.

Intensity Modulation

If there was no vision signal modulation applied to the control cylinder of the cathode-ray tube the field built up would be one of uniform intensity throughout. This is because the number of electrons in the cathode-ray beam reaching the screen remains constant, and during the tracing action moves at a steady speed across the fluorescent material sprayed on the large end of the glass bulb. By passing the vision signal modulation to the cylinder, however, the number of electrons reaching the screen is altered continuously in conformation to the signal strength. The spot intensity or brilliancy (not size) is in consequence varied throughout every picture trace and the eye observes actual moving pictures (really a series of still pictures built up at a rapid rate one after the other), complete with the light and shade of the original scene transmitted.

Properly adjusted and handled with intelligent care, a cathode-ray tube reproducer is capable of showing interesting pictures of sustained entertainment value. Their size will depend on the type of tube employed, and their overall brilliance upon the voltages with which the electrode assembly is fed. In any case, the proposed high-definition television service is capable of furnishing extremely satisfactory results which rival for quality, brilliance, and detail (but not size at present) any home ciné. As a typical example of the results that have been shown to the editor of this journal, reference can be made to Fig. 4, which shows a television receiving set having a 180-line image portrayed on the cathode-ray tube screen. Obviously, with a 240-line definition, these results are greatly improved upon, and it is therefore only natural that the public are awaiting the initiation of the London service with feelings of the keenest interest.

THE BEGINNER'S GUIDE TO CHEMISTRY

(*Continued from page 514 of last month's issue.*)

Balsam.—A substance consisting of oil and a resin obtained by incision of certain trees.

Barograph.—An instrument which records variations in atmospheric pressure.

Bases.—Substances which combine with acids to form salts.

Basic Oxides.—Substances which combine with water to form bases, e.g. quicklime.

Basic Salts.—Salts whose acid radicals are partially replaced by hydroxyl groups.

Basicity.—Represents the number of placeable hydrogen atoms contained by an acid which is classified accordingly as monobasic, dibasic, tribasic, or tetrabasic.

Beakers.—Lipped, cylindrical, glass vessels.

Bell Jar.—A bell-shaped glass cover employed to exclude air from substances.

Bell Metal.—An alloy of copper and tin.

Benzene.—An important organic substance obtained by distillation of coal tar.

Benzene Ring.—The closed chain of carbon atoms in the benzene molecule.

Berginisation.—Hydrogenation of a mixture of coal and oil resulting in an oily fluid.

Bessemer Process.—A method of manufacturing steel. Molten cast iron is poured into a converter through which a blast of air passes. Oxidation of the metal produces increased temperature and carbon is added. The steel is then run off by tipping the converter.

Biochemistry.—That branch of chemistry which deals with the composition of living bodies and all their functions which embrace chemical change.

Birkeland-Eyde Process.—A commercial method of manufacturing nitric acid from atmospheric air by blowing the latter through an electric brush discharge and passing it into water.

Bleaching.—Oxidation or reduction of a substance resulting in its loss of colour.

Boiling Point.—The temperature at which the vapour pressure of a liquid exceeds the external pressure.

Brin's Process.—A commercial method of obtaining oxygen by heating barium oxide under alternately high and low pressures.

Britannia Metal.—An alloy of tin and antimony.

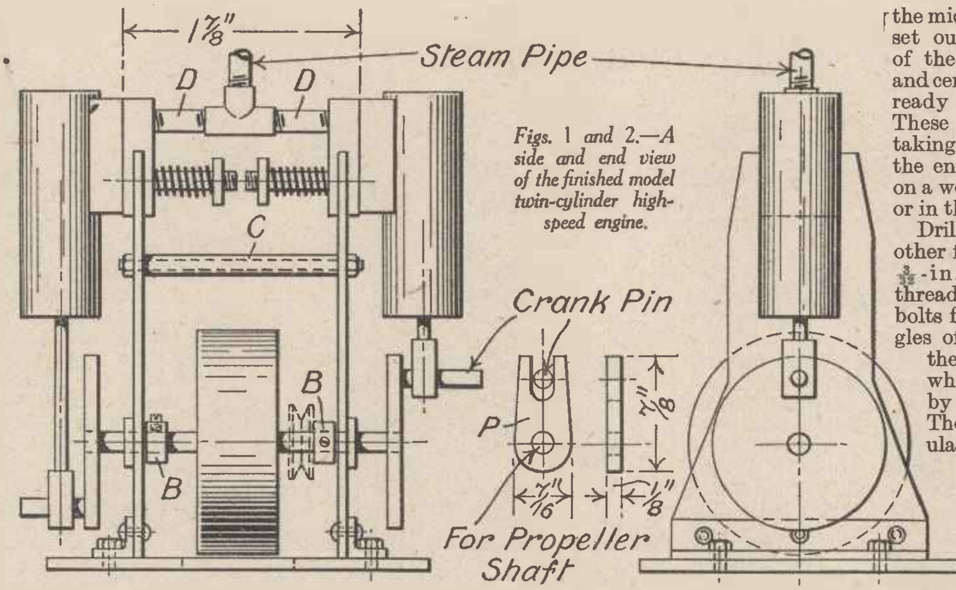
Bromination.—Introduction of bromine to the structure of a substance.

(*To be continued.*)

WORKING MODEL ENGINES

IN this second article of the series we deal with the construction of a small twin-cylinder high-speed engine which is provided with two single-acting oscillating cylinders, and is designed for use either for driving stationary working models, or a small boat.

It will be noticed, with reference to Fig. 1, that the cylinders, which are supported by standards, drive the flywheel shaft by means of disc cranks. Balanced cranks are not required in this case, as the reciprocating parts in one cylinder are balanced by those in the other. The crank pins are positioned at 180 degrees to each other so that there are two working strokes to each revolution of the flywheel which is placed on the centre of the shaft between the standards. This arrangement tends to preserve the balance of the engine, thus minimising any vibration likely to be set up when the engine is running at high speed.



Figs. 1 and 2.—A side and end view of the finished model twin-cylinder high-speed engine.

The Second of a Series of Short Articles for the Beginner, Explaining the Construction and Working of Various Types of Small Model Steam Engines and Boilers. Lathe-work is Eliminated.

Engine Standards

To make the two standards a piece of sheet brass $\frac{1}{16}$ in. thick, measuring $4\frac{1}{4} \times 3\frac{1}{2}$ in., will be required, and on one half of this mark out the shape of one standard to the dimensions given in Fig. 3. Cut this out, carefully file the edges square, and then drill the holes to the sizes indicated. The rectangular slot in the top of the plate is the same size as for the single-cylinder engine standard described in last month's issue. Having finished this standard, lay it on the other piece of brass plate and mark out on it the position of the two holes *A*, *A* with the aid of a scriber. Drill the holes through and then clamp the two plates together by means of two bolts and nuts. Use the finished standard as a template and with a scriber carefully mark out the shape on the other plate. The three rivet holes can be drilled through both plates in one operation, and after this is done separate the plates, cut out the second one and file the edges down to the scribed line. Two pieces of $\frac{1}{16}$-in. brass angle 2 in. long will now be required, and three $\frac{1}{16}$-in. holes can be drilled in each piece for riveting to the bottom parts of the standards. The bottom faces of the angles must be flush with the lower edges of the standards, as indicated in Figs. 1 and 2. Before riveting the angles in place, two $\frac{3}{32}$-in. holes can be drilled in each horizontal member to take the screws for fixing the angles to the bedplate. Solder a brass washer, $\frac{1}{16}$ in. thick, on the outside of each standard to thicken the bearings for the crankshaft.

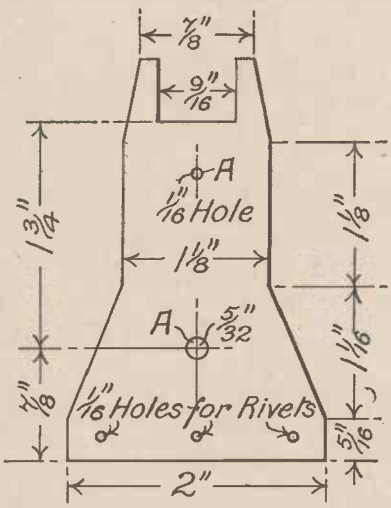


Fig. 3.—An elevation of the engine standard.

Baseplate

The baseplate can now be taken in hand, and for this a piece of $\frac{3}{32}$-in. sheet brass will be required slightly larger than the overall dimensions given in Fig. 4. After marking out the outline, and the rectangular hole in the middle of the plate, set out the positions of the six $\frac{1}{8}$-in. holes and centre-punch them ready for drilling. These holes are for taking screws for fixing the engine in position on a wooden baseboard or in the hull of a boat.

Drill and tap the other four holes with a $\frac{3}{32}$-in. Whitworth thread for taking the bolts for fixing the angles of the standards, the positions for which are indicated by the dotted lines. The large rectangular hole can be first cut out roughly with a hammer and small cold chisel, the edges being afterwards filed up square to the scribed line. This hole will allow the flywheel to clear the bedplate if necessary. The flywheel, which is $1\frac{3}{4}$ in. diameter, and $\frac{5}{8}$ in. wide across the face, is of the solid type and is provided with a grub-screw for fixing.

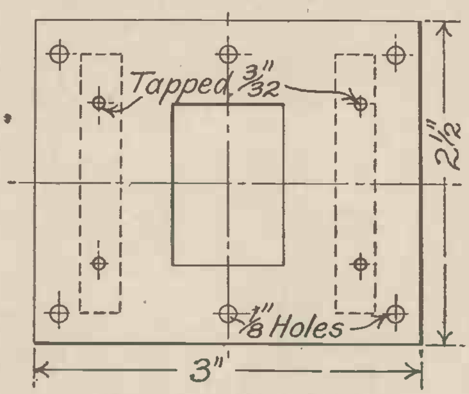


Fig. 4.—Details of the baseplate.

Crankshaft

Taking the crankshaft in hand next, the construction of this is clearly shown in Fig. 5. It will be seen that the piece of mild steel rod for the shaft is $2\frac{1}{2}$ in. long with a thread at each end for a distance of $\frac{1}{8}$ in. on which the disc cranks are screwed. These discs may either be of brass or mild steel $\frac{1}{8}$ in. thick, the two holes being carefully drilled and tapped as indicated. For the crank-pins two pieces of $\frac{1}{8}$-in. diameter mild steel rod will be required, one pin being $\frac{5}{8}$ in. and the other $\frac{3}{4}$ in. long. These must be threaded at each end to screw into the crank disc. One pin is made longer than the other in order to engage with a driving plate, *P* (Fig. 1), which is fixed to the end of the propeller shaft of a boat. If the engine is to be used as a stationary engine, the pins can be of the same length, and a pulley wheel fitted to the shaft in place of one of the collars *B*, as indicated in Fig. 1.

These collars (Figs. 1 and 5) are of brass with a centre hole to fit the crankshaft, and they should each be provided with a small grub-screw for fixing them on the crankshaft.

Assembling the Parts

In assembling the various parts, first slip on the flywheel to the middle of the crankshaft and fix in position by means of the small grub-screw in the boss. Next slip on a collar, and the pulley wheel (if one is used), and then fix one of the standards to the baseplate by means of two $\frac{3}{32}$-in. bolts. Slip one end of the crankshaft through the bearing, place the other standard in position, allowing the end of shaft to slip through the bearing, and bolt down the angle piece. A length of $\frac{5}{32}$ in. diameter brass tubing can now be taken and the ends filed square till it just fits between the standards near the base. The tube has to be finally fixed in position by means of a $\frac{1}{16}$-in. wire stay which passes through the holes in the standards just below the steam blocks, as depicted at *C*, Fig. 1. The ends of the stay, which can be cut from iron or brass rod, must be threaded to take nuts for clamping the standards firmly. The latter will now be quite parallel with each other, and they should also be square with the baseplate. Now adjust the crankshaft so that the flywheel is central between the standards, slip along the collars *B*, till the outer faces all but touch the standards, and then tighten up the grub-screws. The shaft can be allowed an end play of about $\frac{1}{16}$th in. Screw on the crank discs and adjust them so that the crank pins are at 180 degrees, as shown in Fig. 1. If the discs are a tight-screwed fit on the shaft they will require no other means of fixing, but if not, they can be lightly soldered to the shaft, after being finally adjusted for position, to prevent them shifting while the engine is running.

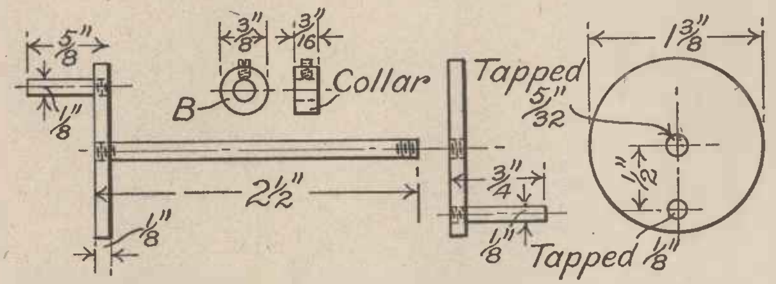


Fig. 5.—Details of construction of shaft and disc cranks.

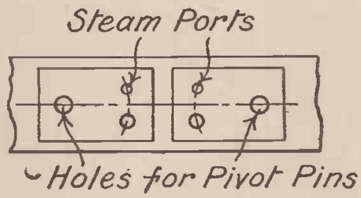


Fig. 6.—Method of marking out the steam blocks on a metal strip.

Cylinders

The cylinders for this model are of similar construction to the one used for the single-cylinder engine described in last month's issue, to which the reader is referred.

One steam block must have the position of the ports reversed, so that when looking at the working faces of the blocks the steam port of one is on the left-hand side, and the other on the right-hand side. The two blocks can conveniently be cut out from one piece of strip brass or gunmetal $\frac{1}{4}$ in. thick, being marked out side by side as shown in Fig. 6. After carefully centre-punching the holes for the ports and pivot pins these can be drilled before the blocks are separated and filed to shape. For connecting up to the main steam pipe, cut two pieces of $\frac{3}{32}$-in. brass tubing (*DD*) $\frac{11}{16}$ in. long, and cut a thread on the ends of each piece for screwing into the steam blocks and the connecting T-piece as shown in Fig. 1. After screwing these parts together so that the outer faces of the steam blocks are $1\frac{7}{8}$ in. apart, the latter can be neatly soldered in the slots in the tops of the standards. After assembling the cylinders, tension springs, and adjusting nuts, and applying a little lubricating oil, the engine will be ready for a trial run under steam.

THE PREPARATION OF RARE GASES

By F. W. BRITTON

THE use of liquid air is coming more and more to the fore in many industrial processes, and now that the rare gases are being prepared on a commercial scale, the manipulation of the air used requires an exact technique if economic production is to result.

It sounds strange to refer to the "distillation" of liquid air, but that actually does apply to the manufacture of such gases as neon, argon, etc. Here, the working limits, instead of being those at which ordinary liquid vaporises and condenses, are in the neighbourhood of — 200° C., and precautions have to be taken to ensure that no loss of heat, from the air outside the apparatus, is possible.

Different Boiling Points

Judging from the following table, argon is the most abundant of the rare gases, occurring in the proportion of ·94 per cent., its boiling point is — 185·84° C. By virtue of their different boiling points, the rare gases may be separately distilled in fractions—fractionally distilled, in other words—the same process applying here as in the ordinary fractional distillation of liquids. The apparatus used for these processes is termed a fractionating column, an appliance which enables amounts of liquids boiling at different temperatures to be separated from a mixture containing them. These fractions are removed at different points away from the liquefier or generator. A brief description of the plant will be necessary.

Compressed air is forced into a vertical tube called an "exchanger," through which also passes two tubes for conveying the nitrogen and oxygen from the fractionating column. The compressed air next passes to a second tube, also containing the nitrogen and oxygen tubes leading from the column. Just before entering this second tube, the compressed air is by-passed down to an expansion pump from which it passes to the bottom of the fractionating column. This lower chamber is divided into three longitudinal compartments, into the first of which the compressed air is fed, where it passes upwards through a tube surrounded by liquid oxygen into the bottom division of the column, and then down again through a tube also surrounded by liquid oxygen, into the second compartment of the lower chamber.

Four Main Draw-offs

From this compartment, the liquid nitrogen which separates is led to the top of the column down which it passes to the fractionating divisions from which there are four main draw-offs for (1) neon and helium (both in one tube); (2) liquid nitrogen; then about half-way down there is a feed for the liquid air and oxygen coming from the third compartment of the lower chamber, while below this feed and about ten divisions down is (3) a draw-off for argon, and at the bottom of the column comes (4) a delivery-tube for krypton and xenon, with a feed (for any gases which accompany them) just above.

Fraction.	*Rare Gas.*	*Boiling Point.*	*Proportion in Air.*
Third .	Argon .	— 185·84° C.	·94 per cent
	Neon .	— 246·30° C.	1 in 65,000
First .	Helium .	— 268·98° C.	1 in 200,000
	Krypton .	— 152·90° C.	1 in 1,000,000
Fourth.	Xenon .	— 107·10° C.	1 in 11,000,000

The second fraction is liquid nitrogen, boiling at — 195·814° C.

The final separation and purification of the gases is as follows. As argon distils, a proportion of oxygen passes over with it; this is removed by combining it with hydrogen, while any nitrogen that comes over is brought into contact with metallic calcium and is thus eliminated at a high temperature. The purification of neon and helium is accomplished by first absorbing and then re-evaporating them from carbon. Krypton and xenon, although easily condensed, are the rarest, and they too are purified in the same manner as neon and helium.

Neon Signs

These gases are used commercially in the popular electric signs displaying various advertisements; this is especially so of neon with its characteristic red discharge. Many of these illuminations, however, are not due to the discharge of electricity through the gas (or mixture of gases) themselves, but are produced in hot-cathode tubes, in which the cathode or negative electrode is covered with sodium, cadmium, or other oxide in an atmosphere of argon. The sodium lamp emits a yellow and the cadmium a blue light. Neon in conjunction with mercury furnishes a green light.

USEFUL PHOTOGRAPHIC ACCESSORIES

By " Photographer "

Dealing with the Construction of a Cover for a Developing Dish; an Electric Shutter Release for a Camera and a Plate-washing Rack

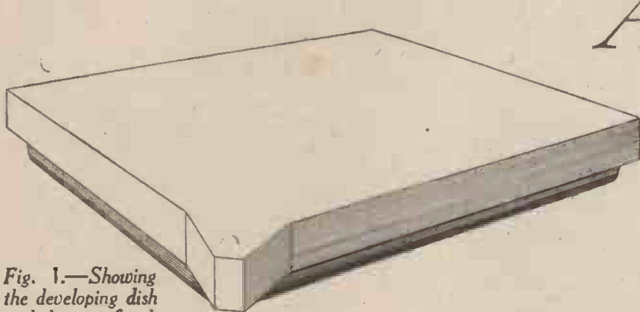


Fig. 1.—Showing the developing dish with the cover fitted.

IN an article on page 515 of our August issue, describing an apparatus for automatically rocking the developing dish, it was stated that, having once set the pendulum swinging, one could leave the dark room. It is certainly a great convenience to be able to do this, particularly when panchromatic plates are being dealt with in total darkness. To enable one to open the door of the room, however, during daylight, or when there is actinic light of any kind outside of the room, it becomes necessary to first cover the developing dish in such a way that no light can possibly reach the plate. The first of the items dealt with, therefore, is a cover which can readily be slipped over the dish and make a perfect light-tight joint around its rim.

Figs. 2 to 4.—A plan showing the rim of the dish and the cover in position. An enlarged cross section through one side of the dish and cover. An alternative joint in the framing of the side.

The Developing Dish

Most amateur photographers who do serious work use dishes made of porcelain, white glazed Staffordshire ware or white enamelled iron. It is essentially for the porcelain dish that the cover, shown in Fig. 1, has been specially designed.

The Dish Cover

Fig. 1 is a perspective view of the cover finished and fitted over a dish, whilst Fig. 2 is a plan showing the rim of the dish and the cover in position. Fig. 3 is an enlarged cross section through one side of the dish and cover together, whilst Fig. 4 is an alternative joint in the framing of the side of the cover at the point where it fits over the spout of the dish. It will be found that porcelain dishes of different makes vary considerably in their exact outline, so the plan views, Figs. 3 and 4, show the spout as it may occur in one type of dish, and the reader must modify the construction at this point to suit his particular dishes. The idea and construction are, of course, applicable to any size dish from half plate, or even perhaps quarter plate, upwards.

As will be seen, the top is a piece of 5-mm. plywood glued, preferably with a cellulose cement, to the framing, and pinned or bradded as well. The corners are filled with fillets of wood and the whole treated with two coats of shellac varnish. The size of the inside of the cover should be about $\frac{3}{16}$ in. larger all round, than the dish. A strip of thin felt, *a*, is then folded and bent to the sides, as shown in Fig. 3, sweeping round the corner fillets, with a neat bend. Over this is placed a single thickness of felt, *b*, turned over the bottom edge of the sides, and pinned to the wood. It is also brought well over the inside of the plywood top, and either pinned or stuck with the cellulose cement, to the plywood. This completes the cover, and when tested over the dish, it should be found to slide on easily, lift off without raising the dish, and yet make a perfectly tight joint. The felt used, of course, should preferably be black, and the lid may very well be given a coat of dead black lacquer on the inside.

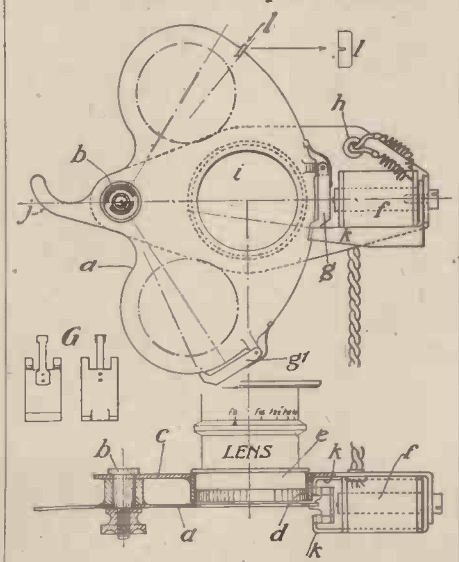


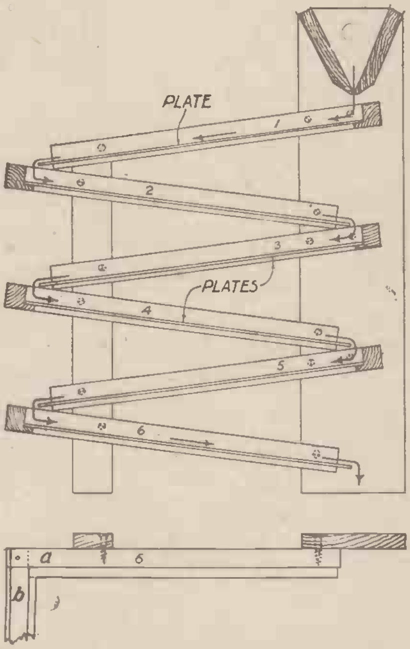
Fig. 5.—Details of an electrical release.

A Camera Lens Shutter

Many photographers at some time or another find the need, when using a field camera, for a shutter which can be operated from a considerable distance. For self-portraiture, for instance, such a shutter is indispensable: so also is it necessary when one is taking a family group, or a group of friends, and it is desired that the photographer himself shall be included in the group. There are times, too, when in making nature studies of birds or animals, it is advisable to remove oneself to a considerable distance away from the object being photographed. Suppose one has set up a camera to focus a bird's nest on the ground glass, and one wishes to expose the plate when the parent birds are feeding their young, it would be necessary for the operator to be entirely hidden and at some distance away. With a shutter which can be released from a distant point, he can watch the nest, and expose the plate just at the critical moment.

The well-known Thornton-Pickard shutter is a type which enables one to make an exposure without touching the lens of the camera, the release being by means of a pneumatic ball and tube, but whether such a shutter could be worked with a length of as much as 40 ft. or 50 ft. of tubing between the ball held in the hand and the camera is very questionable, and an electrical connection would be far less bulky and more reliable.

A suitable electrical release shutter is shown in Fig. 5. This consists of a simple swinging quadrant, *a*, pivoted at *b* on a brass plate, *c*, having soldered in it a tube, *d*, of such diameter which, lined with velvet, will fit over the hood, *e*, of the lens in the place of the ordinary cap. The plate, *c*, extends outwards sufficiently far to carry a small electro-magnet, *f*. The core of this electro-magnet operates on two armatures, *g* and g^1. These armatures are of soft iron and are fitted with very light springs to keep them pressed on to the rim of the quadrant, *a*. The ends of the winding of the electro-magnet are connected to the ends of a length of flex which passes through a hole in the plate, the plate being bushed with a fibre eyelet, *h*. The quadrant is provided with a circular aperture, *i*, having a diameter equal to that of the lens. On the opposite side of the pivoted point to the aperture is a finger hook, *j*, the use of which is to set the shutter. The other end of the flex, which may be of any such length as the



Figs. 6 and 7.—Details of the plate-washing rack. (Below) An end view of the rack.

operator may desire, terminates in a small press-button and a pocket flash-lamp battery, both of which items may be combined in a small case which may be carried in the hand or in the pocket.

To set the shutter, which operates by gravity and is designed to give time exposures only, the lever, *j*, is pulled down until the armature, g^1, engages with the lugs, *k*, *k*, on either side of the electro-magnet. On pressing the button and passing the current through the coil of the electro-magnet the armature will be attracted towards the core and will be drawn off the stop, *k*. The button is immediately released after pressing and the shutter will fall until the second aperture, *g*, engages with the stops. The lens is then open and the exposure commences. To close the shutter the button is pressed a second time and the shutter recommences to fall until the little plate, *l*, comes to rest on the stop, *k*.

Detailed views of the armatures, which are both exactly alike, are shown at *G*, where the left-hand sketch shows the outside and the right-hand sketch the inside faces of the iron plates complete with their springs. The pivot pin, *b*, has a head which should be soldered into the plate, *c*. The opposite end of the pin is shouldered down, screwed and fitted with a milled nut. The quadrant has a bush soldered on to it, drilled to make a nice fit over the pin, *b*. The shutter may be finished in bright lacquered brass all over, except the back of the quadrant next to the lens, which should be either oxidised or coated with dead-black lacquer. Incidentally, it may be mentioned that a simple way of providing the electro-magnet is to remove one of the bobbins from an old electric bell.

A Plate-washing Rack

The third item is a rack built up of wood. It holds six plates, and is intended for placing in the sink of the photographic dark room, under the usual water tap. No tank is necessary, and it costs but a few pence to construct. The material is chiefly the rebated wood, the size of which should measure about $\frac{3}{8}$-in. or $\frac{1}{2}$-in square. From this, six frames are made up, each having three sides.

Fig. 6 shows a longitudinal section through the rack with the photographic plates in position resting on the rebates. Fig. 7 is an end view of the plate rack, whilst Fig. 8 is a part horizontal cross section. From these views it will be seen that the racks are held together by screwing to four uprights, two on each side, two of the uprights being considerably wider than the others. Between these wide uprights there are two pieces of wood, screwed at such an angle to each other that they form a trough, leaving a narrow slit $\frac{1}{16}$ in. between them at their bottom edges. The joints in the frames, which are shown in Fig. 6 numbered 1 to 6, are made as shown at *a* and *b* in Fig. 7.

Two sketches of the same piece of wood viewed from different positions are also shown at *b* and *b* (Fig 8). It will be seen that the tenon on these fits into an open mortise, *a*. The joint should be glued with cellulose cement and pinned, preferably with a little hardwood dowel. The frames 1, 3, and 5 are secured in the uprights, vertically over each other, and these are staggered to

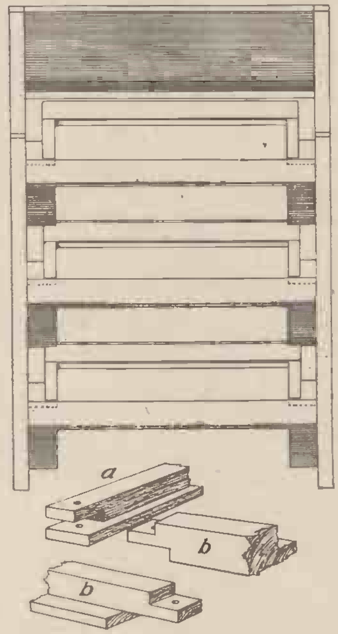


Fig. 8.—A part horizontal cross section of the rack.

an extent of about $\frac{1}{4}$ in. with the other three frames, 2, 4, and 6.

It will be seen that if photographic plates are placed with their film sides upwards on the rack, and pressed up against the rebated upper edge of each frame, there will be a clear passage for water from the trough, which is kept filled by being placed under the tap, first over plate number 1, then over plate 2 and so on, until it falls from the lower edge of the bottom plate, No. 6.

An Old Slave Trader in Modern Guise

A SEVENTY-YEAR-OLD sailing vessel stated to be the only brigantine at present sailing under the British Flag is shown on the right. At one time she was known as *The Island*, but now bears the name of *Lady of Avenel*. She is said to have once been owned by Captain Downham, the skipper of the famous *Cutty Sark*.

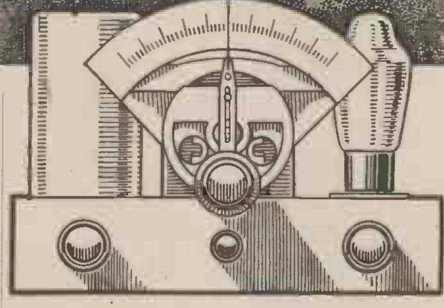
The ship has made two trips to the Arctic under the command of Algarrson, the noted explorer, and prior to that is believed to have been engaged in the African Slave Trade.

Recently she was acquired by one of the principals of a well-known Leeds store, who has had her refitted on entirely up-to-date lines. In her new equipment figures a modern electric lighting system. In addition, a Diesel lighting set, a motor-driven pump, wireless, and heating plugs, and other electrical plant and appliances have been installed.

In the four double cabins, dining-saloon and two bathrooms with which the vessel is fitted, electricity has been introduced so as to provide as nearly as possible the complete electric home afloat.

The "Lady of Avenel," said to have once been owned by Captain Downham, the skipper of the famous "Cutty Sark."

The PRACTICAL MECHANICS WIRELESS EXPERIMENTER



THE P.M. CLASS—B FOUR

Constructional Details of an Efficient Four-valve Receiver Employing a Class—B Valve in the Output Stage.

Class—B Output Valve Ensuring Good Quality

Efficient H.F. Stage Providing Adequate Selectivity

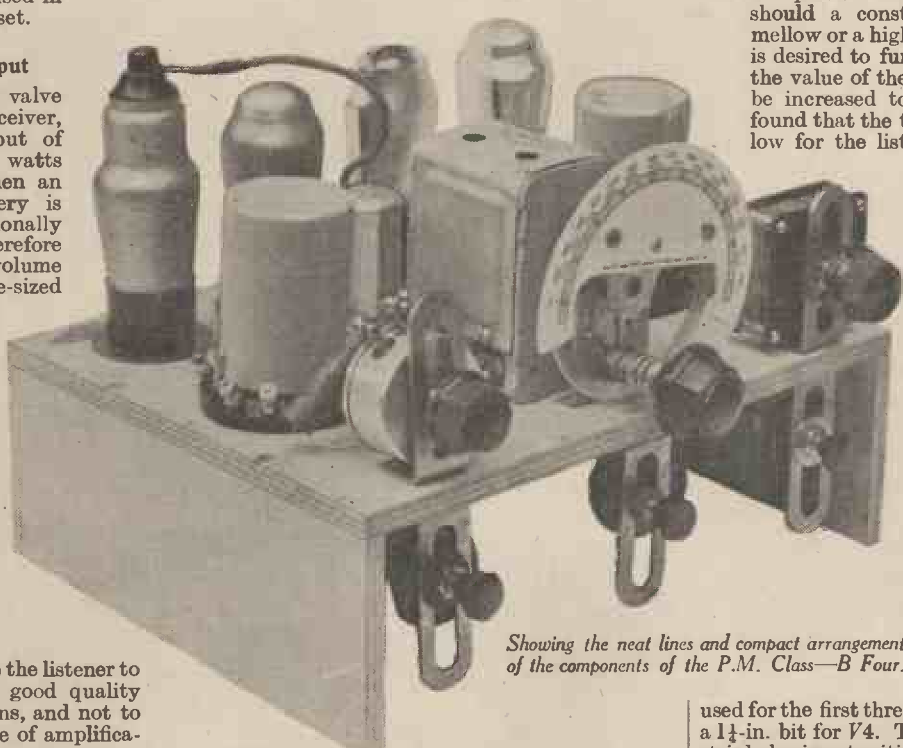
It is a generally accepted fact that a valve having a rated undistorted output of over 1 watt must be used if really good quality of reproduction is desired. This wattage is easily obtainable when mains valves are used, but when batteries are employed for supplying H.T., the consumption of a straight valve capable of providing 1 watt will be approximately 20 mA. This, of course, necessitates the use of an expensive triple-capacity dry battery, or an H.T. accumulator. In battery sets it is therefore customary to use a triode power valve or an economy pentode in order to keep the consumption within the limits of the normal-sized dry battery. These valves have a rated undistorted output of 500 milliwatts or less, and therefore slight distortion is experienced when a heavy passage is being reproduced. The advent of the Class—B valve made it possible to obtain an output of over 1 watt with an average consumption of 10 mA. however, but this type of valve has the disadvantage of requiring an extra L.F. stage, known as the driver stage, which adds to the cost of the receiver, and therefore it is not used in the cheaper type of set.

The Undistorted Output

With the Class—B valve incorporated in this receiver, an undistorted output of approximately 1½ watts may be obtained when an 120-volt H.T. battery is employed. Exceptionally good quality is therefore obtained with a volume sufficient for a large-sized living-room. It is pointed out, however, that when a Class—B is added to a three-valve receiver the overall amplification is not greatly increased, as the driver transformer is of the step-down type. The volume of distant stations is not therefore materially increased, and it is emphasised that the purpose of the Class—B valve is to enable the listener to obtain exceptionally good quality from the local stations, and not to provide a high degree of amplification.

Circuit Arrangement

A study of the theoretical diagram will indicate that the circuit comprises an H.F. stage, transformer coupled to a leaky grid detector, this being transformer coupled to an L.F. valve, which acts as a driver for the Class—B stage. Transformers have been used in the H.F. stage in order to ensure adequate selectivity and perfect stability. It will be noticed that the intervalve H.F. transformer is parallel fed; this method of connection prevents the passage of direct current through the coil winding, and it has been found in practice that this provides a greater margin of stability than the normal method of joining the primary winding between the H.F. valve anode and H.T. +. It was decided to use an L.F. transformer following the detector valve in preference to a resistance-capacity coupling so as to counterbalance the step-down effect of the driver transformer. The anode circuits of the detector and driver valves have been effectively decoupled by means of resistances and high-capacity condensers, and therefore perfect stability is ensured in the L.F. amplifier. Like the pentode valve, the Class—B valve tends to over-accentuate the higher frequencies, and therefore it is desirable to reduce the treble response by connecting a condenser across the driver transformer or across the speaker terminals. It was decided in this receiver to connect the tone condenser across the speaker, as in this position it is more easily changed should a constructor favour a more mellow or a higher pitched tone. If it is desired to further reduce the treble, the value of the condenser *C*11 should be increased to ·01 mfd., but if it is found that the tone is already too mellow for the listener's requirements, a condenser having a capacity of approximately ·003 mfd. may be substituted for the ·005 mfd. component.



Showing the neat lines and compact arrangement of the components of the P.M. Class—B Four.

The Construction

If the wiring diagram and photograph are carefully studied no difficulty whatever should be experienced with the constructional work, as the components are evenly spaced on the top and underside of the chassis. It is advisable to commence by drilling the valveholder holes and the holes for the aerial and earth strip on the back runner. A ⅞-in. bit may be used for the first three valveholder holes and a 1¼-in. bit for *V*4. The size of the terminal stripholes is not critical, but a ¼-in. drill will prove quite satisfactory. It is emphasised that the valveholders must be centrally placed in the holes in order to keep the sockets clear from the metallised surface of the baseboard, and when mounting the component brackets for the three switches short screws must be used, otherwise contact may occur between the brackets and the metallised surface of the chassis. If the specified volume control and reaction condenser are used, the brackets for these components may be screwed to the baseboard, as the spindles are not making contact with the moving arm and moving vanes of these components. It is essential, however, that good contact be effected between the tuning condenser chassis and the metallised surface of the baseboard as the tuned circuit is completed through the chassis.

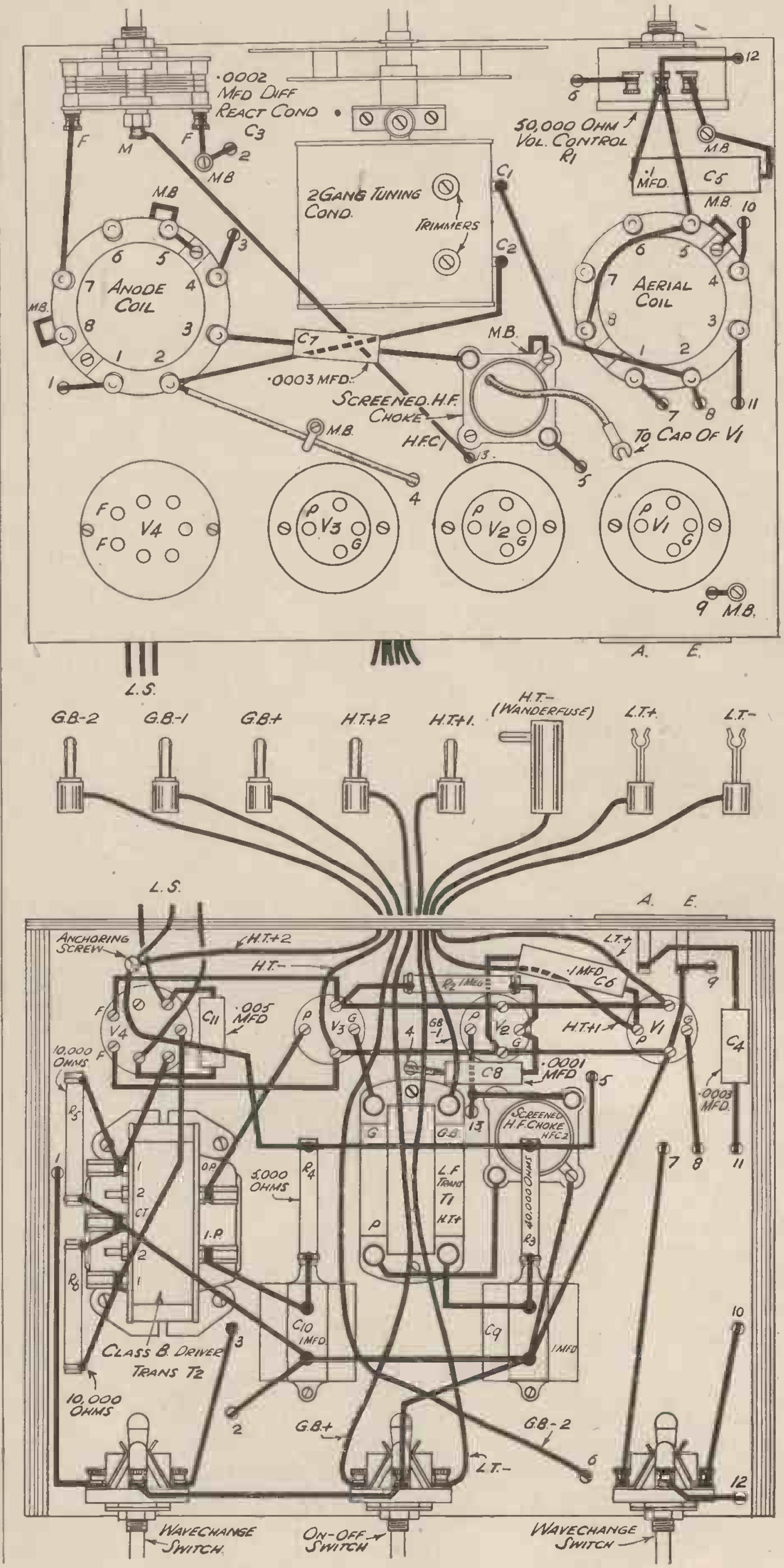
The Wiring

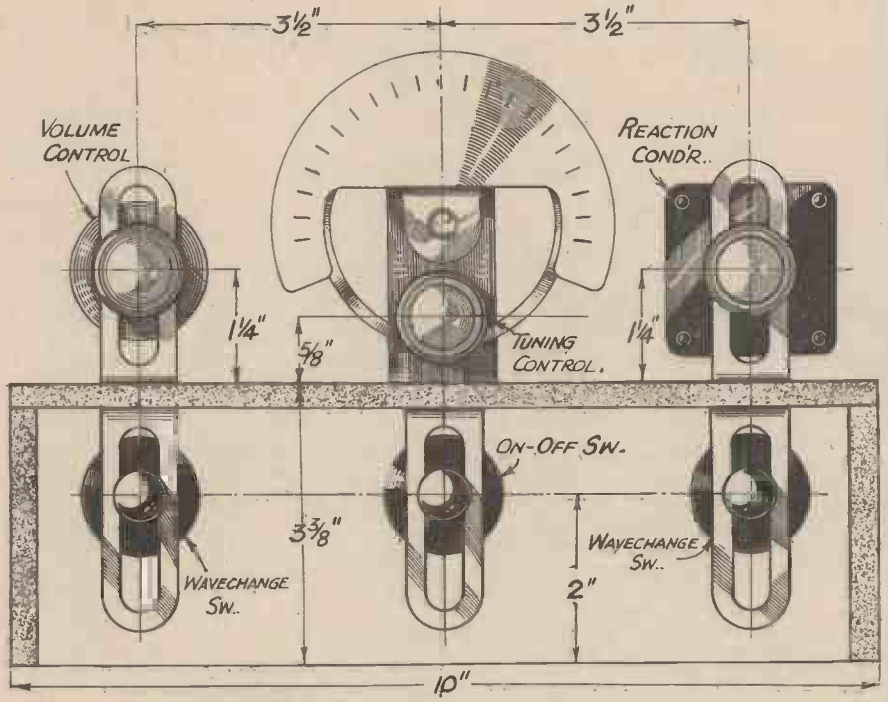
After the components have been mounted, the wiring may be commenced at the aerial terminal, proceeding to the coils and then following the valve sequence to the output stage. There is one point that needs special mention at this stage. Three leads are shown joined to an anchoring screw near the Class B valveholder; it is advisable to place a washer underneath this screw in order to ensure good contact between the three leads, and great care must be taken to prevent the screw from piercing the

LIST OF COMPONENTS FOR THE P.M. CLASS–B FOUR

- Two Coils (Varley).
- One Two-gang Condenser, ·0005 mfd., with drive, *C*1, *C*2 (J.B.).
- One Reaction Condenser, ·0002 mfd., differential type, *C*3 (J.B.).
- Eight Fixed Condensers: two ·0003 mfd., *C*4, *C*7; one ·0001 mfd., *C*8; one ·005 mfd., *C*11; two 0·1 mfd., *C*5, *C*6; two 1 mfd., *C*9, *C*10 (Amplion).
- Five Fixed Resistances: one 1 meg., *R*2; one 40,000 ohms, *R*3; two 10,000 ohms, *R*5, *R*6; one 5,000 ohms., *R*4 (Erie).
- One Potentiometer, 50,000 ohms, *R*1 (B.T.S.).
- Two H.F. Chokes, HFPJ and HFPA (Wearite).
- One L.F. Transformer, 3:1 (B.T.S.).
- Three Three-point Switches (Ward & Goldstone).
- One Driver Transformer (Wearite).
- Four Valveholders, three 4-pin and one 7-pin (Clix).
- Five Plugs: H.T.1, H.T.2, G.B. – 1, G.B. – 2, G.B. +.
- Two Spades: L.T. +, L.T. – (Belling-Lee).
- One Fuse Plug with 60 mA. Fuse (Belling-Lee).
- Five Component Brackets (Peto-Scott).
- One Terminal Strip, A. E. (Clix).
- One Chassis, 10 × 8 × 3 in. (Peto-Scott).
- Four Valves: one VP215, one D210, one L210, one B230 (Hivac).
- 120-volt Super Life H.T. Battery (Drydex).
- 9-volt G.B. Battery (Drydex).
- 2-volt Accumulator, Type CZG4 (Exide).
- One Speaker (Amplion).

ABOVE AND UNDERNEATH CHASSIS WIRING PLAN OF THE CLASS–B RECEIVER





Details for marking out the panel of the P.M. Class—B Four.

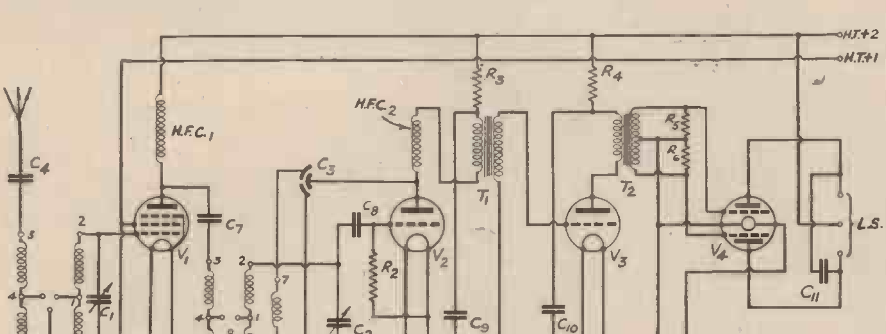
metallised surface of the baseboard, otherwise the H.T. battery will be short-circuited.

Adjusting and Operating

When the wiring has been completed and carefully checked, the battery, loud speaker, and aerial-earth leads may be joined up. H.T. + 2 should be joined to the 120-volt socket of the H.T. battery and H.T. + 1 to the 60-volt socket. The plug marked wander fuse should be plugged into the H.T. — socket. This plug incorporates a fuse which safeguards the valve filaments should the filament circuit become accidentally connected to a point at high potential. G.B. — 2 should be joined to the — 9 socket of the G.B. battery and G.B. — 1 to the — 4½ socket, G.B. + being then plugged into the positive socket of this battery, and L.T. — and L.T. + spades to the negative and positive terminals of the 2-volt accumulator. It will be noted that there are three speaker leads, and therefore a speaker having a centre-tapped transformer must be used; the specified speaker is of this type.

Testing Out

The receiver is now ready for switching on, this being done by means of the centre switch on the underside of the baseboard. The other two switches are for wave changing and should be pulled out for preliminary tests; this is the medium-wave position. A number of stations may probably be tuned in the first time the tuning control is rotated, but best results must not be expected until the trimmer condensers of C1 and C2 have been adjusted. This is a simple procedure, however, it being only necessary to adjust C2 to approximately half-way setting and then tuning in a moderately weak transmission at approximately 300 metres and adjusting the trimmer of C1 until maximum volume is obtained.



The circuit dia ram of the P.M. Class—B Four.

Light-traps

Ingenious Traps in which Light is used for the
and Pests which Attack Crops, Plants
Leaving Innocuous

Fig. 1.—This type of trap uses coloured light and odour to attract the insects.

LIGHT, natural or artificial, attracts most insects; it is therefore surprising that up to the present time very few serious attempts have been made to determine the practicability of using light-

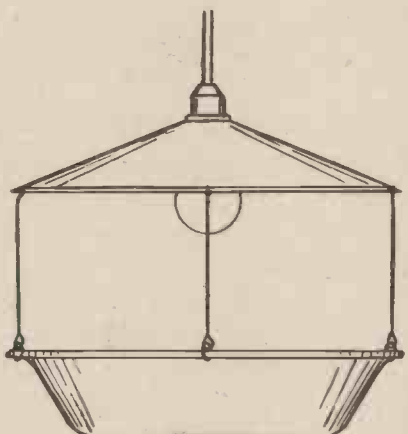


Fig. 2.—A simple type of trap which consists of a metal pan suspended under an electric lamp.

baited traps to control insect pests. Experiments in this field are of great interest, and can be carried out with simple apparatus, such as any of the devices described below.

Insects are either harmful, neutral, or beneficial, according to their effect upon vegetation; some are more than beneficial, they are *necessary*, their rôle in the economics of nature being to hold harmful insects in check. If there were no perpetual battles among insects, they would gradually destroy the human race. Harmful insects will be interpreted by many readers of PRACTICAL MECHANICS as houseflies, gnats, and similar parasites detrimental to human comfort. However, those who own gardens with one or two fruit trees and find half the fruit on the ground, damaged beyond hope through maggots, will understand the full meaning of this menace to the fruit farmer, who depends upon the crop for his living.

A Simple Form of Trap

In its most simple form, a light-trap may consist of a metal pan suspended under the reflector of an ordinary electric lamp in the manner shown in Fig. 2. The pan is three parts filled with water, to which is added a thin layer of ordinary paraffin oil, which acts as a poison. This type of trap is particularly suitable for outdoor (garden) use. For small trees a standard lamp of 60 or 100 watts will be sufficient. A frosted "daylight" (blue) lamp will often attract more insects than a clear or frosted white lamp giving the same light output. It is a mistake to imagine that a stronger light will attract a larger number of insects; in fact, a 500-watt lamp, for example, will repel rather than attract many species of insects.

Fig. 3 shows a convenient type of trap for indoor use. This consists of a round

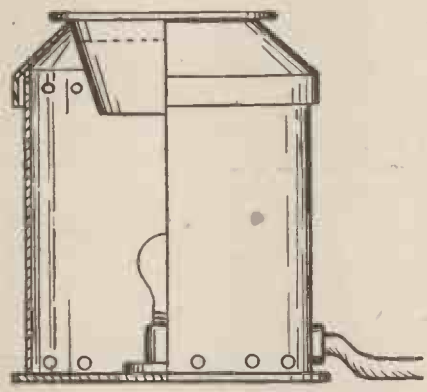


Fig. 3.—A convenient type of trap for indoor use.

metal can about 8 in. high by 6 in. diameter, a standard lamp and holder and a rimmed glass dish as used for preserves, a rubber or felt washer being glued to the under side of the rim to make a light-tight joint when the dish rests over the top of the can. The inside of the can is painted white; the outside black. As in all cases where a lamp is totally enclosed, provision should be made for ventilation; this particularly applies to light-traps, since the unwanted heat is repulsive to most insects. The method of ventilation in this case is clearly shown in the sketch. This device was placed on a table and burned for several nights in an occupied bedroom, with windows open; various species of small gnats and moths were trapped nightly, the biggest catch taking place when the base of the glass dish was provided with a disc of transparent violet cellophane. Owing to the high degree of light absorption in the rather thick glass, the water, and the colour screen, it became necessary to use a lamp of 60 watts, the rising heat from which was somewhat excessive in proportion to the size of the trap.

A More Elaborate Trap

The device shown in Fig. 4 consists of an empty can, two metal funnels, and lamp with reflector. The larger funnel, which should fit nicely over the top of the can, is cut short at *A*, so that the smaller one, previously deprived of the stem, can be soldered as shown in an inverted position. This forms a reservoir similar to the Fig. 3 arrangement, except that it is of metal and has a hollow central shaft, through which passes a vertical beam of light. By means of small cones, *B*, made of transparent coloured celluloid, light beams of various colours may be tried. It will be seen that only a very small part of the light from the lamp is utilised, the remainder serving no useful purpose; it would, therefore, be more economical to use a small flashlamp in conjunction with a suitable transformer. The best arrangement, however, is to cut the inverted funnel as short as possible to permit the use of fairly wide cones, and use a concentrated filament lamp giving a spot-

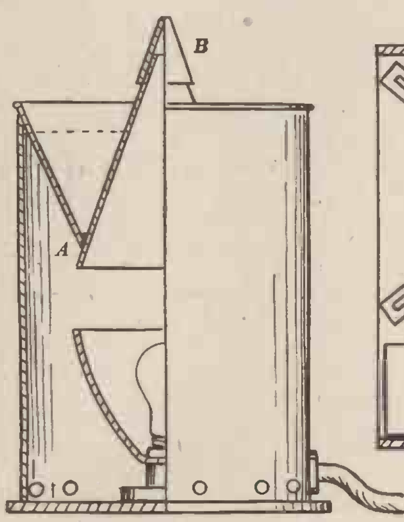


Fig. 4.—A more elaborate type of trap.

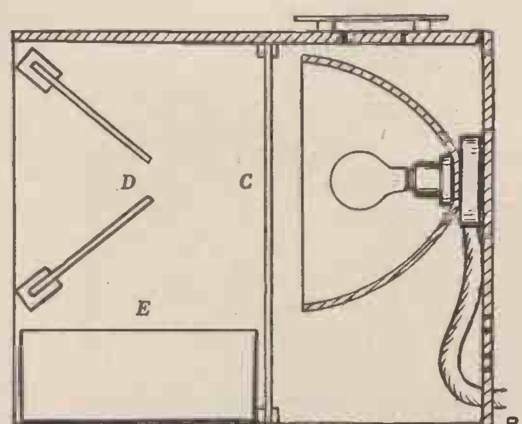


Fig. 5.—A simple idea of which many modifications are possible.

for Insects

"Bait" to Attract and Destroy Particular Insects and Flowers, at the Same Time Insects Unaffected

light. The points on the celluloid cones should be cut off in order to complete the ventilation system.

Fig. 5 shows a simple idea of which many modifications are possible. The device consists of a box fitted as shown with a lamp and reflector, a thin clear-glass panel *C*, two sheets of clear glass *D*, and a metal pan *E*, containing the usual mixture of water and paraffin oil. The space between the two pieces of glass *D* is ¾ in.; this is the entrance through which the insects pass in an effort to reach the lamp, and in battling against the glass panel *C* they become exhausted and fall into the pan.

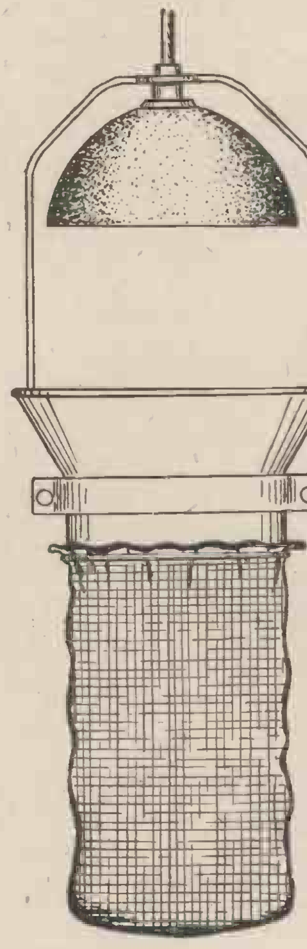


Fig. 7.—A large type of insect trap which has proved very successful.

Special Bait

The trap shown in Figs. 1 and 6 permits as bait a combination of coloured light and odour. It is made from two large metal funnels, some empty tins, a narrow-angle metal funnel as used by pastry-cooks, a 15-watt (sewing machine) lamp with porcelain holder and a metal or bakelite tube. The large metal funnels are cut and arranged as shown, the part *G* being provided at the top with a baffle *K*, and at the bottom with a flat brass band soldered round the periphery, which is made a push-on fit over the rim of the part *H*. The bottom of *H* is made a push-in fit in the top of the stand *J*, which carries the lamp-holder; thus the three main parts are easily detachable. The joint *H–J* is made as follows: a selected boot polish or similar flat tin, with lid, is thoroughly cleaned, and the half forming the base is provided with a hole large enough to pass over the lamp and holder. This is then soldered into the bottom of *H* in such a way that when the other half of the tin, forming the lid, is soldered into the top of *J*, a good push-in fit is obtained. The lamp-holder is bolted to the lid portion, and a few holes complete the ventilation system (air uptake through holes in bottom of *J*, via holes round lamp-holder and perforation in top of tube *M*). The reservoir *L* is formed by cementing the rim of the glass funnel to the inner wall of *H*, the inside of the funnel being first coloured with blue or violet lamp stain. The cement used by the writer was made by melting 20 parts of resin with 2 parts of plaster of Paris and 1 part of boiled linseed oil. The glass funnel and *H* should be well warmed and the cement applied while hot.

The odour emitter (which also isolates the heat from the entrance to the trap) consists of the tube *M*, about 6 in. long, which is perforated at the top and fitted with a wooden plug carrying a thin wooden rod provided at its lower end with a binding of cotton-wool. For houseflies this should be saturated with a solution of beer and sugar or with a solution of ammonium carbonate.

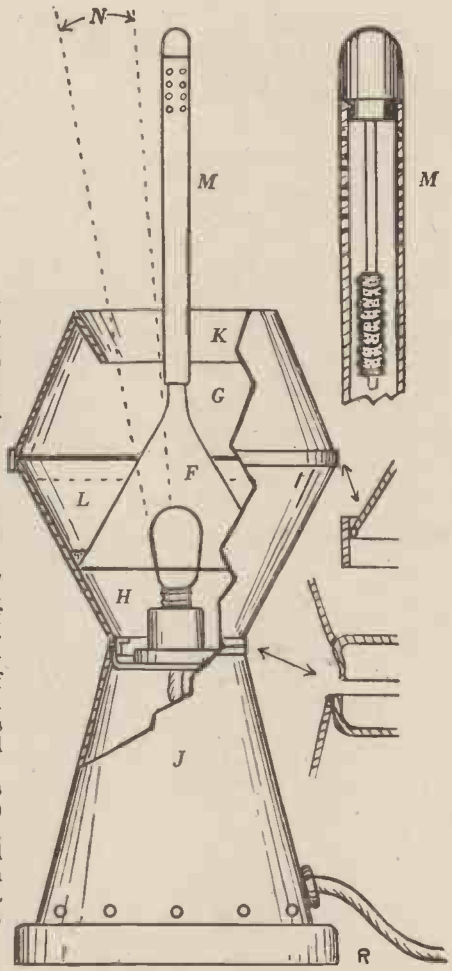


Fig. 6.—Details of the trap shown in the photograph on the opposite page.

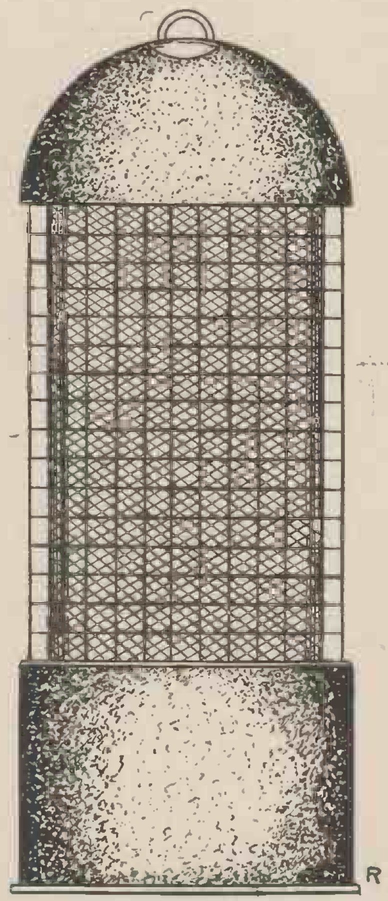


Fig. 8.—This type of trap electrocutes the flies.

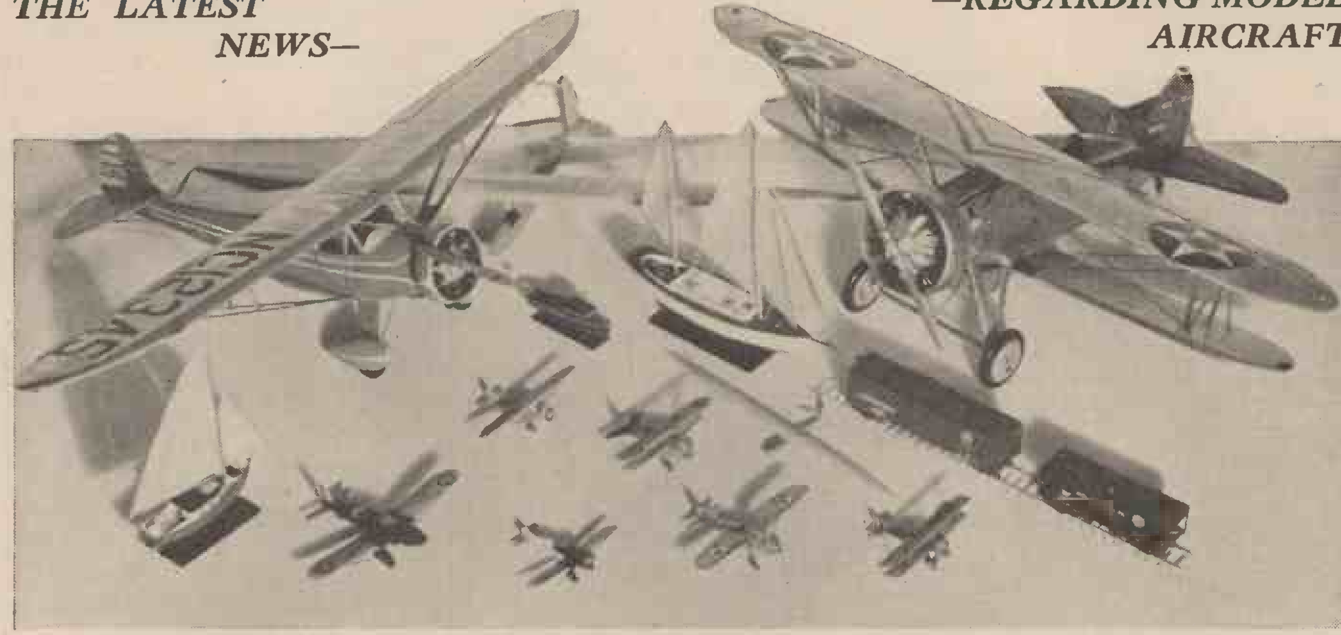
The design of the reservoir and baffle is such that, should the surface of the liquid become dense with a covering of insects, the trap still remains luminous and continues to attract more insects via the free area *N*, where there is always an uninterrupted intensity of light so long as the lamp is burning. As in other instances, the dimensions of the various parts will depend upon the size of the funnels, etc., available. The trap shown in Figs. 1 and 6 has an overall height of 18 in. and a diameter (at *G–H*) of 7 in.

In the U.S.A. successful experiments have been made with the types of traps shown in Figs. 7 and 8, which are giants compared with the indoor traps described above. In Fig. 7 a 300-watt lamp in a conical reflector is suspended over a cylinder in which is placed an electric fan to create a strong downward draught. A muslin bag about 3 ft. long is attached to the lower end of the cylinder.

The electrocuting device shown in Fig. 8 comprises an inner cylinder of fine metal gauze and an outer cylinder of very coarse metal gauze, separated only by a few millimetres. Inside the inner cylinder is a bright light, and across the two cylinders there is a potential of about 1,000 volts. Passing through the outer cylinder to get to the light, the insects are greatly agitated by the strong electric field between the two cylinders, and in fluttering about they complete the high-voltage circuit and are electrocuted or momentarily stunned.

MODEL AERO TOPICS

THE LATEST NEWS— **—REGARDING MODEL AIRCRAFT**



A fine array of models. The smaller models in the foreground consist of ships, trains, and aeroplanes, and are built to $\frac{1}{8}$-in. scale.

WE have recently had the pleasure of inspecting some of the products supplied by Messrs. Williams, Ellis & Co., Ltd., the well-known model aeroplane manufacturers. Their "Welcom" constructional model aeroplane sets which sell at 1*s*. are excellent value for money. Each kit consists of a complete set of parts (partially finished), which can be made up with the minimum of trouble into $\frac{1}{48}$-scale models of famous aeroplanes. Considerable care has been taken in designing the parts, so as to provide each constructor with every unit necessary to make the finished model. All machine work has been done, and all the parts are attractively mounted on a card. The popularity of these kits was emphasised by a recent competition, run in this journal, for the best model of a SE5A, made up from a "Welcom" kit of parts. Hundreds of models were sent in and the workmanship was extremely good. Kits of parts are available for the following models: Comper Swift, D.H.60, Puss Moth, Percival Gull, Auto Giro, Sopwith Camel, S.E.5A, Bristol Fighter, and the Hawker Hart.

A Flying Model Aeroplane

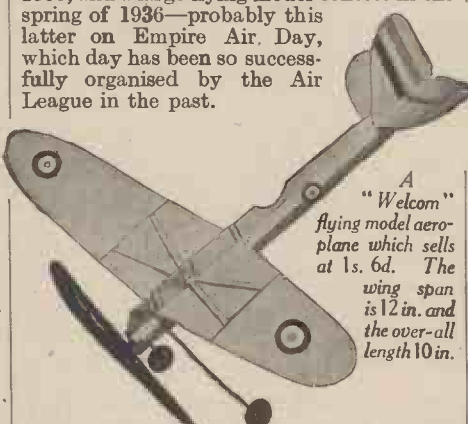
The above firm also market the "Welcom" flying model, shown on this page, which sells at the very reasonable price of 1*s*. 6*d*. The model is constructed of a new metallised material which, although extremely light in weight, will withstand any amount of rough usage.

New Era in Model Aeroplanes

Suggestions made by Messrs. Williams Ellis & Co., Ltd., for the organisation of national constructional and flying model aeroplane competitions have been adopted by the Air League of the ritish Empire.

The League recognise that model aeroplane building and flying are of great value in stimulating the air interest of the young, and intend holding competitions throughout the country.

It is proposed that the first constructional competition shall be held about Christmas 1935, and a large flying model contest in the spring of 1936—probably this latter on Empire Air Day, which day has been so successfully organised by the Air League in the past.



A "Welcom" flying model aeroplane which sells at 1s. 6d. The wing span is 12 in. and the over-all length 10 in.

The League intends securing the maximum publicity for the main competitions through the national and local press, and undoubtedly this publicity will stimulate nation-wide enthusiasm in model aircraft.

Flying Scale Models

Another firm specialising in scale model aircraft is Messrs. F. P. Sweeten Ltd., 38, Bank Hey Street, Blackpool. These models, which actually fly, are obtainable in kits of parts at various prices. Each kit contains formers and ribs clearly machine printed on high-grade balsa; many balsa stringers; wing spars; special quick-drying cement; banana oil for fastening Japanese tissue; rubber for motor; turned balsa (or hardwood) wheels; a shaped balsa propeller; bottle of coloured dope, and a full-size plan with the necessary instructions. A feature of these plans is the detailed instructions for painting the finished model, if it is desired for exhibition purposes. Each kit builds up into realistic models similar to those shown on this page.

Power-driven Model Aircraft

This up-to-the-minute handbook deals with the *very latest* models—not the unsatisfactory contraptions which are often seen crashing and which the uninformed consider "modern"!

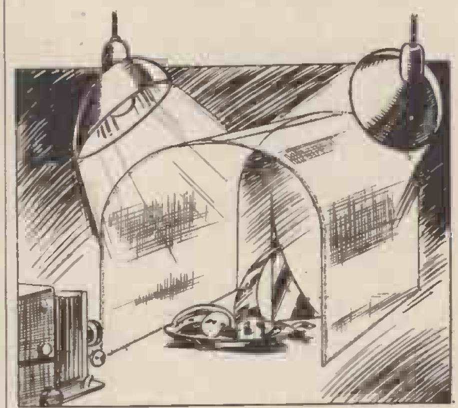
A realistic model of a Martin bomber.

HINTS AND TIPS

A Photographic Hint

WHEN photographing highly polished objects, some method of diffusion must be allowed for, to avoid undesirable glare in the high lights.

The hood shown in the sketch will be found suitable for this purpose.



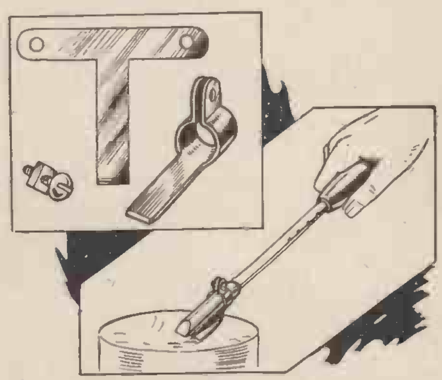
A device to aid in the photographing of highly polished articles.

The framework is made from fairly stout wire, and over this is stretched a piece of fine cotton gauze.

The objects to be photographed are simply arranged on the table and the hood placed over them, the lighting being adjusted to give the desired effect.

For a Soldering Iron

THE little scraper shown in the sketch is very easily made, and will greatly improve the efficiency of any soldering iron.



A useful soldering hint.

It quickly scrapes away any excess solder on a job before it has time to harden.

The scraper is cut from a piece of steel or brass to the shape shown in the sketch, and one end is sharpened.

Bend the collar around the copper bit and fasten with a nut and bolt.

Now simply bend the blade down to a right angle.

A NEW HANDBOOK!

LATHE WORK FOR AMATEURS
1/-, or 1/2 by post from George Newnes Ltd., 8-11 Southampton Street, Strand, W.C.2.

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 Model Helicopter

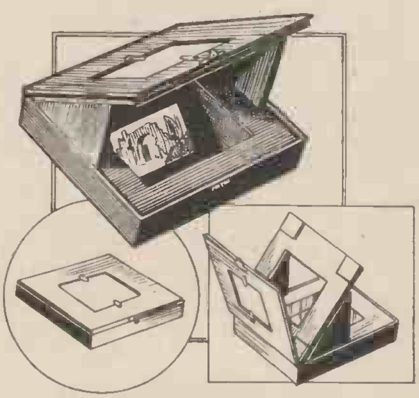
OF simple design, a model helicopter is now being marketed that will afford endless amusement to the younger readers of this journal. It consists of a wire frame to which is attached a tin propeller, which is driven by elastic. To fly the model, rotate the propeller in a clockwise direction for about a hundred turns. Hold the toy in a vertical position by the tailpiece, at the same time preventing the upper blades from rotating with the right hand. When released the model will rise vertically into the air. It costs 1*s*. 6*d*. [140.]

A Useful Photographic Device

A REFLECTOR type of apparatus has been placed upon the market by a well-known firm, for viewing transparencies.

The transparencies are placed in the lid section of the device, the operator viewing the reflected image in a mirror.

Remarkable results are obtained by using this instrument, a great depth being imparted to the images with a kind of stereoscopic effect by means of the reflection mirror.



Details of the photographic device for viewing transparencies.

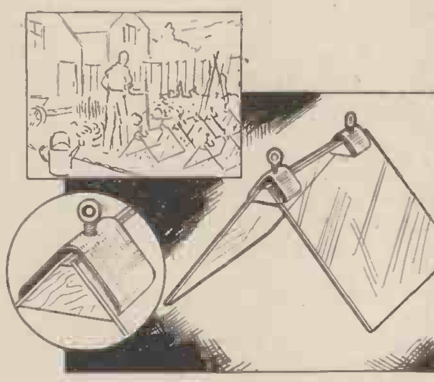
Primarily designed for viewing transparencies, it will be found most useful when scanning negatives for defects. It costs 2*s*. 6*d*. [141.]

Cold-water Glue

A COLD-WATER glue is now obtainable from most stores, in powder form, which will make a considerable quantity of waterproof glue. To a small quantity of cold water add gradually an equal quantity of glue powder (do not add water to powder), and stir well. The resulting glue is much stronger than bone or fish glue. Joints made with this product will withstand damp atmospheres, hot and cold water, heat, and most chemicals. The powder is supplied in tins at 6*d*., 1*s*., 1*s*. 6*d*., 2*s*. 6*d*., and 5*s*. [142.]

Glass Frames for the Garden

GARDENERS will find these simple glass clamp frames most useful for forcing up plants and seedlings. Assembly is extremely simple, and they are every bit as effective as the bell or cloché forcing glass, with the added advantage of economy in storing space, during the autumn and winter months. The clamps cost 3*d*. each, and the panes of glass measuring 18 × 14 in. also cost 3*d*. [143.]

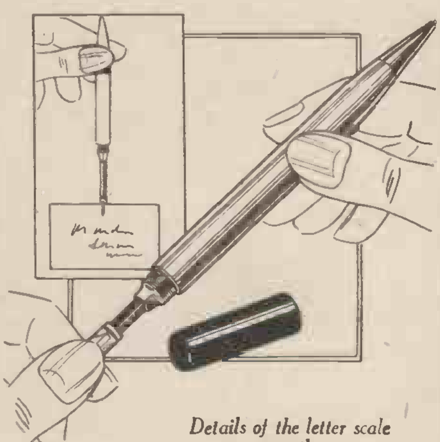


Most gardeners will appreciate this simple glass frame for forcing plants or protecting young seedlings.

A Letter Scale Pencil

THE propelling pencil shown below incorporates a novel feature in its construction. In the barrel is a spring-loaded letter scale, which is accessible when the cap at the end of the pencil is removed. By fixing the letter in the clip, as shown in the inset sketch, the weight of the letter is quickly obtained. The cost is 3*s*. 6*d*. post free. [144.]

(*Continued on page* 578.)



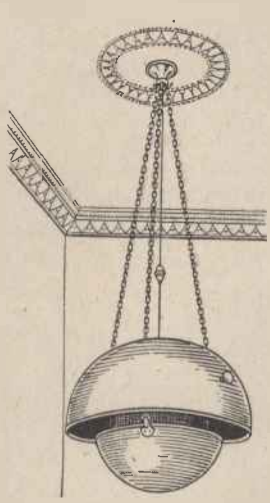
Details of the letter scale pencil.

THE LATEST NOVELTIES

(Continued from page 577.)

The Ashton Air Purifier

WHEN the air of a room contains 0·10 per cent. of carbonic-acid gas it is unfit for continued respiration. Everyone has experienced the exhilarating effect of the freshness of the air after a shower of rain. This same principle is adopted in the new Ashton portable electric air conditioning plant, shown in the sketch, which will keep the air in a room clean, cool, humid, and free from disease germs. Water is automatically raised from a reservoir, and by centrifugal force is made to form a fine spray and cascade, through which the air is continuously forced by an electric fan. Ice or lime may be added to the reservoir; the latter, being very hygienic, will greatly expedite the absorption of smoke, etc., and the destruction of insects. The deodoriser is a self-contained unit and may be switched on at intervals as desired. The price of the complete plant with ceiling plate and chains is £7 15*s*. [145.]

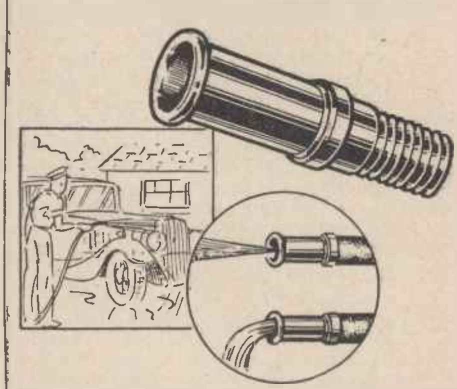


Showing the Ashton air purifier connected to the ceiling.

An Ingenious Hose Nozzle

A HOSE nozzle which can change water delivery from a steady flow into a firm jet, can now be obtained from most stores, and is shown in the accompanying sketch.

The change-over is accomplished with the minimum of effort. To change from jet to flow, a finger is pressed for a second over the outlet. The opposite change is made by giving the nozzle a sharp downward jerk. Obtainable in two sizes, the ½-in. nozzle costs 8*d*., and the ⅝-in. nozzle, 11*d*. [146.]



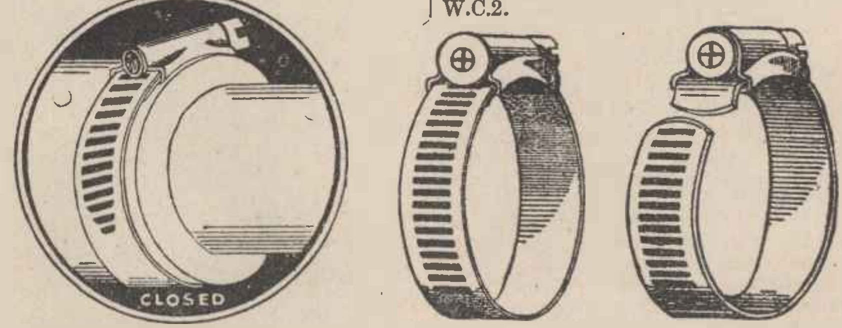
An ingenious hose nozzle that can change the flow of water from a steady flow into a fine jet.

Worm-drive Hose Clips

A Free Offer to All Readers of "Practical Mechanics"

MOST readers know how difficult it is to fit the ordinary type of clip to a hose, as there is always a danger of the rubber hose being nipped between the ends of the clip. By using the "Jubilee" clip, illustrated, however, all such difficulties are overcome, due to the fact that the ends of the circular metal strip overlap each other, and tightening causes uniform pressure over the whole circumference of the hose. This latter is ensured due to the fact that the tightening screw takes the form of a worm, the spirals of which engage with identations made in the clip.

The "Jubilee" clip is made from high-grade steel which is heavily galvanised to prevent any possibility of rust. It is made in a variety of sizes, the standard range of which varies from No. 0, for hoses of outside diameter of between ⅜ in. and ⅞ in., to No. 4, which fits hose pipes between 2¾ in. and 3½ in. diameter. The prices vary from 10*d*. to 1*s*. 6*d*. each, but as a special offer to readers of PRACTICAL MECHANICS the makers will supply one clip free of charge to anyone sending their name and address on a postcard marked "Jubilee" in the top left-hand corner to the Editor, PRACTICAL MECHANICS, Geo. Newnes, Ltd., 8–11 Southampton Street, Strand, London, W.C.2.



These views show the "Jubilee" clip attached to a water hose, closed and opened: note the ridges in the clips which operate in conjunction with the worm screw to grip and close the clips tightly and securely.

ELECTRO-PLATING AT HOME

(*Continued from page 544.*)

polished, they are electrically cleaned in a hot, alkaline solution to remove all grease.

Vat No. 2.—Cold water swill.

Vat No. 3.—*Cyanide Dip.* They then pass through a cyanide bath consisting of 8 ozs. of potassium cyanide to 1 gallon of water, to remove any stains caused by the potash solution and to give a final clean.

Vat No. 4.—Another wash in cold water.

Vat No. 5.—*Acid Dip.* They then enter an acid bath usually consisting of dilute sulphuric acid to remove all traces of cleaning solutions and to leave the articles absolutely clean and bright.

Vat No. 6.—A further wash in cold water.

Vat No. 7.—*Electro-plating.* In the case of nickel-plating, this bath consists of a hot solution of nickel sulphate, nickel chloride, boric acid, and water. The solution is kept agitated by means of compressed air, and the articles remain in the bath until they have acquired the correct thickness of deposit.

Vat No. 8.—Wash in cold water.

Vat No. 9.—Wash in hot water.

The articles are then dried and repolished according to the finish required.

While the usual object of electro-plating is to protect the base metal from corrosion, and to increase the decorative appearance, these are by no means the only uses.

One very important process is for the "building-up" of undersize or worn metal parts. In engineering work it sometimes happens that some expensive machined part may prove to be slightly undersize, or a bearing may become worn through continual use. Until recent years, such a part would have had to be scrapped, but to-day it may be built up to the correct size by properly controlled nickel-plating methods. More frequently it is built-up oversize, and then machined down to the correct size. In ordinary electro-plating, the thickness of the plating is only about ·001 in., but in this special repair work the thickness may be as much as a quarter of an inch.

Chromium-plating

Chromium owes its remarkable stainless qualities to the formation of an extremely thin invisible film of oxide over the surface, as the result of which the metal loses its chemical activity. It becomes non-reactive, and in this condition it resists to a remarkable degree the corroding agencies which would otherwise rapidly result in tarnish. Chromium is an intensely hard metal, in fact it may be deposited in such a hard state that it will easily cut glass. Its wear-resisting qualities are consequently excellent.

Unfortunately, chromium cannot be deposited directly upon any of the common base metals, as it forms a powerful electric coupling in the presence of any moisture which results in the oxidation of the underlying metal. The chromium layer is then forced off in the form of tiny flakes. The electrical action between nickel and chromium, however, is very much less than between chromium and any other common metal, and consequently, a thick layer of nickel is invariably deposited before the chromium. The nickel is a protection for the base metal, while the chromium protects the nickel and prevents oxidisation or tarnishing.

In case any readers should try their hands at chromium-plating, it must be mentioned that poisonous fumes are evolved during the process, and the work should, therefore, be done out of doors.

For the benefit of those who wish to experiment, the following formulæ give the solutions most frequently used in the actual plating bath :

1.—*Copper-plating*	
Copper sulphate	2 lb.
Sulphuric acid	8 ozs.
Water	1 gallon
2.—*Nickel-plating*	
Nickel sulphate	2 lb.
Nickel chloride	2 ozs.
Boric acid	4 ozs.
Water	1 gallon
3.—*Chromium-plating*	
Chromic acid	2½ lb.
Sulphuric acid	½ oz.
Water	1 gallon
4.—*Silver-plating*	
Silver cyanide	5 ozs.
Sodium cyanide	5½ ozs.
Water	1 gallon

Model Engineering Exhibition

THE seventeenth annual exhibition organised by *The Model Engineer* will be held at the Royal Horticultural Hall, Westminster, from September 19th to 28th. It will be opened by Sir Josiah Stamp, Chairman of the L.M.S. Railway, who will be supported by Mr. S. E. Garcke, President of the Institute of Transport, and other distinguished engineers.

Every one of our readers should make an effort to visit this fascinating exhibition, which has become one of the best national institutions. No matter in which branch of mechanics or model making your hobby lies, this exhibition provides an abundance of interest in it. It contains exhibits of marvellous mechanisms and models in miniature—railways, aeroplanes, boats, hydroplanes, machine tools; and the trade exhibits alone are well worth a visit. Here you may also inspect the best literature on your favourite subject, and converse with acknowledged experts in the various fields. A visit is an education in itself, and you will gain valuable information and inspiration.

The competition section will contain a fine show of engineering, marine, and aviation models from all parts of the country, entered for the various championship cups and other prizes. Other models of special interest will be exhibited in the Loan Section, and there will be a very comprehensive trade display of lathes, workshop equipment, and castings and materials for model making. Several working model railways will be on view, and the principal model clubs and societies will be represented by displays of members' work. The Society of Model and Experimental Engineers will have their 72-ft. railway track in daily operation, with steam locomotives hauling passenger loads. The exhibition will remain open from 11 a.m. to 9.30 p.m. each day for the period mentioned, Sunday excepted.

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.

IMPROVING ELECTRIC LAMP

"I WOULD be glad to have your opinion on the following idea relating to electric lamps.

"As an electric lamp radiates a considerable amount of heat, would it be practicable to reduce this, and also current consumption, by surrounding the lamp with a vacuum?

"If practicable, would such lamps be much more costly to produce than ordinary ones? Could the idea be patented? (R. S., Shetland.)

THE proposed construction of incandescent electric lamps is novel as far as is known from personal knowledge, and forms fit subject-matter for protection by Letters Patent. The proposed construction is feasible, but it is feared that the additional cost of manufacture would not be commensurate with the advantages to be gained; in other words, it is not considered that the invention would be commercially successful.

AN ALUMINIUM QUERY

"I WISH to make a meter dial similar to that on a commercial radio meter; it is made of aluminium and has a matt finish. I have been unsuccessful in obtaining the required finish and would be glad if you could furnish me with the necessary particulars. (1) Is it an application—if so, what is the formula? (2) Is it a process—if so, what is the process? Failing this, do you know of any place where I can get a sheet of aluminium with a matt surface." (J. P. H., Bucks.)

SOME of the matt and frosted finishes on sheet aluminium and on aluminium foils are produced by the application of a clear or coloured lacquer (usually a cellulose lacquer), but most of these finishes are produced by chemical treatment of the metal itself. In some instances, the frosted or patterned finish is printed upon the metal surface, the metal being passed through rollers engraved with the pattern and charged with etching fluid. Plain matt finishes on aluminium such as you require are obtainable without difficulty. Immerse your sheet aluminium for about half a minute in a hot solution containing approximately 20 per cent. of caustic soda in water to which, also, has been added (after the caustic soda has dissolved) as much common salt as the liquid will dissolve. After the immersion of the sheet aluminium in the above liquid, wash the metal under a tap, and then re-immerse it in the liquid, this time scrubbing the metal surface with a hard brush. When the fine matt pattern has appeared, remove the sheet metal from the solution, wash well and dry—preferably in warm sawdust. In this way, a fine-grained matt effect will be obtained.

Sheet aluminium may be obtained in almost any surface-finish—plain, matt, patterned, or coloured—from either of the following firms: Aluminium (11) Limited, Bush House, Aldwych, London, W.C.2; The British Aluminium Company, Ltd., Adelaide House, King William Street, London, E.C.4.

CHEMICAL QUERIES

"PLEASE can you supply me with information regarding the following: (1) Is there any chemical means of converting amyl acetate into amyl nitrite? (2) Can you tell me how to make ammonium sulphide? (3) Can you tell me how to make luminous paint from yellow phosphorus. I have tried dissolving it in carbon disulphide, but the solution is very inflammable. (4) Can you give me the names of some chemical compounds which explode on being heated or suddenly struck? (5) Also, can you tell me the composition of the white residue that is left after calcium carbide has given off acetylene gas." (E. J. H., Oxford.)

(1) IT is impossible to make amyl nitrite directly from amyl acetate, in one operation. In order to obtain amyl nitrite from amyl acetate, you must, first of all, heat the amyl acetate with about an equal volume of strong caustic soda or potash solution in a flask on the water bath for about three hours. This will result in the formation of amyl alcohol and sodium (or potassium) acetate. The amyl alcohol thus produced is then distilled off and carefully collected. Now place the amyl alcohol in a clean flask and add to it a quantity of powdered sodium nitrite (not nitrate). The quantity of this material added does not matter very greatly, but it should equal at least half the weight of the amyl alcohol. Cool the amyl alcohol and sodium nitrite mixture in a freezing mixture of ice and salt. Cool, also, a quantity of concentrated sulphuric acid. Now add the cold concentrated sulphuric acid *drop by drop*, and with constant stirring to the cold amyl alcohol-sodium nitrite mixture, taking great care that the temperature does not rise above about 15 degrees C. The acid added should be about the same in quantity as the alcohol. When all the acid has been added to the alcohol, allow the mixture to stand for two hours. Then dilute with water. Amyl nitrite will rise to the surface as a light yellowish liquid. It can be removed by careful decantation. It is purified by distillation, its boiling-point being 96 degrees C.

In carrying out experiments with amyl nitrite you should be very careful not to breathe its vapour which has a very powerful effect on the circulatory system of the body. Remember, also, that amyl nitrite has sometimes a slight tendency to explode when heated strongly.

(2) Ammonium sulphide is made by passing hydrogen sulphide gas into strong

ammonia water until the latter will absorb no more of the gas. The resulting yellow liquid, although it is usually termed ammonium sulphide, is not a pure compound, but is a mixture of various ammonium sulphides of different composition.

(3) It is quite impossible to make any serviceable luminous paint from yellow phosphorus, and you are advised to discontinue your experiments in this direction as they are extremely dangerous.

(4) The fulminates of lead, copper, mercury, silver, and gold are all powerful detonating substances, as are also the diazonium salts (as, for instance phenyldiazonium sulphate, $C_6H_5N_2SO_4H$). Nitrogen iodide is highly explosive on being heated or struck, whilst nitrogen chloride is the most violent explosive substance known. On no account should you attempt the preparation of any of the above compounds. Copper and silver acetylides are, also, very explosive.

(5) The white residue remaining from the generation of acetylene by the action of water on calcium carbide is lime, as will be evident from the following equation:

$$\underset{\text{(Calcium carbide)}}{CaC_2} + \underset{\text{(Water)}}{2H_2O} = \underset{\text{(Acetylene)}}{C_2H_2} + \underset{\text{(Calcium hydroxide or lime.)}}{Ca(OH)_2}$$

AN ARTIFICIAL SILK QUERY.

"I SHOULD like your advice regarding the following: (1) How can I delustre artificial silk yarn (*i.e.* remove the gloss from the yarn so as to make it look like real silk yarn, by means of some chemical bath in a home laboratory, or any other method which may be known to you)? (2) How to prepare green and silver paints for wooden furniture? What should be the method of its appliance? I find that wood sucks up the liquid portion of the paint, with the result that some rough residue remains on the surface; the view of the wood remaining unobliterated. I have seen articles of furniture polished with silver and green colours and want to do such polishing here, but do not know how." (L. H., Karachi.)

WITHOUT knowing exactly the chemical nature of the artificial silk yarn which you desire to treat for delustring, it is difficult to indicate the best procedure. Most artificial silks have their gloss removed by passing through a bath of weak acid such as dilute acetic or dilute lactic acid. Other silks are better treated by passing through a weak alcohol bath. We can only advise you to experiment in this matter in order that you may determine the best treatment for your particular needs.

The paint which you require is a cellulose paint. That is to say, it contains the coloured pigment (very finely ground) suspended in a solution of cellulose acetate in amyl acetate, or one of the other recently produced cellulose solvents. The composition of paints of this nature are not made public by the manufacturers. If, however, you incorporate aluminium powder into a solution of any cellulose compound in a suitable organic solvent, you will obtain a satisfactory cellulose paint. Such paints are best sprayed on the surface by means of a special sprayer, although, of course, they can be applied by means of a brush. In order to prevent the paint from sinking into the surface of new wood, the wood should be washed over with size water (a weak solution of glue) and then allowed to dry before applying the paint.

Patent Advice

By A. MILWARD

The services of a professional Patent Expert are available free to every reader. He will advise you on the validity, novelty, and value of any idea you may have. No charge is made for this service, but the Query Coupon appearing in our advertisement pages must be enclosed with every query.

"Protecting the Inventor"

A Reply by Our Patent Expert

I HAVE read with much interest "Protecting the Inventor," in the July issue of your valued Journal, and since it is written by a Barrister-at-Law, any criticism by one of a lesser qualification may appear presumptuous, and my only excuse must be that, as your readers are always given true expositions on the varied matters so ably dealt with in your Journal, they may deduct inferences from the above article which are not supported by facts.

It is true that in common law there is no personal property in an idea, nor is there any property in an idea under the Patent Law, which would appear to be the suggestion. An idea, *i.e.* a conception of a thing in the mind, is no more patentable than a mere discovery, whether it be the discovery of a new land or the discovery of a natural law, such as the law of gravity or the circulation of the blood. Unless a material product of a substantial character is realised or effected by the invention, it is unpatentable.

The Copyright Act does not protect a worker in the purely artistic field if the product of his labours is capable of being registered under the Designs Act, and is intended to be multiplied by an industrial process.

Originating a New Design

The originator of a new design, *i.e.*, a design "and the trader who originates a Trade Mark," is not safely guarded by the "Patent System," a new design being registrable under the Designs Acts and a Trade Mark under the Trade Marks Acts.

The "issue" of a patent is not based upon an implied contract between the inventor and the State; a patent is a grant from the King, and is binding on him, his heirs, and successors.

It is only incumbent on the inventor to fully and fairly describe his invention in his Complete Specification (the term "official specification" not being understood); it is sufficient to describe the nature of his invention in a Provisional Specification.

The failure of an inventor to observe the conditions upon which a patent is granted does not explain "why an action for infringement is often decided against the patentee." An action for infringement may not succeed, because the Court may decide that no infringement has been committed, and it is only when the validity of the patent is questioned and it is found to be invalid, which may be due to a variety of reasons, that the action is decided against the Patentee.

The Complete Specification

It is true that the Complete Specification must be sufficiently full to allow anyone skilled in the particular art to which the invention relates to be able to carry the patented invention into practice, but not necessarily at the end of the "normal" life of the patent (the normal life being sixteen years), but at the expiration of the life of the patent, it being possible to obtain an extension of the normal life of a patent up to twenty-one years, or in exceptional cases up to twenty-six years.

Although one of the objects of filing a Provisional Specification with a Patent Application is to encourage the inventor to protect his invention as early as possible, it is not the sole object; it is more usually to obtain protection at a nominal cost, thereby allowing the inventor either to work out or perfect his invention, or to obtain financial assistance in doing so, or to interest other parties in his invention. The Complete Specification on a Provisional Application is usually filed within twelve months from date of application, but this term can be extended up to thirteen months.

Two or More Provisional Applications

There is also a provision in the Patents Acts whereby two or more Provisional Applications for patents for cognate inventions can be included in a single Complete Specification, a very valuable provision which is not referred to by the writer of the article.

It does not follow that a patent will be sealed as of right after the acceptance of the Complete Specification, because there is provision for opposing the grant of a patent by any interested party on a variety of grounds during the two months in which the acceptance of the Complete Specification is advertised, and should such an opposition be successful, it may be that no patent will be granted.

Although it is true that when a patent has been sealed the Patentee is then in a position to sue infringers, the fact is not mentioned that he can claim damages in respect of infringement committed after acceptance of his Complete Specification, which may be many months before the Patent is sealed.

Issued for 16 Years

After the patent is sealed, it is issued for sixteen years, subject to annual renewal fees being paid after the fourth year, and although the normal renewal fee is £5 in respect of the fifth year, there is provision in the Patent Acts whereby this amount and succeeding fees may be halved if the Patentee requests that the patent be endorsed with the words "licences of right."

It is not correct to assume that a patent, even if the whole of the renewal fees be paid, becomes public property at the end of sixteen years, because of the provision for extending the term of a patent referred to previously.

REPLIES in BRIEF

R. T. L. A. (Malvern).—It is not possible to operate a mercury vapour lamp direct off the mains, since they require a much higher striking voltage. The special filter such as you require is obtainable from Sands Hunter & Co., Ltd., 37 Bedford Street, W.C.2. Your other questions are not clear, please repeat.

E. B. (Nr. Keighley).—Cannot trace any paper dealing entirely with Amateur Astronomy. Book on Mars probably obtainable from Sir Isaac Pitman & Sons, Ltd., Parker Street, Kingsway, W.C.2. Also get into touch with George Philip & Son, Ltd., 32 Fleet Street, E.C.4.

J. C. (Market Rasen).—The 2-valve Superhet is not suitable for radiogram operation, and I am sorry that we cannot undertake to modify our circuits to suit individual needs. We do not recommend this set for operation on a frame aerial.

R. E. (Ponders End).—Electric motors are quite unsuitable for model aeroplanes, for the simple reason the power to weight ratio is very high. A selenium cell will respond to light variations. The photo-electric cell is, of course, a better device for the purpose.

R. H. (Transjordan).—Recommend you to obtain a copy of *Wind and Wind Motors*, which may be of assistance to you. It is published by Percival Marshall & Co., Ltd., 13/16 Fisher Street, Southampton Row, W.C.1. A suitable solution for cleaning old copper and bronze is a diluted solution of sulphuric acid. The articles should be dipped in a hot solution of caustic soda, then dipped into the dilute sulphuric acid, dried in sawdust, and finally boiled in clean water. Take care not to get the caustic soda solution on the hands.

R. F. H. (Wokingham).—A suitable weed-killer can be made in the following way: cold water, 20 gallons; powdered resin, 56 lb.; creosote oil, 40 gallons; sulphuric acid, ½ gallon; caustic soda lye, 30° B., 9 gallons. Heat the water and dissolve the resin; then add creosote and boil to a brown mass and shut off steam; next run in sulphuric acid and then the lyes, as per information given in *Henley's Twentieth-Century Home and Workshop Formulas*.

B. H. (co. Limerick).—We have no record of the maximum weight lifted by the smallest amount of electrical power. Possibly Sir Isaac Pitman & Sons, Ltd., Parker Street, Kingsway, W.C.2, could advise you regarding a suitable book.

T. W. (Sheffield).—We are not permitted to publish a formula for the various gases to which you refer.

W. B. (Greenock).—Sorry that we cannot give you in a brief reply details of a model single-screw speedboat. Unfortunately, your writing was very illegible. We cannot undertake to prepare special designs for readers—this would require many thousands of words and a number of drawings.

A. G. (S.E.5).—Sorry we cannot undertake to prepare special diagrams. Permanent and electro-magnets will not attract any metal. Your idea is not feasible.

J. E. (Midlothian).—If the engine is overheated, this would point either to its being overloaded or run on too rich a mixture. Two-stroke engines are not usually suitable for stationary work.

BUY, EXCHANGE OR SELL

Advertisements are accepted for these columns at 2d. per word (minimum 12 words at 2s.—advertisements of less than 12 words are charged at the minimum rate of 2s.), subject to a discount of 2½% for 6 consecutive monthly insertions or 5% for 12 consecutive monthly insertions. TERMS :—Cash with order. Cheques, Postal Orders, etc., should be made payable to George Newnes Ltd. *The Proprietors reserve the right to refuse or withdraw advertisements at their discretion.* All advertisements must be received on or before the 5th of the month preceding date of publication and should be addressed to the Advertisement Manager, "Practical Mechanics," George Newnes Ltd., 8-11 Southampton Street, Strand, W.C.2.

CINEMATOGRAPHY

CINEMATOGRAPH FILMS.—Standard size from 6d. 100 feet. Machines, Accessories. Sample Films, 1/- and 2/6 post free. Catalogues free.—"Filmeries," 57 Lancaster Road, Leytonstone, E.11.

"FILMCRAFT."—Here is a fascinating series of authoritative textbooks for everyone interested in the Cinema as the newest of the arts. The Filmcraft series, each 3s. 6d. net, includes volumes by Pudovkin, Adrien Brunel, G. E. Kendall, D. Charles Otley, Percy W. Harris. From all Booksellers and Newsagents.—George Newnes Ltd., 8–11 Southampton Street, Strand, London, W.C.2.

ELECTRICAL

ELECTRIC DRILLS, fan-cooled powerful motor, all voltages AC/DC, chuck ¼ in. max. high-speed drilling, £2 10s. Used reconditioned fully guaranteed drills 14/9 all voltages, with new chucks. Ancel Cine Co., 8 Highbury Terrace Mews, N.5.

INSTRUMENT MAKING, Acoustic and Electrical, etc., Inventors' Models, Experimental Work, Machining, Gear Cutting, Turning, Screw Cutting, Milling, etc. Send requirements for quotation. Gaydon & Co., Scientific Engineers, 42a, Sydenham Road, Croydon.

SURPLUS ELECTRICAL and Engineering Materials, low prices.—The London Electric Firm, Croydon.

A MAGAZINE of Electrical Progress. Amazing developments in Electrical Engineering are rapidly revolutionising industry and bringing new benefits to the whole community. To keep in touch with all the latest in Electrical Progress read this live Magazine. Written by experts, it is indispensable alike to the technician and the ambitious student, while the "layman" will find it full of interest and inspiration. "THE PRACTICAL ELECTRICAL ENGINEER," 1s. monthly. Obtainable at all Newsagents and Bookstalls, or by post 1s. 3d. from George Newnes Ltd., 8–11 Southampton Street, Strand, London, W.C.2.

ENGINES

ENGINES. Build Butler's ½-h.p. practical Model Petrol Engine. Set of Castings 9/9. Interesting Catalogues 3d. Write Profit-Sharing Works, Littleover, Derby.

LITERATURE

OVER 190 PAGES Illustrated Workshop Hints and Calculations in Calvert's Mechanics Almanack, 1935. 8d. post free. Endsor & Co., 5, Bridge Street, Manchester.

MAGIC

BOOKS, Valuable Manuscripts, Secrets, for sale. Stamp for list. BM/TKPF, London, W.C.1.

METAL WORK

MAKE METAL TOYS. Easy, profitable with "SUCCESS" Moulds. List Free. Lee's, Bentinck Road, Nottingham.

MICROSCOPY

MICROSCOPIC OBJECTS—unmounted prepared. Assorted packet 2/-. MOUNTED SLIDES STOCKED. LENG, 183 MANCHESTER DRIVE, LEIGH-ON-SEA.

MISCELLANEOUS

SANITARY AND WEIGHTS AND MEASURES INSPECTORS, Relieving Officers, Handicraft Teachers, and Registrars are in constant demand. Permanent progressive positions. Full details of entry into these attractive careers from C.C., 335U High Holborn, W.C.1.

ALUMINIUM-ALLOY MOULDS for casting Soldiers, Cowboys, Indians, Animals, Trees, Charms, Fishing Weights, etc., in lead. Catalogue free.—Industries, 13 Gordon Avenue, Twickenham.

YOU CAN USE YOUR SPARE TIME to Start a Mail Order Business that quickly brings you a full-time income. Follow the lead of others who are averaging £12 per week net profits. Get away from a drudging routine job—join the big-money class. No previous experience necessary. Few pounds capital only needed. No samples or outfits to buy; no rent, rates or canvassing. New method makes success certain. Write to-day for FREE BOOKLET to Business Service, Institute, Dept. 125c, 6 Carmelite St., London, E.C.4.

MODELS

HALF-PRICE MODELS. Locomotives, Rolling Stock, Stationary Engines, etc. Just like new. Illustrated Catalogue, 4½d. (abroad PICTORIAL Stamps).—Model Exchange, 11 Friars Street, Ipswich.

SCREWS, NUTS, WASHERS (special Model Engineers' sizes). Everything for Electrical Re-winds and Repairs. Lists Free.—Lumen Electric Co., 9 Scarisbrick Avenue, Litherland, Liverpool 21.

BARGAINS: Large stock to clear. Some of the goods described are sold at 70% below their actual factory cost; mostly foreign goods. Sailing, Clockwork, Electric and Steam Boats from 2/6 to 15/-. Also Steam Engines, Boilers, Locos, Trucks, Electric Motors by Stuart's, Marklin's, Bing's, also rails, sheds, etc. Inspection invited without obligation. F. C. Reiser, 72 Twyford Avenue, W.3. 'Phone: ACOrn 1783.

"WORKING MODELS and How to Make Them." Edited by F. J. Camm, 3s. 6d.—This book will appeal to all who are handy with tools. Contains complete instructions for the making of every kind of working model. Each model has been actually constructed in accordance with the details given and subjected to stringent tests. The instructions and diagrams are so clear that even the most elaborate model can be built without fear of failure. Obtainable at all Booksellers and Newsagents.—Geo. Newnes, Ltd., 8–11 Southampton Street, Strand, London, W.C.2.

MONEY-MAKING BOOKS

POLISHES and their Manufacture, 1/-. SOAP-MAKING Course, 4/-. 3,000 FORMULAS, RECIPES; also "DIRECTORY" where to buy Chemicals, BOTH for 4/9. "TECHNOCRAFT," 41 Longford Place, Manchester, 14.

MUSICAL INSTRUMENTS

ACCORDEONS, PIANO AND CHROMATIC. The finest accordeons ever made are obtainable from Hessy's on cash or terms. Scandalli, Soprani, Frontalini, Dallape models in prices ranging from £6 15s. to £75. Hundreds of genuine testimonials. Write for beautifully illustrated catalogue. Below.

GUITARS. Hessy's recommend Dobro Amplifying Guitars. The finest guitars money can buy. Prices, £4 19s. 6d. to 19 guineas on cash or deferred terms. Catalogues free on request to Hessy's. Below.

SAXOPHONES. The sure way to success is with a Hessy saxophone. Beautiful tone, accuracy of pitch, easy fingering. Cash or terms. Write, Hessy's Ltd., 18–20 Manchester Street, Liverpool 1.

PHOTOGRAPHY

£500 worth good, cheap Photo Material, Films, Plates, Cards, Papers, Chemicals. Catalogue and 4 Samples Free.—Hackett's Works, July Road, Liverpool 6.

POSTCARDS FROM ANY PHOTO. Time to finish, four days. 25 1/9; 50 3/-; 100 5/-; 500 17/-; 1000 30/-. Enlargements 1/-. Samples and List Free.—Hackett's Works, July Road, Liverpool 6.

PRINTING

"PHOTO-ENGRAVING."—A practical Handbook with complete set of materials for engraving printing blocks, 4/6. Industries, 13 Gordon Avenue, Twickenham.

TOOLS

NEW GRINDSTONE fitted to powerful (over $\frac{1}{16}$ h.p.) motor all voltages AC/DC, bargain 14/9, guaranteed. Second-hand machinery carriage forward. Lathe bed takes 3-in. diameter work, with head and tail stock, 9/6. Machine stand drill chuck ½ in. max., 8/11; motor for same, about ¼ h.p., 12/6. Three jaw self-centring chuck takes 3 in. diameter, 11/6. Hobbies fret-saw machine, 8/6. Polishing heads, 5/6. Ancel Cine Co., 8 Highbury Terrace Mews, N.5.

GLASS-BORING Outfits avoid risk. Grayson & Company, 300 Campo Lane, Sheffield. Drills for any material.

UNDER COST! 150 American 6-oz. Soldering Irons, 1/6 each, carriage paid. Greenwood, Arnside Road, Southport.

UNDER COST! 150 sets Highest Grade Lathe Tools. Greenwood, Arnside Road, Southport.

30 WONDERFUL 5/- Self-blowing Gas Blowpipes, 2/6 each. Greenwood, Arnside Road, Southport.

WIRELESS

FOR THE RADIO ENTHUSIAST.—"The Wireless Constructor's Encyclopædia," by F. J. Camm (Editor of "Practical and Amateur Wireless"), third edition. Compiled by one of the most accomplished designers and writers on the practical side of Wireless, it covers the whole field. A veritable Treasury of Wireless Knowledge. Price 5s., from all Booksellers and Newsagents.—George Newnes, Ltd., 8–11 Southampton Street, Strand, London, W.C.2.

A DICTIONARY OF WIRELESS TERMS, by Ralph Stranger. A Wireless Work of Reference that should be on the bookshelf of every keen amateur. Compiled by a master of lucidity, it gives the meanings of all Technical terms in general use. Price 2s. 6d. from all Booksellers and Newsagents.—George Newnes, Ltd., 8–11 Southampton Street, Strand, London, W.C.2.

FIFTY TESTED WIRELESS CIRCUITS, by F. J. Camm, 2s. 6d.—This handbook contains every modern circuit, complete with instructions for assembling, component values, and notes on operation. Obtainable at all Booksellers and Newsagents.—George Newnes, Ltd., 8–11, Southampton Street, Strand, London, W.C.2.

WOODWORK

CABINET HARDWOODS, Oak, Mahogany, Ash, White-wood, Ply Woods, etc. Lowest Prices. Send Cutting lists. Planing free. Speciality prime Jap Oak, all thicknesses.—Wilfred Parr & Co., March Works, Lancaster Road, Leytonstone, E.11.

FREE SERVICE FOR READERS

READERS requiring information concerning goods or services advertised in *PRACTICAL MECHANICS* should give names of Advertisers from whom particulars are desired. Any number of names may be included and we will obtain for you catalogues, lists, and any other information you may be wanting. THERE IS NO CHARGE FOR THIS SERVICE.

Readers desiring particulars from a number of Advertisers will, by this method, save time and postage. Halfpenny stamp only is required if your envelope is left unsealed. If any Advertiser stipulates that stamps or postal orders are necessary before samples or catalogues are sent, please enclose the necessary amount with your instructions. You are cordially invited to make full use of this Service.

Post this to

ADVERT. SERVICE DEPT.,

PRACTICAL MECHANICS,
8-11 SOUTHAMPTON STREET,
STRAND, W.C.2

Please obtain and send to me particulars from the Advertisers in your September issue whose names I give on list attached.

Advertiser	Page No.	Information Required

Attach sheet of paper, with particulars, and your name and address (written in **BLOCK** *letters), with date, to this announcement.*

FREE ADVICE BUREAU
COUPON
This coupon is available until September 30th, 1935, and must be attached to all letters containing queries.
PRACTICAL MECHANICS, SEPTEMBER, 1935

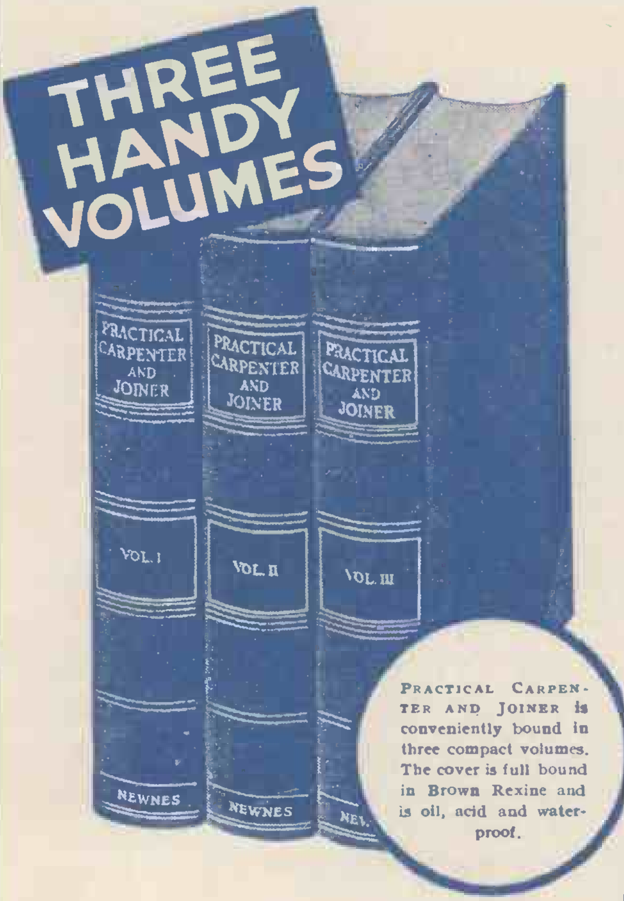
All applications respecting Advertising in this Publication should be addressed to the ADVERTISEMENT MANAGER, GEORGE NEWNES Ltd., 8–11 Southampton Street, Strand, London, W.C.2. Telephone: Temple Bar 7760.

A GREAT OPPORTUNITY!

For Every Reader of *"Practical Mechanics"*

An Invaluable New Work

THE "PRACTICAL CARPENTER AND JOINER"



Free ILLUSTRATED DESCRIPTIVE **FOLDER**

(SEE BELOW)

No obligation to Purchase

Prepared by over 30 Experts for the Man in the Trade

THE trade of Carpentry and Joinery is one which offers wonderful scope for advancement to the man who is prepared to use his brains as well as his hands in his everyday work.

PRACTICAL CARPENTER AND JOINER has been written purposely for those who want to get on by experts in every branch of the industry.

All the articles have been carefully planned in such a way that they place this experience at your disposal. In addition to fundamental principles, the work deals thoroughly with all applications—including work in the Joiners' Shop, Carpentry and Joinery as applied to Building Works, Doors, Windows. Floors, Roofs, Staircasing and Handrailing, Forms, Mould and Shuttering for Concrete Work, Cradling and Bracketing, etc.

The work is equally important for reference purposes to Architects, Surveyors, Timber Merchants, Property Owners and others who are intimately connected with the Building and Woodworking Trades.

We have confidence that every reader who takes a pride in good craftsmanship will find "Practical Carpenter and Joiner" directly useful in his everyday work.

IMPORTANT TO *YOU!*

You may be an Architect, a Master Builder, a General Foreman, Machine Wood-worker, a Carpenter, or a Joiner, engaged in the shop or on building works. You may be an Apprentice or Improver in the industry. Whatever your status, we are confident you will find that the money you spend in purchasing this work is an investment you will never regret.

SEND TO-DAY FOR FREE FOLDER

Practical Contributors include:

R. V. BOUGHTON, A.I.Struct.E.
J. AMBROSE DARTNALL, A.R.I.B.A., P.A.S.I.
C. H. HANCOCK, F.B.I.C.C.
A. TRYSTAN EDWARDS, A.R.I.B.A.
A. MORA.
F. BURREN.
R. H. IRELAND.
RUSSELL LATHAM.
LLEWELLYN E. WILLIAMS, A.R.I.B.A.
C. H. HAYWARD.
H. J. BUTLER.
A. B. SWALLOW, A.I.R.I. (Tech.).
E. W. TWINING.
F. E. DRURY, M.Sc. (Tech.).
H. GRISBROOK, A.M.C.T.
H. R. HUDSON.
W. E. WEBB.
E. GRISBROOK.
T. LINSTEAD.
A. S. HOAD.
T. W. TIDMARSH.
J. S. TARTE.
H. G. PARKES.
C. A. FARLEY, B.Sc. (Eng.).
A. SHELDON.
H. G. GILDART HICHISSON.

Action Photographs and Drawings

The work contains more than a thousand illustrations and numerous useful charts and tables. All the action photographs have been taken in joiners' shops, machine wood-working shops, or on the actual building sites, under the supervision of practical men. Special charts have been prepared by experts. Every illustration has been included with a definite purpose. In constructional articles the illustrations enable the reader to see the whole of the process from the early stages to the finished job..

To THE HOME LIBRARY BOOK CO.
(George Newnes, Ltd.)
23-24 Tavistock Street, London, W.C.2

Please send me free of all cost and with no obligation, the folder describing PRACTICAL CARPENTER AND JOINER, and particulars of the scheme whereby I shall be able to have the immediate use of the three volumes at an outlay of a few shillings per month.

Name..

Address..

....

Pract. Mech., 9/35 ....

If you do not wish to cut your copy, send postcard mentioning "Practical Mechanics" to address above.

George Newnes, Ltd.

Published by GEORGE NEWNES LIMITED, 8–11 Southampton Street, Strand, London, W.C.2, and Printed in Great Britain by HAZELL, WATSON & VINEY, LTD. London and Aylesbury. Sole Agents for Australia and New Zealand—Gordon & Gotch Ltd. Sole Agents for South Africa—Central News Agency Ltd.