THE AUTOMATIC LIFT – *How it Works*

NEWNES

PRACTICAL MECHANICS

JUNE 1939

6D.

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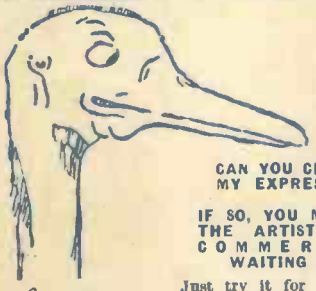

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PRACTICAL MECHANICS

Editor : F. J. CAMM

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FAIR COMMENT

THE CHANGING TIMES

WITHIN our lifetime we have seen new industries emerge from experimental obscurity to positions of national importance. Each new industry brings with it changes of national habit, national inclination, and national outlook. The aeroplane, wireless, television, plastics, synthetic materials, and the contributions of the chemists, have wrought changes which a few decades ago seemed impossible. It is deplorable, perhaps, that the results accruing from these inventions cannot be placed entirely on the credit side of life, but it is inevitable that they must bring corresponding disadvantages. The aeroplane, for example, has entirely changed the technique of War. It has destroyed insular security, and the feeling of safety engendered by a sea-boundary. It has, moreover, brought remote parts of the world nearer together from the point of view of time. Wireless has enabled one nation to speak to another in its own tongue. It is, however, not always used as an instrument of peace (nation shall speak peace unto nation!), but is used for propaganda purposes. Whilst these new industries, therefore, create new opportunities, they also create fresh risks, and it is hence natural that national defence should be the prime consideration. Conscription, we are told, is for the first time in the history of our country a vital necessity in peace time, and there are many who may feel that this interruption of their training, their studies, and their normal life, may also change the entire course of their life. There are those who feel that after military training their outlook may change and they may not wish to resume their studies from the point at which they left them. I do not subscribe to this point of view, which is purely defeatist and fatalistic.

Greater Liberties

THIS country still enjoys greater liberties than any other, but liberties throughout the history of the world have had to be fought for, and once again must be defended. Life will proceed in this country quite normally. My message, therefore, to those readers who have written to me deploring the fact that when they reach the age of 20 they will have to spend six months in the Army, is that they will still be able to continue their studies and probably feel fitter to do so. It is not within my province to discuss the merits or otherwise of conscription. It is here, and the best must be made of it. It is possible that when the international clouds have cleared such an Act may be repealed. The situation does, however, stress the importance of the remarks I have previously made, that in these times it is more than ever necessary to become fully qualified in some trade or profession.

Whilst the new industries hold out great hope, it must not be forgotten that the older industries are extremely short of skilled artisans and whilst seeking fresh fields the trees on the industrial horizon should not be permitted to obscure the woods close at hand.

The Flying Reference Book

IN the aircraft industry there is a surprising dearth of reference literature. The Editor of the weekly journal, "Flying," in discussing this matter with me some months ago, suggested that I should set to work on the compilation of a book of reference dealing with the aircraft industry, air routes, aeroplane specifications, history, aerodromes, records, clubs, associations, etc., etc., and thus bridge a gap which everyone in the aircraft industry has felt should have been filled years ago.

For the past months, therefore, I have been busy surveying the situation and gathering material, and the result is "The Flying Reference Book," which is available to readers of "Flying" on presentation terms. Details of the offer appear in the current issue of that paper. It is the first and only book of its type, and in it I have compressed every item of information likely to be required by those interested in aeroplanes or engaged in the industry. It may be the address of a manufacturer, the name of a model, full size or gliding club, the date of a flight, the speed record, competition rules, an air route, the location of an aerodrome, the winner of a previous King's Cup race, or the address of an association. These and many other facts appear in "The Flying Reference Book."

When the offer is closed this book will appear in the Publishers' Catalogue, and it will cost you more. If you desire to have a copy, it will be necessary to reserve one now.

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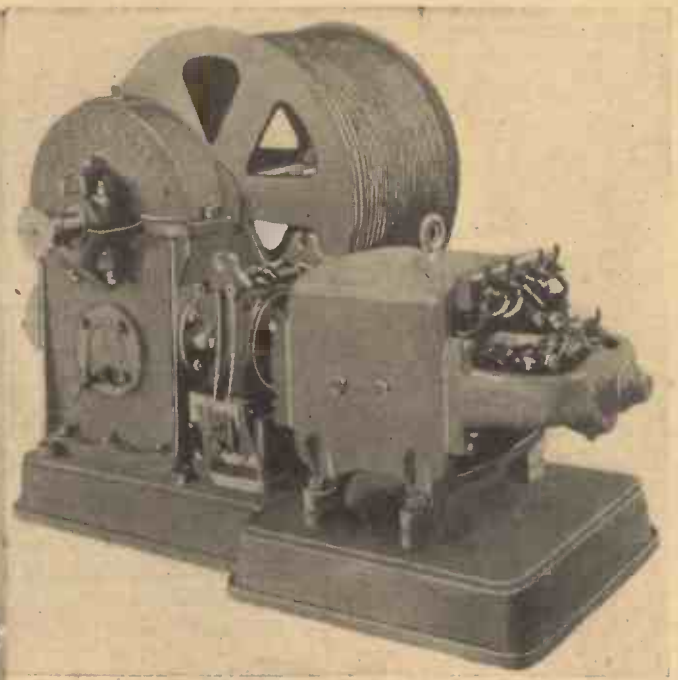
WE have just published a handy-size catalogue of standard books of reference for mechanics, electricians, engineers, radio engineers and constructors, students, practical engineers, model makers, aeronautical engineers, welding engineers, cyclists, motorists, meter engineers, etc. An order form is included for the convenience of readers.

A copy of this catalogue will be sent free to any reader addressing a post card to The Editor, PRACTICAL MECHANICS, George Newnes, Ltd., Tower House, Southampton Street, Strand, London, W.C.2. It is only necessary to add your name and address and mark the postcard "Catalogue."

New books recently published from this office are the "Practical Mechanics Handbook" (6s., by post 6s. 6d.), "Workshop Calculations, Tables, and Formulæ" (3s. 6d., by post 3s. 9d.), and "Practical Leatherwork and Allied Crafts" (1s., by post 1s. 2d.).

We receive many requests for titles of books on given subjects, and this catalogue will supply the answer.



Figs. 1 and 2.—(Left) Gearless traction-type machine. Sheave and brake drum are mounted direct on shaft of slow-speed motor. (Right) The drum type of machine. This type of machine is now used only for special application. With increasing height of modern buildings, size of drum becomes prohibitive.

MODERN LIFTS

By L. S. Atkinson, A.M.I.E.E.

The Increased Value of Land has, for Economic Reasons, Resulted in an Increase in the Height of Buildings, and the Higher the Building, the More Vital Becomes its Lift Installation. Lifts are now so Necessary to Present-day Life that Lift Engineering is an Important and Specialised Branch of Industry

THE majority of lifts before the age of electricity were operated by hydraulic power and were either of the direct-acting or suspended type. A direct-acting lift has its car mounted on a ram which moves vertically in a cylinder let into the ground. The control of such lifts is by means of a hand-rope or rod connected to a "two-way and off" valve which, when opened to the hydraulic main, allows water to enter the cylinder, and the displacing of the ram causes the car to ascend; when the valve spindle is moved to its natural, or off, position the supply to the cylinder is cut off and the car stops. To descend, the valve spindle is moved to a third position which connects the cylinder to an exhaust pipe and the weight of the car and ram forces the water out of the cylinder and the car descends.

As its name implies, the suspended hydraulic lift has its car suspended from wire ropes which are led over pulleys at the top of the lift well to multiplying pulleys attached to the top of the ram and the bottom of the cylinder; the other ends of the ropes are anchored to the cylinder. As water enters the cylinder the pulleys on the ram are forced away from the fixed pulleys on the cylinder, and thus the car is raised. The controlling of such a lift is usually effected by means of a hand rope and valve as arranged with the direct-acting type. According to the number of pulleys on the ram, so the rates of movement of car vary with that of the ram, e.g., if the ram and cylinder have a ratio of 6 : 1 the ram will move 10 feet and the car 60 feet. With the suspended type lift the cylinder is mounted on the wall of the lift well, and thus the cost of boring a hole in the ground to accommodate the cylinder is avoided. It will be appreciated that with a direct-acting lift it is necessary to bore a hole in the ground to accommodate the cylinder and the depth of the hole is equal to the travel of the car.

Electric Lifts

The demand for high car speeds and automatically controlled lifts, however, created many problems which were more easily solved with the development of the electric lift, and so the hydraulic lift was gradually superseded.

Electric lifts vary widely in detail, but the same principles remain, and the main components are the lift car, winding machine, counterweight, controller, ropes and auxiliary operating devices. The disposition of the various components is shown in Fig. 5. Whilst the names of these units explain their purpose, it may be as well to mention that the weight of the counterweight is sufficient to balance the weight of the car plus about, but not exceeding, half the load to be carried in the car, thus

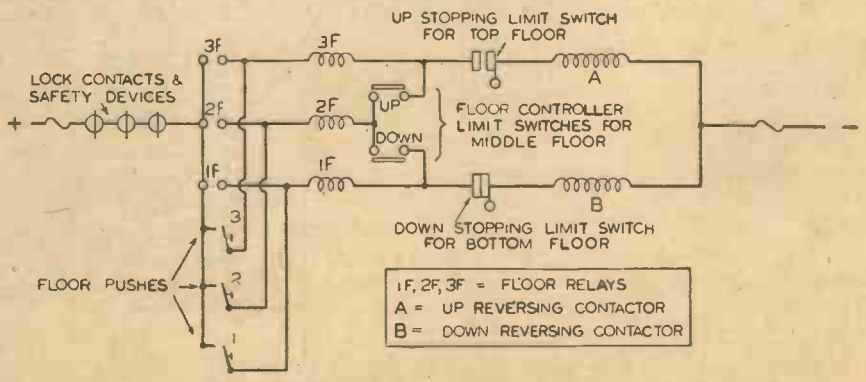


Fig. 3.—Simplified wiring diagram of automatic control for push-button operated lift.

enabling a much smaller sized machine to be used; moreover, the counterweight assists in securing more gradual acceleration and retardation. The controller may be described as an assembly of switches, resistances, etc., mounted as a unit which controls the starting, stopping, speed and direction of travel of the lift.

Drum Machines

Early electric lifts had drum-type machines as shown in Fig. 2, in which it will be noticed that the winding drum is helically grooved and driven by an electric motor through worm reduction gearing and the coupling between the motor shaft and wormshaft serves as a brake drum for the electro-mechanical brake. With these machines two sets of lifting ropes are employed, one end of each set is anchored to the drum and the other ends are attached to the car and counterweight respectively, and so arranged that as one set of ropes is wound on to the drum the other set is unwound from it.

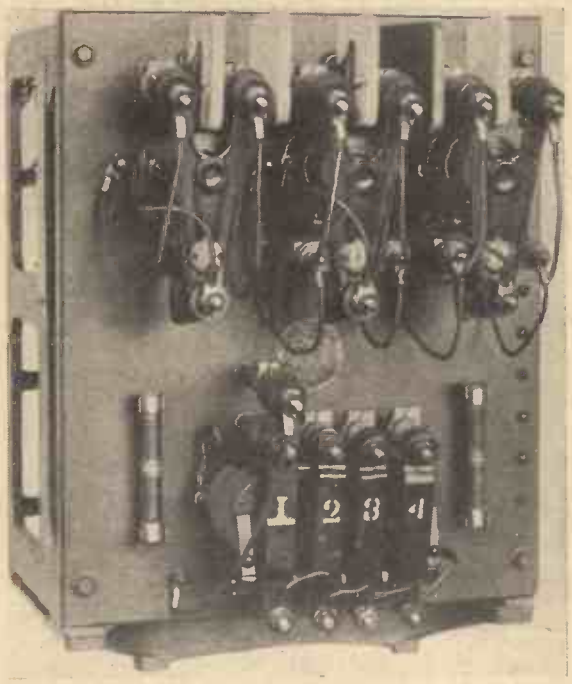


Fig. 4.—Controller for single-speed car-switch operated lift.

Traction Machines

It will be appreciated that the size of the winding drum is dependent upon the length of travel of the lift and the size of such a drum for a modern high building would become prohibitive, and a traction sheave, which is independent of the travel, is substituted for the drum. With the traction-type machine, Fig. 6, only one set of ropes is necessary and the friction between the ropes and the grooves in the traction sheave is more than sufficient to enable the load to be raised.

The motor for a geared machine is arranged for either single or two speeds according to the speed and method of operation of the lift. With two-speed control it is possible to reduce the speed of the car as it approaches a landing and so facilitate the stopping of the car level with the landing. Provision can now be made to enable a car to stop level with a landing quite automatically and independent of the lift attendant or load in the car.

All lift machines are provided with electro-mechanical brakes which are electrically released while power is applied to the lift motor and mechanically applied as soon as power is cut off. The electrical part of the brake varies with the size of the machine and nature of the power supply, although there is now a tendency to use D.C. brakes on alternating current, the D.C. supply for operating the brake being obtained from a metal-plate rectifier.

A, lift controller. B, lift machine. C, car governor. D, overtravel limit switches. E, lifting ropes. F, counterweight guides. G, governor rope. H, car gate. I, call indicator. J, car switch. K, car safety. L, counterweight. M, car guides. N, stopping limit switch. P, car buffer. Q, governor rope tension frame.

Gearless Machines

The geared machines just cited are used for car speeds up to about 350 f.p.m., and for higher car speeds gearless machines are employed. A gearless machine, as shown in Fig. 1, is a shunt wound motor of very slow speed, i.e. between 50 and 130 r.p.m. according to the duty, with the traction sheave and brake drum mounted direct on the armature shaft. As no thrust bearings or reduction gearing is employed, vibration is eliminated and wear is negligible. Such machines are operated on the Ward-Leonard principle, each machine having its own motor-generator set. With this form of control the armatures of the lift motor and the generator are permanently electrically connected, and the speed of the lift motor is varied by altering the strength of the generator field; the direction of rotation of the lift motor is changed by reversing the connections of the generator field winding, and upon interrupting the circuit of this winding the power supply to the lift armature is cut off.

Methods of Operation

The arrangement and design of the various operating devices depends upon the method of operation. For many years the method of operation was limited to either car switch, in which the lift attendant had sole control of the lift, or automatic push button, where a push button is fitted at each landing by the lift entrance to enable a person to call the lift to that landing and a set of buttons in the car by which the car can be dispatched to any floor. With very high car speeds, say, over 400 f.p.m., it is difficult for an attendant to stop a car at a given floor without travelling for many feet at slow speed. and thus losing the advantage of the high speed. It is, therefore, necessary to arrange for the automatic stopping with high-speed lifts, although attendants are employed.

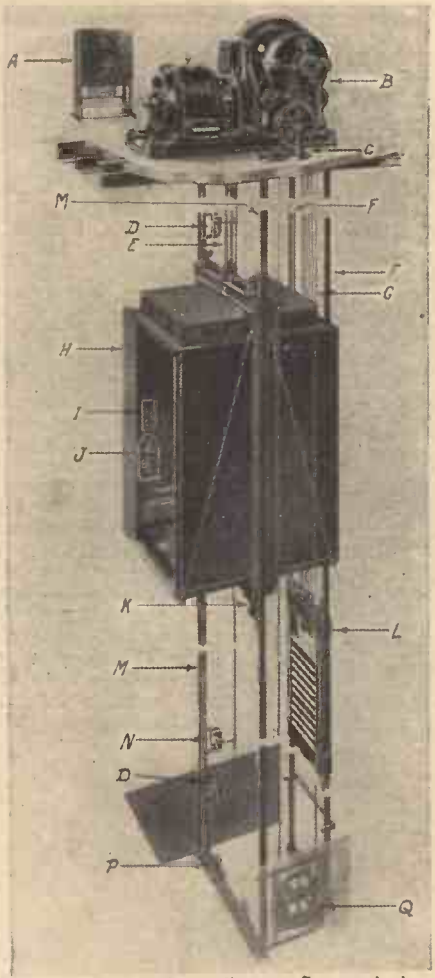


Fig. 5.—Geared lift installation. See panel above for letter references.

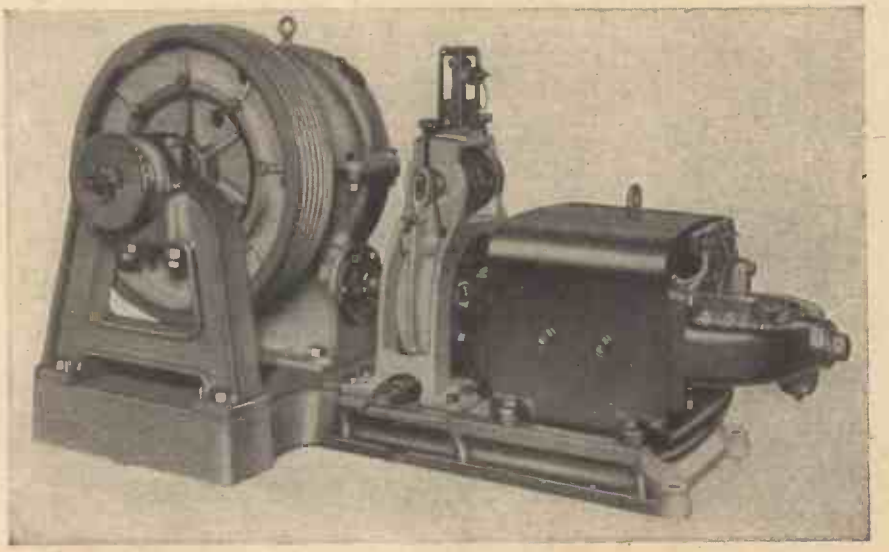


Fig. 6.— The traction-type lift machine.

Apart from the particular method of operation, many operating devices are common to all lifts. Limit switches, actuated by the cam on the car, are fitted in the lift well in order that the car is automatically stopped at terminal floors. With multiple-speed lifts additional switches are provided to reduce the speed of the motor before stopping.

Landing entrances to the lift car are protected by collapsible gates, hinged or sliding doors, and the locking of these gates or doors is most important. These locking arrangements are designed to prevent a door from being opened unless the car is opposite to it and that the car cannot be operated unless all landing doors are closed. The car gate is also provided with a switch to ensure that the car gate is closed while an occupied car is in motion. Whilst landing doors and car gates are usually opened and closed manually, they can be arranged for automatic operation.

With the usual attendant-operated lifts it is necessary to provide a call indicator to enable persons waiting at landings to advise the attendant that the car is required at certain floors. Such indicators can be of "flag" or illuminated type arranged for cancellation either automatically or by the attendant. Other forms of indicators are often fitted at the landing to show the position of the car in the lift well, the direction of travel or the arrival of a car.

Controllers

Lift controllers usually comprise a number of contactors and resistors and the like, suitably mounted to form a unit. The main contactors are used for reversing and starting the motor, and the design of these contactors varies with the type of motor and power supply, i.e., A.C. or D.C.

A controller for a D.C. single-speed car switch operated lift is shown in Fig. 4, and it will be noticed that there are three main contactors, two are for reversing and the third is a main line contactor. The multiple contactor situated at the bottom is for short-circuiting the starting resistors which are mounted at the rear of the controller.

Referring to Fig. 8, which shows a typical wiring diagram of a lift having a controller as illustrated in Fig. 4, it will be noticed that the operating circuits have been drawn distinct from the motor circuit.

Assuming that all landing doors and car gates are closed, current flows from the positive main through fuses Nos. 1 and 3, the various safety switches, landing lock and car gate contacts to the common contacts of the car switch.

If the car switch handle is moved to the "up" position, circuit is completed through the "up" stopping limit switch, "up" reversing contactor coil (A), interlock contact (b. 6), accelerating contact (d. 5), fuses Nos. 2 and 4 to the negative main. The closing of contacts (a. 5) completes the circuit for main contactor (C); the closing of contacts (a. 4), (c. 3) and (c. 4) releases the brake shoes and thus power is applied to the motor and the car commences to ascend. The electrical connections between the car switch and the controller are made by means of flexible cables.

The circuit through the armature is from contacts (C 1), (A 1), (B 3), (A 2), starting resistors, series field winding, contacts (C 2), to negative main; contacts (B 3) are closed and contacts (A 3) are open while the lift is ascending. As the motor armature accelerates to full speed the voltage across it increases and therefore the voltage across the accelerating switch coil (D) increases and thus the starting resistors are gradually short-circuited by the closing of the contacts (D 1), (D 2), (D 3), and finally (D 4), which short-circuits the series field winding. The series field winding increases the torque during starting, but it is cut out of circuit while the motor is running in order to improve the speed regulation and to prevent excessive speed when the car is ascending empty, or descending fully loaded. By providing contacts (d. 5) and resistor (R) it is not possible to close a reversing switch unless the starting resistors are in circuit and contacts (d. 5) closed.

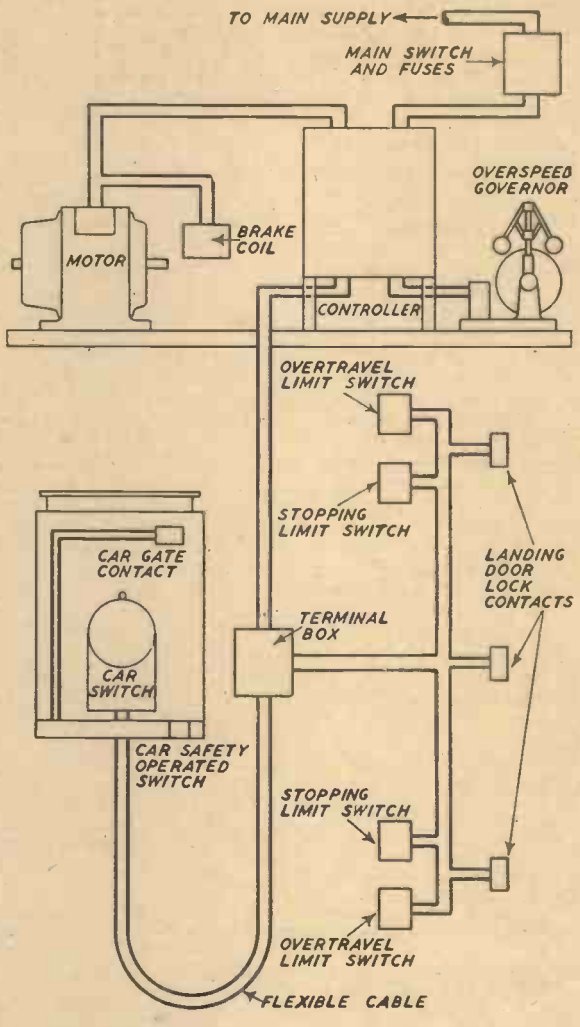


Fig. 7.—Single-speed car-switch operated D.C. lift.

When the car switch handle is moved to the "down" position, the general operation is similar to that described, excepting that reversing contactor (B) closes and the closing of contacts (B 1) and (B 2) and the opening of contacts (B 3) reverses the direction of the current in the armature and the car descends.

Stopping the Car

The car is stopped by moving the car switch handle to its neutral position, or by the opening of a stopping limit switch, and the opening of a reversing contactor cuts off the power supply to the motor and the application of the brake causes the lift to stop. The closing of contacts (A 3) and (B 3) connects the stopping resistor in parallel with the armature and thus a dynamic braking is produced to assist the mechanical braking. Emergency stops are made upon operation of any of the safety devices.

With an automatic push button lift it is necessary to provide an auxiliary controller comprising floor relays and limit switches so that each floor has its own relay and stopping limit switches. These floor limits are actuated by the movement of the car.

The wiring diagram shown in Fig. 3 is a simplified arrangement of the circuits for the automatic dispatching and stopping of a car at any desired floor. Assume that

(*Continued on page* 484)

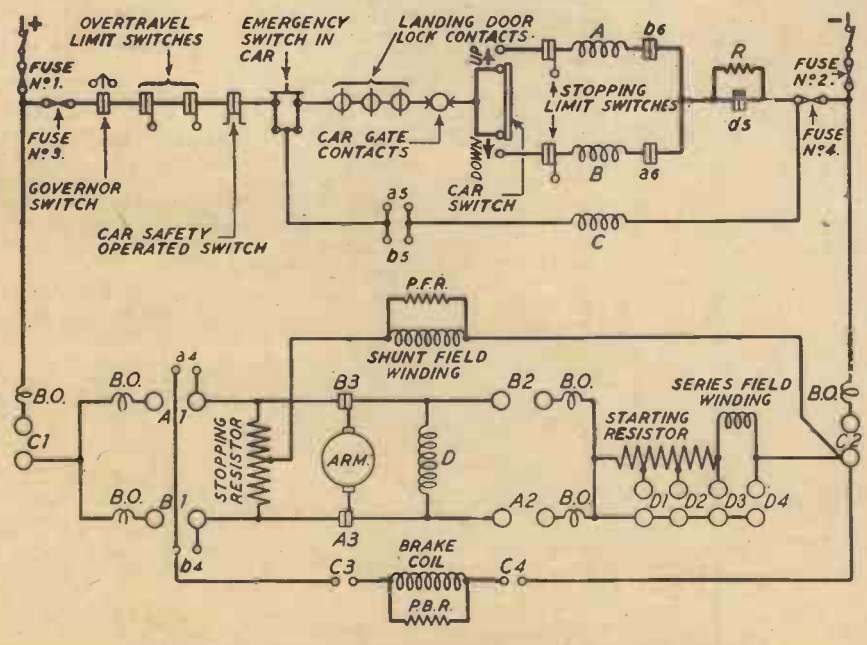


Fig. 8.—Wiring diagram of typical single-speed car-switch operated D.C. lift.

AN AERO-INSTRUCTOR

A Device that will Help you to Learn to Fly without the Necessity of Leaving the Ground

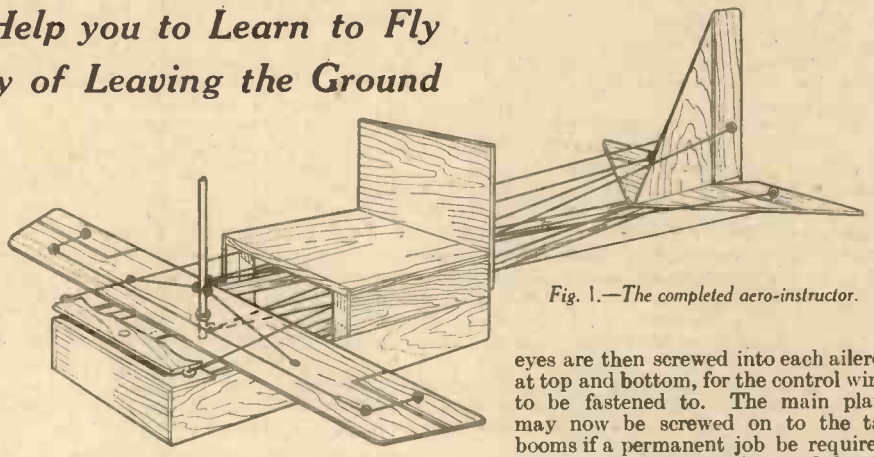


Fig. 1.—The completed aero-instructor.

THE construction of the tutor is very simple, and as it may be made to suit the materials at your disposal, only approximate dimensions are given.

The main body or " fuselage " should be made first. The front two corner pieces are 6 in. x 2 in. x 2 in. and the rear two are 12 in. x 2 in. x 2 in., these acting as the rear legs of the seat. Four pieces of plywood are screwed on to the corner pieces to form a rectangular box with no base. The rear piece of plywood being only 5 in. high to allow for the tail booms. A piece of 12 in. x 3 in. x ½ in. wood is screwed on to the top of the front corner pieces as shown in Fig. 2, and a hole is drilled in the centre to take the rudder-bar bolt. A piece of 1 in. x 1 in. wood is nailed along the inside of the plywood level with the top, between the two rear corner pieces. The two 1 in. x 1 in. tail booms are finally fixed in position as shown.

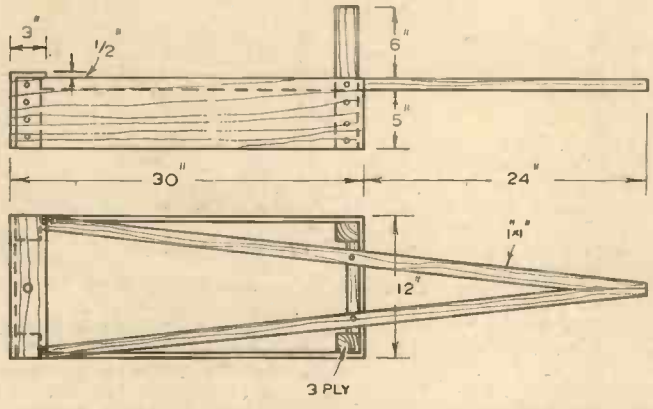


Fig. 2.—Showing the method of fixing the two tail booms into position.

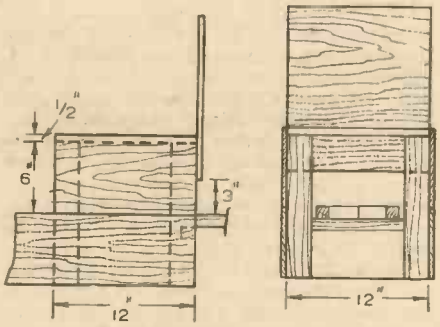


Fig. 3.—Constructional details of the seat.

The Seat

The seat may now be fitted. Two more pieces of 12 in. x 2 in. x 2 in. are screwed to the inside of the rectangular " fuselage," 12 in. in front of the rear corner pieces as shown in Fig. 3. A piece of 12 in. x 12 in. x ½ in. wood is then screwed in place on top of the legs to form the seat. A back may be fitted to suit, as shown, care being taken to leave enough room for the control wires to pass through. Two pieces of plywood can then be nailed on the sides to ensure rigidity.

It is advisable that you make the span of the main plane to suit your own accommodation—say 4 ft. from tip to tip. The wing may be made to any desired shape, but the one shown is quite easily made and is most suitable. The ailerons can be cut out of the plane, after it has been shaped, and fastened on with small hooks and eyes (*a*), or hinges (*b*), if preferred. Two small eyes are then screwed into each aileron at top and bottom, for the control wires to be fastened to. The main plane may now be screwed on to the tail booms if a permanent job be required, or it may be bolted in place and thus be easily detachable for housing purposes. The front of the plane should be 6 in. from the front of the fuselage.

The tail plane may now be cut out, having a span of 2 ft., and the elevators being attached in the same way as the ailerons, will have the same fixture for the control wires. Make the fin and rudder in the same way and screw the fin on to the tail plane. Then screw the tail assembly on to the tail booms as shown in Fig. 5.

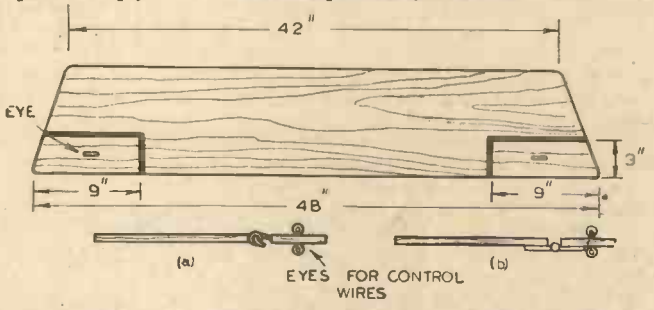


Fig. 4.—Details of the main plane. This can be made to suit your own requirements if desired.

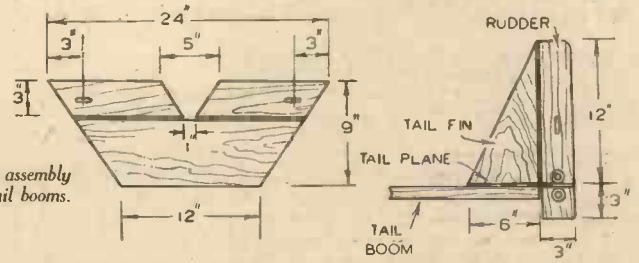
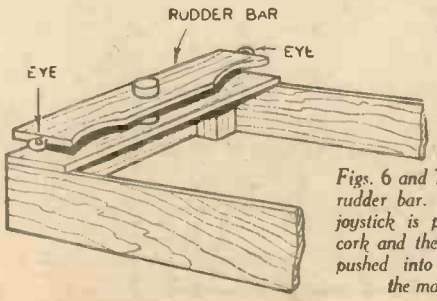
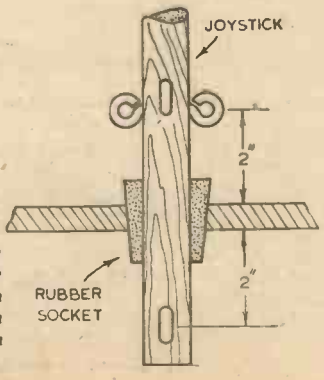


Fig. 5.—How the tail assembly is screwed on to the tail booms.





Figs. 6 and 7.—(Left) The rudder bar. (Right) The joystick is pushed through cork and the cork is then pushed into the hole in the main plane.

The Controls

The rudder bar is made out of a piece of 12 in. x 2 in. x 1 in. wood, and hollows may be cut out for the feet if desired. A hole is drilled in the centre, a distance piece made of wood, tube or a spring is placed between the rudder bar and the " fuselage "

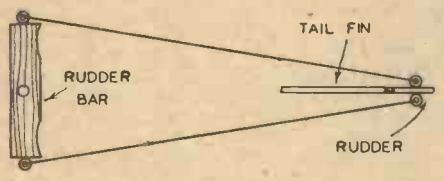


Fig. 8.—The rudder control.

to keep the bar well off the frame and the whole is then loosely bolted together.

The joystick is made of 1 in. diameter rod of length to suit the " pilot." This must be able to move in all directions, so a large rubber cork with a hole in the centre is used (a rubber door-stop is ideal). A hole is drilled in the centre of the main plane, of a size to hold the rubber cork tightly.

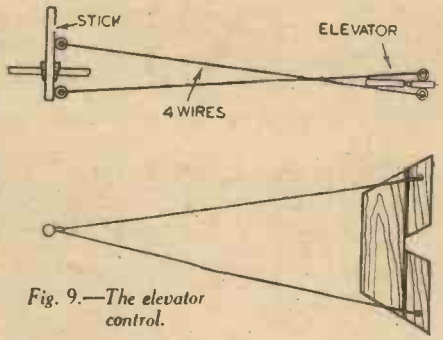


Fig. 9.—The elevator control.

The joystick is pushed through cork and the cork is then pushed into the hole in the main plane. Four eyes are screwed into the rod as shown.

The " control wires " are best made of wire, but although string stretches a little it is fairly satisfactory. The diagrams are self-explanatory.

A useful item to add is a stick screwed on to the inside of the plywood just in front of the seat at the side with a small adjustable cycle mirror attached to the top. Thus the " pilot " can see all that is happening to the tail controls without turning his head. A coat of paint will put the finishing touch to the aero-instructor, not to mention the red, white, and blue rings and registration letters.

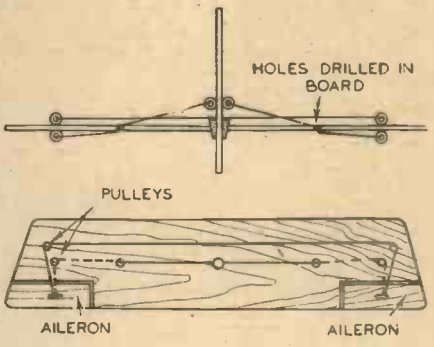


Fig. 10.—The aileron control.

LANDING AIRCRAFT BY TELEVISION

A Brief Account of a Novel System for Guiding an Aeroplane when Approaching an Aerodrome during a Fog

THE most interesting department at the E.M.I. Factories, at Hayes, in Middlesex, is probably the Research Building, where white-coated scientists are engaged in the task of wresting from unseen matter information which will eventually lead to improvements in radio technique.

Their investigations sometimes lead them into subjects which, to the casual observer, appear to bear no relationship to the matter in hand, and frequently result in discoveries which are beneficial to science and to industries outside our immediate sphere of commercial activities.

A Recent Instance

As an instance, here is an account of recent research work at Hayes which might quite easily revolutionise the present methods used for landing aeroplanes in fog.

The use of radio to help the airman when flying " blind " is fairly well known and extensively used, but read how the scientists in the E.M.I. Research Department devised a system whereby television can be used to real advantage for the purpose of landing a 'plane safely during a fog.

They set out with the idea that it would be much better for a pilot to see the aerodrome as he approaches it, and this is how it can be achieved. The aeroplane (4) is in position A while approaching the aerodrome. (Fig. 1.) It transmits a signal which is picked up by the directional aerial (3) situated in the centre of the aerodrome. On the field itself, beneath the aerial, is a room containing an Emitron television camera and miniature transmitting apparatus (7) (Fig. 2). The camera would be focused on a miniature model of the aerodrome and surrounding district, as shown. The model replica of the landing field is so fixed that it will pivot round to any angle with respect to the axis (10) of the camera. This angle is made to depend on the position of the directional aerial taking up the signals transmitted from the aeroplane. A picture of the landing field is then transmitted to the aeroplane, where it is picked up on a television screen; this will ensure the pilot seeing a picture of the landing field exactly in relation to the present position of the 'plane.

Actual Location

Now, obviously, the aeroplane might be anywhere along the line connecting the aeroplane transmitter and the directional aerial on the ground; for example, in Position B, Fig. 1, and would need location before the system could be of use. This can be achieved in several ways.

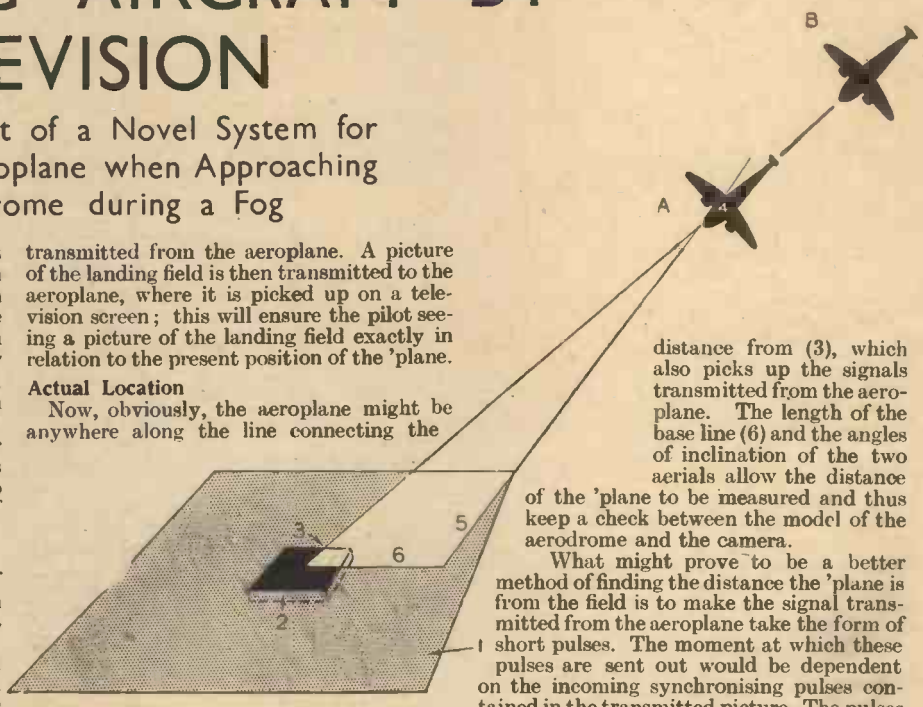


Fig. 1.—How the aeroplane approaches the landing field and directional aerials.

One method would be to arrange a second directional aerial (5) at a distance from (3), which also picks up the signals transmitted from the aeroplane. The length of the base line (6) and the angles of inclination of the two aerials allow the distance of the 'plane to be measured and thus keep a check between the model of the aerodrome and the camera.

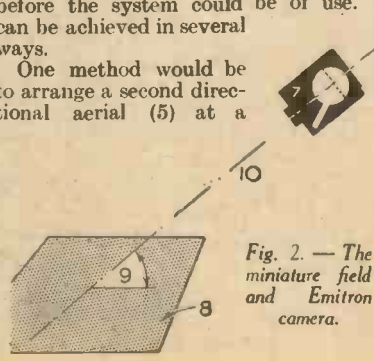


Fig. 2. — The miniature field and Emitron camera.

What might prove to be a better method of finding the distance the 'plane is from the field is to make the signal transmitted from the aeroplane take the form of short pulses. The moment at which these pulses are sent out would be dependent on the incoming synchronising pulses contained in the transmitted picture. The pulses coming from the 'plane and the synchronised pulses could be superimposed, the latter going through a time delay network with a variable delay. The amount of delay necessary is an indication of the distance of the 'plane from earth and can be used to give automatic control of the distance between the camera and the landing field.

None of this would be of any value without a means of showing the pilot in which direction he is flying in relation to the field, and to accomplish this the aerial of the 'plane must be directional. If an indication of the horizontal and vertical direction is required, two aerials could be arranged, or one which could be rotated through 90 deg. The position of the aerial (or aerials) moves an arrow on the dial in the cockpit, and, as it would always point to the centre of the field, the pilot could not only see the aerodrome at the correct angle of the approach but could also judge his distance as he draws nearer to it.

CHEMISTRY FOR AMATEURS

No. 3.—Oxygen, and How to Make this Vital Gas.

A series showing the conversion of an oxide to a hydroxide by mere addition of water. (Left) Lumps of quicklime calcium oxide, CaO. (Centre) The quicklime has partially combined with the water which has been added to it, the effect being known as the "slaking" of lime. (Right) Here the quicklime has been wholly converted into slaked lime, or calcium hydroxide, C a (O H)2. Note the great increase in volume of the material after the water absorption.

IF we take a lighted candle-end and place it under a large glass jam jar, the flame of the burning candle will, within a very short space of time, become extinguished. The candle flame, we would say, in such an instance, has gone out "for want of air" in much the same sort of way as we ourselves would be suffocated if we were confined in a small hermetically sealed apartment.

Facts such as these have been known to mankind from time immemorial, yet it is only within the last two centuries that the basic causes of such facts have been systematically sought out.

We know nowadays, of course that the phenomena of combustion and respiration are intimately connected and that it is solely due to the presence of a life-giving gas—*oxygen*—in the air that these two processes are able to be carried out. Without oxygen, there would be no fire, no combustion in this world. Nor, indeed, would there be any form of animal life on the earth, for all the higher organisms require a regular supply of oxygen in order to carry out their vital functions.

An Abundant Element

Dame Nature has been well aware of our utter dependence upon an adequate supply of oxygen, and she has so arranged matters that oxygen is one of the most abundant elements on earth. The earth's atmosphere consists, for the greater part, of a mixture of approximately one part of oxygen with about four parts of nitrogen. But in combination with other elements, oxygen is found in truly enormous quantities on our globe. For instance, oxygen constitutes eight-ninths of the weight of the water in the oceans of the world and nearly one half of the weight of the rocks of which the earth's crust is made up.

Oxygen, we all know, is one of the most active of all the elements. It unites directly with a number of metals, particularly the metals, sodium, potassium and caesium, at ordinary temperatures, whilst there are relatively few other substances which do not combine with oxygen to form oxides when they are heated in air or in pure oxygen gas.

The burning of a candle or, indeed, of any other combustible matter is due merely to the fact that the oxygen of the atmosphere combines with the combustible material with such avidity that heat and light is produced. Likewise, when, with every breath, we draw air into our lungs, about five per cent. of the available oxygen of each lungful of air is absorbed by the red colouring-matter of the blood, a substance known as haemoglobin. This haemoglobin enters into combination with the absorbed oxygen forming a compound known as oxy-haemoglobin. During its circulation through the body, the oxy-haemoglobin gives up its load of oxygen and is reconverted into haemoglobin, which, arriving again at the lungs, once more enters into combination with some of the oxygen of the inhaled breath and again proceeds upon its oxygen-carrying journey through the arteries and veins of the body.

Preparing copper oxide by heating copper nitrate.

Simplified oxygen making. In the flask is a quantity of sodium peroxide from which oxygen is generated by dropping water on it.

This is the manner in which we maintain life by means of our continuous oxygen intake. It is, indeed, the one basic principle which makes life possible for all animals, and even for fishes, for they live on the dissolved oxygen which they abstract from the water by means of their gills.

Curiously enough, although oxygen is so vital a gas for the maintenance of life, it can, under certain circumstances, act as a poison. Thus, an animal when placed under slightly compressed oxygen, quickly dies, and even when an animal is placed in an atmosphere of pure oxygen at ordinary pressures it does not live very long.

Life on Earth

Without the diluting effect of the air's nitrogen, life on earth would hardly be livable. For one thing, all our vital processes would be so speeded up that, if we escaped other calamities incidental to living in an atmosphere of pure oxygen, we should be more or less senile at the age of 20 and have attained a feeble old age at 30. And again, if the air were composed of pure oxygen, the slightest fire or combustion would spread uncontrollably, rendering all ordinary heating devices impracticable things. All metals, with the exception of gold, platinum and their allies, would be incapable of being extracted from their ores on any commercial scale, and thus, with an atmosphere of pure oxygen, we should be compelled to live in a practically metal-less, combustion-less and fire-less world.

The word oxygen comes from two Greek words, *oxys*, acid; and *gennaein*, to produce. It, therefore, means literally the "acid-producer," this name having been given to it towards the end of the 18th-century when it was thought that all acids and sour bodies invariably contained oxygen.

We know now, of course, that the word oxygen is, in reality, a misnomer, for there are quite a number of acids which do not contain any oxygen at all, as witness, for instance, the well-known hydrochloric acid,

HCl, which contains only hydrogen and chlorine.

It is, indeed, hydrogen which ought to be called oxygen, for *all* acids contain hydrogen.

Pure oxygen gas is very readily prepared in the home laboratory by a variety of methods.

Discoverer of Oxygen

The discoverer of oxygen, the Rev. Joseph Priestley, first made oxygen in 1774 by heating red oxide of mercury. We can imitate his method if we wish by heating this oxide in a glass tube, but, for practical purposes, it is a useless method in view of the great expense of mercuric oxide.

Chemical textbooks are very fond of stating that oxygen is best obtained in the laboratory by heating a mixture of four parts of powdered potassium chlorate and one part of manganese dioxide. Such a method is very efficient, since, under the stimulating, or, as it is called, the "catalytic" effect of the manganese dioxide, the potassium chlorate readily gives off oxygen, becoming itself resolved into potassium chloride in accordance with the following equation :

$$KClO_3 = KCl + 3O$$

Potassium chlorate — Potassium chloride + Oxygen

Often, however, this method of preparing oxygen results in the cracking of the glass flask in which the chlorate mixture is heated owing to the condensation of water evolved from the chlorate. Sometimes, also, the reaction tends to proceed semi-explosively. If, therefore, oxygen is prepared from potassium chlorate and manganese dioxide, it is best to carry out the experiment on a small scale only, heating the oxygen-generating mixture in a hard-glass test tube provided with a cork and a delivery tube as shown in the illustration on this page.

Quite a good method of making oxygen in the home laboratory consists in heating, say, half an ounce of potassium permanganate crystals with about 75 ccs. of dilute sulphuric acid (one part of the concentrated sulphuric acid to four parts of water). If this mixture is placed in a flask provided with a delivery tube and gently heated, oxygen will begin to be evolved abundantly at a temperature of about 50°C, and from half an ounce of the permanganate crystals about 1½ litres of oxygen gas will be obtained.

An Experiment

The method of performing this experiment will be obvious after a short study of the diagram. The permanganate-sulphuric acid mixture is placed in a flask which is provided with a tightly-fitting cork through which a glass delivery tube passes. The delivery tube is so bent that its free end passes below the surface of water contained in a trough or other suitable vessel, the end of the tube being curved upwards. Glass jam-jars are filled with water, and, one by one, they are held over the upturned end of the oxygen delivery-tube so that the stream of oxygen bubbles proceeding from the tube, collect in the jar, displacing the water, and thus filling the jar with the pure gas. When each jar has been completely filled with oxygen, a greased glass plate is slipped over the open end of the jar before the latter is removed from the water. By this means, the oxygen will be prevented from escaping from the jar.

The above means of collecting oxygen in jars is known as the "pneumatic trough" method. Such a method, of course, only applies to the collection of gases which are insoluble or only slightly soluble in water. When conducting the above experiment, it is better to warm the flask by standing it in a saucepan of water, as shown in the diagram, rather than to heat it directly by means of the Bunsen burner or spirit lamp flame. Be very careful, also, to see that the rubber joint of the delivery tube is disconnected before you stop heating the flask, otherwise, as the flask and its contents cool down, cold water will be drawn up the delivery tube into the flask and will probably crack the latter.

Making oxygen in small amounts by heating a mixture of potassium chlorate and manganese dioxide in a hard-glass test tube provided with a glass delivery tube.

There are two very effective methods of generating oxygen abundantly without the aid of any heat at all.

The first of these consists of dropping water on to sodium peroxide, whereupon oxygen is at once evolved and sodium hydroxide formed.

Apparatus Required

For this experiment, we require an apparatus similar to the one shown in the photograph. It consists of a flask or a bottle provided with a cork through which passes a delivery tube and a dropping funnel containing water. In the flask is placed a quantity of sodium peroxide, water being dropped on to this substance. About a quarter of an ounce of the sodium peroxide will evolve a litre of oxygen.

Incidentally, it may be mentioned that this mode of preparing oxygen underlies many of the nowadays well-advertised washing powders. Sodium peroxide, however, is rather an expensive material, and, for this reason, many experimenters will prefer to make their oxygen by the following somewhat cheaper method.

Using the same apparatus, have in the bottle or flask a quantity of a strong solution of potassium permanganate and drop into this solution from the dropping funnel a mixture of approximately equal parts of dilute sulphuric acid and hydrogen peroxide. At each drop of the hydrogen peroxide-sulphuric acid mixture into the permanganate solution, oxygen will be evolved vigorously.

Oxygen, like air, is colourless, tasteless and odourless. It is a gas which is somewhat heavier than air. Oxygen is appreciably soluble in water, a hundred parts of water at ordinary temperatures dissolving about five parts of oxygen. On this property of oxygen gas, of course, all fish life depends, for if oxygen were not soluble in water, most aquatic life would be impossible.

The tremendous vigour with which oxygen supports combustion can readily be seen by plunging a glowing chip of wood into a jar of oxygen, or by holding it against the end of a tube from which oxygen gas is issuing. Instantly, the glowing chip takes fire and burns with great brilliancy.

Burning Sulphur

Sulphur, if introduced on a spoon in the slightly burning state into a jar of oxygen will immediately spring up in active combustion, burning with a dazzling lambent violet flame and combining with the oxygen to form another colourless and invisible—but not odourless—gas, known as sulphur dioxide in accordance with the following equation :

$$S + {}_2O = SO_2$$

Sulphur — Oxygen — Sulphur dioxide

This sulphur dioxide gas, SO_2, has a very strong, penetrating smell of "burnt sulphur." It is soluble in water, combining with that liquid to form an acid—sulphurous acid, as follows :

$$SO_2 + H_2O = H_2SO_3$$

Sulphur dioxide — Water — Sulphurous acid

Hence, if, after burning sulphur in a jar of oxygen, we shake up a little water containing some blue litmus in solution, the latter will quickly turn red, showing the presence of acid in the water.

Most metals, when heated, burn with

(*Continued on page* 496)

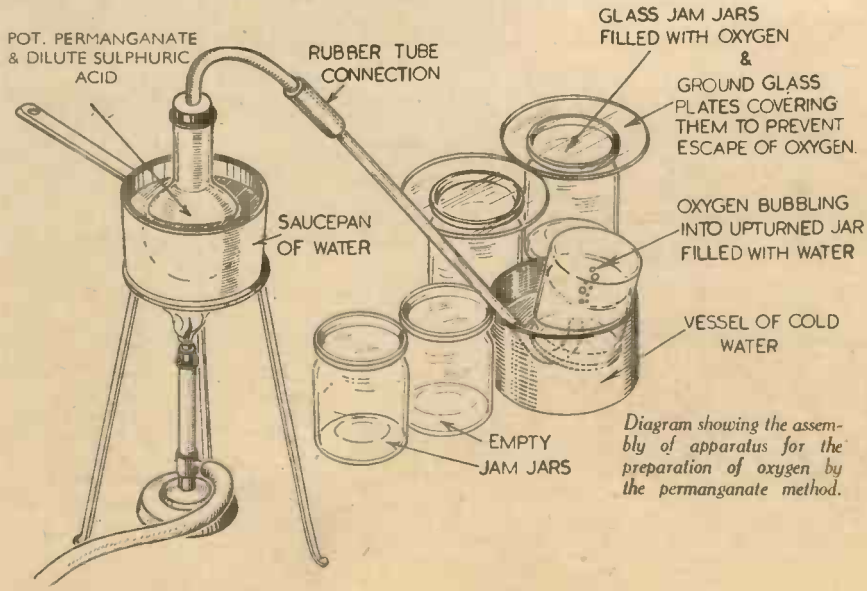


Diagram showing the assembly of apparatus for the preparation of oxygen by the permanganate method.

MODEL AERO TOPICS

Current News from the World of Model Aviation

E. W. Chasteneuf

MR. E. W. CHASTENEUF has joined the staff of Model Aircraft Supplies, Ltd. He was the leader of the British Wakefield Team in 1937 and 1938 and was a member of the victorious team sent to Yugo-Slavia and which won for England the King Peter Cup, and numerous other prizes. He is also the holder of the British Model Glider Record, with a flight of over 20 minutes.

The Green Book

THE MODEL AIRCRAFT SUPPLIES, 171, New Kent Road, S.E.1, have just published the 1939 edition of their famous Green Book. This is something more than a catalogue, for it contains a great deal of other useful information. It lists blueprints, kits, engines, materials, publications, dopes, airscrews, elastic, silks and tissues, etc., etc. Copies cost 4d. each from the address given.

British Records

I AM often asked for a list of British Model Aircraft Records, and append them.

January, 1939

			M.	S.
Fuselage				
Rising off ground	R. Copland	...	33	9
Hand launched	A. T. Paine	...	23	10
Biplane—rising off ground	A. C. Minion	...	4	57
Biplane—hand launched	S. R. Crow	...	3	24.1
Seaplane—R.O.W.(open)	A. H. Lee	...	6	54
Seaplane—R.O.W. (tank)	A. Tindall	...	4	13
Seaplane—Biplane—R.O.W. (open)	A. H. Lee	...	6	54
Seaplane—Biplane—R.O.W. (tank)	J. Worden	...	1	22.65
1-1-P-0 rising off ground	D. A. Paveley	...	1	37.1
0-1-P-1 hand launched	C. W. Needham	...	1	27.25
0-1-P-1 rising off water (open)	R. T. Parham	...	1	3.3
0-1-P-1 rising off water (tank)	R. T. Parham	...	—	45
0-2-P-1 rising off ground	F. A. Bunce	...	1	16.5
Petrol engine—rising off ground	A. T. Frazer	...	16	25
Compressed air engine—R.O.G.	D. A. Paveley	...	1	7.6
Non-fuselage				
Compressed air engine—R.O.G.	D. A. Paveley	...	1	10
Glider				
Hand launched	W. E. Evans	...	3	10
Catapult	E. W. Chasteneuf		20	0.7
Tow-line	H. J. Penny	...	3	22.3
Flying Scale Model				
Rising off ground	S. R. Crow	...	1	49.35
Hand launched	S. R. Crow	...	1	2.15
Flying Boat				
Rising off water	P. M. H. Lewis	...	—	33
Petrol engine—rising off water	C. E. Bowden	...	—	30.4

			M.	S.
Rotor Plane				
Hand launched	S. R. Crow	...	—	49.45
Rising off ground	S. R. Crow	...	—	39.5
Ornithopter—hand launched	A. B. Rainey	...	—	20
Tail-less—hand launched	A. Howard Boys	...	2	5.75
Speed	C. H. Debenham	...	33.25 mph	
Indoor Records				
Fuselage			M.	S.
Hand launched	E. A. Ross	...	4	40
Rising off ground	R. W. M. Mackenzie	...	3	35
Stick				
Hand launched	R. Copland	...	18	52
Rising off ground	J. K. Bletcher	...	4	23
Rotor plane—hand launched	L. B. Mawby	...	—	44
Indoor helicopter	R. W. M. Mackenzie	...	1	38

The New Engine

THE B.I.P. Company, of 1, Ironmonger Lane, London, E.C.2, have sent me the specifications of their new 10 c.c. Fleet Power Unit for model aircraft and model boats. I have inspected one of these engines, and seen it under test, and have no hesitation in stating that it is a high-class job, and an engineering product in every way. It costs 69s. and its specification is as follows: Capacity 10 c.c. Bore and stroke $\frac{13}{16}$ in. by $\frac{13}{16}$ in. H.p. $\frac{1}{4}$. Weight of engine only 8 ozs. Total height over top of sparking plug $5\frac{1}{8}$ ins. Total width over lugs $2\frac{7}{16}$ ins. Total length from rear face of crankcase to end of prop. shaft $3\frac{1}{8}$ in. Total length from end of prop. shaft to rear end of petrol tank, $5\frac{7}{8}$ in.

The cylinder is machined from a solid piece of chrome molybdenum steel and, in accordance with the most advanced practice, is in one piece. The head of the cylinder has a high dome which, in conjunction with the carefully shaped piston head, creates a maximum of turbulence and produces a perfect mixture and rapid assistance to expulsion of the exhaust fumes, around which hinges the success or failure of any two-stroke engine. Following the best principles of standard aircraft engine design, the finning is close, fine, and clean.

The piston follows an ingenious form of skeleton construction which gives great strength with extreme lightness. It is of toughened and hardened fine-grained steel and the transfer port is of special shape to facilitate the flow of the mixture. All contours, etc., are machined and finished clean and sharp, a factor of great importance in the design of a two-stroke engine piston. The connecting rod is of "I" section and is a drop forging with phosphor bronze bushing. This con rod is a work of art in itself.

The crankshaft, of finest quality steel, is hardened and properly counterbalanced and shaped.

The main bearing has hard phosphor bronze lining, into which the oil is forced by a special form of construction which is so necessary to the long life of this important component.

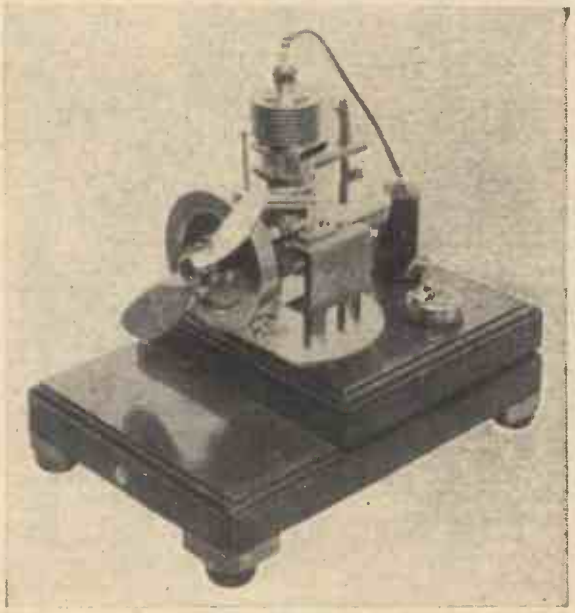
The contact breaker is of a special enclosed type which gives full protection against damage and foreign matter, and a greatly improved appearance over the usual type with exposed and projecting parts.

The crankcase, exhaust manifold, inlet manifold, transfer port cover and other small components are made from extra-strength alloy produced under a new specification and are light, strong, and clean.

All working parts are hand lapped to a mirror-like finish and a perfect fit.

The petrol tank holds 1 oz. of fuel and has a snap filler cap.

Ignition requirements are satisfied by the use of a superfine coil which is fully protected, light, strong, and low in consumption of current. The latter factor is important and is not always to be found in these ultra-light and small coils.



The new Fleet engine.

The Henry Channon trophy.

RESULTS OF WESTON CUP

	Average	Plugge points
1. E. Davies (North Kent)	156.5	82
2. R. Copland (Northern Heights)	150.5	81
3. N. Lees (Halifax)	146.56	80
4. H. Austwick	114.8	79
5. E. Chasteneuf (Blackheath)	113.4	78
6. —. Wilson (Northern Heights)	107.6	77

PLUGGE POINTS GAINED IN WESTON CUP

Blackheath	226
Northern Heights	220
Halifax	219
Luton	213
North Kent	206
Lancs.	173

PLUGGE CUP POINTS

Points gained in Gamage and Pilcher Comps. | *Weston Cup.* | *Ttl.*

Halifax	700	219	919
Northern Heights	665	220	885
Lancs.	659	173	832
Barnes	679	135	814
Luton	565	213	778
Blackheath	544	226	770

(*Continued on page 484*)

THE MONTH IN SCIENCE AND

One of Air Survey's three Puss Moths showing Capt. Lloyd holding one of the special cameras to be used for the complete re-survey of Gt. Britain.

Sandbag-filling Machine

THE Home Office have recently had sketches and plans submitted to them of a sandbag-filling machine. It is the invention of three Nottingham men and a team of four men operate the device which is stated to be capable of filling 700 sandbags an hour.

Longest Direct Telephone

THE People's Commissariat of Communications is now building the world's longest direct telephone and telegraph. It will link Moscow with strategic Khabarovsk in far-off eastern Siberia and will be 5,100 miles long. The previous longest line was between Halifax and Vancouver, a distance of 3,800 miles.

Equipment to be used will enable simultaneous transmission of three telephone conversations, nineteen telegrams and one facsimile reproduction over a single pair of wires.

Television in America

AT the Golden Gate Exposition at San Francisco, the authorities are arranging for television demonstrations whereby visitors will be able to see themselves on the screen, on similar lines to the demonstrations held at Radiolympia last year. This will be in addition to standard demonstrations of new television receivers.

It is also announced that the television transmitter on the top of the Empire State Building is being rebuilt and will probably be working by the end of the month.

Aerial Photography

THE most advanced aerial photography in the world to-day is being carried out at Southampton Airport by C.L. Air Surveys. This firm are to carry out air photography for the Ordnance Survey this summer, with the aid of three Puss Moths, equipped with automatic pilots and special cameras.

A complete re-survey of Great Britain on 25-in. maps is being made by the Ordnance Survey Department, and aerial photography is being used, due to accuracy and saving of time over the orthodox ground survey methods. Photography is done in parallel strips of areas up to 20 miles, the aircraft flying at a constant height of 10,000 ft. Strips are then placed together to form a "mosaic" of the area photographed. Using between 300 ft. and 400 ft. of film, an aeroplane can cover about 20 square miles in one operation, lasting four hours. It is estimated on an average, that the fickle English climate permits air survey work on only 20 days in the whole year.

New Mechanical Man

"ELECTRO" a new mechanical man that has been constructed in America can walk, talk, smoke cigarettes and count up to ten on his fingers. Sometimes, however, the voice of his inventor, Mr. J. M. Barnett, does not register correctly, and "Electro" doesn't do as he is told. The robot is 7 ft. high, and weighs 300 lb.

Weather Forecast by 'Phone

GOVERNMENT weather forecasts for New York and vicinity are now available to the New York City telephone users, and may be had by telephoning a Weather Forecast Bureau established by the New York City Telephone Company.

This information will be the first of its kind in the Bell System and will be made continuously throughout 24 hours, over mechanical equipment which can serve a large number of simultaneous requests. The bulletins will give the latest government forecasts and will present information supplied by teleprinter from the U.S. Weather Bureau, usually four or more times daily.

For Atlantic Service

THE two largest planes ever shipped from England were hoisted by a giant 150-ton floating crane aboard the Canadian Pacific fast freighter *Beaverford* at Ocean Dock, Southampton, recently.

Operating the control desk of the magnetic tape recorder, used for weather service in the new American Weather Service Bureau.

THE WORLD OF INVENTION

These planes, originally Handley-Page Harrow bombers, have been converted into 1,000 gallon refuelling tankers, designed to meet and refuel the air-mail planes which will soon be flying on the Transatlantic service.

World's Wonder Ship

THE royal research ship, *Research*, which has been built for the Admiralty by Messrs. Phillip & Sons, Ltd., at Dartmouth, Devon, has now been launched. The ship has been built for the investigation of problems connected with terrestrial magnetism and atmospheric electricity, but she will also carry out meteorological and oceanographical work. This remarkable vessel, which is the only one of its kind in the world, is brigantine rigged and is built almost entirely of non-magnetic material so that her magnetic survey work can be effectively carried out. As far as is practicable all ferrous material has been eliminated from the hull, machinery and stores. The hull is built up of teak planks on brass frames, and teak and Canadian rock elm have been used for the keel, stem and stern posts.

The *Research* is 142½ ft. in length with a beam of 34 ft. and a load displacement of 770 tons. She is the world's second non-magnetic ship and will replace the American *Carnegie*, which was destroyed by an explosion off Samoa in 1929, after 25 years' magnetic survey work, the results of which were placed at the disposal of all governments.

A Midget Electric Motor

A SWISS inventor, Mr. F. Huguenin, has built what is claimed to be the smallest electric motor in the world. 48 parts are used in its construction, including pieces of platinum and two rubies, as used in watches.

The motor, which took two weeks to complete, weighs only 0.16 of a gramme, is 3 millimetres wide and 3 millimetres in height. It works off a two-volt battery and the power of the midget motor is 0.005 watts.

A "Break-of-gauge" Device

BECAUSE of the varying gauge in railroads, travellers between New South Wales and Victoria have to break their journey at the border town of Albury, and continue on their way in another train.

With a view to overcoming this hold-up, Mr. J. C. T. Brook has invented a break-of gauge device which he claims will make this change unnecessary.

All-metal Airship

AN American inventor, Mr. T. Rose, is at present constructing an all-metal airship in a shed near Camarillo, California. The airship, which will be ultra-modern, will cost about £3,250 to build, and will be able to ascend and descend vertically and zoom through a constant, automatically-created vacuum. It will be capable of carrying 13 persons in its gondola.

Its construction consists of thin aluminium surfacing, thin circular ribs of the same metal and piano wire to stay and brace the whole thing. Six 50-h.p. engines will propel the dirigible, with one motor being fitted in the hollow nose of the craft and another in the tail. The four other motors will be beneath the 180,000 cubic-foot metal envelope. Its diameter will be 49 ft.

New Type of Training Aircraft

AN aeroplane so simple to fly that a novice, following an instructor's directions, can take it off the ground and, after a flight, land again safely, was recently demonstrated at Hanworth, Middlesex. The machine, the General Aircraft Company's Cygnet, is now in production for the Civil Air Guard scheme and, it is claimed, will reduce the time of training pilots by at least half. The outstanding feature of the Cygnet, which is the only British all-metal stressed-skin light aeroplane, is the tricycle undercarriage. When on the ground the aeroplane still remains in flying position, the nose resting on a wheel under the engine. This front wheel is steerable so that all the difficulties of taxi-ing are removed and the aeroplane drives along the ground just like a car. When the speed is increased to about 50 m.p.h. the control stick is pulled back and the machine rises without any swing such as is experienced in ordinary aircraft and will continue to fly straight at any throttle opening. The Cygnet is one of the first British single-engined machine to be fitted with double rudders and fins. It has an engine of 130 h.p., can carry two passengers and ample luggage or three passengers at 135 m.p.h. with a range of 600 miles.

Gift to Museum

THE Science Museum has recently received from Mr. Thomas H. Court a gift of a large number of early optical, mathematical and astronomical instruments, some of which are now attractively displayed in a single group in the Optics Gallery

The seventy objects which comprise Mr. Court's most recent benefaction include an Italian recipiangle of about 1600. This is an instrument used for measuring angles in surveying, and it is also marked with lines and scales which can be used for making calculations. This method of calculating had been invented by Galileo only a short time previously to the making of this particular recipiangle. There is an optometer, invented by Thomas Young for testing eyesight and prescribing spectacles, there are early telescopes with vellum tubes,

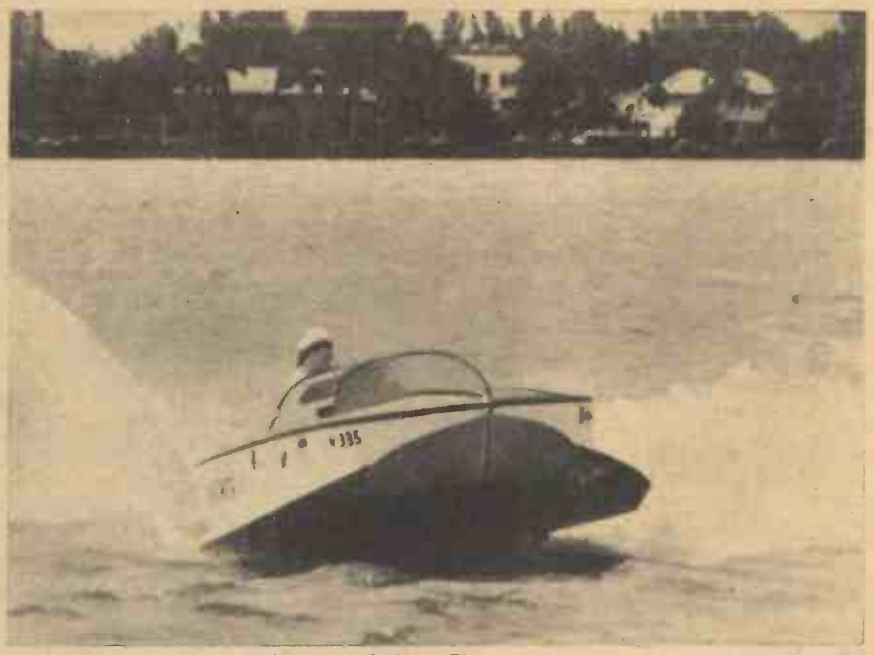
A new type of training machine for air pilots known as the "Cygnet," landing during a recent demonstration at Hanworth. It is one of the first British single-engined machine to be fitted with double rudders and fins.

silver drawing instruments, a diagonal glass by means of which the visitor to the theatre or opera could observe his fellow spectators while appearing to be looking through his glass at the stage, and there are several fine astronomical reflecting telescopes by such noted 18th-century opticians as James Short, John Bird and C. S. Passemant.

The donation also includes several rare instruments of the 17th, 18th and early 19th centuries, notably a beautiful compound microscope of the Divini-Campani form with silver mounts, a number of very fine Culpeper-type microscopes and some of the earliest achromatic microscopes by English and Continental makers.

Five Records Broken

ON this page we show Mr. S. Auerbach, in his 225-class hydroplane "Emancipator VII" in which he covered 162 miles and broke or established the following records. The 24-mile mark in the four-litre class, held by Harold Holte of London, with a speed of 62.0991 miles an hour, compared with Nolte's 53.75, the unlimited 24-mile record held by J. Schoeller, of France, whose speed was 49.883 miles an hour the unlimited one-hour mark set by E. Silvani of Italy, with 62.20 miles an hour, compared with Silvani's 55.75, the one-hour four-litre record and the three-hour record, established with a speed averaging 54 miles an hour.



Mr. S. M. Auerbach shown off the coast of Miami, Florida, in his 225-class hydroplane "Emancipator VII" in which he broke five records.

New Type of Lorry

COMMER COMMERCIAL VEHICLES have produced a new type of lorry that is so simple to drive that the steering can be controlled with one finger. Under test and carrying a load of 4 tons it easily reached its maximum legal speed with no apparent effort.

The lorry is fitted with a 6-cylinder engine and a new form of cab suspension. A sub-frame makes them able to negotiate the bumpiest ground.

Safety Glass

THE Franklin Institute recently carried out tests in Philadelphia, with a new type of safety glass. A girl stood behind a sheet of the glass and a base ball pitcher standing thirty-five feet away threw a hard ball at her. The glass stopped the ball without even cracking.

It is ten times as strong at zero temperature as some of the glass now used in cars and it will be fitted to 75 per cent. of the cars manufactured in the United States this year.

Cheap Electric Power

EUROPE'S longest river, the Volga, which is the main inner waterway of the Soviet Union is now undergoing "reconstruction." The project which will be called the "Greater Volga," will link up five seas : the Baltic, the White Sea, the Black Sea, the Sea of Azoy, and the Caspian Sea, by means of canals.

In this way it is hoped to utilise the huge resources of water for the generation of cheap electric power and for irrigation. The river will be deepened to a depth of 8½ ft. for a length of 2,000 miles. Six huge dams with hydro-electric power stations and sluices are to be constructed as well as the installation of electric pumps to raise water to the neighbouring hills.

Engine No. 1 of the Great Northern Railway, 77-year-old "William Crooks" which recently completed the trip to the New York World's Fair under its own power. It was named after "Colonel Billy" Crooks, who drove the first spike in Minnesota's first railroad.

Television in America

TELEVISION is making rapid strides in America. When the two American television systems begin transmissions they will serve 10 million viewers. The National Broadcasting Corporation of America have designed a revolutionary type of television aerial, and it will be mounted on the top of the Empire State Tower which is the highest building in the world. Columbia's aerial system is mounted on top of the Chrysler tower and has to withstand a 140 m.p.h. wind on top of this 47-storeyed building. Independent di-pole aerials, sixteen in number, have to be heated internally by means of thermostatic control so that ice cannot form on them. 4,800 square miles will be covered by the transmissions.

Pick-a-back Land Plane

OWING to the success of the Short-Mayo pick-a-back flying boat, a land version is now under construction. Specially adapted Ensign class air liners will take the place of the launching plane and they will carry a land plane similar to the Mercury seaplane. It is thought that the absence of floats will increase the speed of the upper craft by at least 40 m.p.h. Used as a mail plane this type of aircraft will have an amazing range of 6,000 miles non-stop and a reasonable fuel consumption.

An Unknown Civilisation

ARCHAEOLOGISTS at the village of Pylos, near Navarino, have brought to light the remains of an ancient palace.

One hundred and fifty tablets have been found inside the palace which have proved to be the archives of the establishment. Writings on the tablets have proved to be lists of provisions, the number of people engaged in the palace, and the wages they were paid.

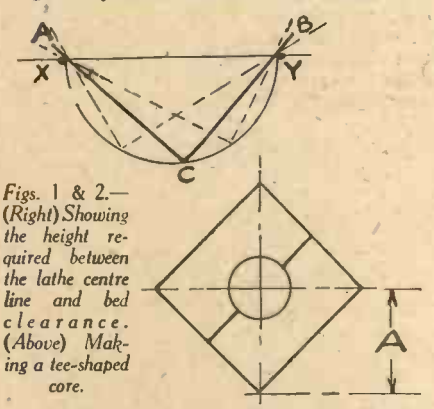
Signs of an ancient town have been found round the palace which when excavated may prove to be the vestiges of an unknown civilisation.

It has been suggested by experts that it may be the Palace of Nestor, built in 1500 B.C. and mentioned by Homer.

Cylindrical Core Boxes

A Pattern Making Hint

IN the making of patterns the owner of a small workshop may find that his lathe is not capable of dealing with some of the bigger core boxes, for a core box can generally be considered to bulk at least twice the width and depth of the greatest diameter of the core, and to swing this on a face plate means as much space below lathe centre line as half the diagonal of the square box. This is shown in Fig. 1, where A is the height required between lathe centre line



Figs. 1 & 2.—(Right) Showing the height required between the lathe centre line and bed clearance. (Above) Making a tee-shaped core.

and bed clearance. In some cases the clearance is less if part of the lathe saddle has to come between the work and the lathe bed.

Lathe Unnecessary

But these core boxes (as long as the core is circular in cross section) can be made without a lathe, and indeed core boxes where cores cross each other (as in the case of a cross or "Tee"-shaped core) can be made quite satisfactorily without a lathe.

The method depends on the fact that a right angle can have its sides touching two fixed points and, however disposed, its apex will follow on an arc forming half of a circle whose diameter equals the distance between the two points. This is shown in Fig. 2, where X and Y are two fixed points and A, C, B is the right angle. The full line shows the position, the dotted lines show other positions—unlimited in number, but all conforming to the basic rule which is the basis of the procedure to be described here.

Take the block of wood which is to form half of the core box for a cylindrical core and mark upon it two parallel lines at a distance apart equal to the diameter of the required core. Then nail upon it two strips of hard wood ¼ in. thick and ⅜ in. wide, having one edge of each coinciding with one of the lines and the strip lying outwards beyond the space enclosed by the parallel lines. This is shown in Fig. 3 in perspective and in Fig. 4 in end view. From the centre X in Fig. 4 describe a half circle of a radius equal to half the diameter of the core we want. The half circle is shown in Fig. 4 by dotted lines.

A Grooving Plane

We now take a grooving or moulding plane—the narrowest we can get—shown in Fig. 5, and with a rounded V-nose iron, shown in Fig. 6, and we bevel its bottom edges towards each other so that they have an included angle of 90 degrees. This is shown in the front view in Fig. 7. Next plane up two strips of wood ⅜ in. thick and of a length equal to the length of the plane and of a width ¼ in. wider than the diameter of the core box we desire to make.

If we are going to use it for various-sized cores, which may be larger than the core immediately under consideration, we can make the width wider so that the tool will deal with the biggest diameter of core box we are likely to need. The plane will then

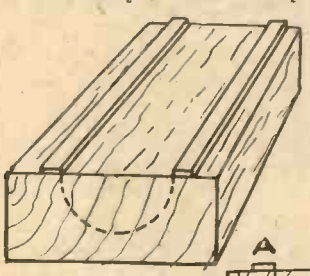


Fig. 3.—(Left) A block of wood for forming half of the core box for a cylindrical core.

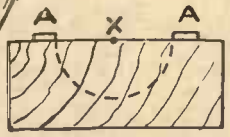


Fig. 4.—An end view of the block of wood shown in Fig. 3

be available for all sizes below this. Therefore, make these side pieces ¼ in. wider than the biggest diameter we shall require. The side pieces are fitted one each side, to the body of the plane, and are shown in position in Fig. 7.

They should be made of hard wood—any hard wood will do. They are bevelled down so that they come together at the bottom, lying against the bevelled bottom edges of the plane body as shown. They assume an angle to each other of 90 degrees, with the central vertical line (shown dotted) of the plane body bisecting the 90-degree angle.

They are held in position by two bracket pieces, AA, on each side. These bracket pieces should be of hard wood, and the shape is such that screws can be driven through their upper ends into the body of the plane and at right angles to it. These screws are indicated by BB.

The side pieces, EE, are attached to these brackets by screws through their undersides indicated at CC and DD. The top screws, CC, screw only into the bracket but the bottom screws, DD, screw through the side pieces and into the plane body. These are indicated at D and D. The side pieces, EE, should fit very nicely together at the bottom and to the bevelled bottom edges of the body of the plane. This is very important. The whole lot may be glued—bracket and side pieces. In any case the side pieces, EE, where they join each other and join the bottom of the plane should be glued.

The Plane Iron

The mouth at the bottom of the plane, for the plane iron to protrude, will have to be extended down into and through the bottom of the side pieces so that the plane iron can pass through. This will be done with a very narrow mortice chisel, holding the plane (fitted up with its side pieces) in a V-groove having an angle of 90 degrees in a piece of hardwood so that the mortice chisel, in coming through at the bottom, does not tear the wood away. If the plane is held tight in the V-groove, the chisel can be driven right through into the hard wood without breaking the wood at the apex of the side pieces.

A perspective view of the plane complete is shown in Fig. 8.

The plane iron which goes with the plane will serve for the new job the tool has to do if it is ground to the shape shown in Fig. 9; which shows the plane iron at approxi-

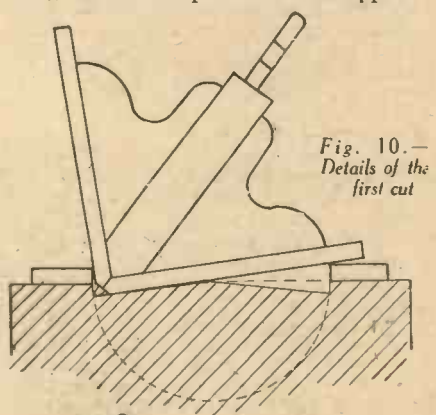


Fig. 10.—Details of the first cut

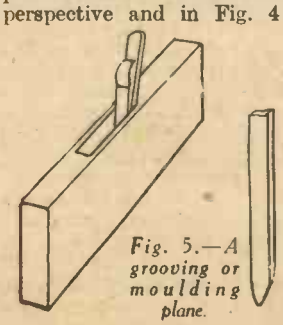


Fig. 5.—A grooving or moulding plane.

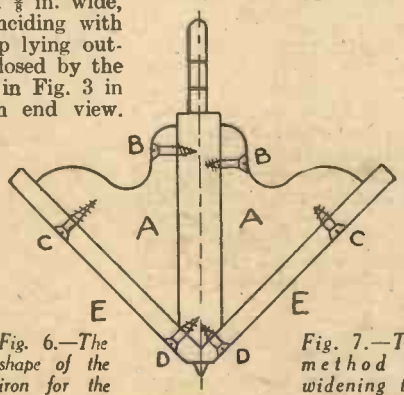


Fig. 6.—The shape of the iron for the grooving plane.

Fig. 7.—The method of widening the grooving plane.

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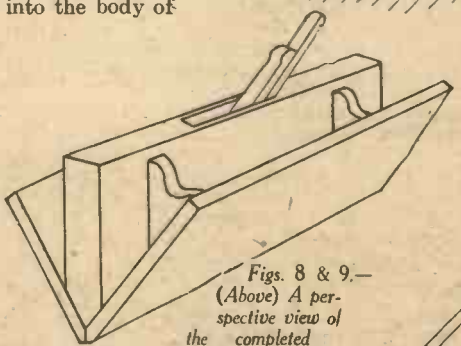
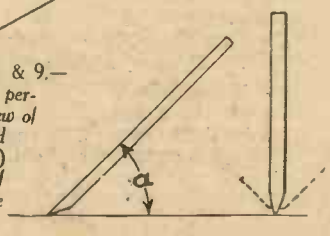




Figs. 8 & 9.—(Above) A perspective view of the completed plane. (Right) Method of grinding the plane iron.

MARVELS AT THE NEW YORK WORLD'S FAIR

A Riderless Bicycle; a Remarkable Robot; the Microvivarium

One of the 12 microscope reflector units in the Microvivarium exhibit. On screens 5 ft. in diameter, images of one-cell animals, whose whole world is a drop of water, will be magnified 2,000 times in their actual colours. (Inset) a magnified view of a group of one-cell animals.

A BICYCLE is doing a 100,000 miles riderless trip at the 1939 New York World's Fair.

In the test run in the Westinghouse Research Laboratories at East Pittsburgh, this riderless bicycle, steered and balanced by a photo-electric cell, did a steady 28 miles an hour, and the research engineers said it was ready to maintain this pace in a 365-day sprint, riding off nearly 400 miles a day.

Unsupported by wires or braces of any kind, the bicycle coasts along on three metal rollers, depending on the electric eye and a team-mate called "Silverstat" to keep the wheel upright. Two corrective weights fastened respectively to the handlebar and front mudguard and the gyroscopic effect of the bicycle's front wheel give stability to the riderless machine.

The electric eye is such a good rider that the bicycle can bear a three-pound sidewise push against its saddle before losing its balance and falling into its safety catch. In fact, the electric eye is so good that it can steer the bicycle without a quiver down the narrow groove formed by the three propulsion rollers. If you have ever tried to ride a bicycle in the groove of a tramway track you'll know that it's not humanly possible. A number of engineers proved this in the laboratory; they attempted to ride the riderless cycle and failed.

The "beam" ride starts when a light beam strikes a mirror under the pedals of the bicycle, which reflects varying amounts of light on the electric eye as the bicycle tilts from its upright position.

The "Electric Eye"

Sensing the tilting, the electric eye transforms its light energy into an electric current which is amplified and delivered to the Silverstat. This recently invented device operates as an automatic rheostat. By a system of silver buttons connected to stops of stationary regulating resistances it controls a regulating motor.

The regulating motor, actuated by the electric eye, steers the front wheel of the bicycle and moves the two attached weights to balance the machine.

Fastened to the front mudguard, the larger of the balancing weights corrects tilting in proportion to the amount of shift from its central position, like a circus rider who balances a bicycle on a tight-wire by changing the position of his long balancing pole.

The smaller of the stabilizing weights is attached to the handlebar and hangs over the front wheel. It is called an "inertia skyhook" because it acts as a "momentarily fixed body" against which the regulating motor can push to correct the tilting of the bicycle. Such correction, according to the engineers, occurs even before the coriolis anticipator can act, because the force of the weight's inertia reacts on the bicycle in proportion to the sidewise acceleration of the weight as the front wheel turns to the left or right.

Probably everybody has used an inertia skyhook at some time to help him recover his balance. Suppose you are standing beside a box that is on rollers and you start to fall toward the box. By reaching out and pushing against the box you would momentarily check your fall and possibly regain your balance. The box in this case is the inertia skyhook. It is a momentarily fixed body, although if you lean against it long enough it will roll away from you.

The "Moto-Man"

But the marvels to be seen at the Westinghouse Exhibit of the New York World's Fair do not end there. Visitors will make the acquaintance of Elektro, the Westinghouse "Moto-man" who weighs 260 pounds, stands 6 ft. 10 in. high, walks, talks, sings, smokes a cigarette, distinguishes colours, smells flowers, counts on his fingers

Elektro, the "almost human" robot.

and does other near-human acts at the spoken command of his director. Also the Singing Tower of Light, which dominates the court of the Westinghouse Building and Exhibit. Each evening it performs a 15-minute ballet of light and water beneath a canopy of gorgeous illumination formed by twelve 1,000 watt mercury arc searchlights. In the Transportation exhibit the visitor steps on to a section of a modern Westinghouse electric street car, and, sitting in the motorman's seat, manipulates the controls which operates a miniature model of the same car situated on a nearby platform. Another fascinating and instructive exhibit is the Westinghouse Microvivarium. Here, projected on 12 circular giant screens, the visitor beholds the ordinarily invisible world of microbe life inhabiting a drop of water. In the actual colours the creatures exhibit all primary instincts of life in its lowest form. They make love, fight, kill, eat enemies sometimes larger than themselves and at times exhibit startling signs of intelligence.

Photo-Electric Cells—Part II

By R. L. Maughan, M.Sc., A.Inst.P.

Photo-Electric Cells have been used Extensively in Recent Years for Automatic Control of Street Lighting, in Sound Films and Television, Burglar Alarms, etc., etc.

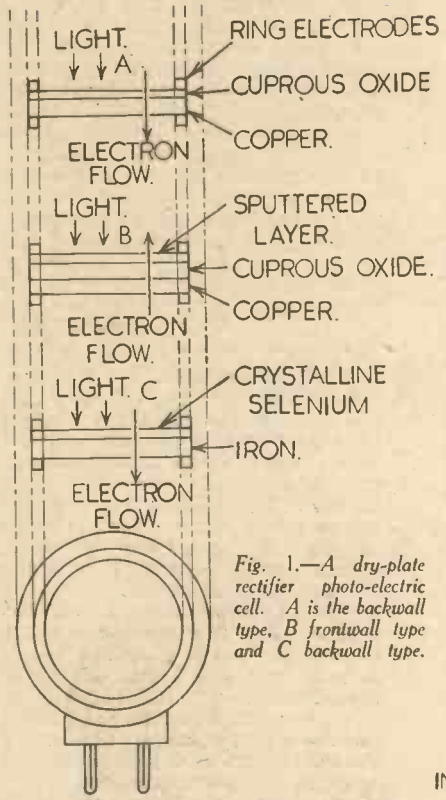


Fig. 1.—A dry-plate rectifier photo-electric cell. A is the backwall type, B frontwall type and C backwall type.

IN design and behaviour the dry plate photo-electric cell makes definite departure from the two types previously discussed, the conductive and alkali metal cells. The development of the dry-plate cell, or rectifier cell as it is sometimes described on account of its close similarity to the dry-plate current rectifier widely used in electric circuits, was initiated by the researches of B. Lange in 1930. It consists of a disc of about 3 in. to 4 in. diameter and about ¼ in. thick built up from a series of close-fitting layers of metallic materials (two or three in number, depending upon the type of the cell), and bound by a protective rim of bakelite containing the ring electrodes, with a base piece attached to hold the plug pins (see Fig. 1). The two types are distinguished by the titles "backwall" (hinderwand type) and "frontwall" (vorderwand type), the main structural differences between the two lying in the number and arrangement of the layers constituting the disc.

Earlier Cells

In the earlier cells, as manufactured by Siemens, Berlin, following upon Lange's work in 1930, the backwall pattern was made up of a copper disc with a thin layer of cuprous oxide deposited on its surface (Fig. 1a). This deposit was laid by heating the copper disc in an atmosphere of oxygen for 24 hours at a temperature of about 1,000 degrees centigrade to give the copper a double coating of cupric and cuprous oxides, the cuprous oxide being sandwiched between the copper and the cupric oxide. The layer of cupric oxide is afterwards dissolved off in aqua regia leaving the cuprous oxide surface exposed and ready to act as the cell window. The action of light upon this sensitised copper oxide surface promotes a burst of electrons at the surface of separation between the copper and cuprous oxide (the "sperrschicht"), in one direction only, from copper oxide to copper, producing a current in that direction through the cell and external circuit which lasts as long as light is being received by the cell. In the frontwall pattern an extra layer of gold or platinum, very thin and semi-transparent, is sputtered upon the cuprous oxide surface, and the incidence of light upon this window causes an electron flow in the direction copper to copper oxide (Fig. 1b). The generation of current in the form of a flow of electrons takes place at the sperrschicht which in the latter case lies between the sputtered surface and the cuprous oxide, the thick copper disc serving only to give the structure mechanical strength. In both types of cell, frontwall and backwall, the electron stream is collected by the ring electrodes and fed into the external circuit.

Dry-plate Cell

A more recent form of dry-plate cell is made from iron and selenium instead of copper and cuprous oxide. Here a thin covering of grey metallic selenium is evenly laid over a disc of iron which is afterwards mounted in a case with glass windows, sealed and evacuated to protect the selenium from the attacks of the atmospheric gases. Fig. 1c illustrates the backwall type of this cell. In the manufacturing process the selenium is applied to the iron in a plastic or molten condition and is rolled or pressed to give the required thinness. Subsequent heat treatment slowly crystallises the selenium and renders it photo-electrically sensitive to light, changing the appearance of its surface from glossy black to grey matt and causing the whole layer to shrink into a firmly bonded contact with the iron.

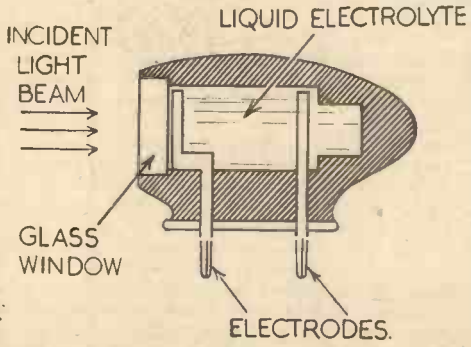


Fig. 2.—An electrolytic photo-electric cell (vertical section).

Two notable advantages of the dry-plate photo-electric cell over the conductive and alkali metal types previously discussed are its relatively large output of current, and the fact that no high tension is required to promote its action. The penetration of light through the thin semi-transparent top deposit to the sperrschicht produces a current through the cell in immediate response, the magnitude of the current depending upon the area of surface illuminated and the intensity of the illuminating beam. It has the defect, however, of being subject to fatigue. Prolonged usage results in a falling off of the current output in a manner analogous to the polarisation of a primary electric cell.

The Becquerel Effect

The electrolytic photo-electric cell in its action is a direct embodiment of the Becquerel effect, and although Becquerel's discovery of 1839 is recorded as the first in the field of photo-electric research, the electrolytic photocell has the fewest applications in modern mechanical apparatus and is the least understood amongst the four classes of photo-electric cell. In structure it may be regarded as a modified primary electric battery sealed and fitted with pin terminals (see Fig. 2). It is a primary electric cell inasmuch as it contains two electrodes of dissimilar materials immersed in an electrolyte, a system which generates an electro-motive force in the usual way, and it is modified in the sense that one of the electrodes has a surface rendered sensitive to light placed in front of a glass window let into the wall of the cell. When light penetrates this window and strikes the electrode a photo-electric current passes through the cell and external circuit which is generated independently and in excess of the current manufactured by the normal chemical action of the cell. The presence of a voltage between the electrodes is essential to the maintenance of this photo-electric current and the cell has the merit of providing its own voltage, and thus does not need the externally applied potential difference required by the conductive and alkali metal cells.

Spectral Response Curve

Common to all classes of photo-electric cells, a property which is of considerable importance from the point of view of practical utility is the power of response

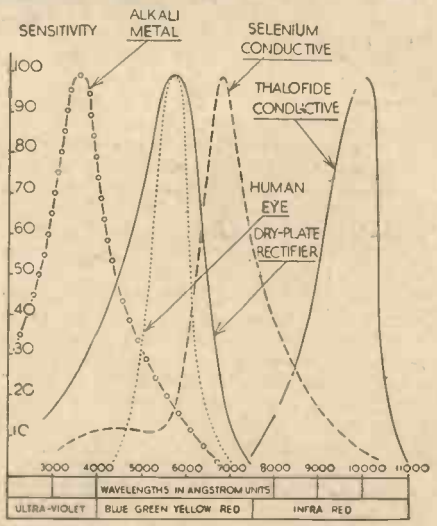


Fig. 3.—Spectral response curves.

to light of different colours. This property is represented graphically in a spectral response curve, which displays the exact relation between colour, measured in terms of wavelength, and sensitivity, measured in current output per illuminating power. (see Fig. 3.) For a given cell this curve has at least one clearly defined peak value which indicates the wavelength of the particular colour to which that cell makes the most response, and a careful consideration of the position of this peak is always made in selecting a cell which is intended to perform some particular operation. For some cells the peak value lies outside the range of radiations visible to the human eye (most usually in the infra-red region of the spectrum), conferring upon these cells the property of " seeing in the dark," which makes them particularly adaptable to the operation of burglar alarms, and to the control of processes in chemical industry where darkness is a necessary condition, as in the manufacture of photographic film emulsions.

A selection of spectral response curves representative of the various cells is illustrated in Fig. 3. The spectral response curve of the average human eye is added by way of standard and for purposes of comparison. This latter curve shows the particular range of colours to which the eye is sensitive, the maximum response being made to a wavelength of about 5,500 Ångström units which corresponds to the colour of green situated approximately midway between blue-green and yellow-green tones. It will be observed that amongst the cell curves that of the dry-plate rectifier cell makes the closest approach to the human eye curve, which proves that this cell possesses the power of " seeing " in the human sense to a much higher degree than any of the other cell types.

Field of Application

The field of practical application of the photo-electric cell is a wide one, and the undisputed success which the majority of the applications have met with is due to the close co-operation between scientist and engineer. Whereas the pure scientist is engaged in the study of natural phenomena in order to gain an understanding of the truth which they manifest, his colleague the engineer is interested more in the practical applications of these phenomena to purposes useful to mankind. The ever-increasing output from the scientist's laboratory of facts and processes capable of being usefully applied by the engineer has made it necessary for the engineer to specialise more and more in some particular branch of engineering, mechanical, civil, electrical, marine, aeronautical and so forth, and these branches are themselves undergoing further subdivision. In particular the radio engineer and still more recently the photo-electric engineer have become specialists in the electrical branch. Given such a device as the photo-electric cell, in which electric currents are produced by the action of light, an expert engineer can design a piece of mechanism which will automatically perform almost any operation which a man would perform in virtue of what he sees.

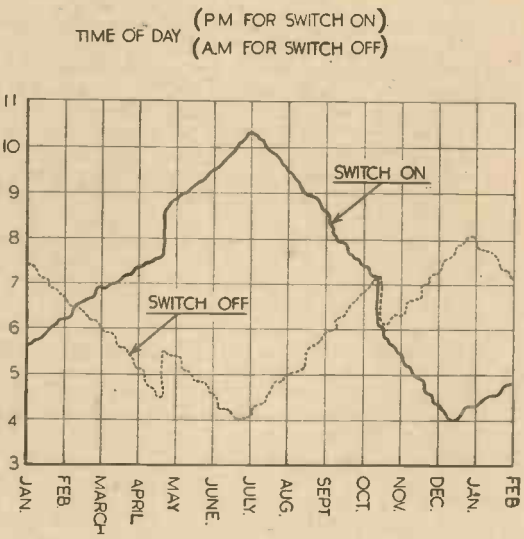


Fig. 4.—A lamp control chart.

Street Lighting

One of the most successful of these mechanisms, and one which has been adopted on a large scale in this and other countries, is the use of the photo-electric cell as an automatic controller of street lighting. The cell is mounted in the standard which supports the lamp and is fully exposed to the daylight. The photo-electric current produced by the cell is proportional to the intensity of the daylight incident upon it and when this daylight fades and reaches a certain dimness, as in the normal evening twilight or a mid-day fog of winter, the photo-electric current falls accordingly and operates a relay which closes the contactor in the lighting circuit of the lamp. With the return of daylight the photo-electric current increases steadily and eventually operates the relay which switches off the lamp. Fig. 4 is a typical chart of this automatic control showing the exact time of day at which the switches were operated, taken over a period of twelve months. The slight discontinuities in the graph showing at the months of April and October are, of course, due to the change-over to and from British Summer time.

Alarms, etc.

Other applications of a more spectacular nature are to be found in the raising of alarms, in the automatic opening of doors at the approach of a person or object, and in the timing of races, all of which may be done without the use of light which is visible to the human eye. A single general principle underlies all of these mechanisms. A narrow parallel beam of radiation is directed from a distant source into the window of the photo-electric cell and is maintained at a constant intensity so as to produce a steady continuous current in the cell and its associated circuit. Any variation in the beam intensity, or its momentary suspension as some object crosses its path causes the cell current to alter in immediate response, and this current change sets into operation the required mechanism. In the timing of races, the horse, car or runner cuts through a beam projected across the track at the starting post and sets a stop-watch ticking, and the interception of a second beam at the finishing post leaves the watch indicating a time interval whose measurement is free from the usual errors inherent in human observation. A similar arrangement in which a beam crosses the entrance to a doorway a few feet from the door itself causes the door to open at the moment the beam is intercepted by the person approaching it. In another apparatus the breaking of the beam by smoke or fire or by a possible burglar raises the alarm in the form of bell-ringing or the flashing of a lamp.

A PATTERN-MAKING HINT

(*Continued from page* 471)

mately the angle, A (it will assume in the plane), and also in a front view. The dotted lines in the front view show the outside surfaces of the plane and how the rounded end of the plane iron just protrudes.

In use the plane is first guided each side of the semi-circular cut it will have to make by the strips shown in Fig. 4, and planing will proceed a little from one side and a little from the other and taking out the intermediate wood by planing along anywhere between the strips. The first cut is shown at Fig. 10, and when cuts have been taken each side and in the centre so that there is a ledge left in the stock itself where the guide strips AA in Figs. 4 and 10 have kept the plane from cutting the stock wider, these edges in the stock itself can be used to guide the plane as the strips did before they were removed, as in Fig. 11.

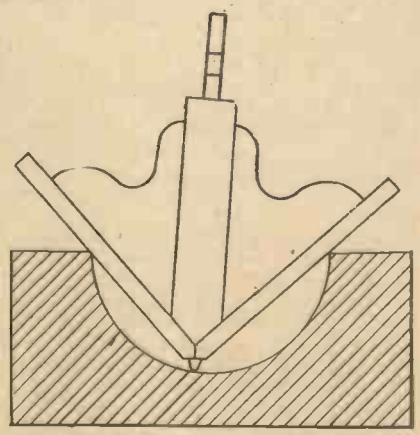


Fig. 11.—Showing the plane with the cuts completed.

The plane can then be used all through the semi-cylindrical channel until it will take out no more stock and that half of the core box is complete. It is shown with the cuts completed in Fig. 11.

A Cross Core

If we want a cross core we can nail strips across the stock and proceed to cut another core hole in exactly the same way, and the cross cut need not be for the same diameter of core. It can be smaller or larger. The strips will guide the plane across the already planed-out core hole. Cores can also be arranged at angles.

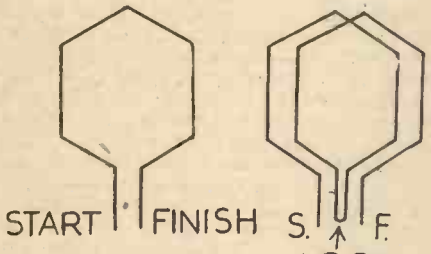
When two halves of the core box have thus been planed out we can put them together and check for circularity. They should line up perfectly and so be clamped together by a wooden cramp. Then two dowel holes at opposite corners should be bored right through both pieces and two hard wood dowels will be glued tight in one half of the core box and eased with glass paper to be a push fit in the other half.

ARMATURE WINDING

By A. H. Avery, A.M.I.E.E.

This Article Deals with Armatures Suitable for Fractional Horse-Power Motors, as Larger Motors are Generally Outside the Scope of Small Workshops

AS many readers may have discovered for themselves, there are a number of pitfalls lying in wait for those who attempt the repair and re-winding of small armatures for the first time. First there is the specification itself to consider, that is, the number of turns to give to each coil and the correct gauge of wire; then comes the matter of insulation, the actual manipulation of the coils, the number of slots they should span, and, lastly, what



Figs. 1 and 2.—One and two-coil-per-slot grouping.

pitch to be given when connecting them up to the commutator.

It is necessary in the present instance to limit the discussion to such sizes of armature as would be employed for "fractional horse-power" machines, since the procedure for dealing with larger armatures wound with copper strip or bar instead of small wire of circular section is generally along totally different lines of treatment, and outside the scope of the small winding shop.

Winding Specification

Concerning the winding specification itself, this belongs to the province of design rather than of repair, and for that reason one must assume it to be already known; there are many handbooks dealing with this aspect of the subject to which the reader can refer if interested. Where repairs and rewinds are in hand, too, the specification is already available from an examination and count of the turns and gauge of wire already existing on the damaged armature, if it is not too badly burned out. Generally it is possible to lift one complete coil out of the armature slots, and either unwind it carefully, counting the turns, or, if this cannot be done owing to its condition, the coil can be cut across the end winding, the individual wires then being spread out and counted.

Admittedly this may prove tedious work if the gauge of wire is very fine, but it forms a much more definite guide to a correct rewind than merely making a rough estimate and guessing at the turns and gauge. In particular it is necessary to be careful in measuring up the gauge. A short length of wire should be extracted from an old coil and the covering removed by carefully passing it through a piece of folded glass-paper of finest grade until the bare metal shows. Stretching must be rigorously avoided, nor is it the slightest use to gauge over the old covering. When the wire is very fine the safest way is to pass a length of it through the flame of a spirit lamp or bunsen burner until it is just reddened; the covering usually then rubs off with very slight friction.

Burnt-out Coil

To discriminate between the different kinds of insulating covering is also not too easy, on a coil that has been burnt. It may be generally taken, however, that plain enamel coverings are employed on wires finer than No. 40 s.w.g.; enamel and single silk or double silk coverings on gauges between No. 32 and 38 s.w.g.; and double cotton coverings, 6 mils thick, for wires of No. 24 to 30 s.w.g. Coarser gauges than No. 22 have generally thicker double cotton coverings ranging between 10 and 15 mils in thickness.

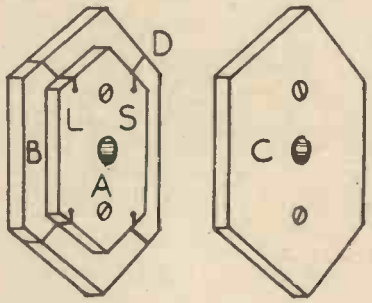


Fig. 6.—A suitable former for small armatures.

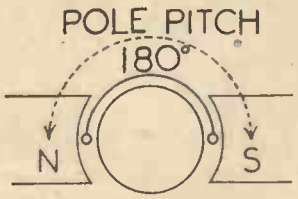
The importance of choosing a suitable covering for the wires is not always fully appreciated. It greatly affects the "space factor" of the windings and often makes all the difference between an easy winding and one that is impossibly tight in the slots. For instance, an armature slot having a winding space equivalent to one quarter of a square inch would accommodate a maximum of 1,110 turns of No. 33 s.w.g. wire covered with 6-mil cotton; but by the use of double silk covering instead 1,600 turns of the same gauge would go into the same space, while no fewer than 1,975 turns of the wire could be accommodated if the covering were of enamel only. Tables giving the number of turns per square inch for various gauges of wire and for various coverings can always be consulted when there is any difficulty with "tight" windings.

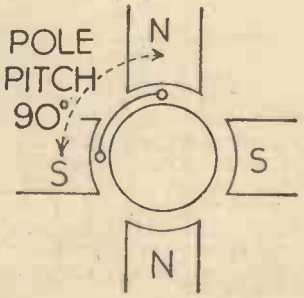
Turns Per Coil

The number of turns per coil being known, together with the gauge of wire and nature of its insulating covering, the next thing is to decide how many coils are required, also how many armature slots each coil should span. The answer to the first question is determined by reference to the commutator. Every armature must have the same number of armature coils as there are bars in the commutator. Even when there is a discrepancy between the number of armature slots and the number of commutator bars this rule still holds good, as such conditions are met by "grouping" two or more coils in each slot instead of one. It is quite a common thing to find a 24-part commutator, for instance, on an armature having only 12 slots in the core, in which case 24 coils would be wound off and two put into each slot instead of only one. Similarly a 16-part core and 48-part commutator would have its 48 coils grouped three per slot, and so on. Nearly all armatures are "former-wound," by which is meant that the coils are all wound on a separate "former" or wood block of

Fig. 7.—The appearance of the formed coil.

Fig. 3.—Three-coil-per-slot grouping.





Figs. 4 and 5.—(Above) A two-pole field magnet. (Right) A four-pole field magnet.

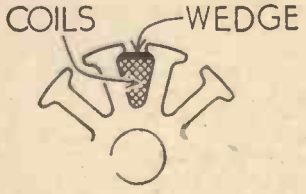
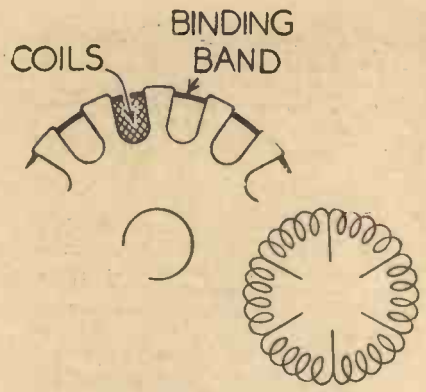


Fig. 8.—An armature with semi-enclosed slots.



Figs. 9 and 10.—(Above). An armature with open type slots. (Right) Windings forming a continuous succession of loops.

suitable shape and all to the same size. The ends are then taped up and the coils packed into the armature slots separately afterwards, instead of being wound on direct in position one at a time. It is only in cases where heavy gauges of wire are called for, such as are associated with very low voltages, that the wire is hand-wound direct into the slots of the core. The great advantage of former winding is that not only can the fine wire coils be run off at a comparatively high speed in the winding machine, but that each coil can now be separately insulated before assembly, giving invaluable protection thus to the most vulnerable points. Also since the coils are all of the same shape and length their individual weights and resistances are identical, the winding becomes symmetrical and better balanced for running at high speeds, and there is consequently less tendency towards sparking at the brushes. With hand windings there is often a considerable difference between lengths, weights and resistances of the first and the last coil put on the core, which leads to vibration troubles and bad commutation. Moreover, should the insulation give way the fault nearly always happens in one of the earlier coils to be put on, making it necessary to unwind the greater part of the armature to rectify it. But in the case of former windings one side of the coils can be lifted out of the slots and the defective coil removed bodily without destroying the others.

Former Winding

If it were necessary to still further stress the advantages of former winding it is that the method lends itself particularly well to grouping two or three coils per slot and saving considerable trouble with their interconnections. For example, the typical shape of any former-wound coil is seen in Fig. 1. This is a single coil, but if they are to be grouped two per slot, instead of cutting the wire when the required number of turns have been wound for the first coil a loop is taken out long enough to reach the commutator as at Fig. 2, and the second coil continued until complete. The interconnections between coil 1 and coil 2 are thus automatically made, and since the ends of the double coil can be taped up as though it were one coil it becomes much easier to assemble in the armature slots than if wound as two separate and independent coils, besides saving work in connecting up later on.

Similarly, if a three-coil-per-slot grouping were called for, as would be the case if the commutator had three times the number of bars as the armature core had slots, the winding would take the form shown in Fig. 3. In these figures for sake of simplicity only one turn per coil has been indicated to avoid confusion. In practice there would generally be a large number of turns in each coil between each starting and finishing point.

Before the former or shape can be made up for winding the coils, it is necessary to decide what shall be their span in the armature slots. This is determined by the number of poles in the field magnet. Theoretically the coil span shonld be the same as the pole pitch, that is, the distance between the centre lines of poles of opposite polarity. In a two-pole field magnet, for instance, the armature coils should span slots diametrically opposite, that is, 180 degrees apart, as Fig. 4. And in a four-pole field magnet the span of the coils would be one-quarter of the circumference, or 90 degrees, Fig. 5. It is usual, however, to shorten the span by about one slot, as this makes the coils easier to assemble, especially in two-pole windings, as they do not then bunch up so much at the ends, while electrically they are almost identical in effect.

Armature Slots

When the number of armature slots is not exactly divisible by two or four, the practice is to make the coil span the nearest smaller whole number. A 13-slot armature, for instance, running in two-pole fields,

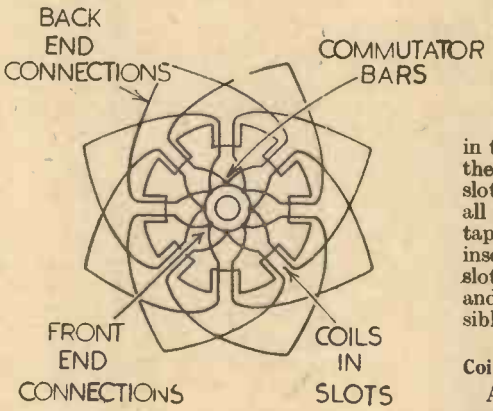


Fig. 11.—A simplified diagram showing the method of winding an armature.

obviously could not have a coil span of 1 to 7½ (= 180 degrees) and would therefore be given a span of 1 to 7.

After settling the number of turns, the gauge of wire, and the span of the coils, comes the question of a suitable former for winding them. For small armatures these are generally lozenge-shaped and built up on the lines shown in Fig. 6. The centre block A is of hard wood or fibre, of a thickness slightly less than the width of the armature slots. Two separate flanges larger in all ways than the centre block by the radial depth of the coils are then made up, B being permanently fixed to A, and C made detachable by means of a couple of wood screws. Sawcuts are made where shown at D, the purpose of which is to enable thread to be passed through from side to side underneath the coils after they are wound on each of the four short ends, tying this firmly to prevent the coil from collapsing when taken off the former. The two sides L and S of the centre block determine the length of the active part of the coil which lies in the slots. S is made about ⅛ in. longer than the actual core length, and L is longer than S by twice the radial depth of the wound coil. One or two modifications will no doubt be found necessary after trial to finally settle upon the best dimensions.

The end windings make an angle of about 90 degrees with one another, and 45 degrees with the sides of the coil.

Preparing the Coils

In preparing the coils the procedure is first to wind off a complete set, tying them at the corners temporarily. They are then made hot in the oven to dry out any moisture and immersed bodily in good insulating varnish such as "Armacell" until all air bubbles cease to escape. They are then drained off, again warmed until the varnish is well set, but not baked out hard, as they must remain flexible until placed in position in the slots. After taping the ends with thinnest cotton tape each coil has its short side laid in one of the armature slots, and when the bottom halves of all coils are inserted the long sides are brought down one by one into the top of the remaining slot spaces giving them the correct span at the same time. When the coils are of fine wire and quite pliable no preliminary "forming" is necessary, but if they are stiff they may need a twist given to the lozenge-shaped ends in order that the inner and outer sides may pass one another more easily in crossing at the ends of the armature, so that they pack together symmetrically. The appearance of the formed coil when shaped thus will be seen from Fig. 7.

Armature coils are not generally taped all the way round but at the ends only, in order to keep them in shape during assembly. It also assists by providing extra insulation in those parts of the winding which are at the greatest potential difference. In open-slot armatures the coil is sometimes taped all over, but with semi-enclosed slots end taping only is possible, since in order to insert the sides of the coils in the narrow slot openings the wires have to be separated and fed in a few at a time, which is impossible when taped all round.

Coil Taping

Although coil taping serves a very useful purpose in separating parts liable to insulation breakdown, neither the taping nor the wire coverings by themselves can be relied upon to provide sufficient protection between the live wire and the iron of the core, without further precautions. Slot linings of presspahn, leatheroid, or empire cloth are always necessary before final assembly of the coils, the thickness of these slot linings depending upon the voltage to which the windings will be subjected. One layer of leatheroid 10 mils thick is sufficient for the slot linings of most small armatures working up to 250 volts, or two thicknesses for 500 volts, but if

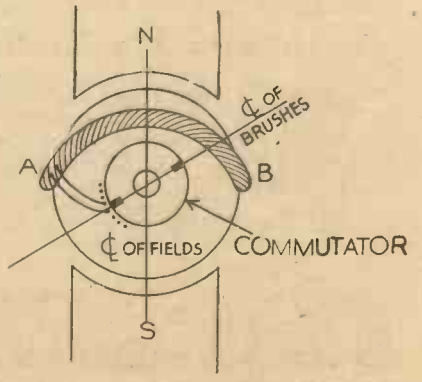


Fig. 12.—A single armature coil shown in position.

these have to withstand a flash test they should be reinforced by a further thickness of 10-mil empire cloth. The more insulation there is in the slots the less will be the room for actual wire, so that one is obliged to keep a close watch on this point and provide only the minimum thickness of insulation compatible with safety from breakdown, otherwise the quantity of active wire, and consequently the final output obtainable from any armature, will be seriously restricted.

When an armature core has semi-enclosed slots as in Fig. 8 the coils are secured from flying out under centrifugal stresses by thick leatheroid strips inserted under the hook of the teeth. If, however, the armature has open-type slots as Fig. 9 the coils have to be held down by binding wire bands of tinned copper wire sunk flush with the surface of the core, strips of leatheroid or mica being laid along each slot previously to protect the coils when the band is being soldered up

The actual interconnection from coil to coil of a small lap-connected armature, although apparently a complicated matter, is in reality simplicity itself if the fact is borne in mind that the object in connecting up is only to join the end of one coil to the beginning of the next all the way round the armature in regular sequence so that all the coils are in series with one another until the starting point is reached again, when the winding closes upon itself, making an endless circuit. Every junction formed where one coil meets the next is made a connection to one commutator bar. The choice as to which one will be explained later, but in effect the windings form a continuous succession of loops as indicated by the diagram in Fig. 10. This diagram shows only six coils but is typical of the method whatever the actual number of coils may be.

Armature Connections

Armature connection diagrams are apt to look complicated even when one turn only per coil is shown, and the least confusing way of showing these is represented by the "radial" diagram, such as Fig. 11 However many turns per coil there may be it is only the start and finish that matter for connecting purposes. In this figure the two active sides of the coil are represented by the radial lines, the commutator bars by the central segments, and the front and back end connections by the curved lines linking together the active wires.

The last remaining point that has to be settled when connecting up the armature coils to the commutator is what pitch, if any, to give to the junctions between coils before soldering them to the commutator bars. This is very important, because no armature, even if its coils are correctly interconnected and otherwise free from faults can work properly unless connected to the commutator with the proper relation between pole centres and brush centre line. In other words, the act of commutation must be arranged to take place while the coil is in its "neutral" position. This may best be explained by inspecting the accompanying Fig. 12. Here a single armature coil AB is shown in a position such that its sides are "sliding" momentarily along the lines of force which proceed from the magnet poles N and S instead of "cutting" them. This is the neutral position in which little or no E.M.F. is generated in the coils and is the best position for the current flowing round them to be "commuted" or changed in its direction. Consequently the starting and finishing ends of this coil must be brought down to those two adjacent commutator bars which lie on either side of a centre line drawn through the brushes, wherever they may happen to be situated. Sometimes the brush line coincides with the centres of the field magnet poles, more often it lies at right angles to the poles, since this leaves more room for the brush holders between the field coils. Occasionally they are placed at some intermediate angle for structural reasons, but no matter where they may be it is always essential that the armature-to-commutator connections should be planned out so that they follow the brush centre line position, when the coil itself is in its neutral position in relation to the field magnet poles.

RE-CREATING A RECORD

ALTHOUGH there are many readers who have no doubt purchased a re-recording of an H.M.V. Caruso record, how many have ever thought how it is accomplished? Up to the present, only Caruso's records have lent themselves to the process of re-recording, since his voice alone gave forth such a full and steady flow of tone equal in all its registers. Others have been tried but they have proved unsuccessful.

During the years that Caruso made gramophone records the system of recording remained practically unchanged. The voice acted directly on a diaphragm, to which was attached a cutter bearing on a revolving wax disc. The singer sang into the diaphragm and the actual sound energy he produced was used to drive the stylus cutting the wax disc. This process favoured the human voice, but gave poor, weak orchestral results.

Once the new electrical method, with all its advantages, was in use, the happy idea was hit upon of having a modern opera orchestra accompany a Caruso record, masking the weak orchestral accompaniment (i.e., submerging it) and recording the resulting merged performance. Thus the best of each recording method was utilised.

Synchronisation Essential

IN practice, the best possible pressing of the Caruso record to be re-recorded is obtained and orchestral parts prepared identical to those used previously. An orchestra is assembled in the studios and tuned up to the oboe, who has previously tuned his instrument to the record. The *chef d'orchestre*, wearing earphones, now takes charge. The record is started and the conductor, listening to the voice, starts the orchestra. It is the conductor's job to synchronise the orchestral accompaniment to the voice on the record. If the "voice" employs too much rubato the conductor and the musicians must be particularly alert and many tests and rehearsals will be made and repeated until all goes smoothly. The amount of orchestra introduced is also carefully controlled during these tests. It must be sufficient to mask the existing accompaniment on the record, but not too much to hide the voice. To treat one record successfully requires three hours.

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"Absolute Zero"

IN the paragraph on "Absolute Zero," which appeared on page 349 of our April issue, it was stated that temperatures only a fraction of a degree above absolute zero are obtained by exposing liquid helium to a powerful magnetic field. A reader points out, however, that Professor de Haas's work, based on the findings of Debye and Giauque, consisted in what is termed the "adiabatic demagnetisation" of a para-magnetic salt such as gadolinium sulphate. The only function of the helium is to produce a preliminary cooling of this salt to within a degree or so of absolute zero. The salt is contained in a small tube within the "Dewar" type tube shown in our illustration on page 350. The helium in the outer tubes is rapidly evaporated under the action of a battery of powerful vacuum pumps. But once the salt has been cooled down to about one degree absolute, the helium is entirely removed, and the remaining vacuum performs the usual function of a vacuum flask, and prevents the salt from absorbing heat from its surroundings. The whole process is carried out between the poles of a magnet giving a field of upwards of 20,000 gauss. But the final cooling stage, down to a small fraction of a degree from absolute zero, is accomplished by means of the thermo-magnetic molecular readjustment which takes place when the powerful magnetic field is switched *off*.

A three-quarter front view of composite model designed, built and described by Mr. W. E. Knight.

MAKING A SIMPLE COMPOSITE MODEL

A model designed on the lines of the Short-Mayo Pick-a-Back Aircraft.

THE Short-Mayo " pick-a-back " aircraft has undoubtedly captured the popular imagination. Daringly revolutionary it seemed when, early in 1938, " Mercury " first took off from the back of " Maia," yet the feat had been performed, though in a different manner, twenty-one years before ! This was at Felixstowe Air Station in 1916, the participants being Flight-Lieut. Day in a Bristol Scout single-seater, and Wing-Commander J. C. Porte in a three-engined Porte " Baby " flying-boat. The object of the scheme, the originators of which were Commander Porte and Squadron-Commander A. Quilton Cooper, was to enable the boat to carry a fighter escort with her on anti-submarine patrol. Though successful, the Admiralty saw fit to drop the idea.

The upper component was merely a " passenger," its engine idling until the moment came to operate the quick-release mechanism. With the Mayo system, both components have their engines in use throughout the flight, the carrier helping to lift the upper machine until, at a certain speed and angle of attack, the latter develops sufficient surplus lift to leave the carrier directly the coupling mechanism is freed. The object is to enable a machine to carry a greater load than it could lift from the ground or water.

Recently, I learned that before the Mayo machine was built, the principle was tried out by means of flying models. These were built by Mr. D. A. Pavely, a pioneer modeller, and consisted of a single-tractor " spar " mounted above a twin-tractor " A-frame." All three airscrews were in action throughout, and separation was effected by the slackening of the upper component's rubber-skein allowing a rubber tensioning-band to withdraw three pegs which held the models together.

At least one other composite model took the air prior to the Short-Mayo's first flights. In Danson Park, in the summer of 1937, Mr. H. A. Jones, of the North Kent Model Aircraft Society, achieved a flight of 80 seconds with a ½-oz. parasol launched from the back of a heavy high-wing model. A strip of rubber was taken from the tail of the carrier, across the wing and propeller of the parasol, and wedged between the carrier's nose-piece and fuselage. As the carrier's motor unwound, the lessened tension allowed the band to pull out.

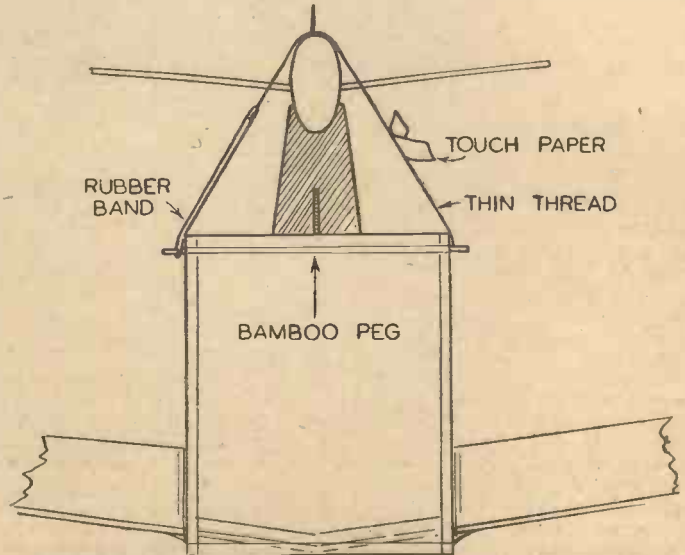
An Efficient Model

Early last year, the writer developed a simple form of composite model, which has proved sufficiently reliable to be used with confidence at flying displays. Two low-wing models of 26 inches span were used to launch a 13¾-inch F.R.O.G. " Raider " mid-wing. The upper component was secured to the lower by a thread tensioned by a rubber-band. To the thread was attached a small piece of touch-paper, which was lighted just prior to launching. The first attempt took place at Wimbledon on May 22nd. A little wobbly at the knees, for spectators were numerous and included a number of crack modellers, the writer faced the wind. Away sped the outfit, a little uncertainly, for the ideal line-up had not yet been found. " Optimist," yelled somebody, but at that moment the upper model was off ! Both came tidily to earth.

A third carrier was built, and between them, the three have made over 100 successful separation flights. The very small percentage of failures has been occasioned by rain or high wind putting out the fire ! This composite system, be it noted, follows the Porte experiment rather than the Mayo The third carrier is here fully described.

The Carrier

The low-wing arrangement lends itself particularly well, because it is not too sensitive to changes in longitudinal trim. A fixed wing position prevents an inadvertent change in the relative positions of the two models. The twin-ruddered tail-unit helps to keep the weight low, and for the benefit of those who distrust a tail of this type, it may be said that it has proved perfectly harmless. However, it is a simple matter to round off the ends of the tail-'plane, and build a single fin about 1½ times the area of one of the composite's fins.



Showing how the smaller model is launched. The touch paper smoulders whilst the large 'plane takes off, and when in the air the thread burns through and releases the smaller plane.

Fuselage

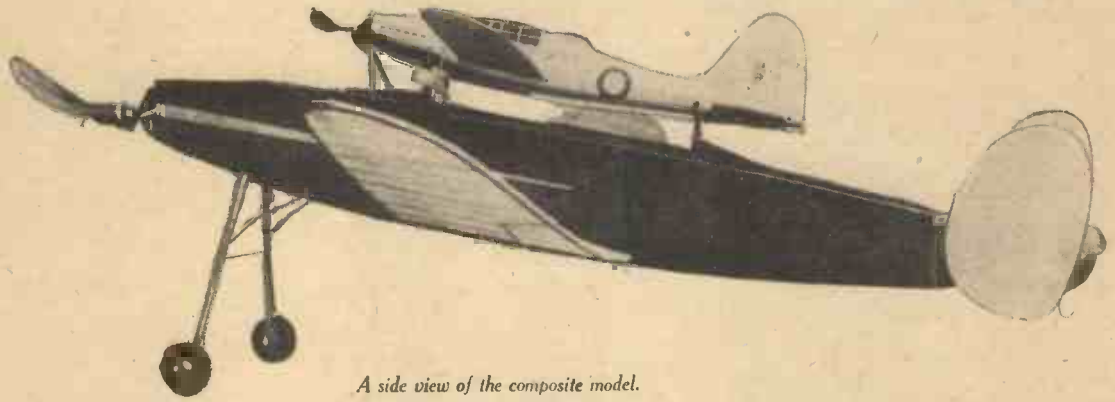
This is a conventional affair of $\frac{3}{32}$ in. × $\frac{3}{32}$ in. balsa longerons and cross-struts, built a side at a time on a building-board. A full-size drawing can be prepared from the diagram herewith. Upright strut " A " had better be in duplicate, or alternatively, the first bay can be covered with $\frac{1}{32}$-in. balsa sheet, after assembly. Upright cross-struts " B " to " K " are fitted in front of the lines shown in the scale drawing, given on page 482. The hole in the $\frac{1}{16}$-in. sheet, intended to accommodate the ¼-in. birch dowel which forms the rubber-peg, should be reinforced with small pieces of thick celluloid.

The fuselage is 2 ins. wide from " E " to " G," so the top and bottom cross-struts in this region must be $1\frac{13}{16}$ in. At the nose it is $\frac{7}{8}$ in. wide, and at " J " 1 in., making the cross-pieces $\frac{23}{32}$ in. and $\frac{29}{32}$ in. respectively. A bulkhead consisting of $\frac{1}{16}$-in. balsa sheet

faced with 1 mm. hard 3-ply $\frac{7}{8}$ in. wide and $1\frac{1}{8}$ in. deep, and with a hole $\frac{3}{8}$ in. × $\frac{1}{4}$ in. cut from the centre—is cemented to the front of the fuselage. The rear ends of the top longerons are shaped as shown, and cemented together, as are the two uprights "K." To the latter is lashed a 22 gauge wire tail-skid. The remaining cross-pieces can now be fitted, their sizes being determined by the curve taken by the longerons.

A piece of 20 gauge brass tube (22 gauge, if you can get it) is laid over the bottom longerons in front of uprights "C" and "D," lashed to the lower cross-struts, and securely cemented. Reinforce the corners between lower longerons and uprights with small triangular gussets of $\frac{1}{16}$-in. sheet, as shown. Diagrams are given of the two $\frac{1}{16}$-in. sheet balsa panels which carry the paper tubes into which the wings plug. These tubes must be very carefully fitted, so that when the panels are cemented to the rear face of uprights "E" and "F," and between the lower longerons, the wings are held at a dihedral angle of 8 deg. A strip of bamboo, full $\frac{1}{16}$ in. × $\frac{1}{16}$ in. is cemented beneath the top longerons behind uprights "E." It should project $\frac{1}{8}$ in. beyond each side of the fuselage.

After the fuselage has been covered with Jap tissue, the $\frac{1}{16}$-in. sheet saddles which support the upper model are cemented over uprights "E" and "H," and braced in front with $\frac{1}{32}$-in. sheet. The front saddle is 1 in. high, and the rear one $\frac{7}{8}$ in. Both are $\frac{1}{4}$ in. wide at the base, and the recess at the top, which is $\frac{1}{4}$ in. deep, is shaped to conform to the bottom of the upper model's fuselage.



A side view of the composite model.

Undercarriage

This consists of two bamboo struts $\frac{1}{16}$ in. thick, and tapering in width from $\frac{1}{16}$ in. at the top to $\frac{3}{32}$ in. at the bottom. Celluloid wheels, 1 in. in diameter, are attached by 22-gauge stub-axles. The curved cross-brace, shock-absorbers, and fittings which plug into the front brass tube in the fuselage, are also of 22 gauge wire. By increasing or decreasing the bend in the shock-absorbers a small variation in longitudinal trim can be effected.

Wings

Points to note are the curve steamed into the outer ends of leading- and trailing-edges, and the precise position of the two $\frac{1}{8}$-in. birch dowels by means of which the wings are plugged into the fuselage. The dowels are placed flat on the building-board, as are the leading- and trailing-spars, but the mid-spar is at the top of the ribs. All ribs are of $\frac{1}{32}$-in. sheet, except No. 10, which is twice this thickness. Their length, and the position of the slot for the mid-spar can be found from the full-size drawing. Their respective maximum depths (in the region of the mid-spar), are as follows: No. 1, $\frac{1}{4}$ in.; No. 2, $\frac{9}{32}$ in.; No. 3, $\frac{5}{16}$ in.; No. 4, $\frac{3}{8}$ in.; No. 5, $\frac{7}{16}$ in.; No. 6, $\frac{1}{2}$ in.; No. 7, $\frac{17}{32}$ in.; No. 8, $\frac{9}{16}$ in.; No. 9, $\frac{19}{32}$ in.; No. 10, $\frac{5}{8}$ in. Their flat lower edges rest on the building-board. Rib No. 10 leans outwards $\frac{1}{8}$ in., thus conforming to the sides of the fuselage when at the correct dihedral angle. There is no washout or washin, despite the fairly sharp wing-taper, and critics notwithstanding, no trouble has been experienced. The dowels should be a fairly tight fit in the paper tubes, any wear being remedied with cellulose paint. Round off the leading-edge with glasspaper, and thin the rear portion of the trailing-edge. Cover with Jap tissue.

Tail-Plane

This is of symmetrical section. First the leading-edge is cracked $\frac{1}{2}$ in. from the centre and bent back as shown. Then the trailing-edge and the two end pieces of $\frac{1}{4}$ in. × $\frac{3}{32}$ in. to which the fins are to be cemented, are fitted. Take a piece of $\frac{1}{4}$ in. × $\frac{1}{4}$ in., slot it to rest over the spars, with its flat lower surface resting on the building-board, sand the top surface to a rough camber, and cement into place in the centre of the tail-plane. When dry, raise the structure slightly from the board to enable the 4 ribs to be slipped into place. These are of $\frac{1}{32}$-in. sheet, and are $\frac{1}{4}$ in. deep, with the slots central. They are cut rectangular, as in the diagram, and are fitted into place in that condition, so that their lower edges can rest firmly on the building-board. They are subsequently cambered by means of glasspaper wrapped around a piece of wood. The camber should be equal on top and bottom edges, and a pencil line may help to guide the eye. Two attachment saddles of 22-gauge wire are shaped to fit firmly over the fuselage, and are bound respectively to the leading-edge and the central cross-member. Cover the tail-plane with Jap tissue before attaching the fins.

Fins

Each fin consists of a double thickness of $\frac{1}{16}$-in. sheet, about $\frac{3}{8}$ in. wide, with the grain crossing. The edges are well rounded with glasspaper, and they are then covered on both sides with Jap tissue. Cement them to the ends of the tail-plane, the latter occupying the position indicated by the dotted lines.

Spray all tissue covering with water, and when dry, give one coat of thick banana-oil.

The propeller at present in use is a 9-in. "Paulownia" *Standard* (not the helical type, which is rather too fine in pitch), with one blade cut away $\frac{3}{4}$ in. from the centre and replaced by a counter-weight consisting of a woodscrew partially embedded, so that its end is 1 in. from the propeller centre, and bound with solder-wire. A normal two-blade propeller is quite satisfactory. The motor consists of 4 strands of $\frac{1}{4}$ in. × $\frac{1}{30}$ in. rubber, 21 in. long, and tensioned by plaiting. A simple free-wheel device is fitted.

The model should balance at the mid-spar of the wing. Its weight should be 2-2¼ oz. About $\frac{1}{8}$ in. of side-thrust, to face the propeller to the right, as seen from the rear of the model, will probably prove beneficial.

The Upper Component

A F.R.O.G. "Raider," costing 2s. (minus the patent winder), and weighing $\frac{1}{2}$ oz., forms an ideal upper component. There is a flange along the top and bottom of the fuselage, and this must be cut away in places, as shown, so that the model rests firmly in the carrier's saddles, and so that it cannot be inaccurately positioned. The centre of pressure of the wing ($\frac{1}{3}$ from the leading-edge) must be vertically over the centre of pressure of the carrier's wings. A cut must also be made in the upper flange just ahead of the cabin to accommodate the thread which holds the upper model to the carrier.

One end of this thread is anchored to one of the bamboo pegs on the carrier's fuselage, the other is attached to a $\frac{3}{4}$-in. rubber tensioning band which anchors to the other bamboo peg. A piece of touch-paper 1¼ in. × $\frac{1}{4}$ in., made by immersing blotting-paper or notepaper in a strong solution of saltpetre from the drysalters, is cemented to the thread by its centre, as shown.

Effecting Separation

Both models having been tested for correct trim, wind the "Raider" and secure to the carrier. Its propeller will be resting against the carrier's fuselage, and will, thereby, be prevented from turning. Test the combination in flight before attempting separation.

When satisfactory, get someone to light both ends of the touchpaper by means of a cigarette, while you hold the model ready for launching. See that it is burning satisfactorily, and then launch gently. By noting the rate of burning, one can vary the time of separation.

Design Hints

Here are a few hints for the benefit of any who may care to design their own composite model.

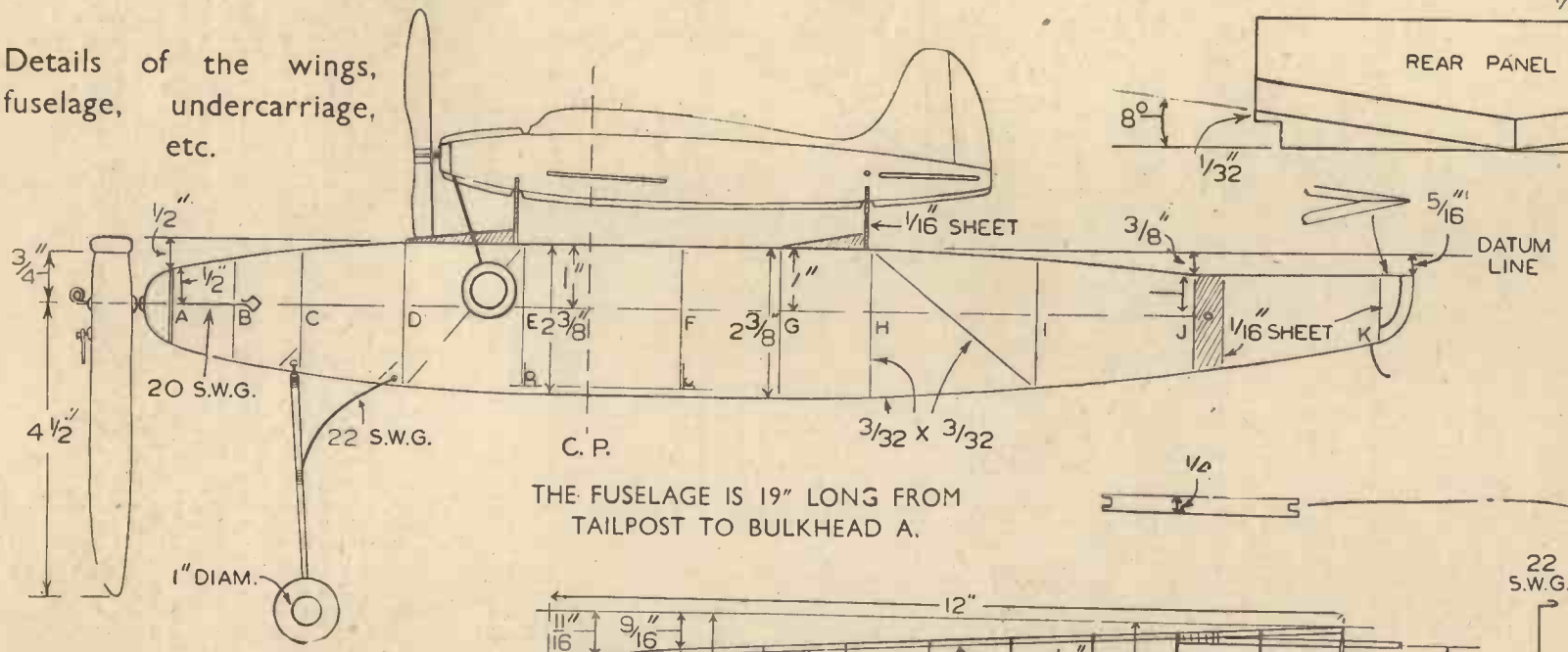
Because of the high centre of resistance with the upper model in position, the carrier must have a very low centre of gravity, and a thrust-line on the centre of resistance (of the carrier), or slightly above it. The low-wing layout is helpful in this respect. The lower model must have a speed substantially in excess of the upper model's minimum flying-speed, or the latter will capsize instead of lifting clear when released. With the model here described, the upper component has never fouled the propeller of the carrier in spite of it being so near. The carrier also needs plenty of power, and a high degree of stability.

The upper model should not be too big, or the centre of resistance of the combination will be too high for convenience. It must also be very stable, and capable of flying at a low speed.

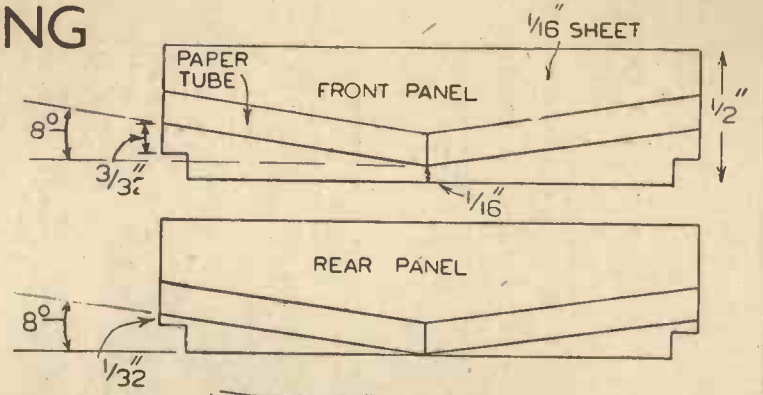
CONSTRUCTIONAL DETAILS FOR MAKING FLYING MODEL COMPOSITE AIRCRAFT

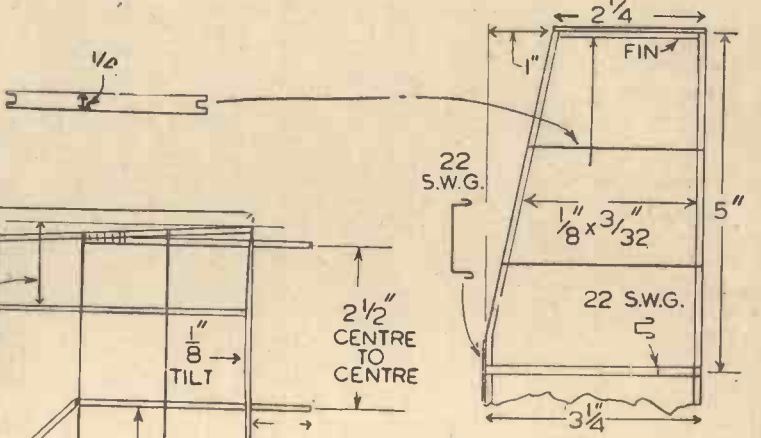
(This Drawing must be copied full size)

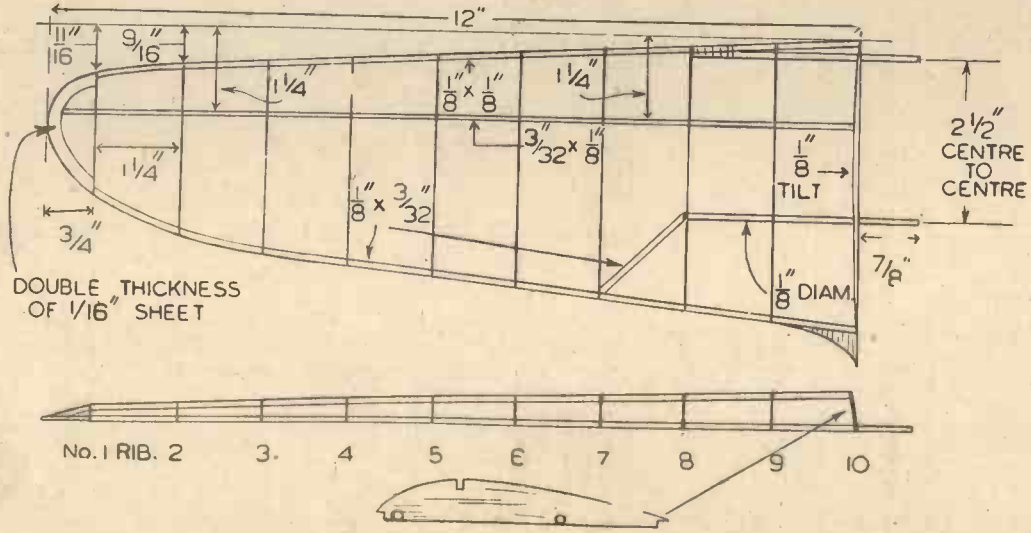
Details of the wings, fuselage, undercarriage, etc.

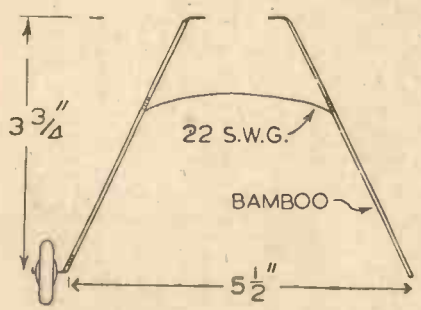


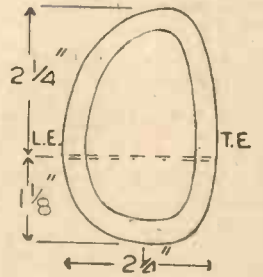
THE FUSELAGE IS 19" LONG FROM TAILPOST TO BULKHEAD A.











Watch Repairing and Adjusting—6

Fitting and Adjusting Existing and New Mainsprings

ALTHOUGH the mainspring is a very essential part of a watch, it is frequently treated by repairers as though it were of a minor rather than a major importance. The life of a mainspring is by no means everlasting. In fact, many mainsprings have a decidedly short life. This makes it all the more difficult to convince a watch owner that a new mainspring is necessary when the watch is working with the existing mainspring.

Faulty Mainspring

The fact that a watch goes, does not signify that it is going correctly. The escapement and all the other parts may be in perfect adjustment, but still the balance may not have the vibration it should. In this case the fault can usually be traced to the mainspring. The coils should not be disturbed any more than is absolutely necessary, which probably accounts for this attitude of indifference towards the mainspring. If the coils are very gummy the spring should be soaked in benzine, and then allowed to dry off. Any slight stickiness can be removed by passing a piece of folded tissue paper between the coils with the aid of a pair of tweezers.

Fig. 1 is an actual photograph of two mainsprings (an old spring and a new spring). That on the left has been in use for a considerable time, and has become "dead" in the centre. In other words, the inner coils have lost a good deal of their elasticity. If this spring were fully wound it would probably give the balance a fair vibration for the first twelve hours; but after that there would be a considerable "falling off" in the vibration, which would seriously affect the timekeeping. Such a spring is really unfit for further use.

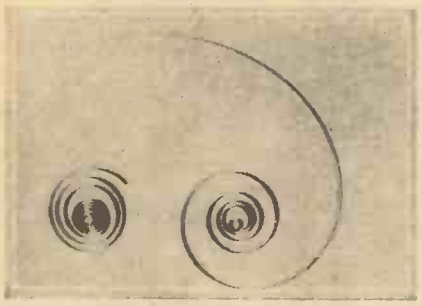


Fig. 1.—Showing an old and new spring. That on the left has been in use a considerable time.

Removing a Spring

When a mainspring is run down there should be as much unoccupied space as the spring occupies when it is lying against the side of the barrel. The space in the barrel should be allotted equally to the mainspring, the barrel arbor and the unoccupied space—one third each. When removing a spring from a barrel, pull up the inner coil carefully and allow the spring slowly to unwind itself from the barrel against your fingers. To let the spring literally fly out from the barrel will be courting disaster, as the necessary disentanglement of the coils will distort the spring and render it useless. Loss of power is often difficult to discover when it is not constant. It is very important therefore to make a careful examination of the spring when it has been removed.

The appearance of bright spots will indicate friction between the coils with a consequent jerky or unequal pull. Oil will have little effect upon coil friction, and the balance vibration will be certain to "fall off" at the weak pull. The only remedy will be a new mainspring. If there are bright marks on the edge of the spring, and the barrel cover shows a series of circular scratches, this will indicate that the spring is fouling the cover, a frequent cause of loss of power. One remedy is to reduce the thickness of the barrel cover by placing it in a lathe step chuck and turning off some of the excess metal, taking care not to remove any of the arbor bearing in the operation. If the cover is too thin to reduce, a new spring, a size lower, will have to be fitted.

Fig. 2.—A popular mainspring winder.

The Barrel Arbor

The barrel arbor should be a good fit in both barrel and cover, with only the minimum of endshake. As the mainspring exerts a certain amount of twisting force when wound, an ill-fitting barrel will also be inclined to twist and undoubtedly come into contact with the underside of the centre wheel with disastrous results. If either of the holes need re-bushing, broach or reamer the hole round, turn a small stopping of brass or nickel and rivet it in position. Place the barrel or cover in a step chuck, turn off any surplus rivet, centre the new bush and drill a true hole. Finally broach the hole to fit the arbor and chamfer a small oil sink.

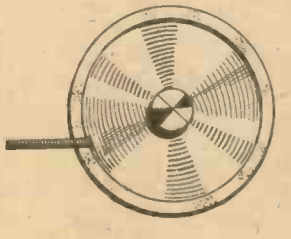
The safety of the mainspring depends upon a good hooking attachment. If the barrel hook is one of the screwed or riveted type, it should be perfectly rigid. It should never stand out from the side of the barrel more than the thickness of the spring. The smaller the hook the stronger; a large hook will not only be more difficult to fix, but it will occupy more space in the barrel. To fit a new hook, drill and tap a *small* hole through the side of the barrel at an angle. This will give a longer hole and allow more threads. File a piece of steel wire and tap it until it shows a full thread, cut off a little above the full thread, and file the top and two sides flat. Screw the new hook from the inside to the outside until only the head stands out from the side of the barrel, cut off the surplus and file flat. Fig. 3 shows a new hook before being cut off. It will be an advantage to undercut the hooking side of the head with a slitting file.

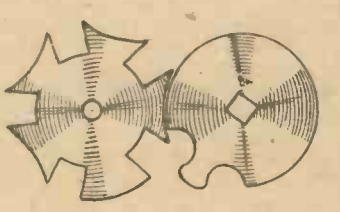
The Barrel Hook

Modern watches favour the recessed type of barrel hook—a step cut in the side of the barrel—as there is no risk of undue projection. As this kind of hook is very shallow it must be square cut to prevent the mainspring from slipping. Any sign of a rounded nose can be rectified by using a sharp, long-pointed graver. Many barrels have a hook which has been pressed through the side with a special tool, and many mainspring punches have a cutter for this purpose, but the risk of distorting the barrel with one of these punches is so great that the screwed-in hook is a much better proposition.

Types of Spring

When replacing a worn or broken mainspring it should not be assumed that the existing spring is the original or even the correct kind of spring for the watch. It may be too weak or too strong. With a strong spring the balance would have an excessive vibration when fully wound with a sudden decline after a few hours, whilst at the end of 24 hours' running the balance would probably come to rest if the watch was placed in a "pendant up" position. Such a condition is most undesirable. A weaker spring would give a smaller but more constant vibration and serve the same purpose as a stop-work. The purpose of a stop-work, which consists of a finger piece attached to the barrel arbor engaging with a star wheel screwed to the barrel or barrel covers, is to allow only the middle turns of the mainspring to be used.





Figs. 3 and 4.—(Left) A new hook before being cut off. (Right) A stop-work mechanism.

The stop-work allows only four turns, so that a spring which makes six turns will permit the stop-work being set up one complete turn, and still allow one turn

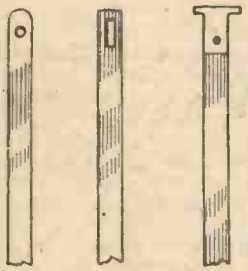


Fig. 5.—Two kinds of plane hook and the pivoted brace.

unused. Fig. 4 shows a stop-work mechanism. From this it will be gathered that at least four turns of spring are necessary. At least five turns should be aimed at whether or not the watch is fitted with a stop-work as this will give a little reserve. When the length of the spring has been determined the outside end will have to be fitted with a hook according to the type barrel. If a stop-work is fitted, an ordinary hole will be quite suitable, as the spring will never be pulled completely away from the side of the barrel Before punching or drilling the hole remove the excess hardness from the end of the spring by "letting it down" over a spirit flame. Run a broach through at an angle to make sharp hooking edge, file the end round and finish with an emery buff Watches not fitted with a stop-work need a more resilient form of hooking as the mainspring is pulled well away from the side of the barrel when fully wound.

Pivoted Brace Hook

Many pocket watches use the pivoted brace hook. This consists of a small tongue with two pivots, riveted to the end of the spring. The pivots fit in holes drilled in the cover and bottom of the barrel. The pivoted brace allows the spring to be tightly wound without undue strain on the extreme end. When fitting a pivoted brace hook make sure that it does not exceed the width of the spring, or what is probably worse be out of alignment with the spring. Fig. 5 shows two kinds of plain hook and the pivoted brace.

Plain Bent Overhook

Quite 50 per cent. of the mainsprings fitted by the manufacturers have a plain bent overhook, made by heating the end of the spring, doubling it back and squeezing it flat with a pair of pliers. Although the manufacturers use this kind of hook it is not one of the best. There is too much strain at the actual bend. Ample proof is to be found in the number of springs which break at this particular point. A much more satisfactory hook is one in which a loose piece of spring is inserted between the bent end of the mainspring and the barrel. To make a hook, gently warm the spring at the point at which it is to be bent (the waste part will bend itself back). As the spring becomes red, squeeze it gently with a pair of pliers. Break off a small piece of waste spring, place it between the bend, warm the end again until it becomes red and squeeze tightly. The squeezing must be done whilst the spring is red, or there will be a tendency to break.

When cold, cut off the waste spring, using the edge of a triangular or square file to make the cut, leaving just a small bend. File off the corners and buff off the discoloured part of the spring. Cut off another small piece of waste spring (there are usually two or three inches to spare) and insert it in the hook. Fig. 6 shows types of bent hook. Fingers should never be used to wind a spring into a barrel. Apart from finger marking, which is likely to lead to rust, the spring will assume a spiral shape causing friction with the barrel cover and a consequent loss of power. Wind the spring on the mainspring winder arbor first, place the barrel over the spring, reverse the ratchet on the winder and let the spring unwind itself into the barrel. Fig. 2 shows a popular mainspring winder.

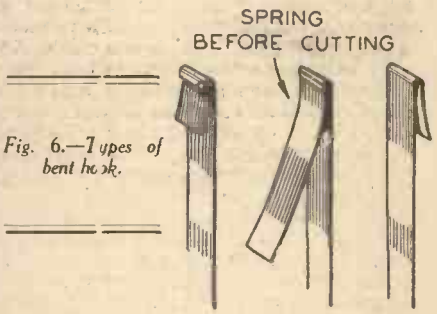


Fig. 6.—Types of bent hook.

Special springs and springs with patent hooking devices should be specially obtained. In fact, the spring designed by the maker should be used whenever possible, as it will provide the maximum of power.

MODERN LIFTS

Continued from page 462

the car is at the top floor and it is required at the middle floor. By pressing the push No. 2 a circuit is established from the positive fuse through the various locks, and safety devices, floor relay coil (2 F), the "down" limit switch of the middle floor, the "down" terminal stopping limit switch, the "down" reversing contactor coil (B) to negative fuse.

The energising of floor relay (2 F) causes its contacts (2 f) to close and thus the floor relay and reversing contactor are held closed after the push has been released. The car then descends and as it approaches the middle floor the "down" stopping limit switch of this floor opens and thus the floor relay and reversing contactor circuit is opened and the car stops.

As the car was proceeding to the middle floor the "up" limit switch of this floor was closed in readiness to open to stop the car when the car is required to stop at that floor when proceeding from a lower one. It will be appreciated that the arrangement of floor relay and limit switches for the middle floor is repeated for lifts serving more than three floors.

The equipment so far described is required for the normal working of a lift, but it will be realised that many additional items, far too numerous to mention in this article, are required.

Safety Gear

One important feature, however, is the safety gear attached to the car frame. Two types are employed, one is the instantaneous for slow speed lifts and the other is the gradual for higher speed. Except for low rise lifts, the safety gear is called into action should the speed of the car become excessive for any reason when descending and the car is held clamped to the guides. With the smaller lifts the safety gear operates in the unlikely event of failure of all lifting ropes.

It may be said that much of the equipment of a modern lift constitutes various safety devices.

Acknowledgment is due to Waygood-Otis, Ltd., for the information in this article, and the illustrations have been taken from "Complete Electrical Engineering," by George Newnes, Ltd.

Grand Coutee Dam

THE Grand Coutee dam which is being built to block the Columbia River in Western America is at present employing nearly six thousand men.

When complete it will create an artificial lake one hundred and fifty miles long, bring light and power to hundreds of towns and cities and supply irrigation to fifty thousand farms.

The Grand Coutee is the largest dam undertaken in the annals of engineering, dwarfing such magnificent efforts as the Pyramids, the world's most important bridges—and even surpassing the Panama Canal.

A particularly interesting illustrated article on the world's greatest dam appears in the current issue of the *Wide World Magazine*.

MODEL AERO TOPICS

Continued from page 467

Skybird League Sixth Annual Rally

PICTURE on page 467 shows the "Henry Channon Cup," Premier Craftsman Medal and Skybird Model Blackburn "Skua." This model, made by D/C R. B. Borra, of Weybridge, gained the premier awards in the Sixth Annual Rally of the Skybird League.

The Normac Catalogue

THE Northern Model Aircraft Co., 25, Lower Mosley Street, Manchester, 2, have recently published a well-illustrated catalogue, price 3d., by post 4d., detailing their "Clipper," "Curlew," "Conquerer," "Lysander," and other flying scale model kits. This firm also stock all of the accessories needed for model aircraft.

Slough and Windsor M.A.C.

THIS club has now taken premises for headquarters and clubroom at "The Bungalow," 201, Clarence Road, Windsor. Meetings are held there every Tuesday evening, and the Hon. Sec. is R. W. Horne, 32, Buckland Crescent, Windsor.

S.M.A.E. Notes

MODELLERS should note that all orders for badges should be sent to the Hon. Treas., L. J. Hawkins, Heathview House, Meadowcourt Road, Lee Green, S.E.3. All technical queries should be addressed to the Hon. Sec., R. N. Bullock, 75, Belmont Hill, London, S.E.13. Competition matters should be referred to the Hon. Comp. Sec., J. C. Smith, 1, Treen Avenue, Barnes, S.W. All press matters should be sent to Mr. H. York, 23, Tyson Road, London, S.E.23.

Our Busy Inventors

By "Dynamo"

Teaching baby to walk. A walking machine invented by a Swiss engineer.

Teaching Baby to Walk

MR. CATILLON, a Swiss engineer, has invented a walking machine, in order to teach babies to walk. He hopes that by the simultaneous movements of the mother, the baby will learn to walk sooner. Leather straps are fixed to the end of the four wooden sticks, as will be seen in the above illustration, which are bound to the legs of the mother and child.

For the baby these straps are fixed above the knee, but below the knee for the mother. A rope to which a wheel is attached is connected to an overhead wire and this prevents the child from falling.

In Aid of Free Speech

DEMOSTHENES, the celebrated Greek orator, in his youth had an impediment in his speech. To correct this defect he spoke with pebbles in his mouth. That was before the advent of chewing gum, which might have answered the same purpose.

The latest method which is claimed to be a cure for stammering has been introduced by a Japanese inventor. And his application to secure protection for his invention has been accepted by the British Patent Office. The new remedy for stammering consists of a support adapted to be attached to the palate without covering the teeth. It is provided with what is termed a pilot sound producer and a projection for pricking the tongue. At the commencement of expiration, the sound producer is operated by a current of air. The inventor states that, by this means, the stammerer will always be conscious of the respiratory movements and will be notified of the suitable time of pronunciation. And it is affirmed that he can easily pronounce without stuttering, by the guidance of the pilot sound. The projection already mentioned gives an unusual feeling to the tip of the tongue when pressed against the palate. As a consequence, adequate movements of the tongue may be effected.

It is a curious fact that some persons, whose speech is hopelessly impeded, can yet sing with ease and fluency. Unfortunately for such folk we do not converse after the manner of operatic artistes whose conversation is set to music.

Mickey Mouse's Rival

THE clockwork mouse has had a long run in the nursery. An improved mechanical Mickey Mouse has now made its appearance. In addition to rotating one of the wheels, the internal motor drives a horizontal shaft having at its end a ferrule for receiving a long, tapering, flexible member protruding from the back of the body, in short—as Mr. Micawber used to say—a tail. As this tail twists and moves in an irregular manner, it exercises a steadying effect, controlling the speed of the motor. And, to some extent, it also balances the mechanism. Although more realistic than its forerunners, the latest thing in clockwork mice would not deceive a cat; it might, however, frighten a female burglar, if such there be.

Safeguarding workers in America. This young lady is wearing aluminium toe guards, fibre shin guards, an eye shield of non-inflammable substance and a respirator. She is also holding a safety belt with red reflectors.

Long Life for Neckties

AN automatic collar-attaching necktie has been patented in the United States. It is a combination of practically a U-shaped flat spring-strip, provided with needle-pointed barbs for entering the collar-band under pressure of the spring-strip.

This invention will undoubtedly contribute to the longevity of the tie. It is the daily tying of the necktie which helps to wear it out. With the spring-strip, on the front of which the tie is adjusted, it will be necessary to tie it once only. And this could be done by an expert at the shop where the article is purchased. A vertical knot could be affixed or a batswing bow. The latter, which many men cannot tie, could be permanently adjusted by the cunning hand of the salesman.

Gadgets which are designed to facilitate the attiring of the human form are useful when they behave themselves. If the contrivance above-mentioned should inadvertently disconnect itself, it might reveal to the amused public the fact that "things are not what they seem." Many years ago, there was devised a wire spring which men placed underneath the collars and lapels of their coats in order to keep them in shape. But it had a "cussed" way of severing itself from the coat and flying off as though it were first cousin to a boomerang.

Exploding Walnuts

A NOVEL method of shelling walnuts emanates from the University of California. The means used entails an explosion, which bursts the shell without damaging the kernel. The shelling operation, performed by a machine, consists of passing the walnuts over a circular saw, which makes an incision in the shell. Into this cut explosive gas-air mixture is blown. Finally the nut is passed through a flame, which explodes the gaseous content. It is stated that the machine opens some 900 pounds of walnuts in an hour. Happily, as a result of this pacific bursting of shells, no one will suffer from shell-shock.

Collapsible Globe

I NOTE that there has been patented in the United States a collapsible globe. This is significant at the present juncture when, owing to the critical state of the world, one almost expects our giddy old roundabout to collapse. But the globe in question has been designed with the object of conveniently teaching geography. By the way, the late John Bright, who, being a Quaker, conscientiously objected to war, stated that war did at least teach people geography.

For Ladies Only

NINON DE LENCLOS, a Parisian beauty of long ago, seems to have preserved her schoolgirl complexion until she was 90 years of age. She received a proposal of marriage at that advanced time of life. It was this lady who said that, if she had had

the creation of woman, she would have caused her wrinkles to appear only under her feet.

It is appropriate that an inventor hailing from the country of this paragon of long-preserved loveliness, should contrive an improved method of enhancing the charms of the feminine features. Having devoted himself to the preparation of an effective rouge, a Frenchman has applied to the British Patent Office for protection for his process.

According to this inventor, previous rouges can be divided into two categories. One contains a rouge formed of compacted powder; the other comprises a fatty rouge. It is said that the compacted powder rouge is easy to apply to the face and to rub away by means of a puff, so that a graded and dimmed effect is obtained. But it seems that it does not adhere satisfactorily to the skin, which it frequently irritates. In addition, as such a rouge is brittle, it is not convenient to carry in a bag or vanity case.

On the other hand, a fatty rouge generally has the consistency of a cream or soft grease. It adheres well and treats the epidermis with due respect. But it is difficult to apply, the consistency precluding the use of a puff. It must, therefore, be applied directly by the fingers, and it leaves upon the dainty digits an unpremeditated stain. Moreover, to obtain the desired diminuendo in tone—that is shading away of the colour—some dexterity is indispensable.

Now, the newly devised rouge is a consolidated mixture of fatty and waxy materials, having a rather hard but easily crumbled consistency. It can be picked up by means of a puff or pad, to which should be imparted a slight rotary or angular movement. The idea is to provide a conveniently carried and easily applied making-up substance. And this a native of the land of Mesdames de Pompadour and du Barry claims to have achieved.

Handbag and Hat

A COMBINED handbag and head-gear has been patented in the United States. This accommodating hat comprises a band of sufficient length and width to encircle, and to afford a covering for the head. It contains a pocket and there are fastening devices at the opposite ends of the band, for securing the ends together, either to hold the band round the head as a covering or to form a sling to be worn over the arm, when this convertible contrivance performs the office of a handbag.

The invention in question will solve the problem of the hatless lady who is prohibited from appearing in a church or a court with her head uncovered. All she need do is to surmount her permanent waves with her handbag.

Paper Statues

SOME adverse criticism has been levelled at the statuary which is found in our churches and squares. In certain cases, unlike that of the Light Brigade, the glory of the alleged hero represented has faded. It may be contended that, in view of the evanescent nature of fame, statues should not be as substantial as the Colosseum at Rome. Therefore, it would be suitable to make them of paper. This has actually been proposed in America, where sculptors have been provided with a new medium for their art in the shape of paper pulp hardened with synthetic resins. This product, which is known as "hard paper," is declared to be practically as hard as boxwood. It may prove to be a competitor with iron, bronze and stone, in the erection of future memorials.

To perpetuate the memory of an illustrious journalist, what could be more appropriate than a paper column?

Because of the varying gauge in railroads, travellers between New South Wales and Victoria have to break their journey and change to another train. Mr. J. C. Brock has invented a break of gauge device in order to make this change unnecessary.

Protection for Rubber

ANOTHER process for prolonging the life of rubber is the subject of a recent application to the British Patent Office. Rubber has the property of becoming hard and brittle, owing to the action of weather and light. Consequently, rubber intended for use in a joint, as for instance, in gas masks or sealing bands for doors and windows, has to be replaced not infrequently.

To delay the ageing of rubber strips, tubes and like articles, an inventor proposes to protect the surface of the rubber by taffeta of black artificial silk, consisting of pure cellulose acetate which has been treated with higher alcohols. He affirms that he experimented with two similar pieces of rubber, one uncovered and the other closed in the taffeta treated as mentioned above.

After exposure for three months to natural temperature changes and weather effects, the uncovered piece showed distinct cracks, while no deterioration was visible in that enclosed in taffeta.

AROUND THE TRADE

Novelties Now On The Market

Model Railways

MULTI-MODELS, LTD. have produced a new Southern Railway utility van, which is available either as a bogie vehicle, corridor type, price 12s. 6d., or as a four-wheel non-corridor, price 9s. 6d. It is 00 gauge, 4 mm. scale, and is fitted with brass buffers and brass bogies of a new design, fully detailed, with 13-mm. disc wheels. The shorter van is fitted with best quality axle guards.

The bogies (which will shortly be available separately) are of the L.M.S. coach type (9-in. wheel base). They are oxidised and so require no painting, have needle bearings, and are exceptionally easy running.

There is no doubt that these vehicles are of outstanding value—they are certainly a great advance on anything of the sort which has been offered in the past.

A New Pocket Wind Instrument

THE difficulty about studying music is that in the initial stages the brain cannot cope with the dual problems of mastering the instrumental technique and the theory of music simultaneously.

By the invention of the Tonette, a new pocket-sized wind instrument, the first of these difficulties has been removed. Anyone can play a scale on the Tonette in a few minutes, and the basic details of musical theory can be mastered in a few days. The range is just over one octave, so that popular songs can be mastered immediately. A further advantage is that the Tonette is practically impossible to play out of tune.

Invented in Chicago, the Tonette has already become a nation-wide craze in the United States. Army bands, dance bands, and school children all use the instrument.

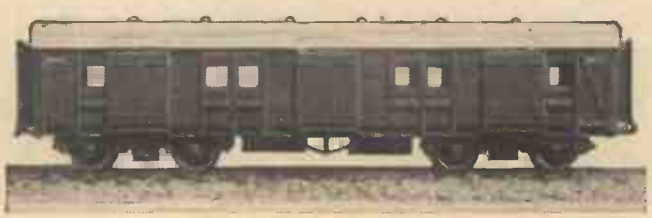
In this country, within a few weeks, it has been featured from B.B.C. and commercial radio stations. School and scout bands have also been formed.

Mechanically the Tonette is interesting by reason of that fact that it is accurately made on the injection moulding principle and is, therefore, unbreakable and hygienic.

How to Make Your Own Movies

THIS fascinating hobby really needs very little tuition. The latest ciné cameras make it very easy and provide hours of fun during week-ends and holidays, or days in the garden with your family. Movie-making is just as economical as snapshotting, but with the former you have the advantage of being able to entertain your friends with a real home ciné show. When you consider that a £10 ciné camera costs only 4d. a day to buy, and takes first-class ciné pictures at only 6d. a scene, you will realise that it is a really worth-while hobby.

Colour movies can also be made at very little more cost than black and white. This method of movie-making has been brought up to the highest standard of perfection, and even the novice can get colour films which evoke the highest praise from his home cinema audience. Fuller particulars and advice to all who are interested can be obtained from City Sale and Exchange (1929), Ltd., 59-60 Cheapside, London, E.C.2.



The new Southern Railway utility van produced by Multi-Models, Ltd.

SAYS EVERYBODY IS HYPNOTIZED

A strange method of mind and body control that often leads to immense powers never before experienced, is announced by Edwin J. Dingle, well-known explorer and geographer. It is said to bring about almost unbelievable improvement in power of mind. Many report improvement in health. Others acquire superb bodily strength, secure better positions, turn failure into success. Often with surprising speed, talents, ability and a more magnetic personality are developed.

The method was found in remote and mysterious Tibet, formerly a forbidden country, rarely visited by outsiders, and often called the land of miracles in the astounding books written about it. Here, behind the highest mountains in the world, Mr. Dinglele arned the extraordinary system he is now disclosing to the Western world.

He maintains that all of us are giants in strength and mind-power, capable of surprising feats, from the delay of old age to the prolonging of youth, and the achievement of dazzling business and professional success. From childhood, however, we are hypnotized, our powers put to sleep, by the suggestions of associates, by what we read, and by various experiences. To realize their really marvellous powers, men and women must escape from this hypnotism. The method found by Mr. Dingle in Tibet is said to be remarkably instrumental in freeing the mind of the hypnotizing ideas that paralyse the giant powers within us.

A nine-thousand-word treatise revealing many startling results of this system is now being offered by the Institute of Mentalphysics, 213 South Hobart Blvd., Dept. V, Los Angeles, Cal., U.S.A. They offer to send it free to any readers of this magazine who quickly send their names and addresses. Readers are urged to write them promptly, as only a limited number of free treatises have been printed.

"PRACTICAL MECHANICS" WIRELESS SUPPLEMENT

EASILY-MADE AMPLIFIERS

Essential Details of a Few Simple Types of Amplifier for Battery and Mains Use. The Units Described are Intended Only for Temporary Use and Are Not "Quality" Amplifiers.

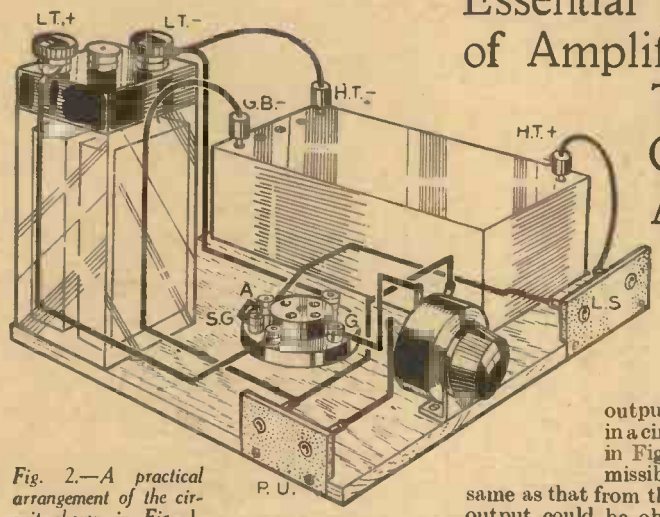


Fig. 2.—A practical arrangement of the circuit shown in Fig. 1. Layout is optional, but the component positions shown are as good as any.

THERE are innumerable uses for a simple amplifier, and the simplest type of unit that could be made is one with a single battery-operated valve. It can be built on a very small baseboard or in a compact wooden box, and can be carried about very easily. Small batteries can be housed within the container so that the only external connections required are those to the microphone or pick-up and those to the loud-speaker.

Single-Pentode Unit

A circuit for a unit of this type is given in Fig. 1, where it will be seen that the valve is a pentode, and that the connections are very few in number. The only component additional to the valve-holder is a .25-megohm volume control potentiometer. Fig. 2 shows the few connections in pictorial form. In this illustration the dry battery is of the type for both H.T. and G.B., and it should have a total voltage of 120 if a moderate output is required. A small accumulator is used for low-tension current, but a 3-volt dry battery with a 5-ohm resistor in series could be used if desired. The available output for the speaker will, naturally, be small but will be adequate for many requirements. At any rate, if the pick-up or microphone is of a sensitive pattern the amplifier will give an output falling not far short of that given by the average battery set.

The most suitable type of valve is one such as the Cossor 220 P.T. or Hivac Z.220 (this is a tetrode, of course). These have a rated maximum undistorted output of 1,000 milliwatts, and will handle a fairly heavy input from the pick-up or microphone.

We do not show the set built into a carrying case, but such an arrangement could easily be provided by mounting a couple of terminal-socket strips on the side of a small wooden box or old attaché case. It would probably be found convenient to allow room in the container for a microphone and its transformer and energising battery.

Greater Amplification

If the input device were known to be somewhat insensitive it would be better to use a couple of valves—a triode and an output pentode or tetrode—in a circuit similar to that given in Fig. 2. The maximum permissible output would be the same as that from the simpler unit, but that output could be obtained when the input was appreciably less. A circuit of this type is often more satisfactory than a single-valve one even when the microphone is of a very sensitive type, because it allows the microphone to be "throttled down" so that there is less chance of instability and back-coupling between the microphone and speaker. It is frequently the case that the most pleasing reproduction is obtained when the microphone volume control is turned well down or when the energising voltage applied to the microphone is reduced to 1½-3 volts, instead of the more usual 4½-6 volts.

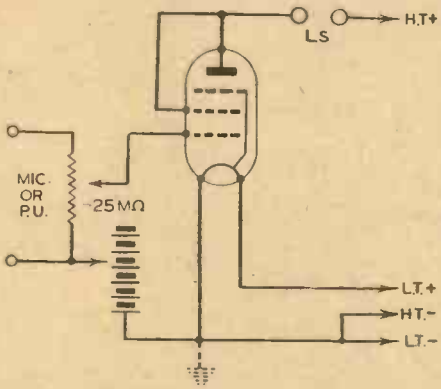


Fig. 1.—One of the simplest single-valve battery amplifier circuits.

Earthing

It will be seen that in both circuits dealt with the earth connection is suggested by broken lines. Very often it will not be required, but on the other hand there are many instances in which it will be found to improve results. When the microphone or speaker lead is screened, the screening braid should in any case be connected to the earth terminal, whether an earth lead is also joined to it or not.

Two Triodes

A slightly more elaborate two-valve battery circuit is shown in Fig. 4. In this case, two triodes are used, the first being an L.F. or General-Purpose type and the second a power-valve of the Cossor 230 X-P., Hivac P.X.230 Osram P.2, or Mullard P.M.202 pattern; the bias voltage must, of course, be regulated to suit the valve chosen. The battery must be of 16 volts maximum rating when using a 120-volt H.T. battery unless a battery with suitable H.T. and G.B. tappings is employed. When using a couple of valves, especially if the second takes .3 amp. L.T., an accumulator is essential for L.T. supply. To ensure that the output valve can be fully loaded a transformer is used to couple the two valves, and this should have a step-up ratio of about 1 to 3.5. Decoupling is also shown in the anode circuit of the first valve although this might not be essential; it is desirable, however, when using transformer coupling. Another minor refinement is an electrolytic condenser between the lower end of the input volume control potentiometer and

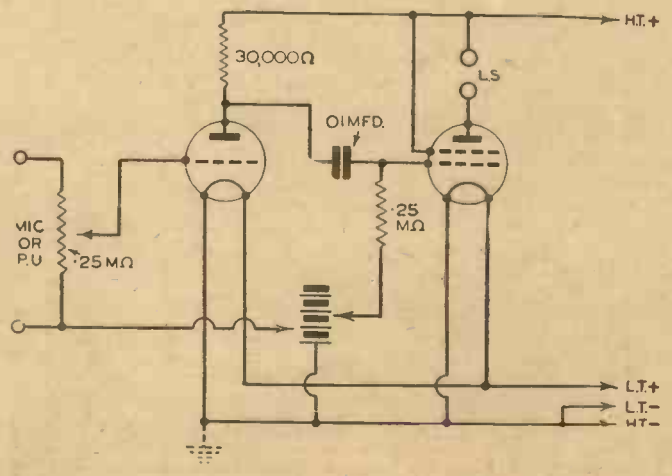


Fig. 3.—This two-valve battery-amplifier circuit is efficient and inexpensive to build. At the same time it will give a satisfactory output when fed from a microphone or pick-up of fairly low sensitivity.

the "earth line." This can often be omitted without affecting results in the slightest. Nevertheless, it is sometimes useful in improving stability and helping the quality side. It need have a working voltage of no more than 12 if used.

A.C. Amplifier

Those who always use a mains-operated receiver will probably favour a mains-type amplifier. This is capable of giving a greater output, of course, and is better in many respects—generally too good for present requirements. It will cost a good deal more to build whilst it is less likely that the requisite parts can be obtained from the junk box. But for those who prefer a set of this type we give a circuit in Fig. 5. It will be seen that the usual A.C. mains transformer is omitted for simplicity, a half-wave rectifier being included in the H.T. positive feed line.

Many will point out that this arrangement is not in accordance with I.E.E. regulations, but it is that which is used in many universal receivers and has been proved to be satisfactory. A single 40-volt .2 amp. tetrode is used, the circuit being similar in all important respects to the battery version shown in Fig. 1. To drop the mains voltage of about 230 to the 40 volts required by the valve heater, a 40-watt lamp bulb is wired in series; this is provided by a pair of 4-mfd. electrolytic condensers, although the capacity of these can be increased to 8 mfd. if the larger condensers are more readily available. With regard to the rectifier this could well be a Westinghouse style H.T.17, which has a maximum D.C. output of 200 volts at 100 mA. This rectifier also has a low resistance, so that the maximum output can be obtained with an input of 250 volts. Assuming that a Cossor 4020 tetrode valve were used, the bias resistor would require

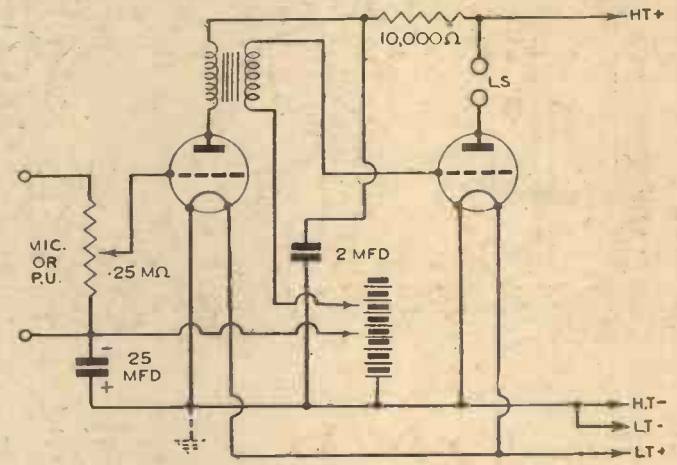


Fig. 4.—This battery amplifier employs a pair of triodes coupled together by means of an L.F. transformer, which may be a fairly small and inexpensive component. The anode circuit of the first valve is decoupled.

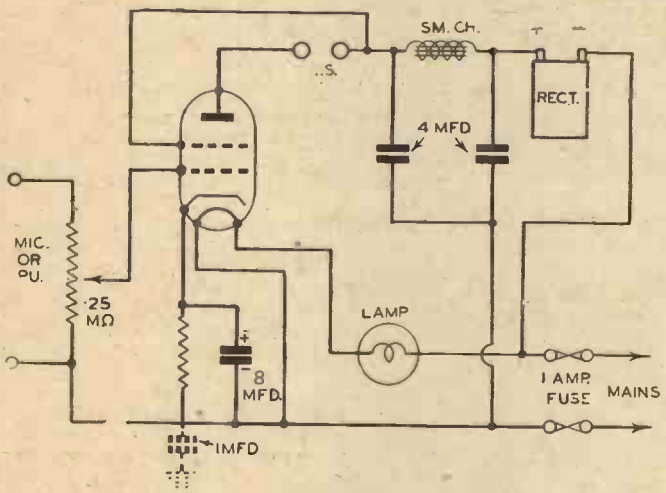


Fig. 5.—This simple mains amplifier can be operated from either A.C. or D.C., and can be built cheaply using standard components, many of which the constructor will already have on hand.

could be mounted on top of the container and used as a "silence" signal to warn the "broadcaster" that the amplifier is alive.

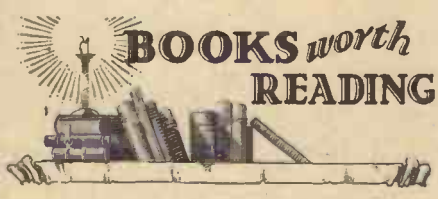
The smoothing choke need not be an expensive one, provided that it will carry up to about 50 mA. and that it has an inductance of not less than 10 henries at that current. Additional smoothing to have a value of 150 ohms and could be rated at one watt.

It would be an easy matter to modify this simple basic circuit to include a second (input) valve of the ordinary L.F. type, since the rectifier would provide an ample amount of current. Coupling between the two could well be as shown in either Fig. 3 or Fig. 4.

Of course, the output of any valve used in this circuit would be less than the maximum rated output due to the fact that applied H.T. voltage would not be more than about 170, and because the heater current would be rather less than the rated current of .2 amp. unless the lamp used as a resistor were replaced by a barretter or by a wire-wound resistor. Another point that should not be overlooked is that if two valves were used a different resistance lamp would have to be used. Thus, if the mains voltage were 240, a 220-volt 40-watt lamp would be suitable with a single valve, but if two valves were used—the first taking .2 amp. at 13 volts and the second .2 amp. at 40 volts—it would be correct to use a 200-volt 40-watt lamp. In both cases the heaters would be slightly, but only slightly, under-run. Of course, a .2-amp. barretter rated at 120-200 volts would be equally suitable whether there were one, two, or three valves in the circuit.

Hints on Use

Points to remember when using amplifiers of this type with a microphone and speaker are that the two should be as far apart as possible, preferably in different rooms. If they must be fairly near, arrange them so that they are not facing each other and/or place a screen of cardboard or paper between them. The leads from the two should be kept apart, and where possible it is better to have a separate earth connection to the screening braid of the microphone lead if this is more than about 25 ft. in total length. With a mains-operated amplifier it is essential that the containing case, when used, should be perforated to permit of ample air circulation round the valves and rectifier so that overheating is avoided.



"Light in Daily Life." By J. Stewart Dow. The Technical Press, Ltd. 127 pages. Price 3s. 6d.

MR. DOW, who is the editor of "Light and Lighting" treats the subject of artificial and natural lighting with extreme thoroughness. The book explains many of the problems which beset the Illuminating Engineer and will prove an ideal text book for students and others connected with illuminating engineering.

The author takes the reader right back into the dim ages and describes the first primitive attempts at lighting and shows not only how it has helped to satisfy the needs of mankind, but also how it has served to develop them.

Step by step he describes the progress of lighting right up to the present day and devotes one chapter to the marvels of invisible light.

Finally, in the last chapter, Mr. Dow discusses the possible future development of lighting and suggests a number of improvements that can be successfully applied to existing lighting conditions. A number of line sketches are also included in the book.

"Pattern Making." By John Mc. C. Wilson. Constable and Co., Ltd. 140 pages. 100 illustrations. 2s. net.

"Gas and Oil Engines: Running and Maintenance." By Peter S. Caldwell. Constable and Co., Ltd. 126 pages. 85 illustrations. 2s. net.

"Pressure Gauges: Indicators, Thermometers, Pyrometers." By James Smith. Constable and Co., Ltd. 144 pages. 117 illustrations. 2s. net.

"Boilermaking." By Kenneth Morrison. Constable and Co., Ltd. 106 pages. 85 illustrations. 2s. net.

"Moulding and Other Foundry Work." By William Bell. Constable and Co., Ltd. 124 pages. 71 illustrations. 2s. net.

THIMBLE MANIPULATION

Fig. 1 (Left).—Thumb palming a thimble. These photographs show the two stages of making the palm. The thimble is on the forefinger which is bent down until the thimble can be gripped in the fork of the thumb. Fig. 9 (Right).—Thimble holder. Two of these holders, each accommodating four thimbles are used, one for each hand. The illustration shows one method of attaching the holder under the edge of the waistcoat.

TRICKS with thimbles are a class of conjuring quite on their own. And although the majority of them are done by what is really a form of sleight of hand, they are in most cases quite easy to do.

Fig. 1 shows the movement that is the basis of all thimble tricks. It is called the thumb palm. In this photograph the hand at the right side of the picture shows the first stage of the sleight and the other hand shows its accomplishment. The thimble is placed on the tip of the first finger. The finger is then bent down and the thimble gripped in the fork of the thumb and forefinger. As long as the thimble is pressed well down into the root of the thumb no difficulty will be experienced in holding it securely and, with the back of the hand kept towards the audience, the presence of the thimble is completely masked.

By Norman Hunter

(The Well-known Conjurer of "Maskelyne's Mysteries" Fame)

Further Articles on the Secrets of Conjuring will appear Regularly and Exclusively in this Journal

A Simple "Vanish"

The simplest means of vanishing a thimble with this sleight is apparently to throw it in the air. The thimble being on the tip of the forefinger, a throwing movement is made and the eyes follow the imaginary flight of the thimble while, with a quick movement of the finger, the thimble is thumb palmed. It is an equally simple matter to reproduce the thimble from behind the elbow, from under a cushion, or anywhere else, by the simple process of bending the forefinger down and replacing the thimble on the tip of it as the hand is thrust into the place from which the thimble is to be produced.

Fig. 2.—Vanishing a thimble. The thimble is thumb palmed under cover of the left hand.

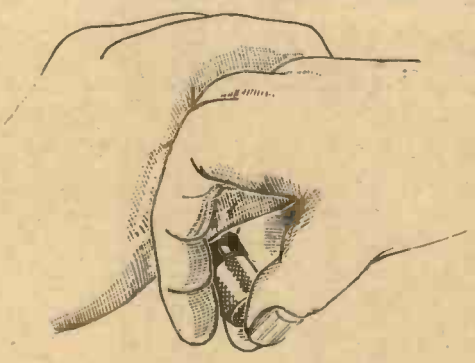


Fig. 3.—A simple vanish in which the thimble is worn on the tip of the second finger. Note the thimble being gripped between the first and third fingers.

Fig. 2 shows another vanish for a thimble. In this case the thimble is apparently placed in the left hand. The hand comes down over the finger with the thimble on it and masks the fingers for a moment. During that moment the right-hand thumb palms the thimble and the left hand is then closed round the forefinger and drawn off at the top as if taking away the thimble. The thimble being already comfortably thumb palmed may be reproduced as fancy dictates and the left hand shown empty.

Other Manipulations

A still easier vanish is illustrated in Fig.

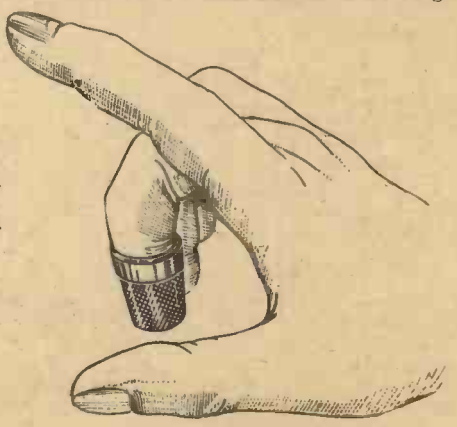


Fig. 4.—Another thimble vanish.

3. Here the thimble is worn on the tip of the second finger. The left hand is closed and the thimble pushed into the fist. As soon as it is out of sight the second finger is bent over and the thimble gripped between the first and third fingers. The right hand is then withdrawn and to the audience it appears that the thimble has been put into the left hand. Actually, of course, it is now held between the first and third fingers of the right hand, from which position it can conveniently be transferred to the tip of the forefinger and then thumb palmed while the attention is directed to the closed left hand.

Another simple vanish is shown in Fig. 4. In this case the thimble is actually on the tip of the second finger, but, by placing the first finger just beneath the second finger, you convey the impression that the thimble is on the forefinger. The right hand is brought with a swing down on to the palm of the left hand which apparently removes the thimble from the finger. Actually, as the hand comes down, the second finger

with the thimble on it is bent under and the first finger is gripped and the thimble seemingly drawn off it.

A Convincing "Vanish"

A very convincing vanish for a thimble, which can be performed after a little slickness in thumb palming has been attained, is managed as follows. The thimble on the tip of the first finger is laid on the palm of the left hand. The fingers of the left hand are closed slowly round it and the forefinger withdrawn, leaving the thimble in the left hand. The forefinger is re-inserted in the thimble and the left hand opened to show it there. Again the fingers of the left hand close and the right hand is withdrawn. This time, however, as the right hand is taken out of the left fist the thimble on the forefinger is withdrawn and rapidly thumb palmed, while the left hand is at the same time raised as if containing the thimble.

Fig. 5 shows a colour-changing effect with a thimble. A red thimble is thumb palmed and a white one is openly shown and placed on the finger tip. It is placed on the second finger, but the audience are led to suppose that it goes on the forefinger, the two finger tips being overlapped as shown. The left hand is now brought up and round the thimble. Under cover of this movement both first and second fingers are bent down, the second finger remains down and the forefinger comes up again with the red thimble on it. The left hand is now removed and the thimble is seen to have changed to red. The white thimble can be later transferred to the thumb palm and, if desired, re-produced.

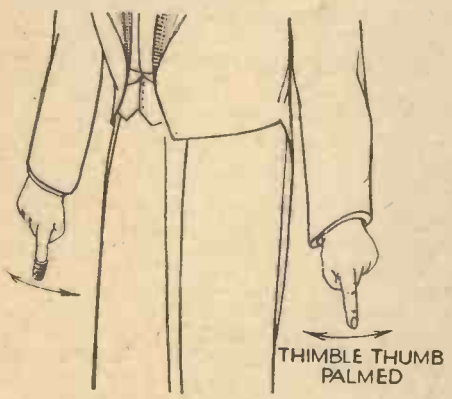


Fig. 6.—By changing the position of the hands, the thimble can be made apparently to pass through the knee.

An Effective Trick

Passing a thimble from the tip of the right forefinger to the tip of the left forefinger is a most effective trick and it requires only reasonable proficiency in the thumb palm with either hand. Two thimbles are used, both alike. One is thumb palmed in the left hand, the other visibly placed on the right forefinger. Holding the hands with backs to the audience, on a level with the knees, the performer waves them slightly from side to side, thumb palming the thimble on the right hand and bringing into view that on the left. The movement is gone through again and the thimble passed back. It will bear repetition quite a number of times. By changing the positions of the hands the thimble can be made apparently to pass through the knee or vertically instead of horizontally. (See Fig. 6).

Swallowing a thimble is illustrated in Fig. 7. The thimble finger is put in the mouth and the thimble apparently sucked off and eaten. Begin by tapping the lips with a thimble on the forefinger then, with

Fig. 5.—A colour changing thimble. White thimble on second finger is bent down into hand while first finger brings up red thimble from fork of thumb

a slightly sweeping movement of the hand, put the forefinger into the mouth. Under cover of the slight movement the thimble is quickly thumb palmed and the bare finger tip goes into the mouth. The effectiveness of the trick largely depends upon the performer's acting ability. After the apparent swallowing, the thimble is produced from beneath the edge of the waistcoat.

A Thimble Holder

Fig. 8 shows a special holder for thimbles which enables them to be securely fixed in a convenient position and secretly obtained when wanted. The holder consists of a metal plate with one edge turned up for the thimbles to butt against. The place is covered with black velvet and there are holes drilled as shown. A length of black cord elastic is threaded through the holes as shown in Fig. 8, and tied off at the back. Four thimbles can now be accommodated on the plate by forcing one under each loop. The plate has either a small safety pin or a couple of wire eyes soldered to either end for attachment, by the pin or by sewing, to the clothing.

Fig. 9 shows the plate loaded with four thimbles attached under the lower edge of the waistcoat. This illustration also shows how easily the thimbles may be obtained.

Fig. 7.—The thimble thumb palmed in the act of apparently putting it into the mouth.

Fitting the Holders

Two of these holders are usually employed and they may be fitted one at either side under the edge of the waistcoat as described, or you may find it more convenient to attach them to the top of the trousers, in the same position. Some performers prefer to fix them to the trouser legs at the back, where they are covered by the tails of an evening coat; while if they are performing in a short dinner jacket, the lower edge of the jacket is a convenient position for the holders.

The holders are used as follows. A thimble having been secured from one holder and various sleights performed with it, a second thimble is got on to the tip of the left forefinger and the trick of passing the thimble from one finger to the other is performed as already described. Then, turning his right side to the audience, the conjurer vanishes the thimble by a throwing movement, thumb palming it as he does so. He then produces it again on the tip of the finger as if catching it from the air. Under cover of these movements the unseen left hand secretly gets the remaining three thimbles on to the second, third and fourth fingers, which are then kept doubled into the palm. The visible thimble is now passed, apparently, on to the forefinger of the left hand and the left side turned towards the audience. Some more sleights with the left hand provide cover for securing the three thimbles. The passing of one thimble from hand to hand is gone through once or twice more, then suddenly the hands are opened and fingers spread out, showing that every finger is now capped with a thimble.

Piano Accompaniment

With all thimble tricks it is a considerable asset to have someone at the piano to strike a single note each time a thimble appears on the finger in a sleight. The pitch of the note can be varied according to where the thimble seems to come from, and at the finish a prolonged chord heralds the appearance of the eight thimbles.

Ordinary white thimbles bought at the drapers are quite suitable for conjuring, but for stage work larger articles are required. For this purpose big thimbles are turned from wood and painted. The outsides of these thimbles are larger than the ordinary domestic article, but the interior is simply drilled to fit the performer's finger comfortably. If you possess a lathe it is an easy matter to turn yourself a set of thimbles which can literally be made to measure. The outsides of the thimbles can either be painted white or with aluminium paint. A striking addition consists of drilling small sockets with a

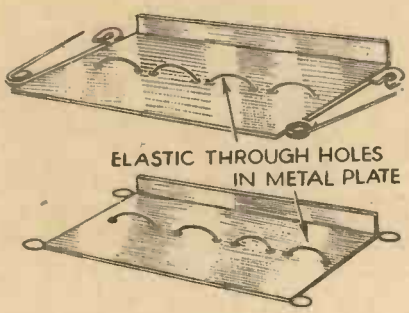


Fig. 8.—Details of the thimble holder shown in Fig. 9.

countersink bit all over the thimble and fixing with Durofix into the sockets some little imitation diamonds taken from a piece of cheap jewellery. These flash in the light and produce a most brilliant effect. A further development of the idea is to have different coloured jewels in the different thimbles (See Fig. 10).

Mechanical Type of Trick

Now we come to the more mechanical type of thimble trick. The first consists of two thimbles of different sizes, nesting one within the other. These are shown on the finger as one thimble and a paper cap is placed over them. The cap is removed and stood on the table, the outer thimble being removed within it as shown in Fig. 11. The inner thimble is now vanished by one of the methods already explained and, the paper cap being lifted, reveals the outer thimble, ostensibly the one that was vanished.

A thimble having a loose lining of transparent celluloid offers another way of doing the vanishing trick. Thimble and lining together are worn on the tip of the forefinger. A silk handkerchief is thrown over the finger and, under cover of this movement, the thimble is neatly thumb palmed, the transparent lining alone being left on the finger. This lining is now removed under the silk handkerchief and the shape of it suggests that the thimble is still there. While a member of the audience is invited to feel the thimble through the silk, the real thimble is either dropped into a pocket or secretly poked under the coat collar of the gentleman who is helping. The finger is now put back into the transparent lining and the covering silk whisked off. At a short distance the celluloid lining is invisible on the finger. The trick finishes with the gentleman in the audience being asked to return the thimble which he is hiding under his coat collar. Needless to say, he is more surprised than anyone when he finds it there.

Expanding Thimble

Fig. 12 shows an expanding-thimble trick. An ordinary thimble, on being covered with a metal goblet, swells up to several dozen times its original size.

The large thimble is made either by turning it from wood or else by adding a domed portion to the bottom of an ordinary cream carton. This large thimble fits easily into the goblet and the insides of both are painted black. Goblet and thimble are shown as one and placed over the small thimble. In doing this the goblet is held between thumb and forefinger, near the rim, the little finger being nearest the audience. The goblet is placed over the thimble with a sweep from front to back and the small thimble is scooped up in the curve of the little finger and so removed, while the large thimble remains to be revealed when the goblet is lifted.

"Hunt the thimble" is a trick in which one thimble and three goblets are used. Spectators are invited to guess under which goblet the thimble is to be found. They guess wrongly or rightly as the performer wishes.

This, again, is a sleight of hand trick, but it is not difficult. Confidence, which comes from practice, is needed more than actual skill.

Thimble and Goblets

Only one thimble is used. In placing the goblets down, when one is apparently placed over the thimble, the thimble is hooked away by the little finger as described in the last trick. The thimble is therefore in the conjurer's possession and not under any goblet. To make the thimble appear under any of the three goblets, the goblet is grasped at the back, near the rim, and lifted, the thimble which has been held in the crook of the little finger is simply left on the table as the goblet is lifted and appears to have been actually under it.

With these two movements the performer can make the thimble appear where he likes and therefore cause the guesses of the audience to be correct or otherwise.

Finally, here is a trick in which thimbles are used as a means of performing the effect, rather than as chief actors in the mystery.

A yard of narrow ribbon is examined and wound round a thimble, an elastic band is snapped over it and the lot given to a spectator. Picking up a pair of scissors, the conjurer makes two or three snips in the air. He asks the person holding the ribbon to unwind it and they find it has been mysteriously cut into three or four lengths.

Prepare for the trick by taking a duplicate length of ribbon and cutting it into a few lengths. Wind these pieces round a second thimble, one after the other, then put an elastic band round the lot. Have this packet, together with other elastic bands, the other thimble and ribbon and the scissors, in a box.

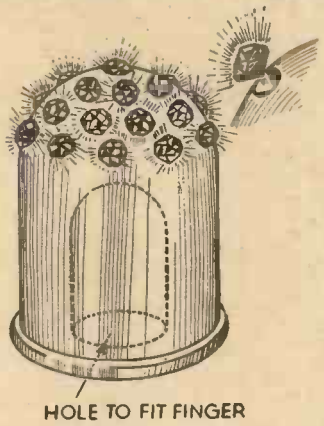


Fig. 10.—Jewelled thimbles turned from wood.

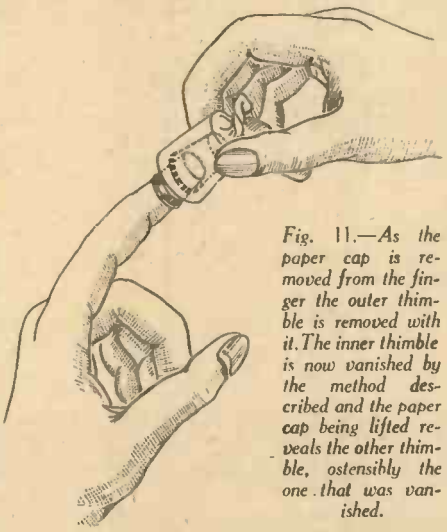


Fig. 11.—As the paper cap is removed from the finger the outer thimble is removed with it. The inner thimble is now vanished by the method described and the paper cap being lifted reveals the other thimble, ostensibly the one that was vanished.

Ribbon and Thimble

Having wound the visible ribbon round the thimble, when you take an elastic band from the box you pick up the duplicate ribbon and thimble on the tip of your second finger. Put the first finger into the visible thimble while you snap the elastic band round it. The second finger is bent down to hide the other thimble. Hold up the first finger to show the ribbon, then, apparently, take thimble and ribbon off your finger. Actually you bend down the forefinger and bring up the second finger in its place so that it is the duplicate thimble and cut ribbon that you actually take off and hand to the spectator. As there is no difference in the look of the ribbon and nobody knows what you are going to do, no suspicion is aroused.

In taking the scissors from the box it is an easy matter to leave behind the thimble and single length of ribbon. The rest of the trick is a matter of working up the mystery.

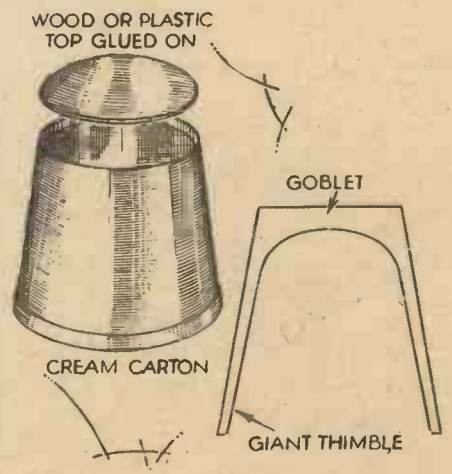


Fig. 12.—An expanding thimble. An ordinary thimble, on being covered with a metal goblet, swells up to several times its original size.

MODERN ABRASIVES

Their Composition, Manufacture and Uses. An Article of More than Ordinary Interest to every Engineer and Mechanic

THERE is no doubt of the fact that man has always been an abrasive-using animal. For, from far back in the mists of remote antiquity there have come to us man-made tools and implements which, crude although they may be, show unmistakably the marks of a rubbing-down process which has been applied to them.

The stone arrow, the ancient axe, the first attempts at the fashioning of knives and other metallic cutting instruments must all have been submitted to some process of grinding and shaping, and, indeed, on many of these prehistoric articles the actual marks of the grinding implement can be plainly seen.

The earliest form of grinding, which, incidentally, has persisted right up to the present day, consisted in the rubbing of one thing over another, as, for instance, the frictional contact of one stone across another one of similar or, perhaps, harder texture.

Common Grindstone

The common grindstone forms an example of this, the earliest of abrasive operations. Actually, however, the grindstone as an abrasive agent is not a very efficient article, for it neither grinds not cuts. The traditional grindstone merely rubs the article against it and exerts rather a haphazard tearing-away action on the object than a true grinding effect.

The first real scientific advance in the application of abrasives came with the more general utilisation of emery and its making up into compact stones and grinding wheels.

Emery is, of course, a naturally occurring mineral which has been known (yet surprisingly little used) for thousands of years. It occurs plentifully in Greece and, indeed, it derives its name from Cape Emeri, in the Greek island of Naxos, near which it was once mined.

In composition, emery is an impure form of aluminium oxide mixed with iron oxide. It is reasonably tough without being unduly brittle and, although at the present time it has to meet much competition from the synthetic abrasive agents, it still retains its many large-scale and commercial uses.

Powdered flint used at one time to be a favourite abrasive, but such material is now less used in view of the varying nature of its composition and physical characteristics.

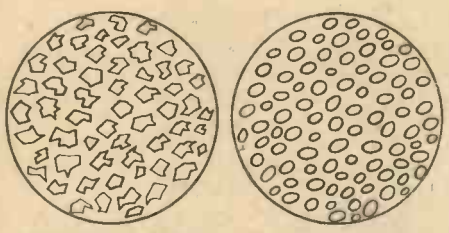
Garnet

Garnet, however, is a natural abrasive material which still has its uses. In composition it is a silicate of aluminium mixed with iron oxide, resembling in this direction the precious stone, which is a crystallised form of it. Abrasive garnet, however, usually occurs in the form of a gravel, which is washed, ground, and carefully graded as to particle size and employed either as a substitute for emery or in admixture with it.

Sand, of course, has long been employed as an abrasive, as witness, for example, the now almost traditional sandpaper. So, also, have powdered glass, brick dust, and similar materials, although, strictly speaking, the particles of these substances exert a tearing rather than a true abrasive action.

The era of modern abrasive materials was initiated, perhaps, by the coming of carborundum, or silicon carbide, a material which was invented by the American chemist, Edward Goodrich Acheson, in 1891. This nowadays well-known and, indeed, indispensable material is made by fusing in an electric resistance-furnace a mixture of coke and sand, together with a little salt to make the mass more readily fusible and a small quantity of sawdust to render it porous.

During the 36 hours of continuous fusing which the manufacture of carborundum requires, a temperature of no less than



Emery grains wear round with frictional rubbing, but grains of silicon carbide (carborundum) split under friction and continually present fresh cutting edges.

3,500 degrees C. is reached, a terrific heat in which all metals would not only be boiled, but actually gasified.

Yet it is at this enormous temperature that the two elements silicon and carbon enter into combination to produce silicon carbide or carborundum, which, when unloaded from the furnace, takes the form of massive and many-hued resplendent crystals.

Carborundum Crystals

The carborundum crystals are crushed and then acid treated in order to remove all impurities. Finally they are washed, dried, and then passed on to further crushing machines, which reduce the material to definite grain sizes.

A companion product to carborundum is fused aluminium oxide, which under the name of "aloxite," now forms a synthetic substitute for emery.

In aloxite manufacture, bauxite ore, which is a naturally occurring form of aluminium oxide, is electrically fused with coke, whereupon the bauxite melts and subsequently takes upon itself a crystalline structure.

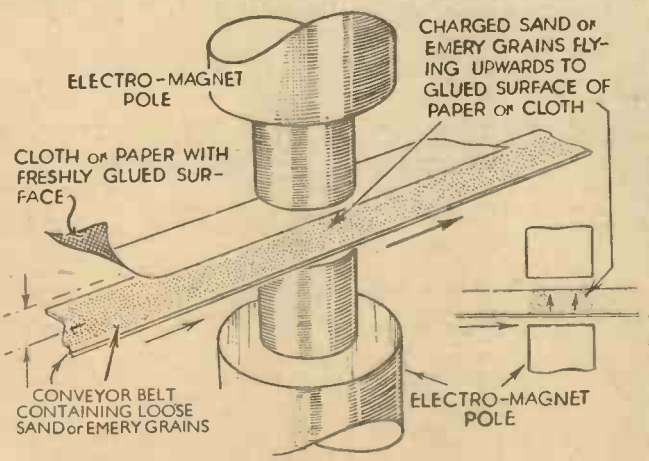
From the aloxite furnaces, the abrasive material is extracted in the form of immense blocks, which are broken up, crushed, and then carefully graded for grain size.

Silicon carbide (carborundum) and aluminium oxide (aloxite) are the only synthetic abrasive materials known, yet, in many respects, they have ousted all the natural abrasives for many types of grinding work.

Both these synthetic materials may be used in the form of powders of varying degrees of fineness, or, alternatively, they may be employed in the form of compacted masses of various shapes, as, for instance, blocks, wheels, sharpening stones, and so forth.

Bonding

This bonding of carborundum and aloxite, and also, of course, of emery and other naturally occurring abrasive materials, is usually effected by mixing a small proportion of china clay with the material and by compressing the mixture hydraulically. The compressed material is then fired in specially constructed furnaces, in which operation the bonding clay is melted and converted into a porcelain-like substance in which the grains of abrasive are firmly embedded.



Illustrating the modern method of sandpaper making.

Of all known abrasive materials, with the exception of diamond powder, which is used by manufacturing jewellers for diamond polishing and drilling, carborundum is the hardest. Carborundum, however, is not tough, but brittle. Consequently, under great rubbing pressure, the carborundum grains do not wear down to smooth surfaces, but they actually split, thereby presenting new cutting edges.

Aloxite (aluminium oxide) and emery, on the other hand, possess grains which are tougher but not so hard as those of carborundum. Hence these grains wear down smooth and do not tend to produce the constant cutting action which is so characteristic of carborundum.

Carborundum cuts, but emery,

aloxite and other materials grind. The difference between these two effects will be evident from the fact that the tiny portions of metal removed by the agency of a carborundum abrasive, when microscopically examined, appear as "curls" or shavings of metal, whereas metal removed by means of aloxite or emery, when similarly viewed, presents the form of tiny globules which have been rubbed away and melted by the heat of friction.

Cutting Action

The characteristic cutting action of silicon carbide or carborundum abrasive has resulted in the rendering of this material supreme for many purposes. Relatively speaking, carborundum is as non-tiring an abrasive as is diamond dust. Since the material cuts instead of rubbing or grinding, a better-finished result is usually apparent, and much less friction is produced during the process.

Dentists, for instance, employ carborundum-tipped drills when they proceed upon their unpleasant but highly necessary excavational operations in our mouths, the carborundum doing its work quicker, more cleanly and with less friction than any other material.

For the same reason motor engine cylinders are frequently re-bored with carborundum boring bars, since the carborundum grains can be relied upon to produce a clean result with the minimum of effort.

In the general run of engineering grinding work it is more or less a rule to employ a hard, brittle abrasive, such as carborundum, for the grinding of materials of low strength, as, for example, aluminium, brass, copper, cast iron, hard rubber, stone, marble, and numerous other non-metallic materials. For dealing with materials of high tensile strength, such as steel and its various alloys, the tougher yet softer emery or aloxite is employed in abrasive operations, since, being tougher than carborundum, they are better able to withstand the frictional strain against a hard surface without breaking down.

Chromium Oxide

In addition to the abrasive materials enumerated above, there are, of course, a number which have lesser uses. Among these may be mentioned chromium oxide, the green polishing powder used in fine metal working and, of course, that gentlest of all abrasives, jeweller's rouge, which is, of course, merely a form of iron oxide, which has been heat-treated and carefully graded for particle size.

Added to these are the whiting and the Tripoli powder or kieselguhr (a diatomaceous earth) beloved of metal-polish manufacturers, and one or two other naturally occurring fine abrasive materials, such as cuttle-bone powder which is the ground internal shell or bone of the cuttle fish, and Rottenstone, a finely ground mineral, occurring in Derbyshire, which is often employed for polishing operations.

Such materials, whilst being strictly abrasives, are only extremely mild ones, for they remove merely the thinnest of deposits from smooth metallic surfaces, and hence are employed merely as polishing agents.

Bound up with the developments which have taken place in the sphere of modern abrasives is the manufacture of abrasive cloths and papers.

At one time sandpaper was a very unreliable material, consisting of sand grains of very unequal size glued down to a thick brown paper. In recent years, however, a demand for improved abrasive papers and cloths of many varying grades has arisen in consequence of the increased activities of the light engineering industries, the result being that these modern papers and cloths have now become highly efficient and specialised articles.

Synthetic Resins

In addition to special glues, various synthetic resins now form the bonding agents for cementing down the abrasive grains of these rubbing cloths and papers. Paper mills provide special grades of tough paper for this branch of the modern abrasive industry, whilst the cloths employed are specially woven, sized, and pre-coated with materials to render their shrinkage impossible.

Perhaps, however, the most interesting development of abrasive cloth and paper manufacture is the modern mode of coating these materials. In order to secure absolute uniformity of distribution of the abrasive particles upon the surface of the paper or cloth, the glue-coated material is passed through an electric field produced by a current of between 40,000 and 50,000 volts. Through the same field, also, and about three-quarters of an inch below the glue-coated paper or cloth, is passed a conveyor belt carrying on its surface the grains of abrasive which are to be coated on the paper or cloth. Under the influence of the powerful electric field, the abrasive particles acquire an electric charge and fly upwards to the glued surface, to which they attach themselves in an absolute uniformity of distribution.

The "Whipping Machine"

Any excess of the abrasive grains which may be present upon the paper or cloth is subsequently removed by passing the coated material through a "whipping machine," which knocks off the surplus abrasive particles which have not become firmly embedded in the glue and returns them to the main feed of the coating machine.

Finally, the coated abrasive paper or cloth is passed on to a room in which it is hung up in festoons for the adhesive material to dry and harden, and afterwards, in special cases, an additional adhesive coating may be flowed over the abrasive surface in order to anchor the grains still more securely in position.

Such is one of the most recent of developments of the now world-wide abrasives industry, a development which, compared with the erstwhile simple peppering of dry sand on to a glued brown-paper surface, is almost as great a measure of progress as is represented by the superiority of the present-day synthetic abrasive over the age-old and tradition-haunted grinding wheel.

CHEMISTRY FOR AMATEURS

(*Continued from page* 466)

much brilliance in oxygen. Magnesium ribbon burns in air with great vividness, but, in oxygen, the effect is still more increased. Even hard steel, when heated to redness, will take fire in oxygen.

Take, for example, a small tuft of steel wool on the end of a length of stout iron wire. Heat this to redness in a bunsen burner flame and then hold it in front of a jet issuing oxygen, or, alternatively, plunge it into a jar of oxygen. Immediately, the steel wool will light up and will burn with dazzling brilliancy, emitting a shower of sparks which will fall to the bottom of the jar in black globules. This is magnetic iron oxide, Fe_3O_4, the reaction involved in its formation being written :

$3\,Fe$	+	$2O_2$	=	Fe_3O_4
Iron		Oxygen		Iron oxide

Oxidation

We have now seen how, when metals burn in air or oxygen they form oxides, which are, of course, compounds of oxygen with the metal in question. Only a few metals, such as gold, platinum, and iridium, can resist the combining energy of oxygen, for, even at ordinary temperatures (and especially in the presence of moisture) this combining effect is still present, as witness, for instance the rusting of iron and the surface tarnishing or oxidation of the common metals.

If, however, we wish to prepare the oxides of some metals in the pure condition, it is not always necessary to heat the metal in air or oxygen for this purpose. Sometimes we may simply heat the ore of the metal, or its sulphide, carbonate, nitrate or other compound.

Limestone or chalk, for instance, consists of calcium carbonate, $CaCO_3$. When this is heated, as in the commercial process of "lime-burning," carbon dioxide gas is given off and ordinary lime or calcium oxide remains. Here is the chemical equation expressing this highly important reaction :

$CaCO_3$	=	CO_2	+	CaO
Calcium carbonate (chalk)		Carbon dioxide		Calcium oxide (lime)

Let us now suppose that we require a laboratory supply of black copper oxide, CuO, which is, indeed, a very useful laboratory commodity. To obtain this, we may dissolve scrap copper in dilute nitric acid, thereby obtaining a solution of copper nitrate. This solution is evaporated to dryness, and the solid copper nitrate remaining is then transferred to a crucible or tin can and heated strongly. Red fumes of oxides of nitrogen will be given off, and black copper oxide will be formed. Similarly lead oxide, PbO, or litharge, is obtained when lead nitrate is strongly heated.

"Hydroxides"

In addition to the oxides of metals, there is a large class of compounds known as the "hydroxides," which may be described as combinations of metallic oxides with water. Caustic potash and caustic soda are well-known examples of hydroxides, being, respectively, potassium hydroxide and sodium hydroxide, KOH and NaOH. These are formed when metallic potassium or sodium acts on water.

Other hydroxides are made by the action of water on oxides.

Take, for instance, the well-known phenomenon of the "slaking" of quicklime. Quicklime, a caustic substance, is, as we have already seen above, calcium oxide, CaO. Now, when water is poured on to quicklime, the liquid combines with the lime to form calcium hydroxide, $Ca(OH)_2$, or slaked lime, the energy of the chemical reaction being so great, that the lime heats up, evolves clouds of steam, cracks, and eventually swells up into an impalpable, soft powder. Chemically expressed, the above reaction is :

CaO	+	H_2O	=	$Ca(OH)_2$
Quicklime (Calcium oxide)		Water		Slaked Lime (Calcium hydroxide)

Many other metallic oxides, as, for instance, copper oxide, CuO, will not combine directly with water to form their hydroxides. In such cases, the hydroxides of these metals have to be prepared by roundabout methods, some of which will be detailed in ensuing articles of this series.

MASTERS OF MECHANICS

No. 45. William Hedley, of Wylam, and the Story of "Puffing Billy"

PROMINENTLY displayed on a stone work plinth at Central Station, Newcastle-on-Tyne, is one of the world's first locomotives, an engine which, in many respects, is of even more historic import than Stephenson's famous "Rocket."

"Puffing Billy," the Newcastle engine, is, at the present time, just one hundred and twenty-six years old, for its construction was completed in 1813, in which year, with six loaded coal trucks behind it, it first began its working life on a colliery tramroad.

And, strangely enough, "Puffing Billy" was the work of an amateur engineer, for although William Hedley, the colliery "viewer," or overseer, of Wylam-on-Tyne, who was responsible for the design and construction of the locomotive, occupied at that time a responsible and important position at the Wylam colliery, he was by no means a professional engineer or even a working mechanic.

Famous Engineers

The district around Wylam-on-Tyne seems to have constituted the cradle of a host of famous engineers towards the end of the eighteenth century. Not only was George Stephenson born in Wylam, but also Timothy Hackworth, whose biography has recently appeared in this series of articles. William Hedley, the inventor of "Puffing Billy" and the "Man who Put the Rails in the Railway," was another famous locomotive constructor who first saw the light near Wylam, for he was born in the Tyneside village of Newborn on July 13th, 1779.

At Wylam, the youthful William Hedley first went to school, receiving his instruction from a teacher named Watkins, who had a reputation for mathematical learning and mechanical knowledge.

Unlike Stephenson and old Timothy Hackworth, who came of humble stock, Hedley belonged to a well-to-do family, his parents being able to afford him the best of educations and to establish him in life in a good position in one of the Tyneside collieries.

It was at Walbottle colliery that William Hedley began his career by being made "under-viewer" or assistant-overseer. His duties here comprised the general care of the mine, together with the supervision of its plant and, of course, its output of coal.

In the year 1805 Hedley obtained the position of "viewer" at the Wylam colliery, a momentous appointment for him, since it was in connection with his duties here that his name became famous to the world.

A "Travelling Engine"

A certain Christopher Blackett was a part-owner of the Wylam colliery, or, as we might say nowadays, was managing director of the concern. Blackett seems to have been a go-ahead man. He was intensely interested in steam locomotion, it being his ambition to have a "travelling engine" in commission at his colliery for the purpose of hauling coal trucks from Wylam colliery to the Tyneside village of Lemington, some five miles distant.

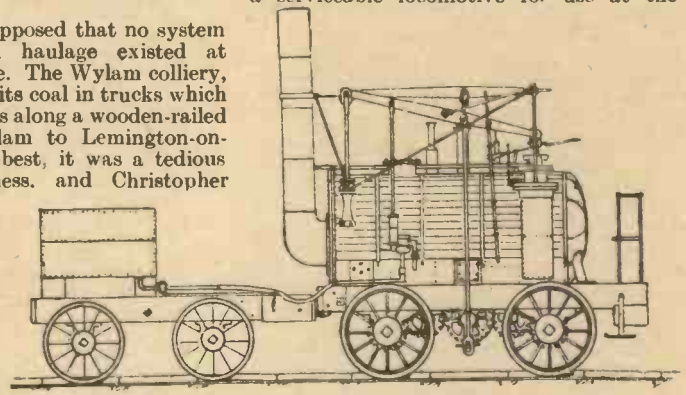
It must not be supposed that no system whatever of truck haulage existed at collieries at this time. The Wylam colliery, for instance, hauled its coal in trucks which were drawn by horses along a wooden-railed tramway from Wylam to Lemington-on-Tyne. But, at the best, it was a tedious and a slow business. and Christopher Blackett, the colliery owner, recognised it as such. For instance, although the length of the colliery tramroad was only five miles, a horse could only make three journeys along it in a day, the dead weights of the loaded trucks being too great for any speedier progression.

Christopher Blackett had seen the steam locomotive of the celebrated Cornish inventor, Richard Trevithick, in London, and he had even gone so far as to attempt to have a similar "travelling engine," as the locomotive was then called, built to his order in a Gateshead foundry. But this engine never proved satisfactory. In fact, it never left the foundry, but was eventually detached from its under-carriage and used in blowing the furnaces of the foundry.

In 1808 Blackett replaced his wooden tramway rails by iron ones, this replacement permitting him to place heavier loads on his tramway system. But here again Blackett came up against difficulties, for the heavier-loaded trucks reduced the speed of horse-haulage very considerably, so that the enthusiastic if, nevertheless, impatient colliery owner found that he had introduced no real benefit as a result of the change-over which he had effected.

Locomotive for Colliery Use

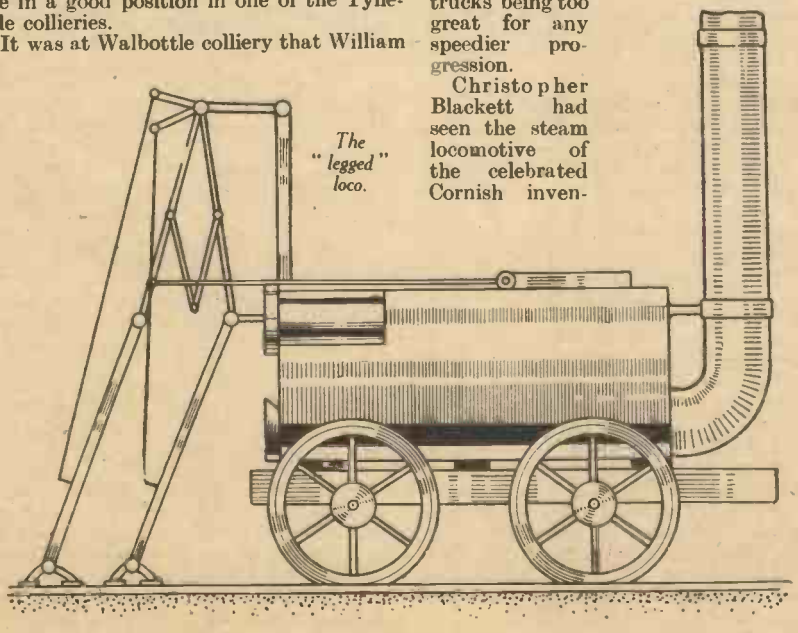
As a final move, Blackett wrote to Trevithick, asking the latter to build him a serviceable locomotive for use at the Wylam colliery. Trevithick, however, was much to busy to pay serious attention to the demands of the Wylam colliery owner. Besides which, there existed, at that time, a peculiar prejudice against these "travelling engines." There were even to be found working engineers and inventors who predicted that a successful "travelling engine" would never be a commercial possibility, simply, they averred, because it was impossible to make such an engine run with safety along a smooth-rail track.



"Puffing Billy," which was of Hedley's own conception and design, and embodied many details which had not previously been seen in other experimental locomotives.

Ideas such as this rose to the state of absolute obsessions in the minds of many engineers of the period. It is, indeed, for this reason that the earliest of the locomotives were invariably equipped with toothed wheels which engaged with racks or indentations provided for them in the track.

The engineer, Blenkinsop, of Middleton, for instance, produced, in 1811, quite a successful locomotive, but this was equipped with a toothed wheel working into a rack-rail in the centre of the line. Chapman, of Newcastle, another working engineer, devised an experimental locomotive having a toothed wheel which engaged with a tightly stretched chain set in the middle of the track, whilst still another engineer, Brunton, actually brought out a locomotive



The "legged" loco.

having mechanically-acting legs designed to assist the steady and speedy progression of the loco along a smoothed rail track.

Locomotive Haulage

It was to his "viewer," William Hedley, that the Wylam colliery owner, Christopher Blackett, turned eventually with the aim of mechanising his colliery haulage system. Hedley, of course, was well alive to the possibilities held out by a system of locomotive haulage and, unlike many of the professional engineers of his day, he was by no means obsessed with the notion of it being impossible to operate a steam "travelling engine" on a smooth-railed track.

Still, thought Hedley, a series of experiments should be made in order to demonstrate once and for all the possibility of the smooth-rail locomotive.

To this end he constructed a small locomotive under-carriage of his own design. He worked by night, in order to avoid the prying curiosity of his neighbours. So ardent, indeed, seem to have been the nocturnal efforts of this industrious and enthusiastic locomotive pioneer that the heavy hammerings which proceeded from his Tyneside residence ultimately procured for that edifice the reputation of being haunted. This, perhaps, was just what William Hedley wanted, for he worked on, unwatched, night after night at his under-carriage in an endeavour to prove, as he himself remarked afterwards, "that if the wheels of an engine-carriage were connected, it would, by the friction of the wheels upon the rails induced by its gravity alone, be enabled to overcome the resistance presented by an attached train of carriages.

An Experimental Model

Hedley's experimental model of a locomotive under-carriage functioned exceedingly well. A repetition of the experiments was made on a smoothed-rail track specially laid down in Christopher Blackett's garden, and, the result of such experiments being conclusive, it was at once determined to embark upon the construction of a "travelling engine" or locomotive, which would function on a smooth-rail track between Wylam colliery and Lemington-on-Tyne.

Thus came into being the famous "Puffing Billy," so named, no doubt, on account of the loud and characteristic noise of its exhaust. "Puffing Billy" was constructed throughout at the Wylam colliery under the active superintendence of William Hedley. Engaged upon its building was Timothy Hackworth, one of the colliery enginewrights, whose subsequent career we followed in a recent article in this series.

"Puffing Billy," however, was of Hedley's own conception and design, and, in this connection, it emboided many details which had not previously been seen in other experimental locomotives.

The building of "Puffing Billy" took a year or more to complete. Indeed, an experimental loco preceeded it, but was voted a failure, in consequence of which it never left its shed.

In 1813, however, "Puffing Billy" was placed on the specially strengthened wrought-iron railway which connected Wylam colliery and Lemington-on-Tyne, and it quickly began its regular running life with six colliery trucks attached to it.

A Curious Locomotive

The locomotive was a curious one, as, indeed, anyone who has inspected it at Newcastle-on-Tyne's Central Station will agree. Having two vertical steam-jacketed cylinders of 9-inch diameter and 36-inch stroke mounted on opposite sides of the boiler, the movement of the pistons was transmitted to the wheels by an arrangement of grasshopper beams which transmitted the power downwards by connecting rods to a shaft having cranks set at right angles. The shaft was fitted with a spur wheel, and the power was transmitted through four additional spur wheels to the four 39-inch driving wheels of the locomotive. Steam gained admittance to the cylinders by means of slide valves operated by a tappet motion.

The total weight of the locomotive was approximately eight tons, and, in good order, it was capable of a speed of five miles per hour on the level track.

After "Puffing Billy" had been placed in commission on the Wylam-Lemington rail-track, all went well for a few weeks. But suddenly, opposition arose from the owner of a tract of land through which the railway line passed. Added to this, the people in the neighbourhood of Wylam rose up in condemnation of the locomotive line because they considered that it would put the local smiths, farriers and other individuals interested in the provision and upkeep of horses out of employment. Indeed, the mining population of the Tyneside colliery villages, as most of the inventors of the period and district were well aware, strongly deprecated the introduction of machinery into mining practice.

A Difficult Task

Like inventors who had gone before him—and also like many who came after him—William Hedley had much uphill work to do before he became able to sooth the feelings of the local populace and, also, to assuage the outraged conventions of the obstructive landowner. In such locomotive propaganda, of course, Christopher Blackett played a great part.

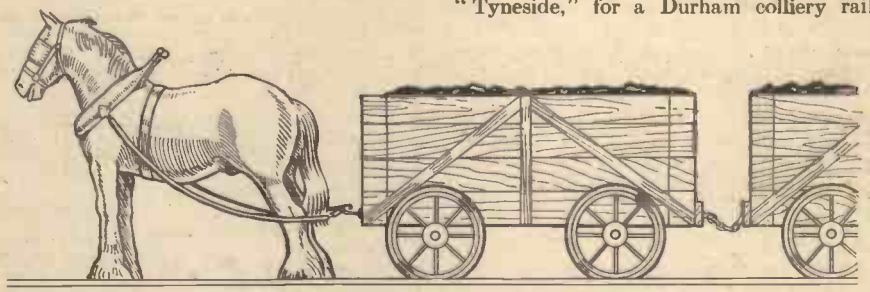
A patent was granted to Hedley in 1813 for his "travelling engine," and a little time later this now famous locomotive was doing haulage work on the Wylam-Lemington-on-Tyne railroad equivalent to that ordinarily and formerly performed by sixteen to eighteen strong horses.

"Iron Roads"

From this era dates the beginnings of our present "iron roads." Not only did William Hedley with his "Puffing Billy" completely vindicate the cause of the smooth-rail, rackless "travelling engine" or locomotive by demonstrating in an essentially practical fashion the soundness of the principle of locomotive adhesion to a rail under the influence of gravity, but he also initiated an age of locomotive building which rapidly followed his pioneering efforts.

Hedley himself did not build any other very famous locomotive after "Puffing Billy." And, although he patented his celebrated loco, he gained, so far as we can tell, no pecuniary benefit from it.

Perhaps it may be that Hedley was too wise and too practical a man to continue in his inventive career at that time. At any rate, he became interested in the South Durham coal trade and, apart from one short period of locomotive-building activity, in which he designed an improved loco, the "Tyneside," for a Durham colliery railway, he remained content to leave to others the task of developing and improving the steam locomotive so that it could be adapted to regular and serviceable passenger traffic.



The earliest form of truck haulage was done by horses which pulled a truck along a wooden-railed tramway.

Smooth-Rail Locomotive

It is significant, however, that after Hedley's "Puffing Billy" had demonstrated the essential soundness of the smooth-rail locomotive, no other loco constructors and inventors went back to the old absurd and unnecessarily complicated rack-geared engines. Hedley, by showing and insisting upon the simplicity and superiority of the smooth-rail loco track, is virtually the father of our modern railroad system, or, as we might say, the "man who put the rails in the railway."

By his work in connection with the expanding coal trade of the North, Hedley gained a position of affluence. He died at his residence, Burnhopeside Hall, near Lanchester, on January 9th, 1843, in his sixty-fifth year, and, as a sort of lasting commentary upon his exceedingly active and useful life, his remains were buried in a churchyard close by which passed the old Wylam waggon-way which had brought into being "Puffing Billy" and which had contributed so greatly to the universal adoption of the smooth-rail loco track.

"MOTILUS" PEEPS INTO THE MODEL WORLD

Our Model Fan — at Home Again—has been on the War Path among English Enthusiasts. Here are the Items he has Snapped with his Camera this Month!

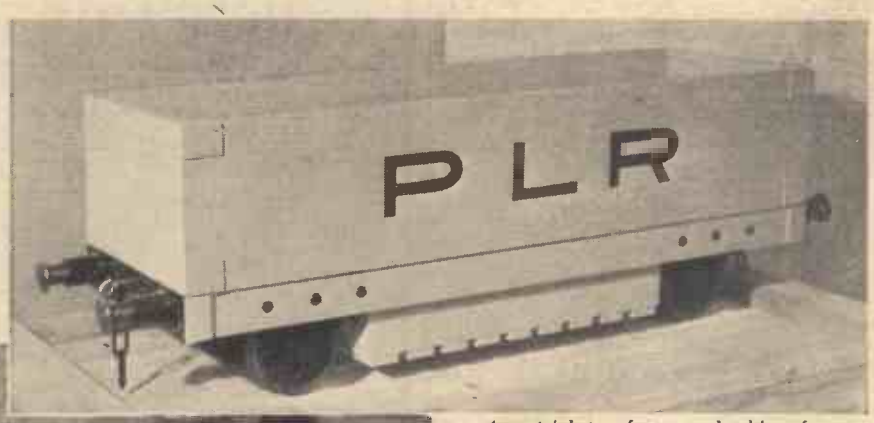
Interested spectators round the Trix Twin Railway stand at the recent Model Railway Exhibition.

NO one, however slightly interested in model railways, could miss the Annual Model Railway Club Exhibition which is held every year in Easter week at the Central Hall, Westminster. This April it was as crowded as ever, despite the counter-attraction of beautiful weather for out of door pursuits. One of the features of the exhibition was the excellent display case arranged by Captain Sir Francis Leyland Barratt, Bart, for the G.W.R. exhibit. This consisted of a double-sided, glass-framed case, in the foreground of our picture, floodlit from the top, with suitable ventilation. This gave all the models an added finish, and at the same time prevented them getting dusty, or damaged from the fingers of inquisitive juveniles!

Mills Brothers were there, and practically opposite them was the Trix Twin Train Table Railway stand, whose excellent layout drew crowds to watch the intricacies of auto-uncoupling devices, working crossing gates, etc. In fact it was a strong competitor with the cinema, and the real railway rides behind the locomotives on the passenger-carrying track. Bassett-Lowke of Northampton were not showing many of their high-class productions, but had devoted the space allotted them to bargains from their stock-taking sale, with the object of giving those who had not a large amount to spend, the chance of starting a good railway at a low cost. Judging from the crowd around, a brisk business was being done.

Collector of Early Models

One of my American friends in New York is a keen collector of early models of every make—American, British, German, French. He has a wonderful selection of old Bing, Marklin and Carette models, and here is his picture of one of the early Ives gauge "O" electric locomotives. This type of model had a cast-iron body (generally cast in two halves), a method with some advantages, but with the one great disadvantage of its weight. This method has been superceded on the modern small-gauge engine of to-day by pressure die castings, which give finer detail and also weigh less. The model in this picture is particularly interesting, in view of the fact that it is one of only three gauge "O" models of this type specially plated in copper. The famous Major Segrave had one, in fact the train itself was named "Major H. O. D. Segrave Special Delux."



A special design of wagon ordered by a famous Indian prince.

A model of the new "Mauretania" under construction.

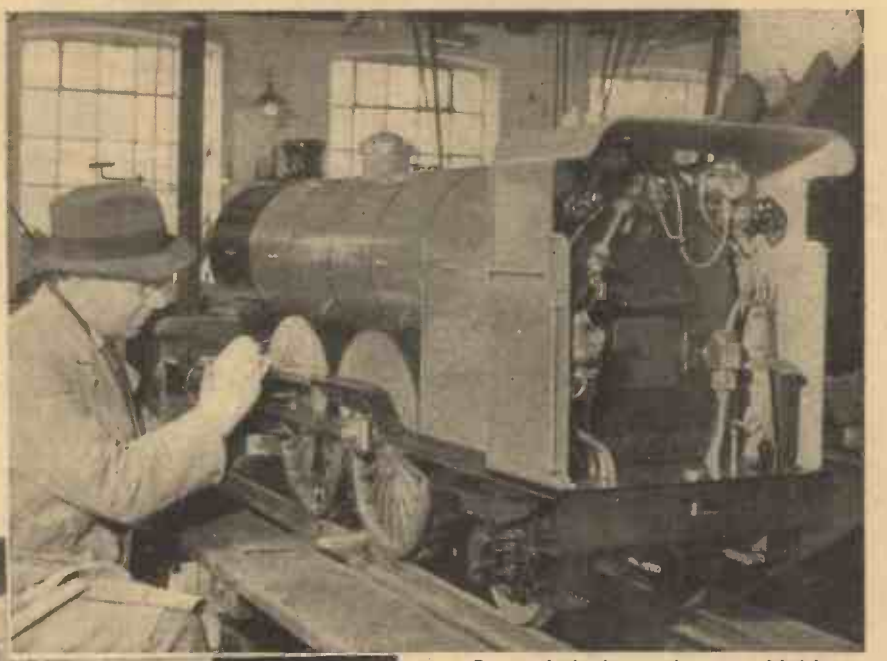
The New "Mauretania"

The new *Mauretania*—latest addition to the Cunard-White Star fleet, which makes her maiden voyage from Liverpool on June 17, is now fitting out with all speed at the yard of Messrs. Cammell Laird of Birkenhead. Here you see a model of her also

"fitting out." This model, which has just been completed, and is now in the Entrance Hall of the builder's offices at Birkenhead, has been built to a scale of 3/16 of an inch to the foot. She has an overall length of 12 feet and therefore is approximately 1/72nd the size of the actual ship. Do you like her as well as the famous old *Maure*? She will find her predecessor's record hard to beat.

A Garden Railway

The 9½-inch gauge Garden Railway is a leader in popularity for passenger carrying, where a fair load of passengers is to be hauled. Here is one of two L.N.E.R. Atlantics being completed in a high-pressure steam and locomotive workshop at Northampton for a famous Indian prince. This rajah is already owner of a considerable length of 9½-inch gauge railway track, and has had an L.N.E.R. Atlantic, Northampton made, for the past seven or eight years. These new Atlantics, however, are the latest pattern fitted with vacuum brakes, four-speed lubricator and two safety valves. They are built to traverse 60-feet curves. With the locomotives came an order for a special design of wagon with a well in the centre so that the passengers, in twos, could be seated with reasonable comfort.



Putting the finishing touches to a model Atlantic L.N.E.R. engine.

A section of the Trix Twin layout at the 1939 B.I.F.

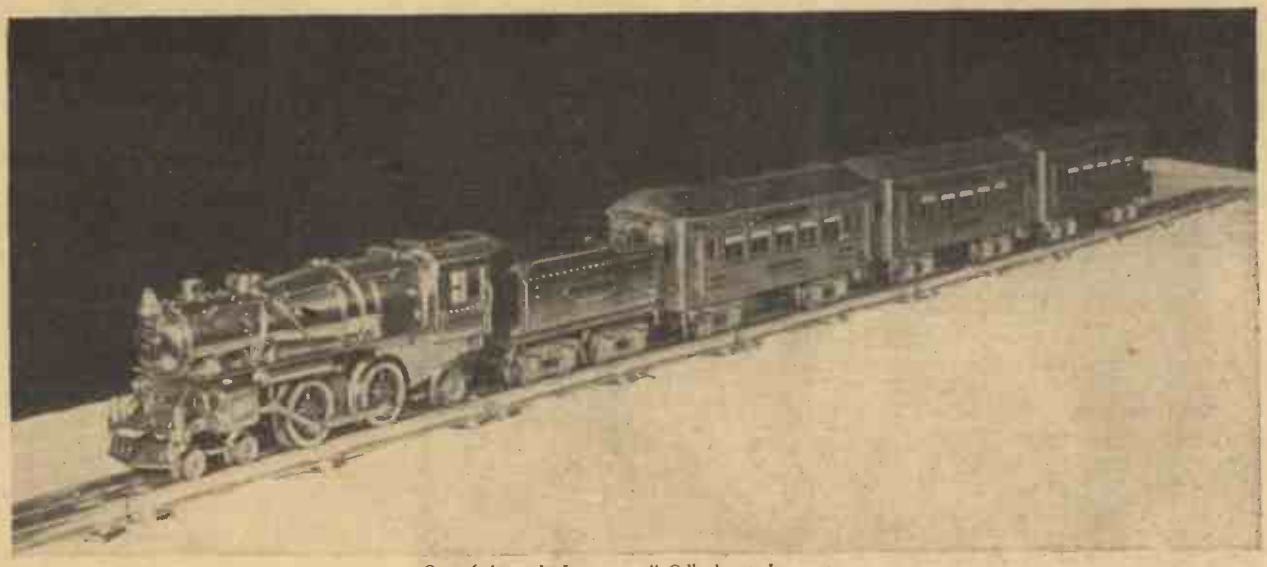
Coronation Train

I heard recently that the Duke of Kent has accepted on behalf of his son, Prince Edward of Kent, an electrically driven model of the L.M.S. streamlined Coronation train. This was the work of Bassett-Lowke, Ltd., of Northampton, and special permission was obtained from His Royal Highness and from the L.M.S. to name the model engine "Prince Edward," and the railway company granted the engine a special number, No. 6235, which has not yet been used by any locomotive on the company's service.

The train—seven feet long, with four coaches—was housed in a special presentation cabinet, and handed to the Duke of Kent by Brigadier General R. F. Legge, chairman of the British Electrical Development Association's annual luncheon at Grosvenor House. Its scale size is proportionately 5/16th of an inch to the foot, and its full speed is equivalent to 120 m.p.h. on the part of the actual train.

Model "Coronation Scot"

Here is a crowd at the B.I.F. admiring the Twin Trains. Following on the news in the April issue, I am informed that the "Coronation Scot"—an exact replica of the locomotive now in America with its headlight—is actually to be produced. The details are gathered together and the dies are practically ready, and production will be starting in a few weeks. Further details of this, however, I hope to let you know in about three months' time, so do not bombard me with queries till then!



One of the early Ives gauge "O" electric locomotives.

QUERIES and ENQUIRIES

A stamped addressed envelope, three penny stamps, and the query coupon from the current issue, which appears on page 504, must be enclosed with every letter containing a query. Every query and drawing which is sent must bear the name and address of the sender. Send your queries to the Editor, PRACTICAL MECHANICS, Geo. Newnes, Ltd., Tower House, Southampton Street, Strand, London, W.C.2.

CHEMISTRY

MAKING A BAROMETER

"I AM making a barometer, but find that the tube has a number of specks of dirt inside it. Can you tell me the best method of cleaning the tube and also how to fill it with mercury?" J. W. (Hunstanton).

ON no account should you use methylated spirit for cleaning a barometer tube, since the spirit contains various impurities which will cling tenaciously to the inner walls of the tube. Ether is the most suitable liquid for barometer tube cleaning, but it must be used with great care in view of its extreme inflammability.

As a matter of fact, however, if your barometer tube has been purchased in the new condition, it should be perfectly clean inside. If not, it should be returned to the suppliers for replacement. It is very possible that the specks you mention are actually embedded in the glass, in which case, they will do no harm.

The method of filling the barometer described in the "Practical Mechanics" issue for March, 1937, is the best for amateur purposes and its efficiency has been proved. Other methods comprise heating the entire barometer tube in a sandbath and filling it with mercury whilst in a heated condition. As the tube cools, the mercury is forced into it by atmospheric pressure.

You will find the filling method described in the "Practical Mechanics" article quite satisfactory. Be careful to have all materials and appliances scrupulously clean in order that perfectly clean mercury is introduced into a perfectly clean tube. This is the one secret of successful barometer-making and you will find that the barometer you make will be actually more sensitive than countless of the popular dial barometers which are marketed at the present day.

ACETYL-CHOLINE

"WHERE can I obtain acetyl-choline and how much an ounce does it cost?" F. P. (London, S.E.24).

THE catalogues which we have consulted do not list acetyl-choline, but you will probably be able to obtain small quantities of this material from Boots Pure Drug Company (Research Chemicals Department), Nottingham. The British Drug-houses, Ltd., Graham Street, City Road, London, N.1, will supply through your local druggist acetyl-choline-bromide and acetyl-choline-iodide, and the prices are 2s. 6d. and 2s. 10d. respectively per one gram.

CHLOROSULPHONIC ACID

"CAN you tell me how to make chlorosulphonic acid?" A. L. (Bristol).

CHLOROSULPHONIC ACID, $So_2Cl(OH)$, is prepared by passing dry hydrochloric acid gas over sulphur trioxide, or by distilling a mixture of phosphorus pentachloride or phosphorus oxychloride with concentrated sulphuric acid. It is an almost colourless liquid, boiling at 155° C.

ALUMINIUM COMPOUNDS

"HOW many chemical products are obtained from aluminium? Can you recommend any books dealing with the subject of aluminium compounds?" C. M. (Wimbledon).

THERE are several thousand distinctive products which can be obtained from aluminium. Hence it is not within the bounds of possibility for us to enumerate them here. If, however, you would give us some indication of the exact type of aluminium compounds which you desire information on, we should be very pleased to assist you.

There is, also, no single book dealing with all the possible products of aluminium. A comprehensive work on the subject, however, is Edwards, Frary and Jeffries' "Aluminium, Its Production and Products." This is an expensive two-volume work, published at 60s. You may, however, be able to refer to it at your nearest Technical Library.

For merely general information on the subject of Aluminium, you should apply to the British Aluminium Company, Ltd., King William Street, London, E.C.4, which will provide you, free of charge, with copies of literature on the subject of aluminium and its commercial applications.

A "FROG" BAROMETER

"WHERE can I obtain a frog barometer, and what is their approximate cost? Also can you explain their method of working?" J. T. (Carmarthenshire).

WHAT you term a "frog barometer" is, if we understand your description rightly, obtainable from Messrs. W. Watson & Sons, Ltd., High Holborn, London, W.C., price about 8s. 6d. It is really a hygrometer, for it measures the humidity or water-content of the atmosphere, and it operates in virtue of the condensation of water vapour inside a tube, this condensation taking place under the cooling influence of the evaporation of water around the tube. The rate of the evaporation of the water is governed by the humidity or water-content of the atmosphere and thus, to some extent, the instrument may be used as a true barometer.

LIGHT-MATCH MATERIAL

"WHAT substance is employed in the manufacture of a million-light match and is it a British product?" L. S. (Grimsby).

THE light-match material which you mention is composed mainly of a mixture of red phosphorus and antimony sulphide with various admixtures of potassium perchlorate. It is a foreign product and has not had widespread use in this country

FINISH ON PLASTER

"I WISH to make a varnish capable of producing a transparent glossy surface on plaster. It must also be washable and capable of withstanding a certain amount of heat." C. O. (Guernsey).

DISSOLVE perfectly clear scrap celluloid in a mixture of equal parts of acetone and amyl acetate, shaking the mixture well until it has the consistency of thin syrup. This lacquer when painted over any surface will give a shiny finish and it is reasonably permanent. It will stand up to gentle washing and to considerable amounts of heat.

You can obtain the above-mentioned liquids from any firm of chemical suppliers, as, for instance, Messrs. Harrington Bros. Ltd., 53 City Road, London, E.C.1.

Ordinary painter's varnish might also suit your purpose. When painted on in a thin layer, and allowed to dry thoroughly, it will give a perfectly hard, transparent, glossy and enduring film.

PHOTOGRAPHIC DESENSITISER

"CAN you suggest a chemical or formula which would be suitable for desensitising photographic plates or films in order to develop them by candlelight?" B. L. (Nr.. Wakefield).

AN excellent photographic desensitiser is Pinakryptol Green, a dyestuff, which can be obtained, price about 3s. per gram, from Agfa, Ltd., Queen Street Place, London, E.C.4. A solution of this dye containing 1 part of the dyestuff in 5,000 parts of water, completely desensitises a photographic emulsion in two minutes.

Messrs. Ilford, Ltd., Ilford, London, also supply a good photographic desensitiser which is termed "Desensitol."

BLUEPRINTS

"I HAVE to colour a number of blueprints. Being interested in the experiment side of chemistry, I want to make four blue print corrector solutions. The colours of the correctors I need are white, red, yellow and brown." F. S. (Lewisham, S.E.13).

WE are not clear as to the meaning of your term "corrector solution." If you refer to a solution which will change the colour of a blueprint, you would find no such solution satisfactory, since an ordinary photographic blueprint cannot be interfered with chemically.

If you wish to make coloured markings on a blueprint you will find ordinary watercolours the best. These are the easiest applied, they will not affect the stability of the blueprint and they can always be washed off when required.

ELECTRICAL

"JAMMING" NERVE IMPULSES

"I HAVE heard that there is a method of 'jamming' nerve impulses by using rays of varying frequencies. Is this accomplished by wireless or light waves, and can I obtain a book on this subject?" A. S. (Liverpool).

EXPERIMENTS on nerve impulses have, of recent times, been proceeding in the direction of applying cathode and radium rays (not wireless waves) to nerve channels. Information on this subject has not yet reached the stage of book form, but may be found in the various Journals of Physiology, to be consulted in most public technical libraries.

INFRA-RED RAYS

"IS there any substance which, when a large current of electricity is passed through it, will give off large amounts of

infra-red or ultra-violet rays." D. Y. (Walsall).

WHEN a current of electricity passes through a wire so as to heat it to redness, the wire evolves infra-red rays, mixed, of course, with visible red rays. Similarly, an electric current passing through mercury vapour and other materials as, for example, in the various types of electric discharge lamps, produces light which is very rich in ultra-violet rays. A carbon arc produced between two tungsten-cored carbons also produces a light rich in ultra-violet rays.

FORCING SEEDS

"HOW can I make an electrically heated raising box for seeds? The size of the box is 18in. x 14in. x 7in. I enclose a suggested wiring plan."

THE wire used is of special make by Messrs. Callender Cable Co., Hamilton House, Victoria Embankment, London, E.C.4. Ordinary wire cannot be used because it must be buried in the soil. A thermostat is necessary in order to cut off the current when the soil gets too hot, but you could do without this if the heater is arranged so that it is impossible for the temperature to rise too high.

ELECTRIC CLOCK

"I HAVE made an electric clock, but find that since it has been installed it gains considerably. I found that by timing the second reduction gear spindle that the motor was running at approximately 390 r.p.m. instead of 375 r.p.m. A. C. (Oxford).

YOU have not told us the voltage and frequency of your supply, which is a very important point. You will probably find that your frequency differs from that quoted, hence the result. This, by the way, once the motor has been run in, can be the only fault with the clock.

As you are not used to electrical calculations we advise you to count the poles on a commercial clock and compare with yours.

ULTRA-VIOLET RAY LAMP

"I DESIRE to construct a carbon arc ultra-violet ray lamp, and should be grateful for any advice you can offer on the matter. At present I am experimenting with one iron core and one solid carbon (¼in. dia.) connected to 230 volt A.C. mains with a 1 k.w. fire in series. This produces quite a brilliant arc with a gap of about ½ in. Is this apparatus producing U.V. rays in sufficient quantities to be beneficial?"

MUCH has been written on U.V. light and a visit to your local reference library will help you. You should look up the Medical section.

Keep the carbon arc at the white light as this is the most efficient. You have, with the fire, quite a good combination because of the emission of infra-red rays. There is no simple method of measuring the U.V. output, but you can obtain a rough estimate by comparing the length of time required to darken a strip of photographic paper in the light from the arc and in direct sunlight.

K. Billington (Birmingham).

WE cannot do better than advise you to purchase an elementary text-book dealing with electricity. You will find these elementary matters dealt with in F. J. Camm's "Workshop Calculations, Tables and Formulae." We are sure that if you study this you will understand the elementary points involved.

PATENT ADVICE

TYPEWRITER ERASER

"CAN you tell me if there is any chemical which will remove typewriting ink from paper without defacing the document? I think there should be a market for an article of this kind to supersede the ugly scratches caused by the usual rubber, and if possible I should like to market it." J. M. (S.W.12).

IF the typewritten characters are written in black ink, nothing will remove the ink without defacing the surface of the paper, for the basis of black typewriter inks is carbon, a material which, as you are probably aware, cannot be dissolved by any practical means. Coloured typewriter inks usually owe their hue to the presence of an aniline dye. Such inks may often be removed by wiping over them a strong solution of bleaching powder made slightly acid or, better still, by dabbing the written characters with a solution of sodium *hydro*-sulphite. Note that this latter material is not sodium hyposulphite, which is the name usually applied to the photographer's fixing salt, hypo.

Until you can find an effective solvent for carbon it is useless hoping to prepare an efficient ink-remover for ordinary black typewriter inks. The only solvent for carbon is molten cast iron—a material which could not very well be applied to paper!

TOOTHPASTE TUBE CAP

"I HAVE invented a new form of tooth-paste tube cap, and wondered if it formed fit subject-matter for a patent." J. M. (Widnes).

THE proposed means for closing the orifices of collapsible containers for toothpaste is not thought to be novel. The broad idea of applying a perforated slide to move across the passage of a container to control the distribution of the contents of the container is already well known, and has been extensively used for powder containers.

It is not known whether the particular arrangement has been applied to tooth-paste tubes, but in view of analogous uses it is not thought to contain sufficient subject matter or invention to support a valid patent. It is not considered that the idea has any commercial value, or worth the expense of patenting.

AN INGENIOUS CIGARETTE

"I HAVE devised a cigarette incorporating a match head in the end, in such a way that all dangerous fumes are prevented from entering the mouth of the smoker. Is it novel?" A. R. (Wellington, W.1).

THE broad idea of attaching a match composition to the end of a cigarette is quite old. It has been proposed and patented many times within the last fifty years. It is, of course, possible that the particular construction employed by you is novel, and capable of being validly patented, but even so it is thought that it has no possibility of being made a commercial success. In the first place, whatever igniting composition is employed it must deleteriously affect the flavour of the cigarette, which is probably the main reason why previous attempts have never been successfully employed.

Secondly, cigarette manufacturers employing the invention, not being match manufacturers, would have to have a separate factory for their manufacture, since the manufacture of matches is strictly controlled under the Factories Acts.

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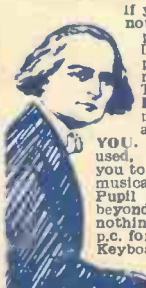

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