IS THERE A FOURTH DIMENSION?

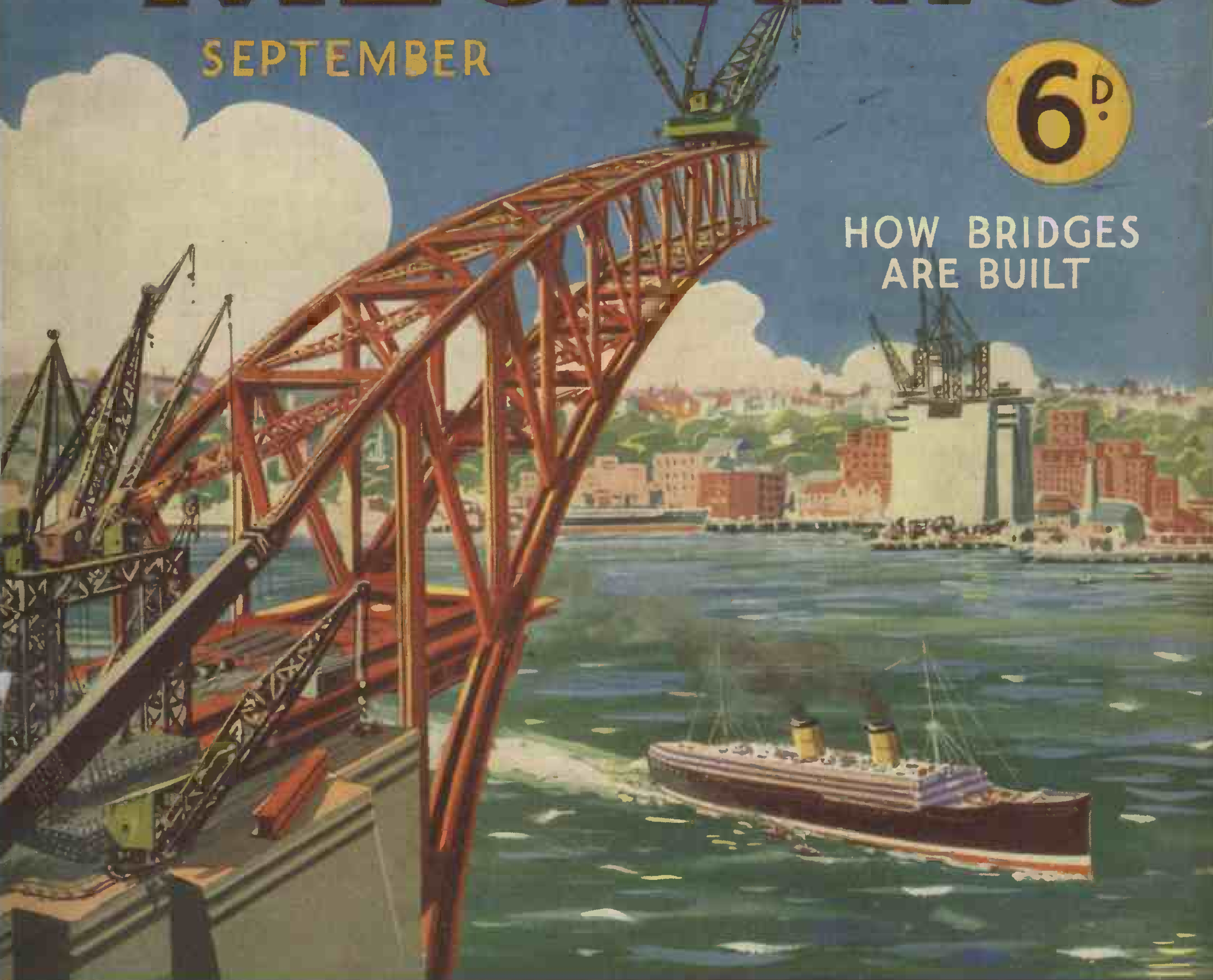
NEWNES

PRACTICAL MECHANICS

SEPTEMBER

6D.

HOW BRIDGES ARE BUILT



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Yours sincerely,

J. H. Bennett

Note address carefully:

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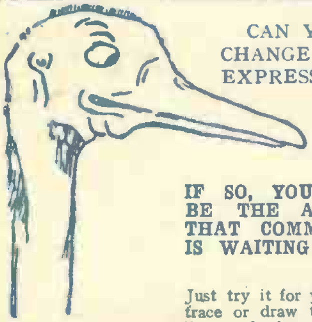

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Notes, News and Views

A New Volume commences Next Month

THIS issue completes Volume I. of PRACTICAL MECHANICS, and an announcement regarding binding cases and index will appear next month. The first milestone is passed, and I am glad to learn from the shoals of enthusiastic letters I regularly receive from readers all over the world that the first stage of our journey has been so pleasant. During that journey we have made pleasant excursions, even though only in print, into the stratosphere, into the fields of aviation, television, radio, mechanics, below the sea with divers, and we have dallied to study rays, to make models, to examine novelties, and to read about the latest scientific endeavours. The second stage of our journey will be even more interesting than the last. Make quite sure that you miss none of the sideshows, by ordering PRACTICAL MECHANICS to be delivered regularly to your home.

Our New Companion Journal "Practical Television"

THE growing interest in television—the missing link to complete home radio entertainment—is indicated by the volume of correspondence we regularly receive from readers on this intriguing and fascinating new science. Our readers, therefore, will be interested to learn that Messrs. Geo. Newnes Ltd. (Publishers of PRACTICAL MECHANICS) have just published No. 1 of our companion journal, *Practical Television*, which is obtainable from all newsagents for 6*d*. The first issue contains instructions for Building a Simple Disc Visor, How to Make Synchronising Gear, Television Simply Explained, Telenews and Televiews, Building up the Picture, The Cathode Ray Oscillograph, Scanning Systems, Will my Set Operate a Television Receiver? Receiving Sound and Vision, Teletips, and many other important articles on this new subject. Purchase a copy to-day—unless the issue is already sold out!

A Mammoth Oil Engine-driven Alternator

A HUGE generator recently put into operation at the Copenhagen Electricity works is driven by a two-stroke double-acting oil engine having eight cylinders. The cylinders, which have a bore of 33 in. and a stroke of no less than 5 ft. 11 in., develop 20,400 b.h.p. The engine is started by compressed air, which is supplied by a separate compressed air plant. The length of the engine is 66 ft., the height 40 ft., and the breadth over 27 ft. Its total weight is approximately 1,200 tons.

The 50-cycle alternator is designed for a continuous output of 19,000 K.V.A., the stator being wound for 6,600 volts. To give an indication of the immense size of this machine, the total height of the alternator, measured from the engine room floor, is 18 ft., and it projects 16 ft. 6 in. below the floor. Its total weight is 187 tons.

Germany's New Airship

ACCORDING to a recent report, the new Zeppelin "L.Z.129," which is nearing completion in Germany, will be slightly longer than the American airship "Macon," which is at present the largest airship in the world. She will have a gas capacity of over 7,000,000 cub. ft., and will be propelled by engines of 4,400 h.p. Accommodation will be provided for fifty passengers, a crew of thirty-five, and 10 tons of freight.

THE MONTH'S SCIENCE SIFTINGS

According to a recent report, a telescope which is claimed to be the largest in the British Empire is to be installed at the new Dunlop Observatory in Toronto. The telescope has a 74-in. reflector and in all weighs about 50 tons.

A new world long-distance gliding record of 233 miles was recently established by Heini Dittmar. He started from the summit of the Rhoen Mountains and landed at Likkau, in Czecho-Slovakia. The flight took six hours twenty-five minutes.

An oil well has been drilled to the record depth of 11,377 ft. in the San Joaquin Valley, California.

All kinds of articles from toys to electric cables will be manufactured in a rubber factory which is now being constructed at Trivandrum, Southern India.

One of the four propellers for the new Cunarder has just been shipped from London. Each of the propellers weighs about 35 tons.

The latest addition to the Japanese Navy is a midget submarine, only 29 ft. long, and which can be hoisted on board a large warship. The boat is electrically driven, current being supplied by accumulators. She is armed with a single torpedo tube and a machine gun, and is manned by a crew of four.

New Streamlined Locomotive

WHAT is claimed to be the most powerful express passenger locomotive in Great Britain was recently completed at the Doncaster works of the London and North Eastern Railway. The new locomotive is of the 2—8—2 Mikado type, its eight coupled driving wheels being 6 ft. 2 in. in diameter. A large boiler, working at a pressure of 220 lb. per square inch, supplies three cylinders fitted with poppet valves. Two chimneys are fitted on this huge locomotive, and, as no steam dome is visible, the streamline effect of the boiler is unbroken. The engine is named "Cock o' the North."

India's New Dam

THE Mettur Canvery dam, said to be one of the largest in the world, has just been completed. It is situated about 230 miles from Madras, and has taken ten years to build. Three million tons of concrete have been used in constructing the dam, which is a mile long, and impounds an artificial lake containing 94,000 million cubic feet of water. The stone crushers used for crushing the granite for the concrete aggregate, which are the largest machines of this kind ever built in this country, were constructed by Messrs. Hadfield Ltd., of Sheffield. These huge "jaw-breakers," which break up the crude stone into 6-in. lumps at the rate of 200 tons of stone an hour, weigh about 100 tons each, and were used to feed the smaller jaw crushers.

Britain's Latest Flying Boat

THE second largest flying boat ever put into service has been designed by the Blackburn Aeroplane Co. Accommodation will be provided for fifty passengers, and it will be fitted with six engines of about 650 h.p. The machine will be a high-wing monoplane, four of the engines will be housed in the leading edge of the wing, and the other two in the trailing edge. Designed for speed and great range, it is intended for trans-ocean mail and passenger services.

Coloured X-Rays

AN Armenian scientist, Mr. Luther Simjiam, has perfected an apparatus which enables variations of the density of the body structure to be seen, not in the usual X-ray grey tones, but in contrasting colours. The apparatus embodies the X-ray fluoroscope and the photo-electric cell used in television. The operator can intensify any of the colours as desired, thus permitting particular organs to be shown up in sharper relief. The apparatus makes use of X-rays of weaker intensity than is customary, and the patient may therefore be safely subjected to longer periods of observation.

HOW BRIDGES ARE—

The positions, foundations, design, construction and erection of great bridges of various types are and of exceptional interest, but they have taxed the brains of our best engineers

By R. V. BOUGHTON,

Twickenham Bridge over the Thames, a fine example of a reinforced concrete arch bridge.

UNTIL a few decades ago it was the general policy for engineers to not only design bridges in the most important matters of structural engineering and mechanics, but to design them architecturally, with the consequence that many of our bridges, while being masterpieces of the science of engineering, lack the beauty that only an artistic brain can conceive. It is therefore in the public interest that the promoters of bridge schemes have for some years past recognised the importance of engineers and architects collaborating in the design of many of our bridges, the engineers being responsible for the structural design and safety, and the architects for the beauty. The result of this combination of the best brains is manifested by some of the illustrations shown in this article, where one may wonder at the feats of the engineers and be thrilled by the work of the architects, who have put beauty into great masses of engineering works.

A full appreciation of bridges may be engendered in our minds if we consider contrasts. Many of us gave but little thought when, in our childhood days, we placed a plank across a little stream to provide a safe (and sometimes a most hazardous) crossing, that we were constructing a bridge. It was crude, yet a bridge that was subject to most of the principles that govern the design of our great bridges. To contrast our early efforts at bridge-making but few of us connected our thoughts of that single plank with such bridges as our Forth Bridge, with each of the two main spans 1,710 ft. long and a total length of 5,330 ft., or with the Sydney Harbour Bridge, Australia, designed and constructed by British engineers, with the largest "arch" span in the world of 1,650 ft.

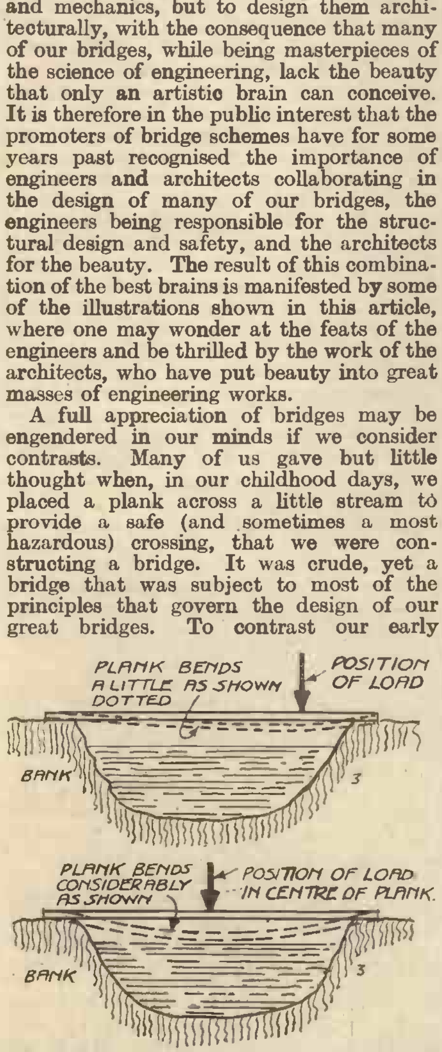


Fig. 3.—As the load is applied near the bearing the plank begins to bend or deflect. When it is in the centre the plank bends considerably.

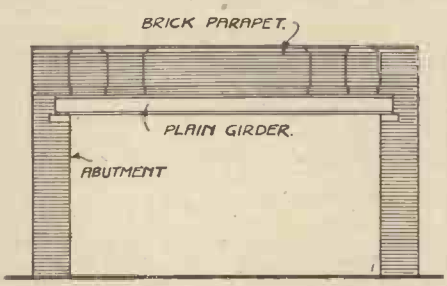


Fig. 1.—A simple form of bridge with a plain girder supporting a parapet wall.

Many Types of Bridges

There are many types of bridges that necessitate different principles being adopted, not only in their structural design, but in their erection, the latter often presenting difficulties that force the use of certain design principles that prohibit any, or but little, scope for the architect to beautify. The general types of bridges are: (1) plain and compound or plate girder, (2) framed girder, (3) brick or masonry arched, (4) steel framed arched, (5) cantilever, (6) suspension, (7) reinforced concrete girder or beam, (8) reinforced concrete arch, and (9) combination of some of the above principles. There are types of opening bridges, such as swing, bascule, rolling, vertical lift and transporter, which, however, cannot be dealt with in this article. Types (1) to (9) will now be explained.

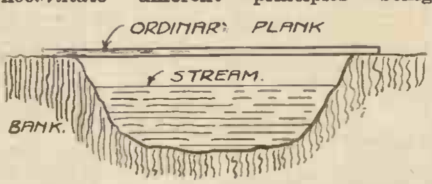


Fig. 2.—An ordinary deal plank placed across a stream illustrates some of the principles of our great bridges.

Plain and Compound or Plate Girder Bridges

These simplest types of bridges, which are much like that little plank before described, allows the simple explanation of the fundamental principles that govern their design and erection. Fig. 1 depicts an elevation of a small bridge with a plain girder on each side which supports the floor and a light parapet wall. Fig. 2 is our little friend, the plank bridge over the stream, and we will confine our minds to it for a while. As we rather gingerly put one foot on the plank, we were relieved to note that it felt firm under the load; as we progressed a little further towards the centre of the plank it was noticed that it commenced to bend or deflect under the load; as we stood in the centre of the span it bent very considerably and thoughts of collapse and a good wetting entered the mind. The bending under the two positions of the load of the

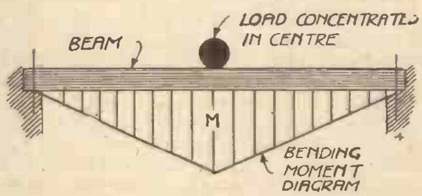


Fig. 4.—A beam with a load concentrated in the centre produces the maximum bending stress at the centre, the stresses reducing as the bearings are neared, as shown by the vertical ordinates of the bending moment diagram.

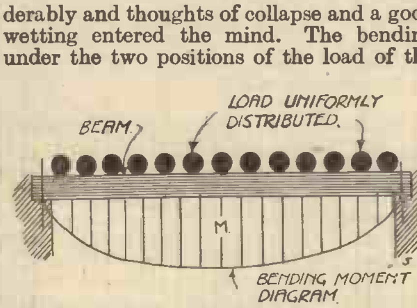
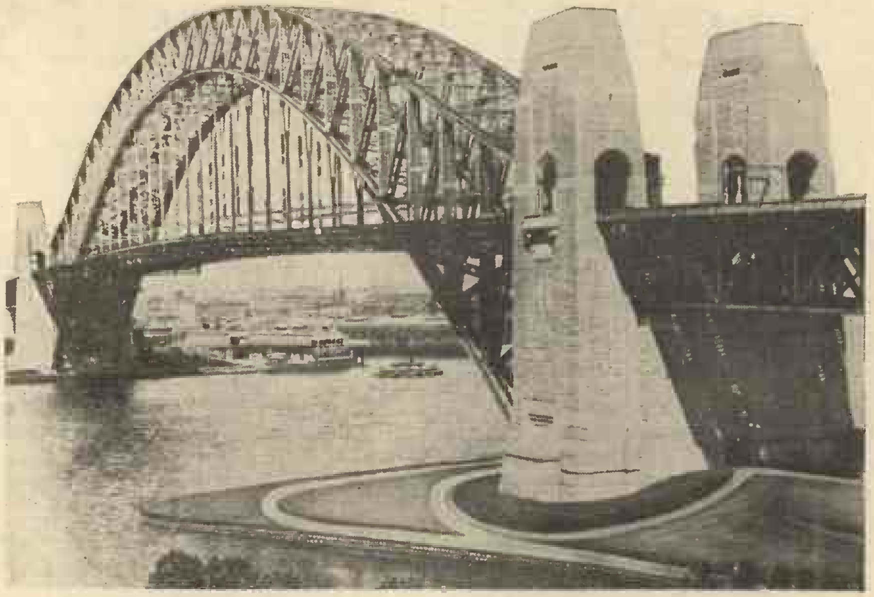


Fig. 5.—Loads evenly distributed along a beam produce bending stresses of values represented by the vertical ordinates of the bending moment diagram which is bounded by the beam and the parabolic curve.

—BUILT

subjects not only of importance for many generations.

A.I.Struct.E.



The Sydney Harbour Bridge with a span of 1,650 ft., the largest arched bridge in the world.

body are diagrammatically shown by Fig. 3, and this presents one of the chief principles of structural mechanics, *i.e.*, bending moments, or what may be termed the value of the forces which induce bending. By the fact that the plank bends most when the load is in the centre proves that the greatest stresses are induced, and the greatest strains are produced, *in the centre of the span.* It must be understood that a stress is a force that produces a strain. As the load becomes further away from the centre and nearer one of the supports, the strain on the plank is reduced. It should be manifest that to resist these stresses in a beam there should be a force in the beam itself that will safely resist them. This force is known as the moment of resistance, and to provide equilibrium it should at least equal the bending moment. The value of the stress, or the bending moment, in any part of a beam that is subject to various loadings is easily calculated either mathematically or by what is known as a stress diagram. If Figs. 4 and 5 are studied they will very simply explain the reason why a compound or plate girder, as shown by Fig. 6, has much more steel in the form of plates at the top and bottom at and near the centre. Fig. 4 depicts a concentrated load in the centre of the beam, such as a person in the centre of a plank, and the bending moments at various parts of the beam are equal to the value represented by the lengths of the vertical lines or ordinates. The maximum bending moment occurs at the centre and is represented by the line marked M. It is important to understand that a uniformly distributed load produces stresses the value of which are represented by the ordinates shown by Fig. 5, the curve being parabolic. Before another interesting matter is explained, it is necessary to state that shearing stresses have to be seriously considered by engineers. Vertical shearing is the action of one part of a material tending to slide or shear off the part immediately adjoining it, as is shown by Fig. 7. The maximum shearing stress occurs near the supports of a beam, and for the purposes of this article may be said to be *nil* at the centre of the span.

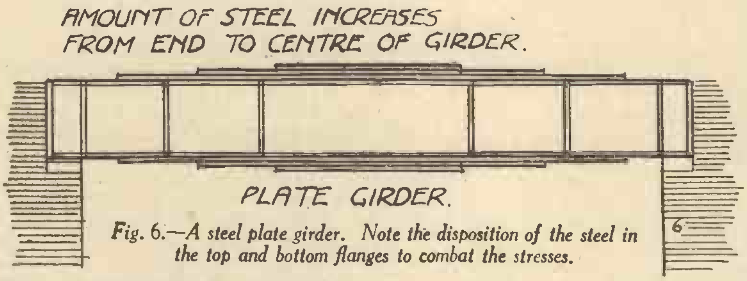


Fig. 6.—A steel plate girder. Note the disposition of the steel in the top and bottom flanges to combat the stresses.

Now we will explain why engineers, for the sake of economy, endeavour to make girder bridges as high as possible, and to do this we will show two small plank bridges, again to bridge our little stream, and each of these bridges will have exactly the same amount of material, yet the scientific arrangement of one will provide a bridge that is 4½ times as strong as the other! Fig. 8 shows the weaker arrangement with the 9 × 2-in. planks laid flat as girders, and which will bend or deflect very considerably when people walk over it. Fig. 9 shows the planks laid on edge, providing a much greater strength.

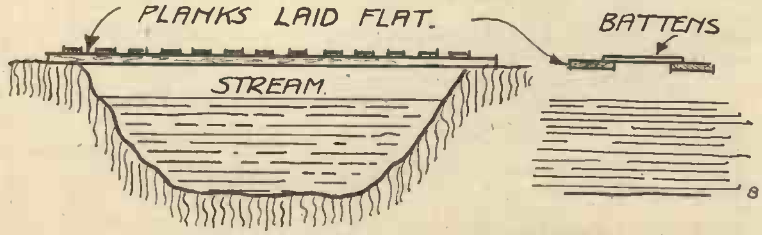


Fig. 8.—The simple plank bridge over a stream with the planks laid flat, which is constructionally weak.

Fig. 10 depicts a compound girder bridge that carries a railway over a street, and the supports are brick abutments. The girders would be placed in position by hoisting or by rolling into position with the aid of temporary supports from the street.

Fig. 10.—A large plate girder carrying a railway over the Sutton By-pass.

Framed Girder Bridges

This type of bridge is used for great spans over valleys or rivers for roads or railways, or both. Fig. 11 shows one of many arrangements of the various members, and a study of the principles of the stresses in them, their construction and erection, is not only of great interest, but makes the more complicated types of bridges more easily understood. Referring again to Fig. 9, it may be stated that the tendency for the 9 × 2-in. plank to bend causes the fibres in the top to be compressed and those at the bottom to be in tension. Exactly the same occurs in connection with the top and bottom members of the framed girder, as Fig. 11. The top and bottom booms are in compression and tension respectively. The laws of mechanics of structures show that the greater the distance apart of these booms, the less are the stresses induced in them, and consequently less metal is required in them to resist such stresses, and this is why engineers make the height of this type of bridge as high as possible, subject to certain limitations regulated by conditions which are a little too complicated to explain in this article.

Fig. 12 indicates the approximate varying amounts of the stresses in the various members by means of thicknesses of the lines, the thicker the line the greater the stress. The solid lines are compression and dotted lines tension members. There is, theoretically, no stress in the centre member shown by the long dotted line. Fig. 13 is a photographic reproduction of a framed

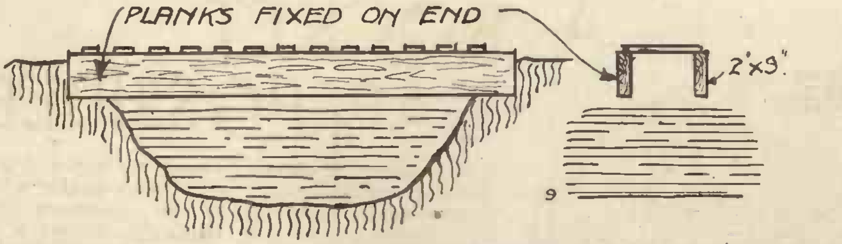


Fig. 9.—Exactly the same quantity of timber is used in this little bridge as that shown by Fig. 8, but the planks are laid on end. With 2-in. × 9-in. planks this bridge is four and a half times stronger than if planks were laid flat.

girder bridge. The methods of erection of this type of bridge, as well as others, will be dealt with under a following heading.

Brick or Masonry Arched Bridges

These are a very common form of bridge and are used for small and great spans, either single or in series as viaducts. Old Waterloo Bridge is one example of an arched masonry bridge, and an interesting article on it appears elsewhere in this issue. There is a rather considerable difference in the principles of arch and beam construction which may be better understood by giving a very simple example. A brick arch over an ordinary window opening is in effect a very small bridge. It will be illustrated next month. The separate wedge-shaped units or voussoirs are kept in position owing to the fact that each of them exerts a lateral pressure on its neighbour, and the stresses are eventually transmitted to the abutments or piers. The sharper the curvature of the arch, the stronger is the arch, provided the depth of the rings are the same. For instance, any arch which is much flatter than another might require two rings to carry the same load as a deep arch would do with one ring.

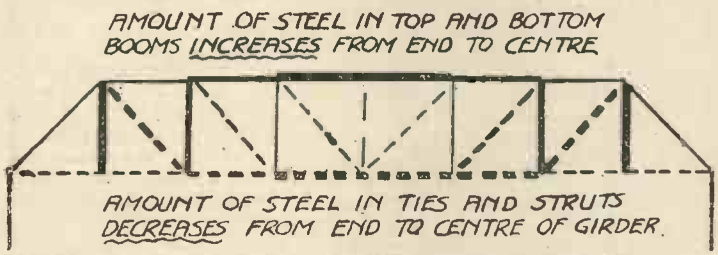


Fig. 12.—An outline of a steel framed girder, showing the compressional members in solid lines and the tensile members dotted. Note the varying amount of steel required in the various members.

Steel Framed Arch Bridges

In this type of bridge (to be dealt with next month) the main stresses being taken by the arched construction from which is suspended members which support the level road or railway. One of the best examples is the Newcastle-on-Tyne Bridge, which has the largest steel arch in Great Britain, constructed in 1925–28 to carry the Great North Road across the Tyne. The length is 1,254 ft. Sydney Harbour Bridge, Australia, was built on this principle, and has the largest arch span in the world of 1,650 ft.

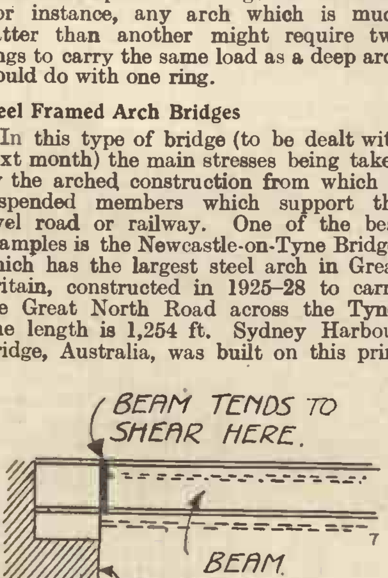


Fig. 7.—This shows how a beam would shear.

Cantilever Bridges

This particular type of bridge must not be confounded with suspension bridges, which may appear to be similar, but are constructed on totally different principles. The principle of cantileverage will be dealt with later. Most of them use ordinary steel girders or rolled steel joists extending or cantilevering over brick piers and the ends of each cantilever supporting a simple beam member. As will be gathered by the description of the erection of bridges, it will be readily understood that the fundamental principle of this type of bridge is to allow the gradual building out of each cantilevered framed part until each meet at the centre, where they are connected together by the suspended span. Great care has to be exercised by the designers to ensure that no collapse shall occur during the erection or building out of the cantilevered parts, and that such parts are well held back or balanced by the projecting arms reaching shorewards and anchored down. An instance of serious disaster is the Quebec Bridge crossing the St. Lawrence River. This bridge had a channel span of 1,800 ft. Twice during its construction it failed, which necessitated changes in the original design. The Forth Bridge is a fine example of a cantilever bridge, the two main spans being each 1,710 ft.

Fig. 13.—The large steel framed girders used for the temporary Waterloo Bridge over the Thames. The bottom booms are hidden by the parapet to the footways.

Suspension Bridges

A good English example is the well-known Chelsea Bridge, over the Thames, The general principle is that steel wire ropes or steel links, or series of them, pass over high towers, forming an exceptionally powerful loop or loops between the towers, such ropes or links being anchored down on the land side of the towers. The platform for the roadway is suspended from the ropes or linked loops by vertical wire ropes or rods. This type of bridge can be used for very large spans.

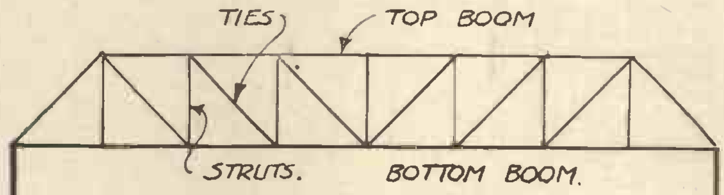


Fig. 11.—An outline of a steel framed girder.

Reinforced Concrete Girder or Beam Bridges

This method of construction is comparatively modern, and is extensively used nowadays, especially for bridges of moderate span As it is of a mass construction composed of concrete cast *in situ* with steel rods incorporated with it, it does not lend itself to such engineering feats as framed steelwork does in allowing erection over great spaces by gradually cantilevering out. Briefly, the principle of reinforced concrete is that concrete is exceptionally strong in compression and very weak in tension, whereas steel, although very strong in compression, is also very strong in tension. Therefore, steel introduced into those parts of a concrete beam which are subject to tensile stresses makes up for the lack of tensile strength in the concrete. The scientific disposition of mass concrete and a little steel results in a method of construction which is exceptionally strong, the steel is protected by the concrete and the whole has a long life and requires but little repairs and practically no decorations.

The photograph shows a rocket car capable of travelling between 80 and 90 m.p.h.

IS A ROCKET CAR POSSIBLE?

The rocket-propelled vehicle has long been a dream of inventors. For ages men have clamoured after a means of locomotion which would do away with gears, pistons, wheel-trains and the like. Hence, from time to time, engineering and mechanical visionaries have toyed with the idea of rocket propulsion as applied to earth-bound vehicles, not only on account of the simplification of mechanism which such a principle of propulsion would involve, but, also, and, perhaps, more particularly, in view of the exceedingly high speeds which any practical system of rocket motive power would bring about.

STRANGELY enough, although the idea of employing the rocket principle as a means of locomotion seems ultra-modern, it constitutes one of the oldest applications of motive power known. The *œolipile*, attributed to Hero of Alexandria about the time B.C. 130, is the first device on record for demonstrating the power of steam. It comprises a hollow metal sphere which is pivoted between two steam pipes rising from a boiler beneath. The steam filling the metal ball makes its escape from two oppositely placed orifices in the latter, thus turning the ball round at high speed.

Now this device is nothing more than the application of the rocket principle, and it was in operation centuries before the principle of the piston was ever dreamt of. In the *œolipile* a gas stream (in the form of hot steam) is forcibly ejected from the metal sphere. Reacting on the surrounding air, the escaping steam tends to push the metal sphere away from it, and in this manner sets up the rotary motion.

A skyrocket functions in precisely the same manner. In this instance, the escaping gas is not hot steam, but expanding gases chemically generated by the combustion of certain materials within the body of the rocket. At the commencement of the rocket's flight the stream of outcoming gases which has been suddenly generated reacts against a very solid base—the ground. This reaction gives motion to the rocket immediately, and the rocket, having once been set in motion, tends to travel upwards in a straight line with steadily increasing motion until the gas stream which it throws out behind it is spent.

Racing Cars

This is the principle which inventors have from time to time endeavoured to apply to the propulsion of cars. Some years ago one or two racing cars in Germany had rocket attachments fitted to them, but these attachments failed to be really practicable.

The actual fitting up of a car with the means of rocket propulsion would not present any formidable difficulty to engineers. The rockets would be electrically fired, and, no doubt, this firing would be carried out automatically. The rockets themselves would be placed in a battery of "firing tubes"—strong steel tubes placed one above the other in horizontal or vertical rows at the back or at the sides of the car. The firing charges of the rockets might easily be manufactured in strengthened cardboard cylinders which would fit in the firing tubes, this construction making for easy replacement of the expended charges. Yes, the construction of an experimental rocket racing car along these lines looks dreadfully simple, but, unfortunately, there are a whole host of objections to be placed against the project. First there is the expense. Well-constructed rockets are not exactly cheap articles, and a battery of twenty or more of these rockets fitted at the rear of the car and lasting, perhaps, from half an hour to an hour in actual use would necessitate an expenditure which would at once preclude such a car from being put to any practical use.

A Disadvantage

Then again there is the fact that rockets are uncontrollable as regards their speed. You may, of course, have rockets containing slow, medium or rapid-burning mixtures, and in this way the average speed of the car throughout its journey could be varied. Nevertheless, so violent is the combustion of the propulsive chemicals contained in a rocket that there would be no means of stopping the action in the event of the driver of the car wanting to slow up.

It has been proposed to get over this difficulty by substituting cylinders of highly compressed air for rockets containing combustible mixtures, the compressed air stream being controllable by means of a valve. This method, however, on the score of expense and in view of the enormous weight of the necessary equipment is obviously impracticable.

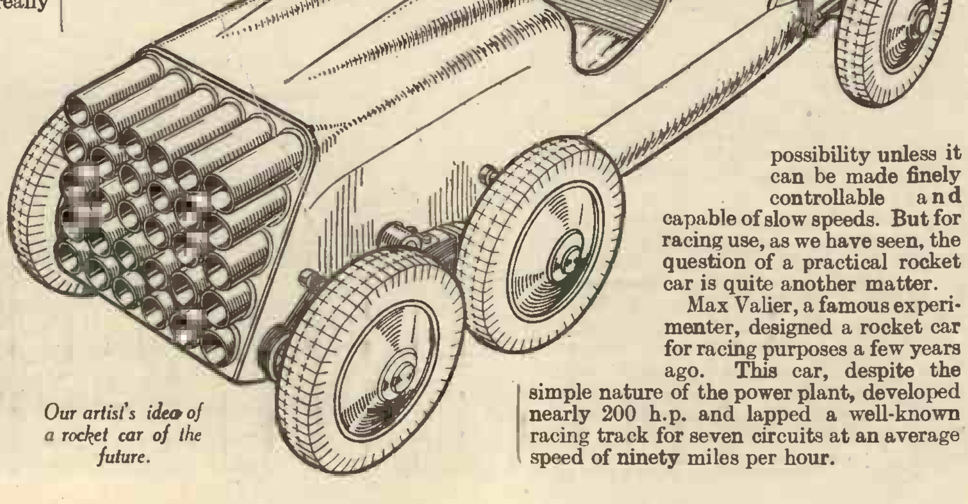
Again, with any car working on the principle of propulsion by means of a stream of escaping gases there must be something substantial behind the car for the gaseous stream to react upon. Otherwise the inertia of the stationary car will tend to overcome the propelling action of the gas stream. In other words, a rocket car would have to be started from a wall or from some other solid object in order that the gas stream from the rocket apparatus could impinge against it and thus give the car the necessary starting push-off. For racing purposes, however, this difficulty would be overcome without much trouble.

Perhaps in the years to come we shall see some form of controlled rocket propulsion applied to racing cars, but, although it is always dangerous to prophesy in this scientific age, it is difficult to see how the system could be applied in practice to ordinary road cars. For one thing, the escaping gases ejected at the rear of the cars would be not only decidedly unpleasant and inconvenient to other road users, but they would be actually noxious. Indeed, the emerging velocity of these gas streams would be so great that men, horses and other comparatively light road objects would be bowled over at once if they happened to cross the path of the ejected gases.

For Ordinary Road use

Then, of course, for ordinary road use a rocket car would have far too great a normal speed for it to be of any practical value. Imagine a rocket car careering at 60 m.p.h. along the main thoroughfare of your busy town. Imagine not one of these cars, but an average "roadful" of them. Bring considerations such as these to your mind and you will see quite clearly why the rocket road car can never become a practical possibility unless it can be made finely controllable and capable of slow speeds. But for racing use, as we have seen, the question of a practical rocket car is quite another matter.

Max Valier, a famous experimenter, designed a rocket car for racing purposes a few years ago. This car, despite the simple nature of the power plant, developed nearly 200 h.p. and lapped a well-known racing track for seven circuits at an average speed of ninety miles per hour.



Our artist's idea of a rocket car of the future.

HOW WATER IS RAISED

A Review of Methods used in Modern

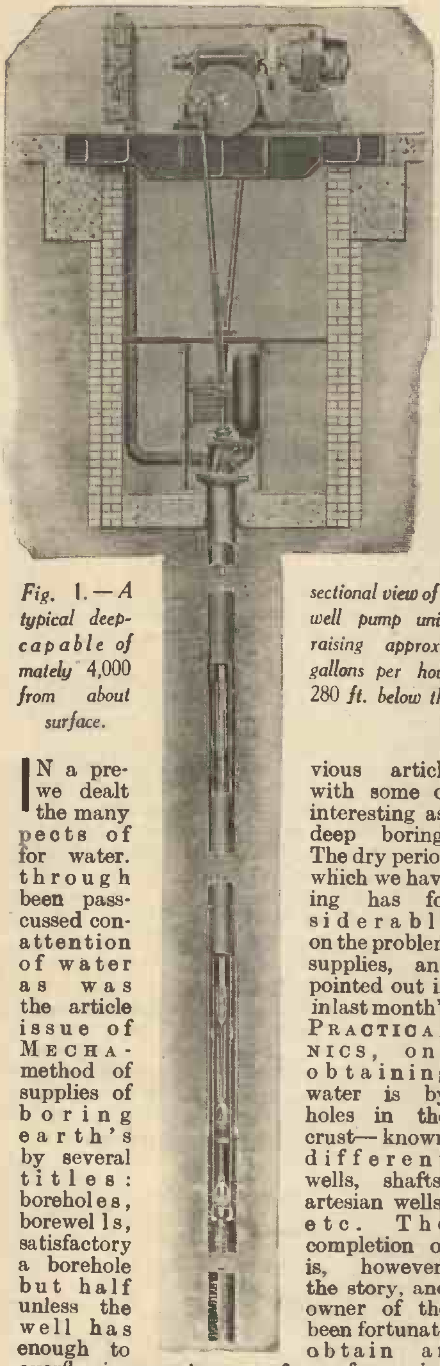


Fig. 1.—A sectional view of a typical deep-well pump unit, capable of raising approximately 4,000 gallons per hour from about 280 ft. below the surface.

In a previous article we dealt with some of the many interesting aspects of deep borings for water. The dry period through which we have been passing has focussed considerable attention on the problem of water supplies, and as was pointed out in the article in last month's issue of PRACTICAL MECHANICS, one method of obtaining supplies of water is by boring holes in the earth's crust—known by several different titles: boreholes, borewells, wells, shafts, artesian wells, etc. The satisfactory completion of a borehole is, however, but half the story, and unless the owner of the well has been fortunate enough to obtain an overflowing supply, some form of pumping unit will have to be considered to raise the water to the surface, and thence to some point of delivery above the surface, from whence the water is delivered to various points in the premises for use as required.

During recent years almost every branch of mechanical engineering has witnessed considerable progress and improvement, and borehole pumps have not been left out of the picture. Thus to-day there are several excellent new pumps to be had, and it is much easier to obtain a really efficient pump than, say, twenty years ago. We will, before starting to consider in some detail the various points of interest about these pumps, consider in a general way some preliminary aspects.

Before any constructional work is commenced on a borehole pump, the borehole is usually finished and completely tested, so that the responsible individuals are in possession of many important details concerning the well while under test. Thus, in order to approach the problem of providing a pump to suit a particular well, the following details should be available :—

(*a*) Total depth of the well or borehole.

(*b*) Inside diameter of the well casing, top and bottom.

(*c*) Static or rest level of the water in the well.

(*d*) The level to which the water falls while pumping any given quantities.

(*e*) The exact yield of the borehole (usually in gallons per hour).

(*f*) Some idea of the quantity of water it is desired to pump—in gallons per hour.

(*g*) The height above surface at which the distribution tanks are situated.

(*h*) Some particulars of the power available, *i.e.*, electric current, A.C. or D.C., volts, etc., steam pressure in lbs. per square inch.

Pumping conditions vary so considerably, even in borings of similar size and depth, that it is frequently necessary to choose from a number of interesting types of deep well pumps that particular unit which is most likely to prove efficient in the long run.

A summary shows that four different types of pump are now available as follows :

(1) Reciprocating pumps—single and double acting.

(2) Air lift pumps.

(3) Vertical spindle borehole centrifugal pumps.

(4) Submersible motor pumps.

Reciprocating Pumps—Single and Double-Action Types

The tendency nowadays is to make borings of fairly large diameters, ranging upwards from 12 in. to 48 in., very usual sizes being 12 in. and 18 in. internal diameter, and where the supply required is not too large, say 4,000–6,000 gallons per hour, the reciprocating or plunger type of pump is still very popular, and has much to commend it.

Pumps of this class continue, in spite of a somewhat antiquated design, to hold their own, and when carefully designed are usually very economical in power consumption. To ensure efficient functioning the borehole should be reasonably vertical. Run, as a rule, at low speeds—15 to 18 r.p.m.—pumps of this class operate with a minimum of vibration, and excessive wear and tear is eliminated. Double-stroke, double-acting and differential plunger pumps, with, say, a cylinder of 6¾-in. bore and a stroke of 18 in., have speeds up to 35 or more complete strokes per minute.

Plunger pumps may be operated by belt drive or by means of a reduction gearing directly coupled to an electric motor, or belt driven by gas, gasoline, steam or water wheel. Direct-coupled steam heads have been extensively used, and have given good service, but they are necessarily extravagant in the use of fuel, even when in perfect condition.

Before passing on to the next class of pump a brief description must be given of the reciprocating pump, and a glance at Fig. 1 will make the cycle of operations clear.

The reciprocating motion is obtained by means of a crank suitably mounted between a pair of " A " frames ; the crank is rotated through gearing by an electric motor usually. The water is raised to the surface through a steel rising main, screwed into the underside of the pump head ; the rising main is of such length to give sufficient submergence, and is lowered into the borehole inside the actual casing. Situated at the bottom of the rising main is the unit which performs the actual pumping : this is the barrel, made of gunmetal, and usually about 3 ft. long. Within the barrel are two valves, the lower valve and bucket : the latter performs the actual lifting of the water into the rising main, while the former permits the water to pass up into the barrel. The bucket has connection with the pump head by means of pump rods, usually of pitch pine ; these rods are coupled together by

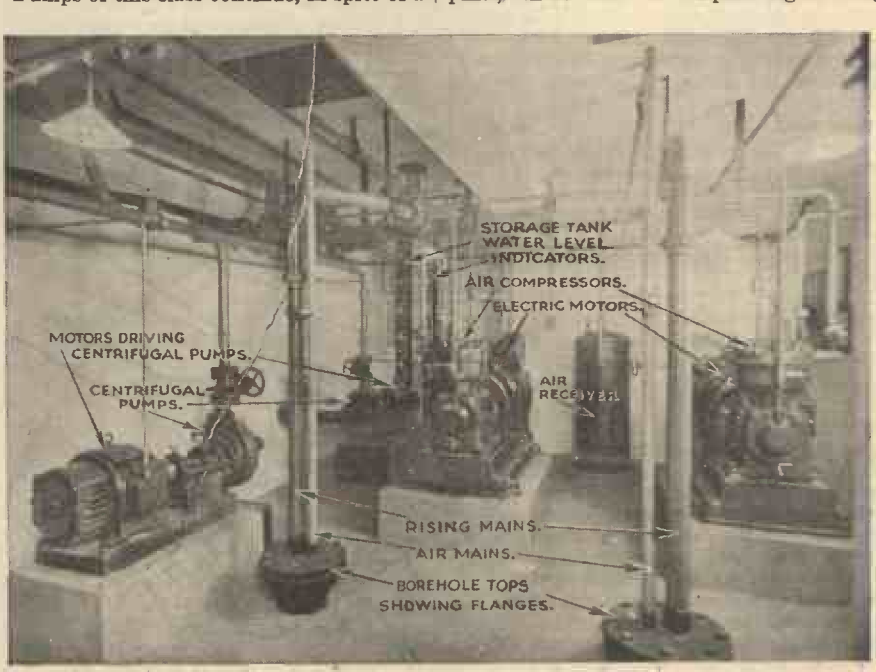


Fig. 2.—Duplicate air lift pumping units, each designed to raise 1,500 gallons per hour from 300 ft. below surface.

FROM DEEP WELLS

Pumping Plants at present on the Market

means of wrought-iron couplings, and the complete set of rods is moved up and down inside the main by the rotation of the crankshaft, thereby causing the bucket to move up and down in the barrel. The action is very simple: on the down stroke the water in the barrel is forced up through the valve in the bucket; on the up stroke the water now above the bucket is lifted into the rising main, thus causing a vacuum in the barrel into which the water flows from beneath the lower valve. On the next down stroke the water is again forced into the main, and thus the actual lifting goes on, the rising main thus performing the double function of a main for the water and a guide for the pump rods. A suction tube is fitted to the lower end of the barrel and a differential plunger is fitted at the delivery outlet to equalise the flow of water in the delivery. The water can be raised to any reasonable height above the surface, and such pumps are capable of raising any quantity from 100 to 6,000 gallons per hour from depths varying from 50 to 500 ft. below the surface.

Frequently deep well pumps are required to be super-silent in operation, particularly when used to supply water to blocks of offices; in such cases the mechanical functioning is obtained by means of the worm reduction gearing, and Fig. 2 shows a head gear of this type operating in a London building.

Air Lift Pumping Plants

We come now to a form of deep well pump which is fairly well known and in use in quite a number of the very well-known London buildings. Raising water by compressed air has the great advantage in that all the moving machinery is situated in accessible positions on the surface, so that in the event of mechanical trouble it is a very easy matter as a rule to make necessary adjustments, and very many air lift plants are in operation at the moment which have not been overhauled for years and are still giving excellent service.

Figs. 2 and 3 show two views of a typical air lift plant; in Fig. 2 the surface gear is plainly seen, while in Fig. 3 a well equipped with such a plant is shown in section.

The essential units are (*a*) an air compressor; (*b*) a driving unit—usually an electrical motor direct-coupled to the compressor; (*c*) an air receiver; (*d*) an electric starter. Water is raised to the surface by means of compressed air, which, passing from the compressor through the receiver, is stabilised and passes down the smaller tube. When it reaches the bottom of the air main the air mixes with the water and aerates it, causing the water in the borehole to flow up the rising main on account of its decreased density.

Duplicate Machinery

Sometimes it is a sound plan to instal duplicate machinery—the duplicate to act as a standby set. Sometimes the standby set is installed in, and operates, a separate borehole; while not infrequently, where the diameter of the borehole will permit it, a double set of pipes may be fitted, so that the surface machinery may be arranged to operate either set. The limit of practical utility to which water can be raised is governed by the working water level, together with the height to which it is desired to raise the water above the surface.

Should there be a considerable drop in the working water level it is perhaps better to discharge into a small tank at surface level and pump from there into the elevated storage tanks by using a small surface centrifugal pump. The air lift system is not adopted for pumping horizontally for a great distance; for this reason the horizontal discharge should be kept as short as possible.

While it is conceded that the air lift type of plant is not perhaps so economical and efficient as other methods of pumping, under certain conditions such pumps have turned out to be extremely satisfactory. With this type of pumping unit the water is generally raised to the surface and delivered into surface collection tanks, and from thence raised by small high lift centrifugal pumps to the gravity tanks on the roof of the building. Glancing again at Fig. 2, the tops of two boreholes can be seen—the small centrifugal pumps just referred to can be seen in the left foreground and background. It will be noticed that the boreholes and the pumping sets are duplicated; this is a very usual custom, and enables a building so equipped to carry on indefinitely, one set acting as a standby set, and it is usual to use each on alternate weeks.

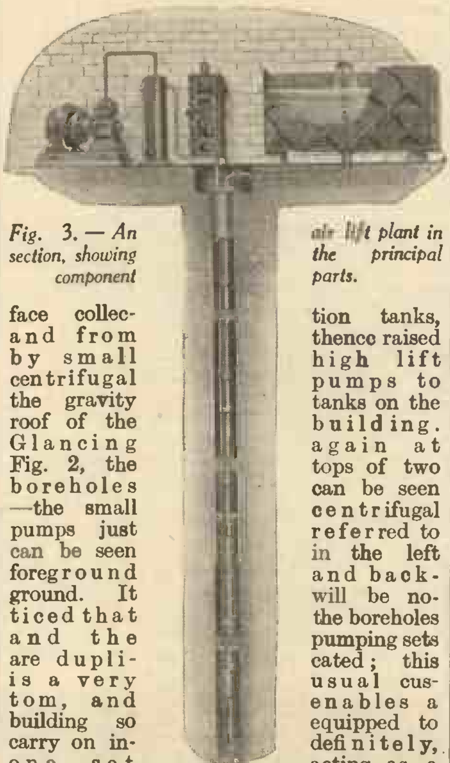


Fig. 3.—An air lift plant in section, showing the principal component parts.

Borehole Centrifugal Pumps—Vertical Spindle Type

During the last decade another type of pump has been considerably developed—the Vertical Spindle Turbine Pump. There are two advantages about this type of pump, and these are the very little floor space needed and likewise head room; also very large quantities of water may be pumped.

The pump of this variety is situated at the desired depth in the borehole, and is connected to the prime mover on the surface by means of a vertical steel shaft revolving at a high speed. It is usual to operate such a pump by an electric motor directly coupled to the shaft. Generally the motor is mounted on a special motor pedestal, situated immediately over the borehole. The steel shaft is supported at intervals by specially constructed bearings which are automatically lubricated by the water itself; the bearings are situated in the rising main, which also does service as a delivery main. At the bottom of the shaft is a series of specially designed impellers which lift the water and force it up the delivery main to the surface tanks. This class of unit may be operated by means of crude oil engines if required, or a steam engine may be used, or, again, the motor may be a separate unit and the drive achieved by means of a belt.

These excellent pumps are capable of raising water from considerable depths below the surface to great heights above the surface, and quantities of water up to 100,000 gallons per hour may be dealt with by some of the larger sizes. A modern practice is to instal a series of wells with a pump in each.

Submersible Motor Borehole Pump

To the English market this class of pump is somewhat new, but one or two manufacturers have, it seems, succeeded in producing an electric underwater motor pump, and a number of such pumps are in use in various parts of the country.

The centrifugal principle is adopted, the motor being situated below the pump and directly coupled thereto—thus commencing at the bottom there is the motor, the pump, the rising main or delivery pipe: apart from a starting unit this comprises the pump entirely. There is no suction pipe, and the complete unit is suspended from the surface on the actual rising main tube, which is usually of ordinary steam quality. At present the smallest pump of this type requires a borehole of not less than 8 in. internal diameter, and so far the electric drive is the only practicable one. Submersible motor pumps are designed to pump up to 35,000 gallons per hour on 150 ft. head with efficiencies from 40 to 60 per cent. All parts of these pumps which come in contact with the water are made of bronze or rustproof steel, including the ball-bearings. The motor and pump complete are submerged well below the proved pumping water level, and the initial charge of special grease is sufficient to permit approximately 6,000 hours' running, representing one year to eighteen months under normal working conditions.

In conclusion, it should be added that nearly all borehole pumps can be installed to operate automatically, so that practically no attention is needed: this is accomplished by carefully designed water level indicators, which automatically switch off the power when the tanks are filled and switch on again when the level drops to a certain point. Speaking generally, water may be pumped from a borehole at between 3*d*. and 4*d*. per 1,000 gallons, a figure which represents a very considerable saving, especially where large quantities of water are used.

Some Interesting Facts about Water

Sea water contains an enormous quantity of dissolved solids, hence its density, instead of being 1, as in the case of pure water, is 1·026, and its freezing point is approximately 29° F. and not 32° F., as is that of fresh water. The "saltness," or salinity of water is due to the substances dissolved during the passage of the water over and through the rocks and soil whilst on its passage to the sea. The constant evaporation that occurs over all water does not deprive it of any of its solid contents.

One of the results of the continual dissolving of rocks by natural water is the formation of subterranean caves, notable examples being the caves of Cheddar.

The medicinal properties of the mineral springs found at "spas" are due to the dissolved solids they contain, such as sodium, potassium, lithium, ammonium, magnesium, calcium, barium, chloride, bromide, silicate, carbonate and sulphur.

IS THERE A FOURTH DIMENSION?

The Human Being only knows a Three-dimensional World ; Is there a Fourth ?

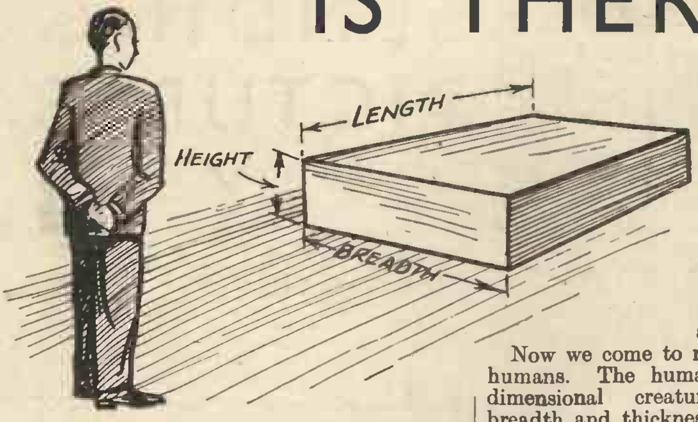


Fig. 4.—Human beings see everything in two dimensional terms—length and breadth.

PERIODICALLY this question crops up, and now that the cult of science-fiction is gaining more adherents every day, authors are giving greater attention to tales of pseudo-scientific wonder such as narratives of time-travel, interplanetary adventure, and projections of earthly peoples into a fourth or even "fifth" dimension.

In the first place we must clearly understand that there is absolutely no scientific proof that such a dimension does not exist, and the root of the whole matter lies in the fact that we ourselves are three-dimensional creatures, living in a three-dimensional world, and able to appreciate only the facts which are apparent to our three-dimensional brains. There is no reason whatever why there should not exist in the same space as the objects we see and feel other objects, or other aspects of the same objects, of which we are mentally and physically incapable of having any knowledge.

This is a very difficult matter to explain without delving into abstruse questions of relativity, but perhaps the following will serve as an illustration.

Let us imagine, first, a creature after the style of an eel or worm, but so long and thin that it is simply a living exposition of Euclid's definition relative to a line, namely, length but neither breadth nor thickness. Such a creature, when facing one of his fellows, would see him solely as a dot or point, and by his one-dimensional nature would regard the whole world as a universe of dots or points.

A Flatlander

Now imagine a two-dimensional being—the best analogy is probably that of a shadow ; so imagine your own shadow as a sentient being. It would have length and also breadth, but no thickness whatsoever ; in fact, it might be very aptly termed a flatlander.

Such a creature would know a world of lines only, or, in other words, they themselves would see everything as one-dimensional (the dimension of lines and length) though themselves actually two-dimensional, having length and breadth.

Now we come to normal beings such as humans. The human being is a three-dimensional creature, having length, breadth and thickness ; but the world as seen by us is two-dimensional in actual fact, everything appearing in planes and length and breadth (the three-dimensional effect of our sight being in a sense an artificial one due to the stereoscopic arrangement of our eyes).

Now, to summarise, if a one-dimensional creature sees only points, a two-dimensional creature only lines (or one-dimensional) and a three-dimensional creature sees only planes (or two dimensions), ingenious thinkers plausibly argue that it is quite reasonable to surmise the existence of a fourth dimension or state of being to which we are visible to all three dimensions, though this fourth dimension would be as invisible and incomprehensible to us as we are to the Flatlander.

Fig. 2.—The Flatlander would know a universe of lines only.

This, of course, allows great play to the imagination, and has resulted in many very ingenious and extremely plausible plots for exciting tales.

An Interesting Example

To postulate a case : the moon is some quarter of a million miles away, and to our three-dimensional minds and bodies more or less inaccessible, but, given a fourth dimension, there is no reason why it should not be just round the corner.

To "prove" this, let us go back to our friend, the Flatlander again. If we had a huge roll of paper and unrolled it along the road until it was half undone, then doubled the other half over the first so that the two long lengths of paper were separated by 1 in., we would have a very suitable track for experiment. At the beginning of the paper let us imagine our Flatlander starting off to reach his "moon," which we place as a disc at the end of the paper on the same side as the little creature is started on. Actually the moon is 1 in. above the Flatlander, but as he is a two-dimensional creature the words "up" or "down" do not enter into his cosmos at all, and so he can only wriggle the whole length of the enormous roll to reach the "moon." Given a third dimension he would find it within an inch of him. So with ourselves ; the distance to our moon is enormous as far as our three-dimensional senses can tell us, but given a fourth there is no knowing what short cut we might find ourselves precipitated into. Naturally all this is pure hypothesis, but it gives one furiously to think.

Time as the Fourth Dimension

There is, however, another aspect of the term "fourth dimension," which is very often confused with the above. We refer to the application of the term to time in the relativity theory of Professor Einstein. Here the phrase has a definite meaning, for Einstein states that time is the fourth dimension necessary to the three dimensional position of space to specifically define such position.

In other words, it is no use saying "John Jones was at the second window up of the house at the corner of Russell Square and Tottenham Court Road" unless we add the time at which he was there, for the flow of time is as essential in space as is position itself.

To show how deceptive time may be, let us imagine that we are on one of the very distant stars watching the earth. If the star were ten light years distant we would see events which happened in 1923 because it has taken that time for the light impulses of these events to travel there. Now suppose we were able to leave that star and travel towards the earth at the speed of light, we would, at the end of one year, be able to observe events which were taking place in 1925, not 1924, because two years of earth time have passed during only one year of ours. This illustration can be elaborated quite scientifically until one is able to visualise time and events actually proceeding backwards, but this is sufficient to illustrate the importance of the time dimension in the relativity theory, and to show that Einstein's specific reference to a fourth dimension has a definite application, whereas the generalised term previously discussed is usually a reference to a hypothetical dimension in space itself.

Readers who wish to pursue this subject should study Hinton's work entitled "The Fourth Dimension." The theses advanced in this article are not, of course, originated by the staff of PRACTICAL MECHANICS. They have been the playthings of scientists for years. But if we admit the possibility of a fourth dimension, why not a fifth, a sixth, a seventh—in fact, any number ?

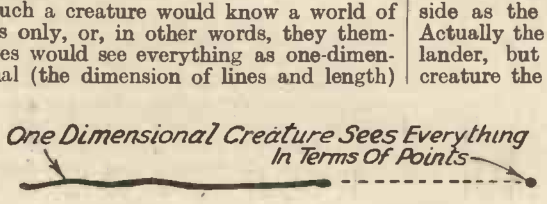


Fig. 1.—This creature would regard the whole world as a universe of dots and points.

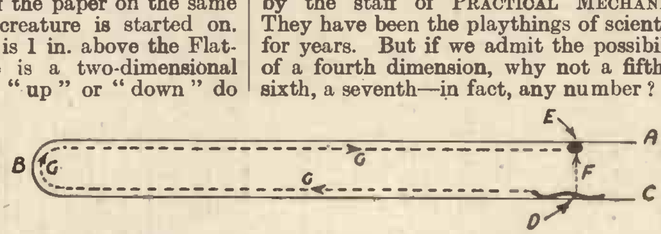
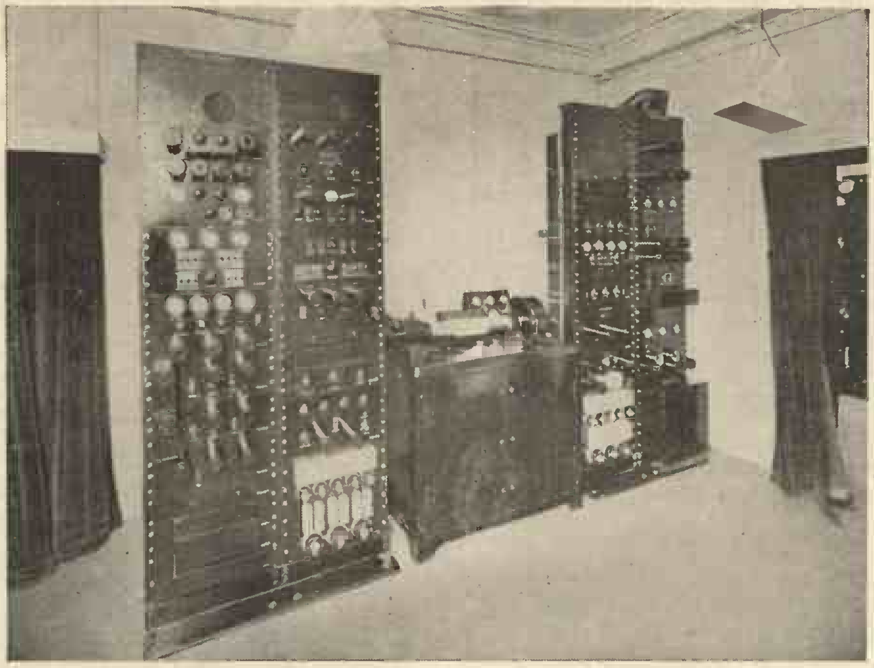


Fig. 3.—The Flatlander's journey. A. B. C., the paper path. D, flatlander starts. E, the "moon" (flatlander's goal). F., third dimensional distance. G. G. G. is the only feasible distance to a two-dimensional creature.



Part of the equipment installed in the Central Telegraph Office of Cable and Wireless Ltd., for transmitting and receiving pictures. The drum can be seen on the desk in the centre.

SENDING PICTURES BY TELEPHONE

An Explanation of the Method of Transmitting Pictures and Photographs by Wire. The Principles Underlying the Transmission and Reception are Explained

By BERNARD DUNN

IT is by no means an uncommon experience to open the daily paper and find the reproduction of a photograph taken only a few hours earlier in a foreign country. It is obvious that the photograph could not have been taken and brought in the usual manner to the offices of the newspaper in time for a half-tone block to have been made, and the secret is to be found in the fact that the picture has been sent in the same manner as its accompanying text—over the 'phone. The system should not be confused with television, although the underlying principles are in some ways rather similar.

The apparatus used for transmitting pictures is of an extremely complicated nature, as a glance at the photograph on this page will show, but the principles are by no means difficult to follow. Most readers are aware that the transmission of sound over the telephone wires depends upon the conversion of the sound into varying electric currents, and the re-conversion of those currents into sound. It is all a matter of changing one form of energy into another, and the same thing applies when light is concerned. In other words, varying intensities of light can be made to produce corresponding variations of electric current —it depends upon the use of some device which is capable of responding to light variations, and turning them into fluctuating electric currents.

Converting Light into Electricity

The photo-electric cell is, as its name implies, the type of instrument which is required, since if this is exposed to a light source of varying intensity its resistance to electricity changes. When the cell is in darkness its resistance is infinite and therefore no current can pass through it; also, its resistance becomes less as the light directed upon it becomes brighter.

Bearing these fundamental facts in mind, it is not difficult to imagine what would happen if a point of light were directed on to a picture and moved all over it, the reflection being focussed on to a photo-electric cell. In the system of picture transmission under consideration the picture is clipped on to a cylindrical drum, this being placed inside another drum in which is a small hole. Opposite to the hole is the cell, this being in turn connected, through a valve amplifier, to the telephone lines. The picture is illuminated, whilst the inner drum rotates and moves longitudinally. As a result, points of light are reflected from every point of the picture on to the photo-electric cell, the complete picture being "scanned" along a spiral path. In practice the reflected light is not continuous, but is broken up by means of a "chopper" disc inserted in its path. This disc is nothing more than a rotating flat disc of metal with a certain number of holes in it, and its object is to break up the picture into the series of small dots of different degrees of blackness which are apparent when the picture is printed on the newspaper. By altering the speed of the disc the number of dots per square inch (known as the "screen") can be varied as desired.

At the Receiving End

The "dots" of electrical current of varying strength produced in this way are sent along the telephone lines to the receiving end, where they are transformed into "dots" of light again. This is done by connecting the telephone wires to a powerful amplifier which feeds some form of glow-discharge tube similar in principle to that used in a television receiver. A neon lamp cannot be used because the light which it gives off has no actinic value, and therefore it is usual to employ a cathode-ray tube. The light from this is directed on to a drum similar to that used at the transmitting end, but which has attached to it a sheet of unexposed printing paper. The drum revolves at precisely the same speed as that used in transmitting, with a result that a true reproduction of the original picture is printed on it. After exposure the paper is developed and fixed in exactly the same manner as when a contact print has been made from a negative.

Synchronisation by Tuning Forks

One of the greatest difficulties of the system is that of ensuring that the two drums at the transmitting and receiving ends of the line revolve at exactly the same speed; in other words, of obtaining exact synchronisation.

This is secured by using synchronous electric motors at both transmitting and receiving ends, these serving to rotate the drums and "chopper" discs. The motors are driven by independent supplies of alternating current which is generated by tuning forks accurately designed to resonate at the same frequency. So great must be the degree of accuracy that the forks are made from Elvinar steel, which has a very low temperature coefficient of expansion. Still further to avoid possible variations, the forks are housed in special chambers maintained at a uniform temperature.

The chambers consist of copper boxes containing lagging, and these are housed in larger boxes lined with felt. Between the inner and outer compartments the air is maintained at approximately 50° C. by means of heating mats. The temperature of the latter is regulated by means of mercury-contact thermometers.

The output from the tuning fork is magnified by means of a valve amplifier and fed to the synchronous motors at a high frequency.

Reference has only been made to the transmission of photographs, but any form of printed or drawn matter can be dealt with in exactly the same manner. It is also possible to send a negative, so that an enlargement of the finished photograph can be made in the minimum of time. Incidentally, a negative can be "received" although a positive is "sent," this being arranged by reversing the action of the glow-discharge tube so that its emitted light becomes less, instead of greater, as the electric current increases.

Portable Apparatus

Until lately pictures could only be sent from a somewhat elaborately equipped station, but the present apparatus can be built in portable form, and may simply be carried in a motor van and connected up with little delay to any telephone system, or even to an extension. Additionally, the same apparatus can, with slight modification, be used for either transmission or reception.

So far as we are aware this form of picture transmission has not yet been used (other than experimentally) for transmitting pictures by wireless, but there is apparently no reason why this should not be done in the near future, especially if the present rate of progress in ultra-short wave transmission is maintained.

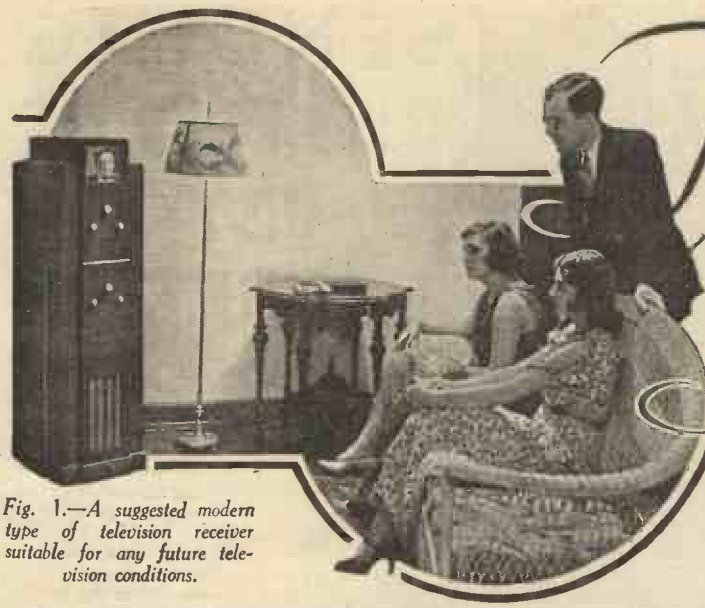


Fig. 1.—A suggested modern type of television receiver suitable for any future television conditions.

This New Television

By H. J. BARTON CHAPPLE, Wh.Sch., B.Sc.(Hons.), A.C.G.I., D.I.C., A.M.I.E.E.

With the prospects of television reception in the home becoming possible in the very near future, considerable speculation abounds as to how we shall all look-in to the programmes.

AT the present moment nothing *definite* can be said regarding recent developments in television, because the television committee of inquiry appointed by the Postmaster-General has not yet finished its deliberations. Furthermore, the secrecy with which they have undertaken their task makes it impossible to forecast the nature of the recommendations which they will make.

Irrespective of this, however, it is both interesting and instructive to see what proposals have been made in the past for television receivers which would suit a potential buying public. Naturally, the designs have varied between fairly wide limits according to the form of scanning device and modulated light source which happened to be popular at each period.

One of the First Efforts

One of the first really good efforts at providing an "all-in" machine for home entertainment is shown in Fig. 3. A dual radio receiver was incorporated in the large cabinet, the controls being situated near the bottom. It was for reception on the ordinary broadcast band, and the loud speaker was positioned behind the fret on the left. A large-diameter apertured scanning disc driven by a special fractional horse-power motor and working in conjunction with a large plate high-voltage neon lamp served to reproduce the image. To increase the image size to dimensions of comfort for looking-in, the large-diameter lens on the right was incorporated. Finally, in a left-hand top compartment was placed the record turntable and electrical pick-up, while on the right was arranged the record storing compartment. Unfortunately, this design, while quite sound electrically and mechanically, was suggested at a time when no real television service was available; and coupled with this was the fact that sufficient progress had not been made to give transmissions which approached those now being furnished by the B.B.C. As to the cost of the complete machine, no figures are available, but obviously from its very nature this "console model" would have been high priced.

Another Design

Fig. 2 shows a home-constructed disc machine complete with the radio receiver arranged on neat but less pretentious lines than Fig. 3. This model happens to be of foreign origin, but was capable of giving really good results within the range of the receiver incorporated. As in the Fig. 3 model, disc scanning was used, but

Fig. 2 (left)

Fig. 3 (above)

Fig. 4 (right)

Figs. 2, 3 and 4.—(Top) One of the first proposals for an "all-in" television receiver. (Left) A suggested design for a home-constructed disc receiver. (Right) A neat mirror-drum television receiver.

the scanning member was of rather small diameter. In addition, arrangements had been made to take advantage of both the British and Continental television transmissions. The former uses vertical scanning, so that the images were watched through the magnifying lens on the right. For the horizontally scanned Continental transmissions the centre top lens was employed. A simple, neat, complete receiver of this character has many points in its favour, not the least of which is the relatively low cost of assembly and ease of control. When mirror-drum scanning is used, so that the image is built up by back projection on to a translucent frosted glass screen, the designs for a complete receiver can take on an entirely different character.

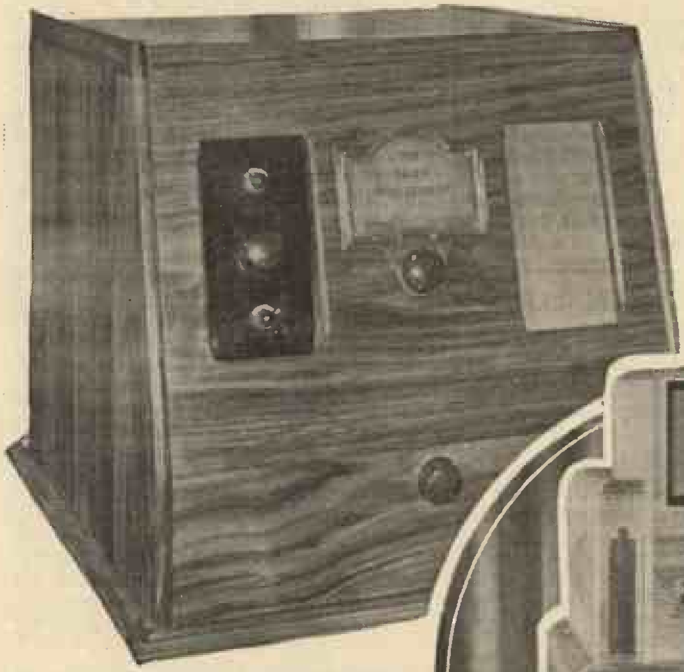


Fig. 5.—An experimental mirror-drum television model for home use.

When the television receiver only is required, the radio set employed for the reception of the actual broadcast signals functioning as a distinct unit, the equipment can be accommodated in quite a small compass. For low definition television, Fig. 4 shows a proposed German design, which is solid in character, with only two controls to handle once the machine has been set up. Fig. 5 shows another design which used a mirror-drum scanner, and this was a Baird experimental "Televisor" used for demonstration purposes, and included the low-frequency amplifier inside the cabinet. The image was seen on the right-hand rectangular screen, while the amplifier controls were mounted on the left-hand panel, leaving the framing and phasing knobs in the centre. It must be admitted that a receiver of this character looks particularly neat, and would make a good table model for use in conjunction with a separate H.F. amplifier and detector unit.

A Table Model

Fig. 6 is a table model which would grace any drawing-room, and shows a singular absence of stray leads, while the controls are reduced to bare essentials. The relatively large translucent screen at the top is for portraying the television images (mirror-drum or similar scanning arrangements have been catered for here), and a home screen of this size would amply meet the requirements of a large section of a radio and television minded public. Immediately below the screen is the radio receiver, an all-mains model, the tuning control and indicating aperture being positioned in the centre. The other two controls can serve a variety of purposes—combined framing and phasing adjustment, image intensity regulation, volume control, etc.

Undoubtedly the present trend is to reduce working controls to the barest minimum, it being assumed that all other essential adjustments can be undertaken at the time the equipment is installed. Once these initial settings have been made, then the user is only called upon to manipulate two or three knobs to suit his own personal tastes.

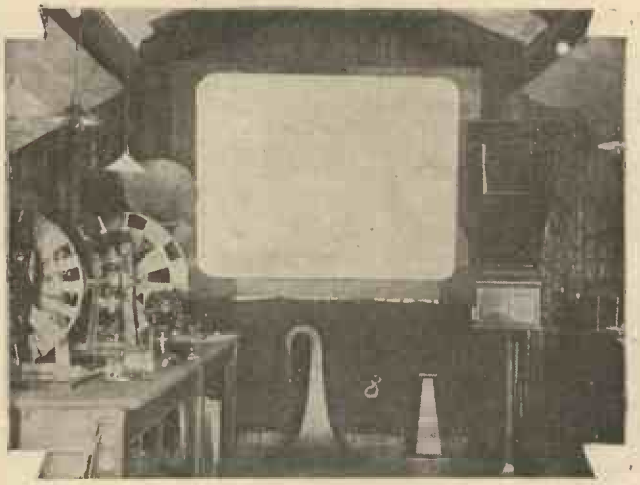


Fig. 8.—How soon will it be before the television images received in the house will be projected on to the small cinema screen of this size?

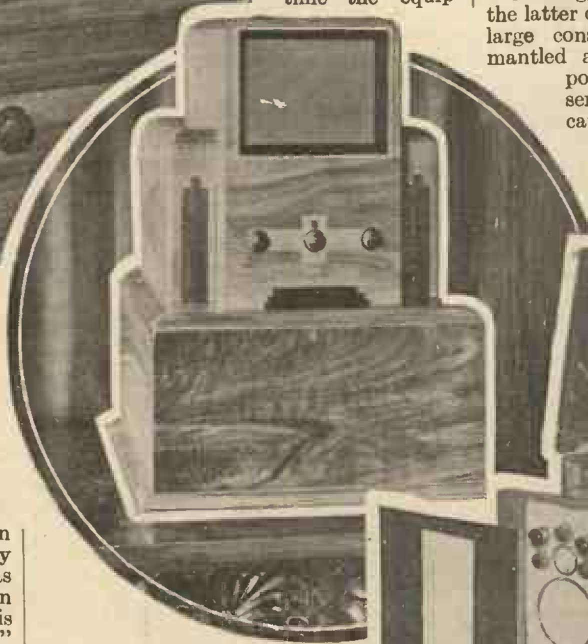


Fig. 6.—A high-quality television receiver design of very pleasing character.

Reverting to Fig. 6, the large rectangular wooden cabinet base would house all the mains eliminator equipment together with the low-frequency amplifier. Questions of cost for a design of this nature cannot be considered, for they would depend naturally on the extent of the plans of production. One objection that might be raised is the absence of any provision for accommodating the sound side of the complete television programme. Each television transmission to be complete is of a dual character, and unless the loud speaker reproducing the music, song or speech is in close proximity to the image screen, the illusion of a "talking picture" is lost.

Needs of the Future

One suggestion for meeting the needs of the latter class appears in Fig. 7. Here is a large console model shown partly dismantled and built with an eye to any possible high definition television service demanding the use of a cathode ray tube. Within the past twelve months the earlier despised cathode ray tube has returned to marked favour for the purpose of reproducing television images. Intense activity is being displayed by those manufacturers

Fig. 7.—Another design, incorporating a dual radio receiver with a cathode ray tube for building up the television images.

having facilities for producing these tubes, and undoubtedly the result of this work will manifest itself in the marketing of tubes which possess none of the inherent disadvantages of their early prototypes. Limitation of image area size on the tube's fluorescent screen end seems to be one of the prime objections put forward by mechanical scanning protagonists, and research is being directed towards a complete solution of this point. Absolute silence in operation is an outstanding advantage, together with the comparative ease of change to accommodate the receiving apparatus to any alterations which might take place in the number of scanning lines, image area, shape, and so on.

Returning to Fig. 7, the tube's fluorescent end is shown as the white disc encompassed by a black circle immediately below the controls at the top of the intermediate vertical panel support. The radio receiver, time bases and amplifiers are housed in sections with their appropriate connections, while the loud speaker is covered by a figured fret near the bottom of the panel. To add to the scope of usefulness of a set of this character, a gramophone turntable, together with an electrical pick-up, is incorporated in a top compartment immediately beneath the lid.

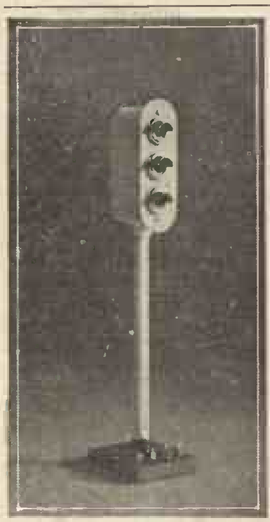
Meeting Special Conditions

Of course, a scheme of this character is capable of numerous modifications, and in Fig. 1 is shown a further suggested design which could meet the conditions of "this new television" when any form of long and regular service of transmissions becomes available to the general public on a wholly acceptable basis. A dual sound and vision receiver is indicated here, the actual cabinet design being one which will tone with the average modern room furnishings.

The image screen is located near the cabinet top, being a comfortable eye level when viewed from a few feet distant. Either a cathode ray tube or one of the suggested mechanical forms of scanning would be suitable here, the cabinet depth being governed by the methods used for image integration. Below this could be grouped the actual radio and television receiver essential controls, symmetrically disposed on the slightly projecting upright wooden panel. A little lower could be placed the sound radio receiver controls with the loud speaker underneath. Ample accommodation would be available for low-frequency amplifiers, H.T. and L.T. supplies, together with the auxiliaries essential to a scheme of this nature. Undoubtedly we shall see models of similar character to this on the market, and it must be agreed that any attempt made to provide home entertainment in this form is sure to meet with the approbation of the buying public, even if the price rules high when compared with the radio receiver alone now doing service in the home.

Of course, there are still many who look forward to the day when the received television images will be projected on to a home screen comparable in size with that illustrated in Fig. 8. Here we see the white screen of normal home talkie dimensions, and many of the television schemes now being investigated show promise of giving brilliant high definition pictures suitable for this purpose. At present, however, the apparatus required is costly, and needs the services of a skilled operator. This stage in the process of evolution towards the mass-produced commercial product is inevitable, however, and a measure of patience, leavened with a little helpful criticism, will do much to stimulate the pioneer efforts now being directed to give "this new television" the status it deserves in the home life of every household.

COLOUR LIGHT SIGNALLING
Its Application to Model Railways



The realistic appearance of the finished model signal.

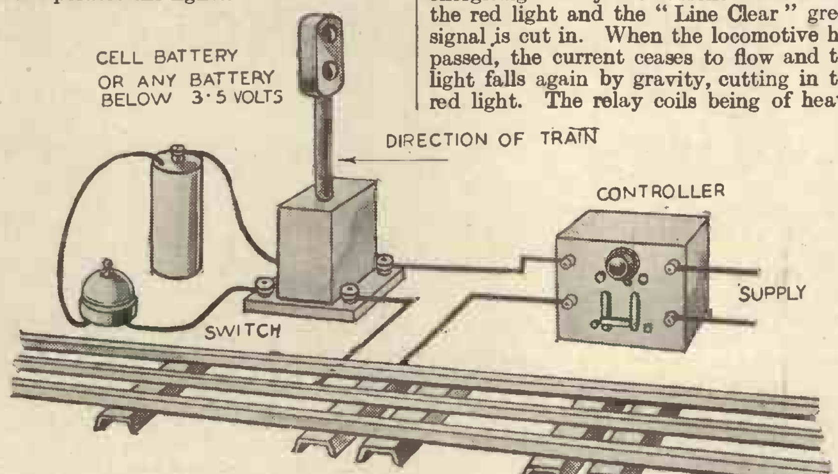
THE railway—that old-established but still very efficient means of transport — is now copying the road. How long will it be before both road and railway obey the red, green and yellow lights of the robot ? Drastic methods are certainly needed to regulate the enormous congestion of the metropolis, and it seems eventually that a system not unlike the railway "block" will result.

Naturally, improvements and innovations on the railways cast a representative reflection on model railways, and enthusiasts of this fascinating hobby can now modernise their track with model colour-light signals.

The model of London transport, constructed by Bassett-Lowke Ltd., of Northampton, is fitted with the new type of automatic colour-light signalling. This is an excellent example of realism and modernity in model railways, and the signalling is rendered automatic by an original method of working.

How they work

The power circuit passing through the locomotive energises a magnetic device which operates the lights.



A pictorial wiring diagram for connecting the signal to a model railway layout.

The signal lamp is fed by a separate battery and can be cut out of the circuit by a switch when it is not being used. The local battery can be a single dry cell, and this, added to the fact that the lights are not subjected to an inconstant track circuit, prevents damage to the lamps and lengthens their normal life. The lamps are 3·5 volt bulbs, but for signalling, a much lower voltage should be used (2 volts).

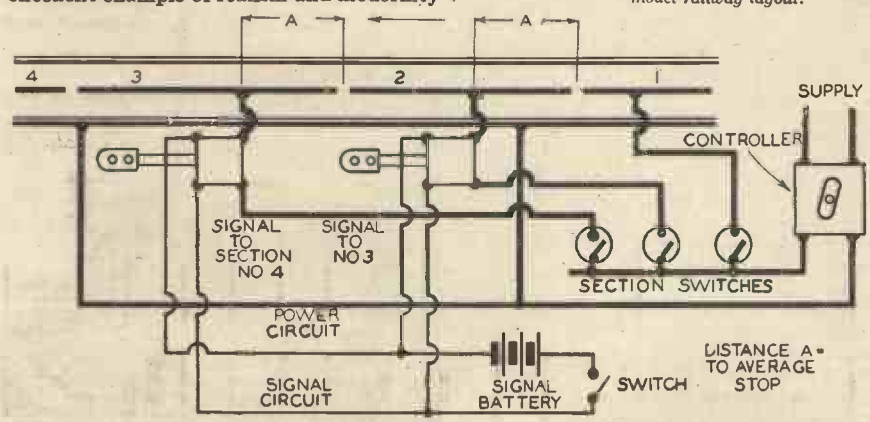
The normal red light shows until the locomotive enters the section, and then by energising a relay the current switches out the red light and the "Line Clear" green signal is cut in. When the locomotive has passed, the current ceases to flow and the light falls again by gravity, cutting in the red light. The relay coils being of heavy wire and in series with the locomotive motor cannot be burnt out.

Signals, situated in advance of separated sections, although governed by one controller, can be switched in as desired, and trains will not proceed and signals will remain at "Danger" until this switching is accomplished.

Starting Signals

When used as starting signals from a station with two or more roads, the point levers can be used to switch in the sections, and then only the desired locomotive will start and the correct signal go to the "Line Clear" signal.

This new model railway signalling system opens up an entirely new field for model enthusiasts to experiment in, and is of practically unlimited application.



The theoretical circuit for connecting the signal.

FILES AND FILING

Although filing is a process of removing and finishing metal well known to everyone, the various grades and varieties in which files are available are so numerous that the selection of these tools is likely to become confusing to anyone lacking experience in their use. A perusal of this article will avoid such confusion.

By W. H. DELLER

Fig. 1.—The top face of the jaws should be set at a convenient height, which may be gauged by standing erect with the elbow in the position shown.

WHILE the production of accurate surfaces by filing, particularly in restricted openings in thickish material, is only likely to result after considerable practice, many inaccuracies are created by employing the wrong type of file for the job in hand. Therefore, a brief description of the various grades and shapes of files, together with some of their uses, will be given.

Types of Files

The commonest types of files are those known as hand, flat, half-round, round, square and three-square. Hand and flat files are both rectangular in cross-section, the difference between them lying in the shape of the blank. Hand files are parallel in width, but are thinner at the point, or end, than in the centre, whereas flat files are tapered from the centre to the point in both width and thickness. An indication of the section of the remainder may be gathered from their names, that of the "three-square" being an equilateral triangle. In the same class as hand and flat may be included mill, pillar and warding files. The first is generally made parallel throughout its width and thickness, but it is proportionately thinner than the hand variety by about one-third, also it is cut in a different manner. Pillar files may be regarded as narrow hand files, and the warding type is similar in shape to a flat file, the difference being that it is equal in thickness throughout the length.

Round and Square Files

These are made in two distinct forms, these being taper and blunt. The latter type are equal in section throughout. Another form of three-square file is made for saw sharpening. This differs from the ordinary type in the following manner: the file diminishes gradually in size from heel to point, and the three corners are radiused. Further, a portion of the file is left blank at the point, the teeth being single cut and extending round the corners.

The term "half-round" as applied to files is somewhat misleading. Actually the curved face of the file represents an arc of about 120 degrees of a circle. There is, however, a file made that may be described as being truly half-round. This is the "pit-saw" type. Unlike the half-round, these files are made in the "blunt" form, and are single cut. As may be gathered, they are primarily intended for sharpening a certain kind of saw, but are also extremely useful in other directions.

Differing from the "half-round" in one point, namely, the front is also curved, but to a lesser degree than the back, is another type, which are known as crossing files. Cant files are triangular in form, the proportions of the triangle being such that the base is equal to and the point the same height as a corresponding section of a half-round file.

Knife files, while being proportionately similar to warding files, are tapered from one edge to the other, so that the section is wedge-shaped ike a knife blade. Feather-edge files are tapered from the centre towards both edges in this manner. Various other special sections are obtainable, but these, or a modification of them, will cover most requirements.

Fig. 2.—Showing the method of holding a file for flat filing.

Used to a large extent in place of ordinary hand and flat files on account of their free and rapid cutting properties, are a brand of files known as "Dreadnought." These files are easily distinguished by the tooth form, which, instead of being straight and arranged diagonally, are semi-circular in shape, the tooth spaces being machined, *i.e.,* cut away from the blank; the teeth appear very coarse in pitch in comparison with ordinary files.

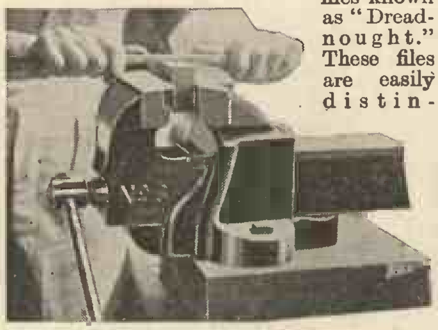


Fig. 3.—Narrow surfaces are finished by draw filing, the file being drawn backwards and forwards along the work as shown.

For finishing convex or hollow surfaces there is a special kind of file available. These are known as "rifflers." They are usually made double-ended, and in effect represent short round or half-round files which have been curved at the ends by bending.

Sizes and Grades

All of the files mentioned, with but few exceptions, are made in a range of lengths commencing at 4 in. and increasing by increments of 2 in. up to 20 in. These lengths do not include the length of the tang or drawn-out portion, to which the handle is attached. The files are also made in different cuts or pitches of teeth. Regular lines are made in four cuts, these being bastard, second cut, smooth and dead smooth. The pitches of the teeth in any one particular cut do not agree throughout the range; thus the teeth of a 4-in. hand file are finer than those of a 12-in. of the same grade and shape.

Saw files are made in second cut only, and mill files in smooth as well, but both of them are single cut, the teeth being cut across the blank at an angle. All of the other ordinary files mentioned are double cut, the teeth being lightly overcut in an opposite direction, so breaking up each tooth into a series of jagged edges. File teeth, by the way, are raised up from the metal with a tool shaped like a cold chisel, and, as may well be imagined, was at one time a process carried out entirely by hand.

Swiss Files

For fine, accurate work there is a range of what are known as Swiss files. These are made in ten different lengths, ranging from 2 in. to 10 in., also in ten cuts. Unlike the files previously mentioned, the degree of cut is in this instance referred to by numbers. These run from numbers 00, 0 and 1 to No. 8. Those with the coarsest teeth, No. 00, are approximate to a bastard cut, while No. 8 is extremely fine.

Shapes approximate to those of ordinary files are to be had, together with other shapes, such as "Barrette," which is similar to a cant file, but cut on the widest face only, and "Pippin," which in section have the shape of an apple pip. The general appearance of these files is clean, that is, the edges and corners are sharp, and their use on profiles requiring really sharp corners makes a marked difference in the quality of the work.

Files similar in quality are those known as needle files. These are not tanged in the ordinary sense. The file blanks are produced from steel wire. This is formed to the required section at one end, and the remaining portion is left as it is, to provide a means of holding or attachment to a handle. Such files are made in several lengths, but those of the various shapes in each length are made from the same gauge

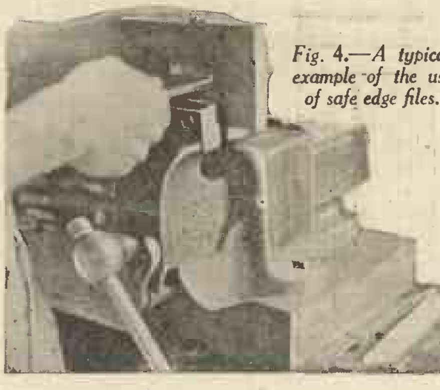


Fig. 4.—A typical example of the use of safe edge files.

material. Consequently they may conveniently be held in a handle fitted with a chuck or set screw.

Safe Edges

Hand files are as standard, made with one safe edge, that is, one of the narrow sides has no teeth cut on it. The object of this is that when filing against a shoulder, the safe edge of the file is kept adjacent to it, thus preventing "cutting in" on that side. Square files are also made in this manner, having one or more safe edges, but not as standard.

Where a particular shape of file is not readily obtainable, ordinary files may be modified in various ways in order to make them suitable for the purpose. This is chiefly done by grinding extra safe edges or reducing the width to permit working in narrow spaces where a smaller file would be too flimsy.

For filing large surfaces the end of a file is sometimes cranked to permit the handle to clear the surface of the work. To do this it is necessary to heat the file, and in so doing care must be taken to prevent the heat travelling up and drawing the temper from the cutting portion. Round and half-round files are sometimes heated and bent at the ends to serve as rifflers. This means rehardening, which, if carefully carried out, is satisfactory, but seldom will a file so treated stand up to prolonged use.

Handles

The question of handles is an important one, particularly when heavy filing has to be done. Thus bastard files of reasonable size should be fitted with handles of such a diameter and shape as to afford a comfortable grip, free from any suggestion of cramping. Common file handles of wood, and suitably ferruled, are quite satisfactory, although there are various types of special handles which offer certain advantages, and are mostly of a non-splitting character.

There is also a special holder made which enables an ordinary hand file to be used on large surfaces without the necessity of cranking the end. Whatever type of handle is used, care must be taken to see that it is a rigid fit when in position. This is most necessary if accurate work is to be produced.

Filing

The first point to receive consideration should be the vice. This should be of such a size that it will hold the largest work likely to be handled. It is an important point that the top face of the jaws are set at a convenient height. This may be judged by standing erect with the elbow in the position shown in Fig. 1, the vice being packed up to the correct height.

For small work a small vice may with great convenience be used in conjunction with a larger one. The small vice is mounted on a piece of plate to the bottom of which is attached a piece of hexagonal steel bar 3 or 4 in. in length. This shank may then be held in various positions in the larger vice. The method of holding a file for flat filing is seen in Fig. 2. Normally the handle is gripped in the right hand with the thumb upwards, and the point of the file being held between the ball of the thumb and the fingers of the left hand. If the surface is a rough one, or there is much metal to remove, a bastard cut or Dreadnought file is used.

The filing is carried out in a diagonal direction, and the pressure which is applied on the forward stroke is reduced on the return stroke. After a time the direction of filing is reversed, this having the effect of taking off the series of ridges left by the file when travelling in the opposite direction. The filing is continued in alternate directions until the work is close to the required size. Care must be taken to see that the file is kept moving in a horizontal plane. At first there is, however, a general tendency to raise the right hand on the return stroke and the left hand on the forward one. The effect of this is to produce a surface anything but flat, and is a condition to be corrected by practice. Carry on the filing with a second cut file to remove the marks left by the previous one, and finish with a fine file. Fine files are liable to pick up pieces of metal in the teeth, with the result that the surface of the work is deeply scratched. This clogging can be obviated by cleaning the file and filling the teeth with chalk. Narrow surfaces are finished by draw-filing. The file is held and drawn backwards and forwards along the work, as seen in Fig. 3, a "straight-line" finish resulting.

A typical example of the use of safe edge files is shown in Fig. 4.

ABOUT COUNTING DEVICES

Anything that is made, regardless of how it is made, has to be measured, weighed or counted, and the tally must be accurate. Otherwise, how could costs be estimated and profits ascertained?

But to count by hand each piece produced would, of course, be impossible. Even to tally one hour's output of the average factory of to-day would be a tremendous task. Some other method of checking is necessary.

Count and measure can be computed by weight, likewise weight can be determined by count or measure, but the process is indirect, inaccurate, slow and consequently costly.

This hand tally registers at every pressure of the thumb lever.

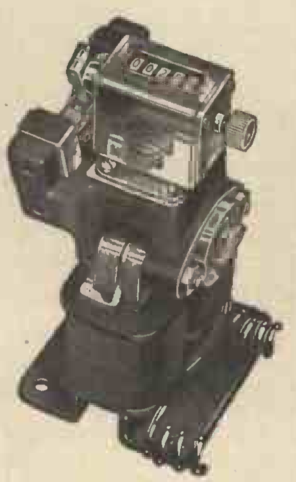
While some factories are still using the above methods, the majority of modern plants have adopted the mechanical method of counting each piece as it is produced from the machine itself. Such a tally is made possible with the aid of a small counting machine which faithfully and ceaselessly, if desired, works twenty-four hours a day and without pay.

A Common Application

Probably the most common of counter applications is on the stamping press or drop hammer. Here the counter records each stroke of the press from which production is easily computed. If desired, a bell can be attached which will ring when a certain total is reached, warning the operator.

Other common applications are on printing presses, turret lathes, automatic screw machines, bottle-filling machines, conveying machines, buttonhole machines, folders, wire-cutters and straighteners, marine indicators and cancelling machines.

A recent development is a predetermined counter which can be set to any desired total, the machine put into operation and when the predetermined number of pieces have been produced the machine is automatically stopped. By turning a small reset knob, the counter is ready for a second count of the same predetermined number of pieces, when the machine is again automatically stopped, and so on, until the total quantity has been reached. The operator does not have to keep mental notes on the amount of pieces produced, and therefore can give his attention to other machines. A gong or signal light can also be attached to the counter, which calls the operator's attention to the machine that has stopped.



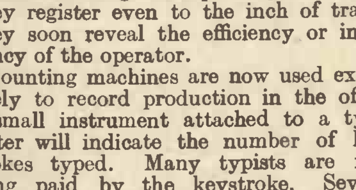
An electrically-operated counter.

The Hub Odometer

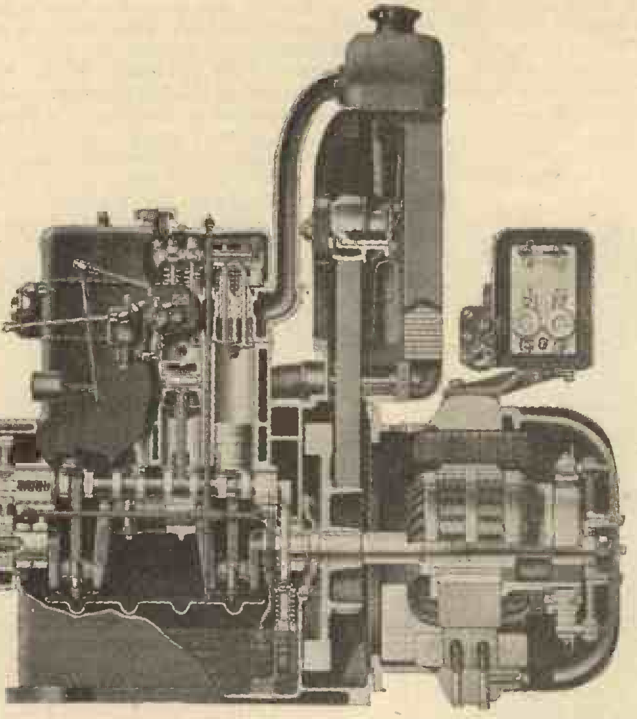
Another well-known Veeder-Root product is the Hub Odometer, a device which seals on to the left front hub of a pleasure car, motor truck or 'bus and accurately records the mileage of travel to the tenth of a mile. The Veeder-Root bicycle cyclometer, too, has for years been the choice of cyclists all over the world. More than ten million have been sold. Then there is the mileage recorder for freight and passenger elevators. They register even to the inch of travel. They soon reveal the efficiency or inefficiency of the operator.

Counting machines are now used extensively to record production in the office. A small instrument attached to a typewriter will indicate the number of keystrokes typed. Many typists are now being paid by the keystroke. Several other office machines, too, can be equipped with counters—operators earn more and fewer machines turn out more work.

The hand tally, a counter of 1,001 purposes, is made to comfortably fit the hand, either right or left, and is manually operated by pressing a small thumb lever. It is easily carried in the pocket, and will record anything where a count is desired. A small speed counter, operated by a clutch, will indicate the number of revolutions of any revolving part over a given period of time. Another counter is being used to count the corpuscles in the blood, still another will count drops of water, and there is a small counter that will register each time one's finger is pointed at it. Then there is the traffic counter, which records the number of vehicles passing certain points.



A speed counter for recording the revs. per minute of engines, motors, etc.



A sectional view of the Kohler automatic 1,500-watt plant, illustrated below. The dynamo is driven by a four-cylinder water-cooled petrol engine working at a speed of 1,000 r.p.m. Special features of this plant are mechanical throttling, automatic controller for current supply, and forced lubrication.

SELF-CONTAINED ELECTRIC LIGHTING PLANTS

An article describing the ingenious units for generating electricity in houses, or other buildings, in remote country districts where no public supply is available.

By A. J. BUDD

PEOPLE residing in country districts where the facilities of the town and city are not available can now enjoy all the advantages of electricity for lighting, heating and cooking purposes. To-day there are several makes of compact, self-contained plants that run on petrol or paraffin, and which require very little attention once they are installed.

There are various types of these plants available suitable for any household requirements, and these are of three main classes, viz.: (1) automatic; (2) semi-automatic; and (3) hand-controlled. In each class are examples of four-stroke and two-stroke engines using petrol or paraffin as fuel. The dynamo is either belt-driven or direct-coupled to the engine.

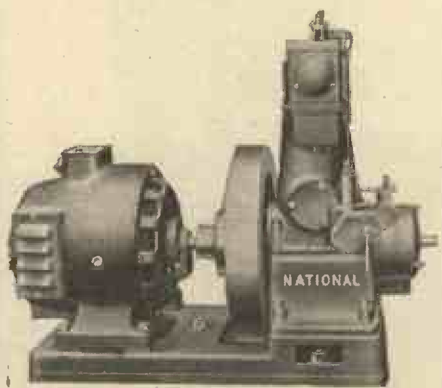
An automatic plant is very compact and ingenious, and dispenses with storage batteries, except for a car-type starting battery which is charged automatically. When the first lamp or appliance is turned on, the starting battery uses the dynamo as a motor, and rapidly cranks and starts the engine. The engine then drives the dynamo, which supplies current direct to the point at which it is to be used. When the last lamp, or appliance, is switched off, an automatic control device stops the engine.

A semi-automatic plant is used in conjunction with a storage battery, and is designed to run without any attention from the beginning to the end of the battery charging. At other times a little attention can be given as occasion requires. The dynamo with this type of plant is a self-regulating one, and the switch gear is designed to shut down the engine when the batteries are fully charged. The engine is started by pressing a switch on top of the dynamo or on the switchboard.

In the hand-controlled type of plant the running of the engine, and also the output, are under the direct control of the person whose duty it is to look after the plant. The actual time taken up in attending to such a lighting set is very little more than that necessary for a semi-automatic plant. One of these compact plants, installed in a suitable outhouse, transforms it into a miniature generating station capable of supplying the house with electric light and current for operating various domestic electric appliances.

Some Representative Plants

Among the automatic electric lighting plants that require no storage batteries, a

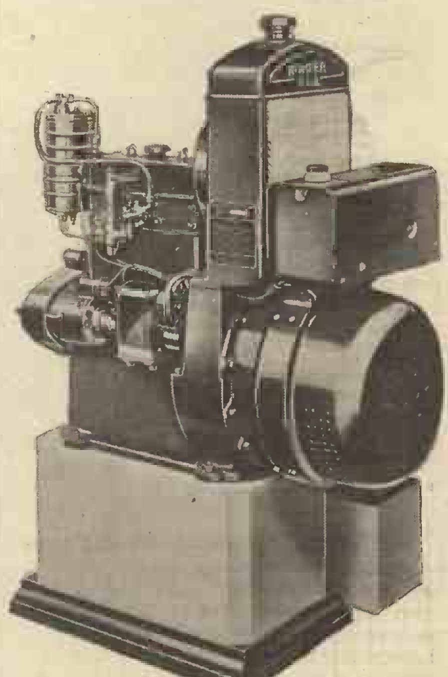


A small 4 to 5 kw. electric light plant by the National Gas and Oil Engine Co. Ltd. The engine, of 8½ b.h.p., works on heavy oil, and runs at 800 to 1,000 r.p.m.

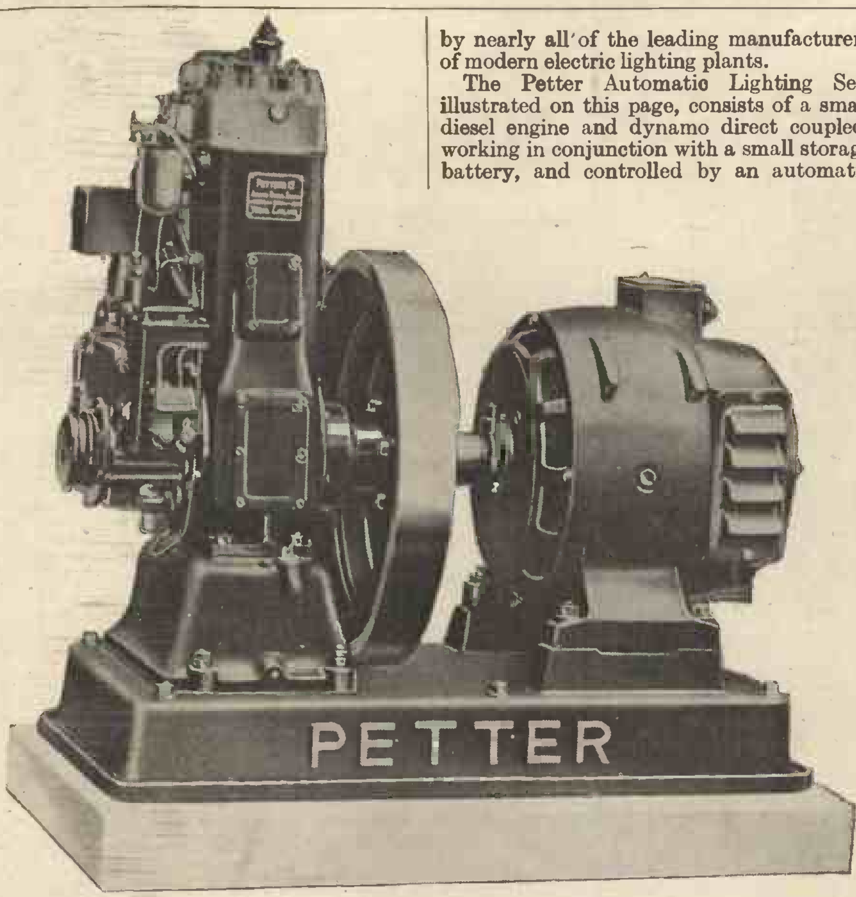
good example is the "Kohler," two models of which, the 800-watt and 1,500-watt, are particularly suitable for small country houses. The smaller plant will supply current for an installation of twenty-seven lamps, each of 30 watts, and when all the power is not required for lighting it can be used for operating domestic appliances. The larger model is designed to meet the requirements of the average country house, and supplies current for fifty 30-watt lamps, or the equivalent in larger or smaller lamps. The generator of the smaller model is driven by a two-cylinder air-cooled four-cycle petrol engine of about 1¾ h.p. The governor is of the magnetic throttling type which automatically proportions the fuel consumption to the number of lamps in use. By means of a patent automatic controller the plant is started when the first lamp or appliance (of 20 watts or more) is switched on, and stopped when the demand for current ceases. The dynamo is of the four-pole compound-wound type.

In the semi-automatic class, a very efficient and economical lighting set is the "A.L." plant made by Allen-Liversidge Ltd. It is rated at 1½ kilowatts, the dynamo being direct-coupled to a four-cycle paraffin engine. The plant is so arranged that the engine can be started by simply pressing a switch on top of the dynamo, thus doing away with the trouble of hard cranking. When started, the set will run for hours without any attention, and supplies current for twenty to fifty 30-watt lamps, according to the capacity of the storage battery installed. When all the power is not required for lighting, it can be used for operating a vacuum cleaner, iron or fan.

A popular lighting set for the country residence, hotel or garage is the Crossley, manufactured by the well-known firm of Crossley Brothers Ltd. This lighting set



The Kohler automatic 1,500-watt electric light plant. The generator delivers current at 110 or 220 volts D.C., suitable for an installation of 60 lamps, each of 25 watts, or the equivalent in larger or smaller lamps.



The Petter Automatic Diesel Electric Light Plant, for use in conjunction with a storage battery. These sets are made in capacities of from 1 to 5 k.w.

by nearly all of the leading manufacturers of modern electric lighting plants.

The Petter Automatic Lighting Set, illustrated on this page, consists of a small diesel engine and dynamo direct coupled, working in conjunction with a small storage battery, and controlled by an automatic switchboard. The automatic operation is controlled by an ingenious but simple switch panel (not shown in the illustration). The first few lights are supplied from the battery, but on the load reaching about 15 per cent. of the capacity of the set, the engine starts automatically, and current is supplied direct from the dynamo. When the demand for current has fallen again the set automatically stops. The engine is of the vertical two-stroke solid injection type, totally enclosed, and starts instantly from cold without preheating.

The dynamo is of the fan ventilated type, fitted with ball bearings. It is shunt wound with special series windings to limit the starting current.

Emergency Lighting

A special panel is supplied with this set when the plant is required for emergency lighting. Upon failure of the main supply, a master relay controlling a circuit breaker starts the set instantly, automatically lights the whole of the emergency lamps, and cuts out when the main supply is restored. The automatic control device is connected to the main supply, and will operate in conjunction either with alternating or direct current. These emergency sets are made in capacities from 1 to 5 k.w., and are ample for all normal demands.

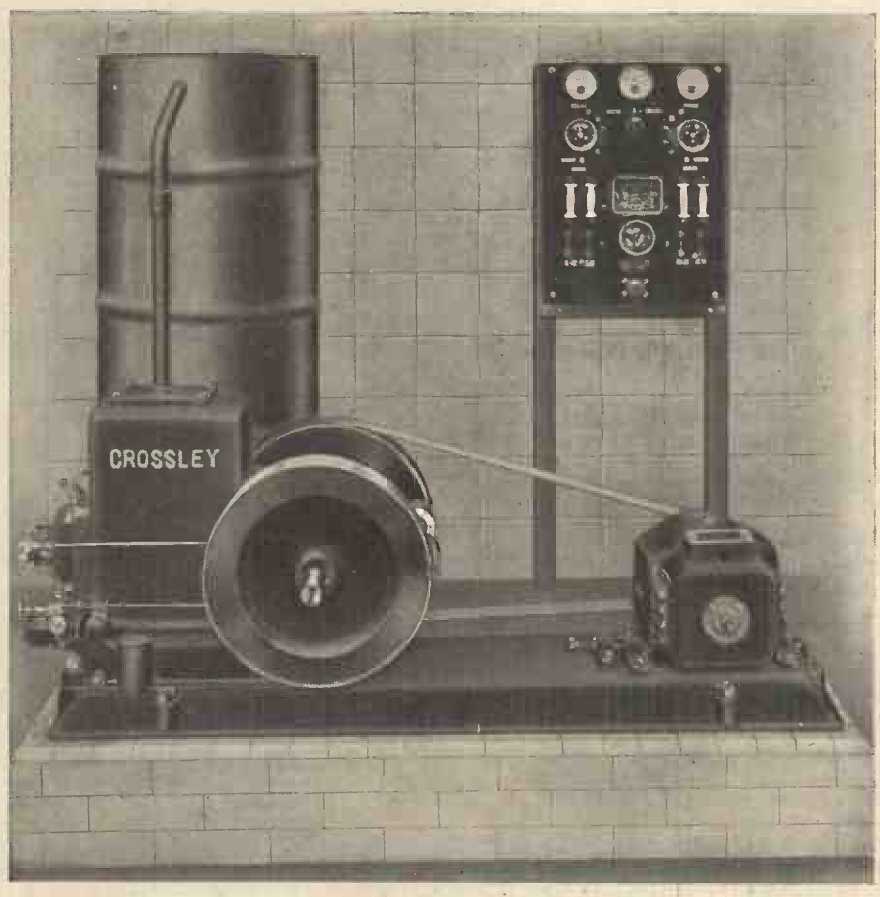
With regard to the size of plant required for house lighting purposes, it may be mentioned as a rough guide that a 750-watt plant is suitable for 25–35 lamps, and a 1,500-watt (or 1½ k.w.) plant for 35–55 lights. This applies to lighting only, and when other loads than lighting are added, it is necessary to consider a plant of larger capacity.

consists of a compact, horizontal engine, dynamo, switchboard and storage battery. The engine and dynamo are separate units mounted on a substantial iron bedplate or upon a suitable brickwork foundation. The generator is belt driven and the engine, which is designed to run on paraffin, has a single cylinder, water-cooled, and operating on the four-cycle principle. The dynamo is of the enclosed ventilated type, shunt wound with interpole, and fitted with series winding for motor starting from the batteries. The switchboard is an independent unit consisting of a black enamelled slate on which are mounted the various meters, switches, etc.

Storage batteries form a very important part of a modern lighting set, and only those of the highest grade are supplied with a Crossley lighting plant. These small house-lighting plants, driven by a paraffin engine, as described above, are made in three sizes, viz., 1 k.w., 1½ k.w., and 3 k.w. output, suitable for 25, 38 and 80 30-watt lamps respectively. These plants can be started by turning a switch, and will run for hours without attention.

Storage Batteries

Each of the semi-automatic and hand-controlled electric light plants available to-day has its own particular features, but in every case the storage battery forms one of the most important parts of the installation. The battery is usually required to furnish regular cycles of charge and discharge more or less continuously, and the batteries manufactured by the Chloride Electrical Storage Company Ltd. amply fulfil these conditions, whilst requiring a minimum of attention in operation. Incidentally, these storage batteries are specified



A 1½ k.w. Belt-driven Lighting Set by Crossley Brothers Ltd. The engine, dynamo, cooling water tank and switchboard occupy very little floor space.

ELECTRIC CLOCK CHIMES

Interesting Details Concerning the Construction of Mechanism for Operating Chimes from an Electrical Clock System

By W. J. DELANEY

Fig. 1.—The popular Westminster Chimes.

WE recently described a Master and Slave clock system (see PRACTICAL MECHANICS, March, 1934), and many readers have written to ask how this system could be modified to include some form of chiming mechanism. This is not quite such a simple matter as would at first appear, owing to the fact that it is almost essential to call in the aid of clockwork in order to govern the strikers. The reason for this is that the only alternative is a motor which would turn the necessary governing roller, and apart from the power required for the motor the necessity for self-starting arises. The master clock operates through the power of a 3-volt dry cell, and it is almost impossible to find a satisfactory self-starting motor which would operate from this voltage, and this means that a separate supply would be required for the motor with the added complication of some separate switching to be operated at the chiming periods. Before dealing with the construction of suitable mechanism the principles will first be described.

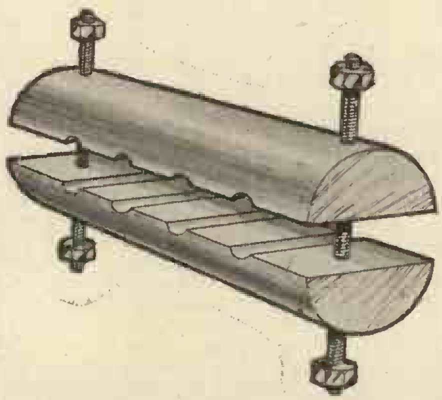


Fig. 2.—Method of constructing a support for chime rods.

The Chimes

There are in use in England several musical sequences known as chimes, some of which are only popular in the particular district in which they are heard, whilst others are of almost universal popularity. The Westminster (or Big Ben) chimes are undoubtedly the most popular and probably the simplest to construct from the amateur clockmaker's point of view. Residents of Portsmouth probably prefer to call this particular combination the Pompey chimes. There is also the Cambridge combination, and others which are less known. The Westminster consists of forty notes in all, divided up into ten separate peals or combinations, each of four notes. If the majority of people were asked to hum these chimes they would be found to offer different versions of the quarter, half and three-quarter intervals. They do not each commence in the same sequence, but are varied, and to any musical ear it is obvious after hearing each peal just what part of the hour is being rung, as there is a musical arrangement in the peal which gives each chime a completeness, somewhat after the manner of an ordinary sentence in English. Thus, when the first quarter is chimed it expresses finality with only four notes, and if the musical arrangement of the chimes in Fig. 1 is carefully studied it will be seen how the peals vary. It will be obvious that only four separate notes are required, and in most striking mechanisms these four notes are struck together to form the hour-striking note. In more elaborate mechanism a separate note is employed, as with the actual Big Ben system. This arrangement will necessitate a separate contact and other complications which may not be considered worth while.

Rods or Tubes

For the actual notes metal rods or tubes are usual; the rod enables a more compact arrangement to be constructed, but the tube gives a much more pleasing tone and enables deeper notes to be obtained. Brass will be found quite suitable, and if rod is to be employed it must be clamped at one end, a satisfactory arrangement being depicted in Fig. 2, where a piece of ordinary broom-handle is cut down the centre after four holes are drilled transversely to accommodate the rod. Tone will be improved if thin leather is placed between the wood and the rod, and the notes may be adjusted by sliding the rods through after tightening the nuts to hold the rod moderately firmly. A pencil or any piece of wood will enable the rods to be struck whilst adjusting the notes. For tubes a hole should be drilled slightly below one end and pieces of gut (a violin or banjo string will be found admirable) looped through, as shown in Fig. 3. It will be seen that in addition a strip of wood should be arranged a short distance below the suspension point, and a small block of wood should extend between the rods and be joined to a similar strip on the other side of the rods. Felt glued to

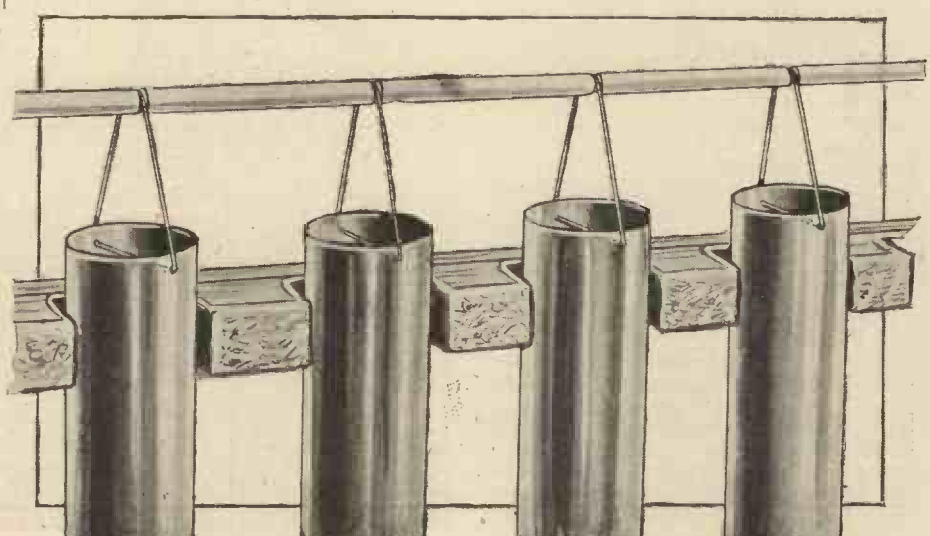


Fig. 3.—How to suspend chime tubes to prevent undue movement without impairing the tone.

the surfaces of these wooden pieces will prevent undue movement of the tubes, and will prevent movement due to vibration without impairing the tone when the tubes are struck.

The Operating Hammers

The cleanest tone will be obtained from leather-tipped hammers, and one of the easiest methods of constructing these which I have found is to take a piece of brass rod $\frac{3}{8}$-in. in diameter. This is cut into $\frac{1}{2}$-in. lengths and one end of each length is bored out to $\frac{1}{4}$-in. diameter by $\frac{1}{4}$-in. deep, and into this is forced a piece cut from a leather lathe belt (round section). This is hammered lightly into the recess in the brass hammer and furnishes a most useful striker. A transverse hole to accommodate a piece of 20-gauge piano wire, and a tapped hole to take a locking screw enables the hammer to be fitted to the striker and to be adjusted to provide the correct blow. Details of this

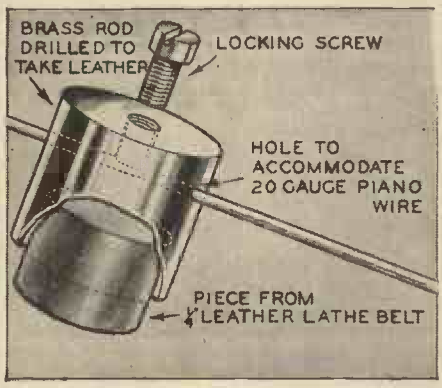


Fig. 4.—The simplest method of constructing a chime hammer.

are given in Fig. 4. When mounting the hammer the wire should be bent so that in the position of rest the surface of the leather is slightly clear of the rod or tube, and when lifted the weight will be sufficient to enable the hammer to give the requisite blow to the rod or tube, and then jump clear. This adjustment may easily be made after assembly.

Direct or Remote Control

We now arrive at the point where we have to decide upon the method of operating the chimes. The advantage of the electric clock is that the master may be stowed away in a cellar or attic and slaves operated at any desired position. In a similar manner the chimes may be placed in any desired position and operated from any slave. To preserve a neat appearance the chiming rods may be mounted in a small cabinet with electromagnets for striking, and these may be controlled by the striking mechanism arranged in some other position. Alternatively, the striking mechanism may consist of ordinary clockwork gears with the hammers raised and released by pins on a drum, and this gearing may be set free by electrical means at a distance. Fig. 5 illustrates the two methods diagrammatically, and it will be seen that the second method offers the simplest solution and is by a great deal the cheaper. One magnet only will be required, and this will release the rotating drum carrying the pins which raise the hammers.

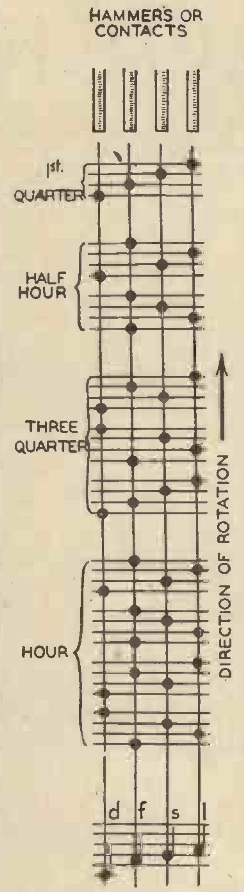


Fig. 6.—To mark out the chime-operating drum a strip should be marked off in this manner and then wrapped round the drum.

For both methods it is necessary to mark out the drum or cylinder which carries either pins to lift the hammers or pins to make the contacts to operate the magnets to lift the hammers. In general a large diameter drum will be needed, as this not only facilitates the insertion of the operating contacts but reduces errors in setting out. For this it is necessary to mark out the surface of the cylinder in the ten separate peals mentioned in the first section. A space must separate each peal, that between successive quarters being slightly greater than between the individual sections of each peal. A specimen marking-out strip is shown in Fig. 6, from which it will be seen that forty pins have to be inserted to agree with the notes in Fig. 1. The strip should be of the same size as the circumference of the drum which is used,

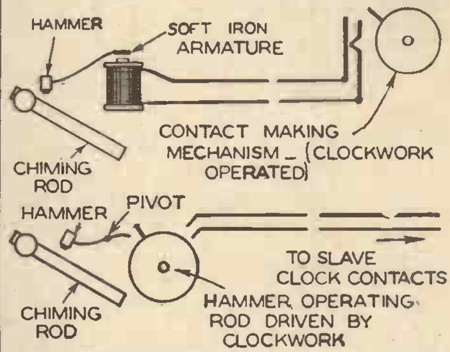


Fig. 5.—Two methods of arranging the chiming mechanism.

and it should then be wrapped round the drum and holes drilled at the points which are marked, or, alternatively, nails may be driven into the wood. For the direct operation of the hammers 1-in. wire nails will be suitable, but for operating the contacts gramophone needles will be found more suitable on account of their shortness and ridigity.

Sufficient has been written to enable the amateur clockmaker to build a complete electric chiming mechanism, and it is not proposed to give constructional details this month as it is possible that each constructor will desire to assemble the apparatus to suit his individual requirements. A word of advice may be given before closing, and that is, use at least an eight-day clock mechanism for the striking gear, or the continued rewinding of this part of the clock system will detract from the advantages of the electrically operated time-pieces.

TABLE OF ELEMENTS

Arranged according to the Periodic Law (first discovered by Mendeleef.)

Atomic Number.	Element.	Atomic Weight.
First Period		
1	Hydrogen .	1·008
2	Helium . .	4·00
Second Period		
3	Lithium . .	6·94
4	Beryllium .	9·01
5	Boron . .	10·82
6	Carbon . .	12·00
7	Nitrogen . .	14·01
8	Oxygen . .	16·00
9	FLUORINE .	19·00
10	Neon . .	20·2
Third Period		
11	Sodium . .	23·00
12	Magnesium .	24·32
13	Aluminium .	27·1
14	Silicon . .	28·3
15	PHOSPHORUS	31·04
16	Sulphur . .	32·06
17	Chiorine . .	35·46
18	Argon . .	39·88
Fourth Period		
19	Potassium .	39·10
20	Calcium . .	40·07
21	Scandium .	45·1
22	Titanium .	48·1
23	Vanadium .	51·0
24	Chromium .	52·0
25	Manganese .	54·93

Atomic Number.	Element.	Atomic Weight.
Fourth Period		
26	Iron . .	55·84
27	Cobalt . .	58·97
28	Nickel . .	58·68
29	Copper . .	63·57
30	Zinc . .	65·37
31	Gallium . .	69·9
32	Germanium .	72·5
33	Arsenic . .	74·96
34	Selenium .	79·2
35	Bromine .	79·92
36	Krypton . .	82·92
Fifth Period		
37	Rubidium .	85·45
38	Strontium .	87·63
39	Yttrium . .	88·7
40	Zirconium .	90·6
41	Niobium . .	93·5
42	Molybdenum .	96·0
43		
44	Ruthenium .	101·7
45	Rhodium .	102·9

Atomic Number.	Element.	Atomic Weight.
Fifth Period		
46	Palladium .	106·7
47	Silver . .	107·88
48	Cadmium .	112·40
49	Indium . .	114·8
50	Tin . .	118·7
51	Antimony .	120·2
52	Tellurium .	127·5
53	Iodine . .	126·92
54	Xenon . .	130·2
Sixth Period		
55	Cæsium . .	132·81
56	Barium . .	137·37
Rare Earths 57	Lanthanum .	139·0
58	Cærium . .	140·25
59	Praseodymium	140·9
60	Neodymium .	144·3
61		
62	Samarium .	150·4
63	Europium .	152·0
64	Cadolinium .	157·3
65	Terbium .	159·2

Atomic Number.	Element.	Atomic Weight.
Sixth Period		
Rare Earths 66	Dysprosium .	162·5
67	Holmium .	163·5
68	Erbium . .	167·7
69	Thulium .	168·5
70	YTTerbium .	173·5
71	Lutecium .	175·0
72	Hafnium . .	178·0
73	Tantalum .	181·5
74	Tungsten .	184·0
75		
76	Osmium . .	190·9
77	Iridium . .	193·1
78	Platinum .	195·2
79	Gold . .	197·2
80	Mercury . .	200·6
81	Thallium .	204·4
82	Lead . .	207·20
83	Bismuth .	209·00
84	Polonium .	210·0
85		
86	Niton . .	222·0
Seventh Period		
87		
88	Radium . .	226·0
89	Actinium .	226
90	THorium .	232·12
91	Protoactinium	230
92	Uranium . .	238·2

PHOTO CELLS AT WORK

The photo-electric cell in its modern form is an actual current generator, and must not be confused with the older form of selenium cell, which operated only at a variable resistance under the action of light controlling the current from an external battery.

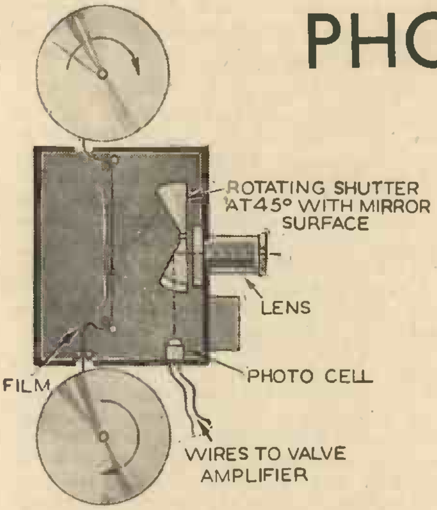


Fig. 1.—The auto-exposure cine camera.

THE modern photo cell, capable of being modulated at enormous frequencies with a high degree of accuracy and employing alkali metals, such as calcium, is a direct scientific relation of the radio valve, whose cathodes, coated with alkali earths, give off electrons under the action of heat instead of light.

There are two main types of self-generating photo cell. Those which require, like the radio valve, an anode to collect the electrons given off, and those of the copper type, which will generate quite high currents of the nature of 20 m.a. without any kind of polarising battery. This latter type is more sluggish in action compared with the vacuum cæsium type of cell used for television. All that is required to operate the photo cell is a shadow—the new magic wand of science and commerce.

One of the most ingenious of its applications is the auto-exposure camera, which, without human adjustment, makes the correct exposure, whatever the degree of light presentance, and however that light varies. This new device is of special value in news-reel and cinema work, and is shown in Fig. 1.

How the Auto-exposure Camera works

The simplest theoretical arrangement of this camera is the use of a plate of optical glass at 45° to the plate, which reflects some of the light from the lens on to a photo-electric cell (see Fig. 2). This cell controls the anode current of a valve by applying a varying grid bias on to the grid of the valve.

The amount of grid bias will depend on the amount of light falling on to the cell. In the anode circuit of the valve is a solenoid magnet operating a ratchet device which rotates the iris diaphragm of the camera, thus varying the "stop" and, therefore, the exposure continuously and entirely automatically as the light from the lens varies.

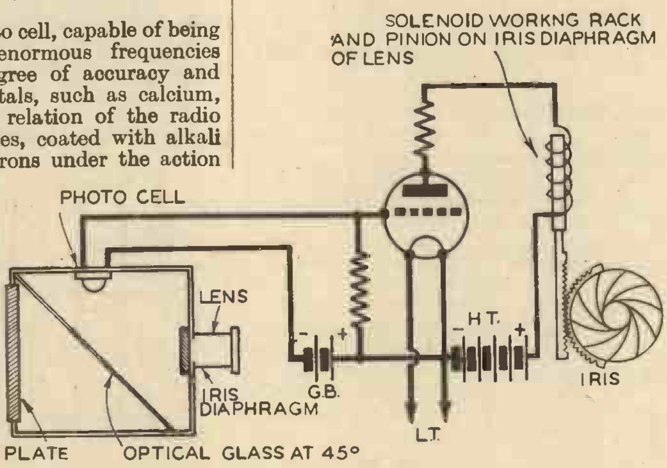


Fig. 2.—How an automatic exposure camera is arranged.

In the cinema camera the reflector is incorporated with the rotating shutter, thus doing away with the sheet glass, and giving the necessary signal to the photo-electric cell between "frames" of the film.

Photo-cell Exposure Meters

The new photo-cell exposure meters are a further example of the way in which the photo cell is coming to the aid of the photographer. These little devices give a direct reading of the correct exposure on a meter attached directly to the photo cell, which is usually of the direct-output copper-oxide type capable, without a polarising battery of any kind, of giving currents as high as 15 to 20 m.a. (see Fig. 3). As a measuring device the photo cell has a paramount quality which makes it invaluable for sensitive measurements, since it can make use of a weightless beam of light.

Fig. 4 shows the general arrangement. The height of slits "A" and "B" can be set in any position up the column of the thermometer. Reference to Fig. 4 shows that the photo cell receives light from two directions—firstly through the lower slit and also *viâ* the mirrors and top slit.

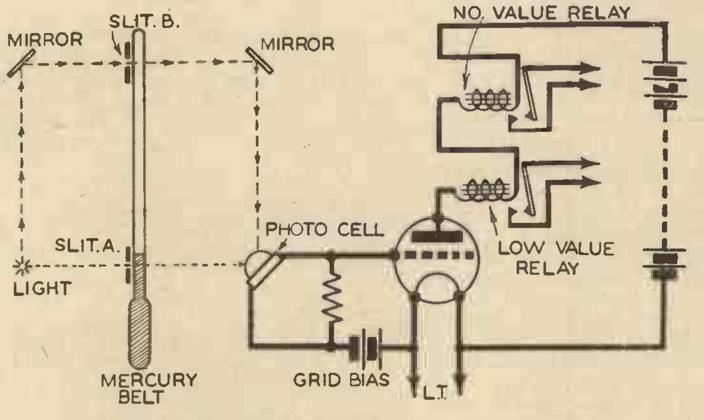


Fig. 4.—The arrangement of the photo-cell thermometer.

When the mercury has covered the lower slit, cutting off the light through that particular slit on to the photo cell, the output of the photo cell, which, it should be noted, still receives light *viâ* the mirrors and the top slit, will be nevertheless reduced, and, if necessary, a relay can be adjusted to operate at this point.

As the temperature goes up and the mercury rises, it will eventually close the top slit, and the output of the photo cell will cease altogether. A further relay can be made to operate at this point a warning signal, or, if necessary, control thermostatic gear.

The Photo-gas Flow Meter

An example of the use of a ray of light to indicate the action of something which is mechanically inaccessible is the method employed to measure or indicate the rate of flow of a gas in a pipe (see Fig. 5). The gas revolves a fan bearing slots which intercept the ray of light from a lamp passing through the slots on to a photo cell. The speed of rotation affects the amount

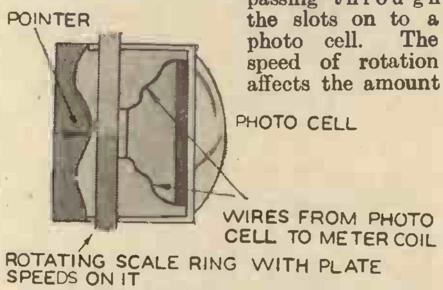


Fig. 3.—Details of the photo-cell exposure meter.

of light falling on the photo cell, but the revolving vane, not being mechanically connected to the measuring device, is free to revolve in the gas flow, and is subject

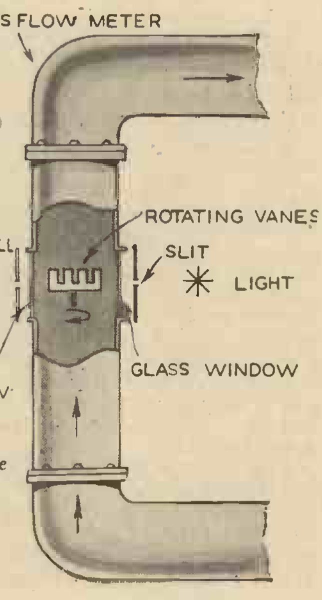


Fig. 5.—The photo-cell gas-flow meter.

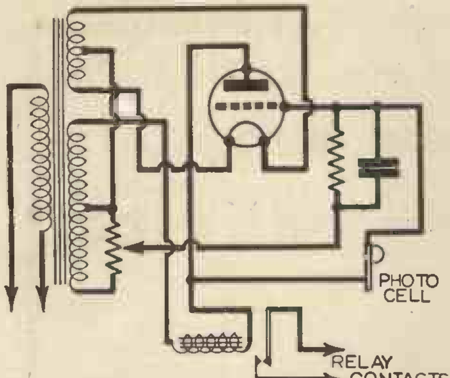


Fig. 8.—A photo-cell working entirely off A.C mains.

only to the friction of the pivot, on which it revolves, which is very small.

The Photo Cell as an Automatic Tester

One of the cleverest applications of the photo cell in the radio industry is the use of the cell to detect movements of a wheatstone bridge galvo for the automatic acceptance or rejection of mass-produced resistances. Fig. 7 shows the arrangement of the bridge and galvo, and Fig. 6 the arrangement of the photo cells. Only resistances having a valve between certain limits are accepted. The units are fed on a conveyor, which passes them between contactor clips, which are in turn connected to the wheatstone bridge.

If the galvo needle swings too far to the right or left, a ray of light impinging on a high-limit or low-limit photo cell is interrupted. Whichever photo cell is affected operates a rejector ram, which throws the resistor into a high or low position, as the case may be. Photo cells incapable of optical fatigue have been in operation day and night continuously for five and six years with perfect reliability, and with the

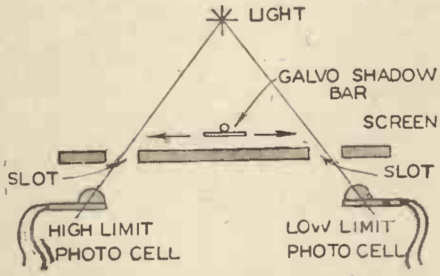


Fig. 7.—The arrangement of the wheatstone bridge and galvo.

aid of their cousin, the radio valve, can control far heavier things than galvo needles or columns of mercury.

The huge high-speed printing plants of daily newspapers are started and stopped, as it were, by a mere wink, by photo cells watching the miles of paper tearing along into the press for the slightest sign of a split or a break. If the paper does break, the alarm gongs go, and the vast machines slow up and stop as soon as a second photo cell "sees" the broken end of the reel of paper arrive at a point where the menders are standing by to join it up again.

The fact that photo-cells are themselves rectifying devices, makes it possible for exceedingly robust self-contained units to be built which operate entirely off alternating current, and which can be installed in exposed places, such as steel rolling mills, where they perform the double functions of watchman and sheer operators. Fig. 8 shows a typical A.C. photo-cell circuit for A.C. mains.

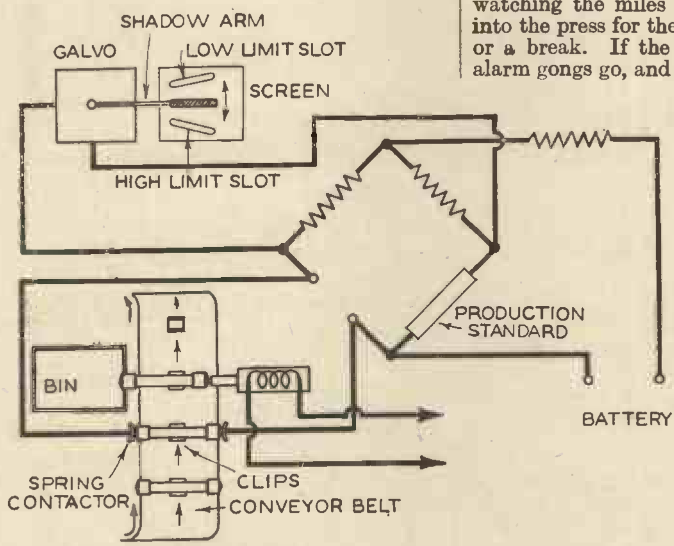


Fig. 6.—The arrangement of the photo cells for the automatic tester.

Photo Cells in Steel Mills

The white hot steel rails which shoot out of the rolling mills and streak across the floor of the sheds at the speed of an express train take some getting used to. The slightest touch is disfigurement or disability for life. But in the modern mill photo cells are relentlessly watching the danger areas. If any careless operator steps across one, the photo watchman links up electrically with another cell, which has already " seen " the rail enter the rollers from the other side, and lets fly the alarm gongs, and if necessary stops the rollers after a interval of time by means of an ingenious " pause " circuit, which makes use of the discharge period of a condenser through a given resistance, Only one of these circuits can be dealt with in these present notes, but the application of them, specially in photo traffic control, will be dealt with on another occasion. Fig. 9 shows a photo-cell " pause " circuit.

How the " Pause " Circuit works

While the contacts of relay " A," which is opened by the photo cell, are closed, the

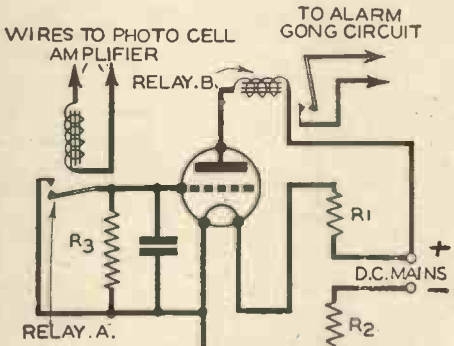


Fig. 9.—How the photo cell can be made to pause.

grid of the valve is kept negative with regard to the filament, thus stopping the flow or anode current through relay " B." When, however, the photo-cell amplifier opens the contacts of relay " A," this negative potential is removed from the condenses, which starts slowly to discharge through the resistance R3. As this occurs, the negative bias on the grid of the valve if gradually reduced, and the anode current through the relay " B " slowly rises until the relay " B " is actuated and its contacts are closed, making the alarm gong or roller control gear circuit.

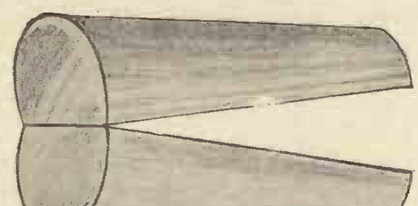
THE MAGIC EGG

The solution to the trick described on page 532 of last month's issue.

How it is Done

Pick up the empty tumbler and hold it over and partly inside the mouth of the bag. With the other hand pick up bunches of confetti and drop them into the tumbler. The bag should be so placed on the table that the empty compartment is towards you, and the tumbler, held in the right hand, poised just over the empty compartment. The left hand lifts the confetti from the side nearest the audience and its movement is from front to back. When the visible tumbler is nearly full, and as seemingly the last handful of confetti is to be placed into it, it is allowed to drop into the padded compartment masked by the approaching left hand, which, on its last journey, brings, not loose confetti, but the prepared tumbler, which, kept well covered by the hand holding it, is carried forward into the right hand to take the place of the one just released, the hinged portion of the partition yielding under slight pressure to make way for it. A final pinch of confetti is piled above the fake in the glass and then casually shaken back into the bag, as though to level off the surface. The combined movements are very deceptive, and to all appearance the glass is filled with loose confetti. The bag, having served its purpose, is placed aside to leave the table clear for the glass so that the latter is the object of attention and that the former may be forgotten. The glass is covered with the handkerchief, the egg is taken in the left hand and the fan in the right. As the egg is fanned the shell is crushed and the mass of confetti kneaded by the fingers. This loosens it to facilitate its scattering and also breaks up the shell which mingles and falls with it.

In lifting the handkerchief from the glass, the thread is seized through the fabric and withdrawn with it, leaving the egg in the glass. In conclusion, the egg is broken into the tumbler to prove its genuineness.


Details of the shell showing how it is cut.

ALL RADIO QUESTIONS ANSWERED FREE.

The PRACTICAL MECHANICS Wireless Experimenter

Every Question must be accompanied by the Coupon on page 3 of Cover.

THE "PRACTICAL MECHANICS'" TABLEGRAM

A neat and compact table radio-gramophone which is designed and built on novel lines.

THE gramophone is obtainable in either a pedestal cabinet form or in a more simple design intended for occasional use. In this latter form it may be built into a portable cabinet or in a small table cabinet which may not be obtrusive when not in use. The combination of a radio receiver and a gramophone has hitherto only been carried out by assembling the separate parts of the apparatus in a large pedestal cabinet, but in the "Practical Mechanics'" Tablegram we have incorporated the idea of a table model gramophone which contains all the essentials of both radio receiver and gramophone, and, furthermore, possesses the advantage of entire mains operation.

The apparatus is divided up, the turntable and electric motor, together with the pick-up, being fitted immediately beneath the lid on the upper surface of the table cabinet, and the radio receiver proper being mounted on a shallow chassis fitted on the bottom of the cabinet. The controls thus project through the front in the most accessible position, and immediately above these is the opening for the loud speaker. This component is mounted on a separate base, which is supported on side runners in the cabinet, and the entire mains unit is included on this base. Connection between receiver, mains unit and gramophone pick-up is carried out between the units by means of ordinary flex.

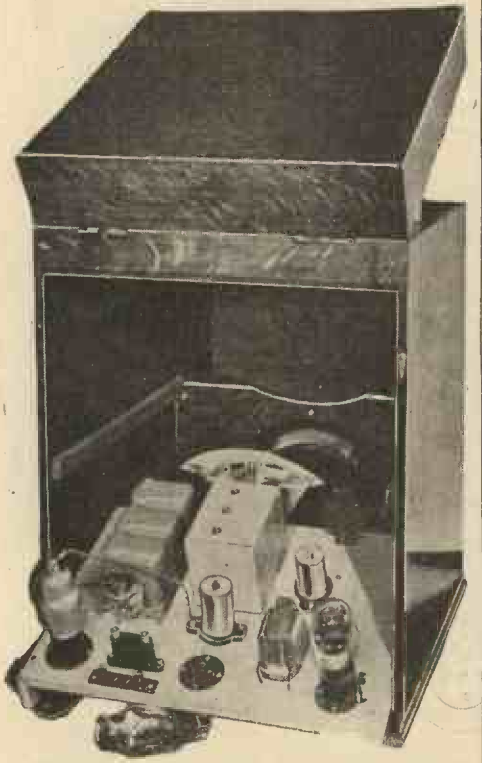
Construction

Using the wiring diagram and the photographs as a guide, mount the components on the receiver chassis. Note that holes or slots will have to be cut to enable the leads from the coils to be passed through the chassis, and also that a number of small holes are needed in order to carry the connecting wires from the upper to the lower surface of the chassis. When all the parts are mounted, carry out the wiring with the coloured connecting wire, using flex in its twisting condition for wiring the heater circuit of the three valves. Next mount the mains section and the loud speaker, the wiring for this section being carried out on the upper surface of the base and no holes being required. Extending from this section are the heater leads, the H.T. negative and positive leads and the connections for the loud speaker. The four leads which comprise heater and H.T. supplies should be twisted together and fixed to the base by means of an ebonite or wooden cleat and then carried down to the chassis, or, alternatively, the leads from the chassis should be made of sufficient length to reach up to the mains unit and then cleated to the chassis; a hook cleat may then be attached to the mains unit base to hold the wires in position. The leads to the loud speaker should be kept away from the power supply leads and preferably held at the opposite end of the base or cabinet by means of a small cleat. The leads from the pick-up have to be joined between the switch on the coil assembly and earth (H.T. –), and accordingly one lead should be joined to the negative terminal on condenser C 14 in the mains unit, whilst the other is taken down to terminal P on the coil switch. The gramophone motor must be joined up according to the maker's instructions, connecting the leads to the mains input terminals on the mains transformer. Make certain that the motor setting is correct for the particular voltage of your mains, and then when this is joined to the mains transformer the switch on the receiver will bring the motor into circuit, although it will not run until the pick-up carrier arm is moved to the playing position and the automatic stop thus released. As this is both an electrical make-and-break as well as a mechanical break, the motor is prevented from injury.

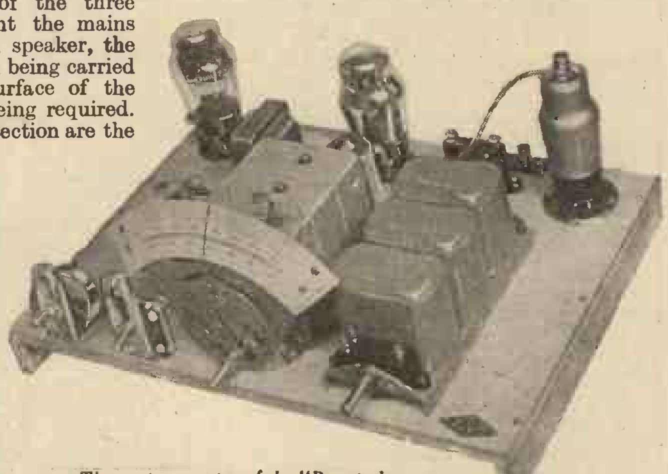
This view shows the completed radiogram in its neat cabinet.

Check the Wiring

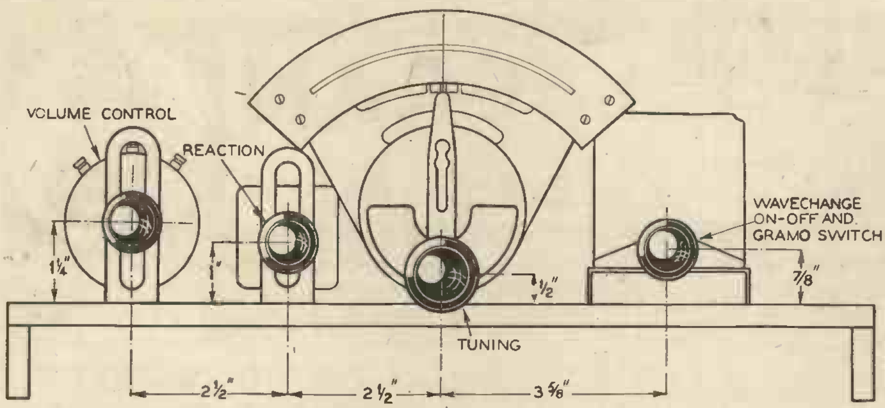
Before making connection to the house mains it is essential to go over all the wiring and carefully check the connections. Although fuses are included in the mains plug these will blow if a short-circuit is caused in the receiver and you will be wasting time waiting for the valves to heat up. Note that the mains plug is of the two-pin type, and must therefore be inserted into a two-pin socket. Usually this type of socket is arranged on the power side of the circuit in the house, and therefore it will be necessary to arrange sufficient length of flex to reach to the nearest point, after the position of the receiver has been decided upon. Should it be desired to use the apparatus in conjunction with a lighting point the specified two-pin plug should be



The receiver portion of the "Practical Mechanics'" Tablegram in its cabinet. The mains unit shown on the left stands on the upper shelf.



The receiver portion of the "Practical Mechanics'" Tablegram.



Dimensioned diagram of the controls of the radiogram.

retained and one of the lamp-socket adaptors should be obtained and plugged into the lamp-socket so as to accommodate the two-pin plug. When checking the wiring it is a good plan to use a meter and a battery, thus making perfectly certain that joints are soundly constructed as well as short-circuits avoided. When finally certain that everything is in order the receiver may be tested out, but for this purpose it is preferable to ignore the pick-up connections, and to place the receiver and the mains unit side by side on a table so that all connections are easily got at for testing purposes.

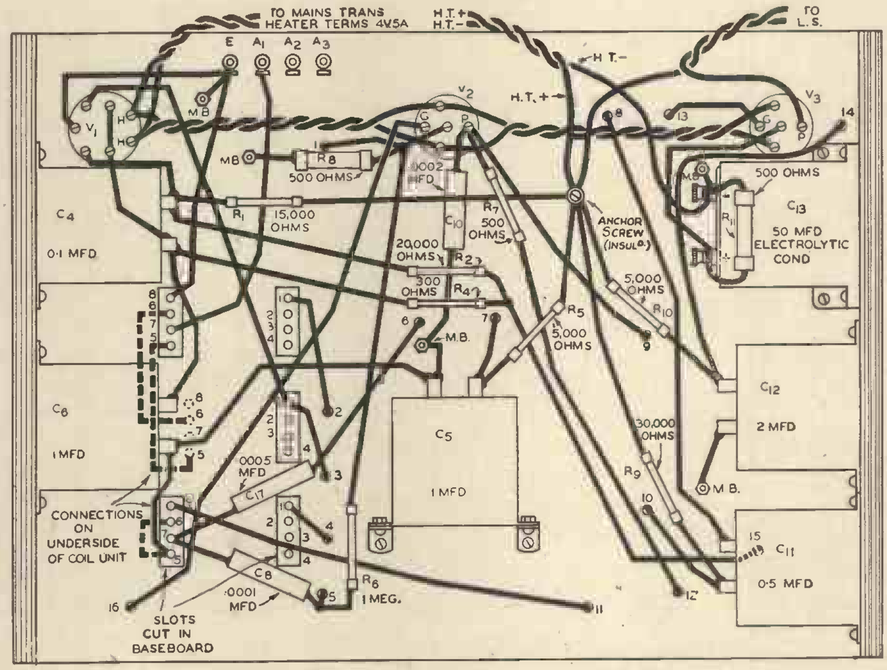
Operation

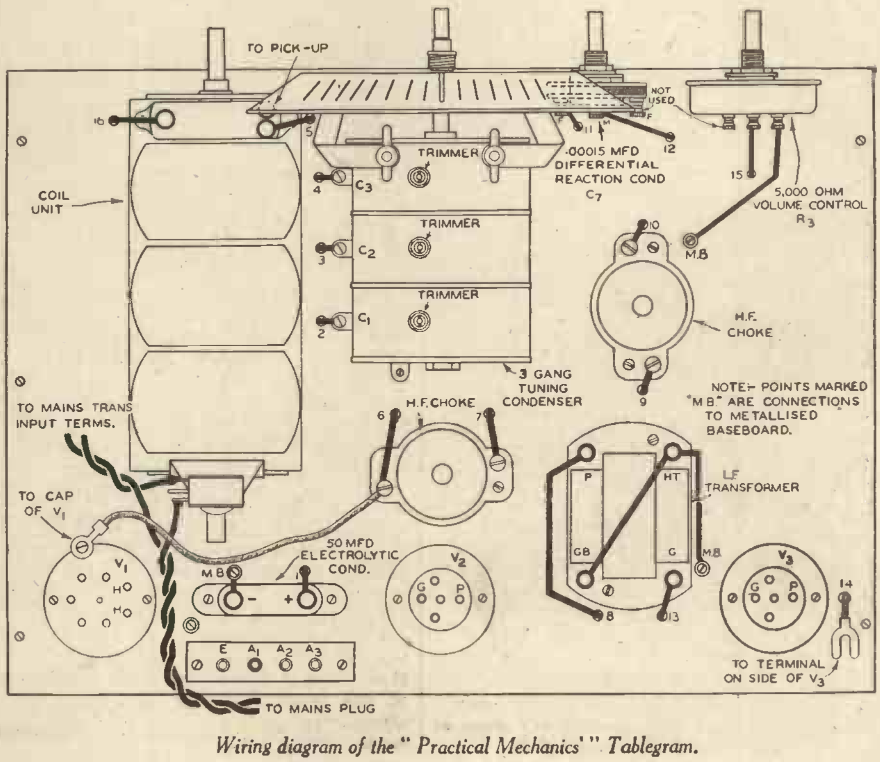
Operation of this instrument is simplicity itself. The control knob on the coils has four positions—when turned in an anti-clockwise direction as far as it will go the receiver is switched off and is dead. As it is rotated in a clockwise direction it will fall into definite positions, the first being the medium waveband, the second the long-wave band and the third switches out the tuning circuits and connects the grid of the detector valve to the pick-up circuit. A small letter will be found embossed on the control knob to indicate these positions, so that no difficulty should arise. When the coil switch has been adjusted to the desired position, the main tuning control should be turned so that the pointer is in the position indicating the nearest station, and if any doubt arises concerning its exact wavelength the programmes published in the daily paper or the *Radio Times* should be consulted. Provided that the station is not too far away, it should be possible to hear some sort of signal at this setting, and the extreme left-hand control should then be adjusted to reduce the strength of the signal to almost inaudibility. Now carefully adjust the

(*Continued on page* 566.)

LIST OF COMPONENTS

One set Ferrocart Coils, G1, G2 and G3, with Mains Switch, Colvern.
One Midget Three Gang Condenser, ·0005 mfd. with Drive, Polar.
One ·00015 mfd. Differential Reaction Condenser, Polar.
Two S.H.F. Screened H.F. Chokes, Ward and Goldstone.
Two 5-pin and one 7-pin Chassis Type Valveholders, Clix.
One Toco L.F. Transformer, Multitone.
One 5,000-ohm Volume Control, Burne Jones.
One W.31 Mains Transformer, Heayberd.
One H.T. 8-metal Rectifier, Westinghouse.
Three 4 mfd. Fixed Condensers (350-volt test), T.M.C.
One ·0001 mfd. Tubular Condenser, T.M.C.
One ·0002 ,, ,, ,, ,,
One ·0005 ,, ,, ,, ,,
Two 1 mfd. Type 25 Fixed Condensers, T.M.C.
One ·1 ,, ,, ,, ,, ,,
One 2 ,, ,, ,, ,, ,,
One ·5 ,, ,, ,, ,, ,,
One 30,000 ohm. Fixed Resistance, Ferranti.
One 15,000 ,, ,, ,, ,,
One 20,000 ,, ,, ,, ,,
Three 500 ,, ,, ,, ,,
One 300 ,, ,, ,, ,,
Two 5,000 ,, ,, ,, ,,
One 1-megohm Grid Leak, Ferranti.
One Mains Smoothing Choke (Type 751), Heayberd.
One M.C.22 M.C. Speaker, Amplion.
One Tablegram Cabinet, Peto-Scott.
One Metaplex Chassis, 14" × 10" with 1½" runners, Peto-Scott.
One Bulgin Mains Connecting Plug with ·5 amp Fuses, Bulgin.
One AC/VP Valve, one AC/HL Valve, and one AC/Y Valve, Hivac.
One 50 mfd. (Type 501) and one 50 mfd. (Type 521) Electrolytic Condenser, T.C.C.
One Belling-Lee A. and E. Strip.
Flex, Connecting Wire, Screws, etc.
One Garrard Electric Gramophone Motor
One Pick-up, Belling-Lee.
Two Component Brackets (2½ in.), B.R.G.





Wiring diagram of the " Practical Mechanics' " Tablegram.

The mains section and the loud speaker.

(*Continued from page* 564.)

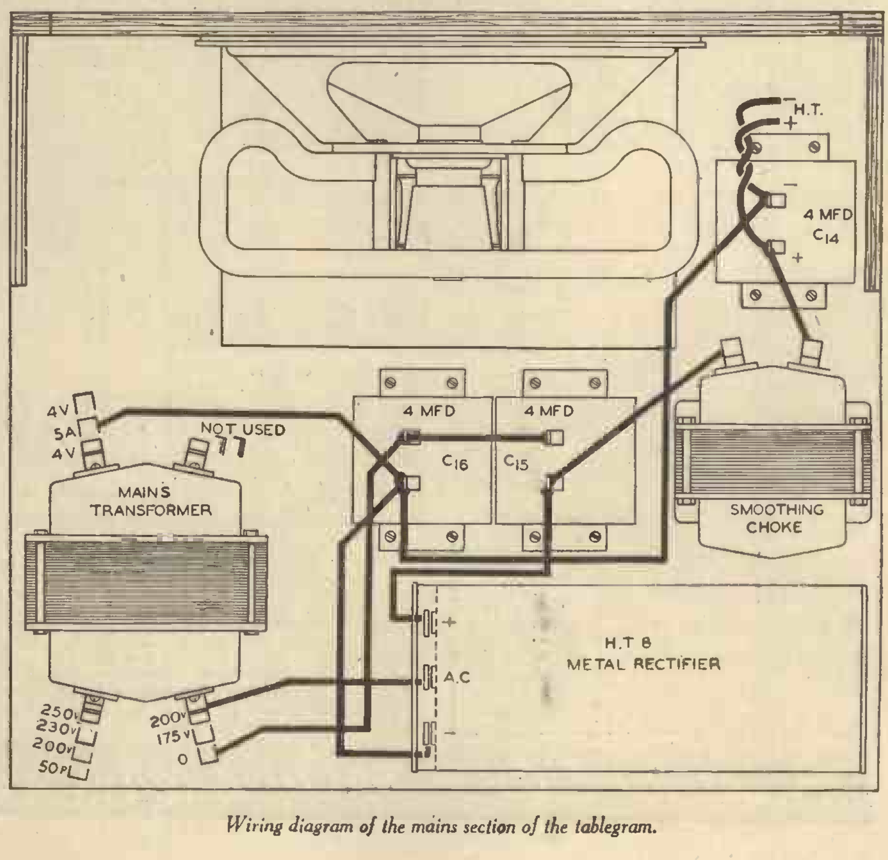
screws projecting from the top of the ganged condenser until signal strength is improved, and as soon as an improvement is obtained again reduce strength by means of the left-hand control. Proceed in this way until the maximum setting has been found on the three trimming screws, when the receiver will be accurately ganged and no further use need be made of these adjustments. It should now be possible to rotate the tuning control throughout the entire scale and the left-hand control will increase or reduce the volume as desired on all but the very weak stations. For these it may be found necessary to increase signal strength above that obtainable with the left-hand control, and therefore the control situated immediately on its right should be used. This is an ordinary reaction control, and, generally speaking, its use should not be found necessary. It will increase the strength of stations only at the expense of quality, and therefore it should only be employed when a very weak station must be tuned in.

Possible Faults

Although a receiver of this nature is remarkably free from faults there is always the possibility that some little point may have escaped attention, or that one of the parts has broken down or is faulty, and thus prevents the receiver from functioning in the correct manner. Therefore, as soon as the receiver is switched on it should be noticed that the cathode in the pentode output valve will immediately commence to glow. After a very short interval a faint hum will be heard from the loudspeaker if everything is in order. If this does not occur, and no glow can be seen in the valve when it is screened from direct light by the hand, it will be safe to assume that either the fuses are not intact or that the plug is not making good contact in the holder. Move the plug about and see if any noise can be heard from the speaker. If not, remove the plug and open it and examine the fuses. A fine wire should be seen passing down the centre of each tube, and if this is missing, then the fuse has blown due to an overload and the wiring must be checked, as there is a short-circuit. If, on the other hand, the valves immediately commence to heat up when switched on, and the hum may be heard at the speaker after fifteen or twenty seconds, but no signals are obtainable, it may be that the volume control is set to its minimum position, so rotate this to its maximum position in the opposite direction, and then rotate the tuning dial. If no signals can be heard then, the pointer on the dial should be set to the exact wavelength of the local station, and then the centre trimmer on the three-gang condenser should be turned in each direction. If this does not produce a signal, it should be moved slightly in one direction whilst the trimmer nearest the control knob should be turned and it will be found that a station can be heard with some setting of these two trimmers. If, however, no adjustment of the trimmers will bring in a station, then it will be safe to assume that there is a fault in the wiring, and to localise this it is preferable to cut out the first stage by removing the aerial from its socket and connecting it to the anode of the H.F. valve, whilst this is left in its socket. On no account should any valve be removed whilst the receiver is switched on, as a surge may be caused which will result in the breakdown of some component, or the fuses may blow and cause trouble in location. If signals are obtained when the aerial is joined to the anode of the H.F. valve, then it will indicate that the fault arises on the H.F. side of the receiver, and it should not take long to find this. If, on the other hand, the receiver is still silent, then the trouble should be looked for between the detector and the output valve. Systematic searching in this manner should soon enable any possible fault to be traced, and the receiver to be put into working order in a very short time.

When reproducing gramophone records the volume control on the panel will not affect the volume of reproduction, and the control fitted to the pick-up must then be employed. Generally speaking it will be found that a needle of the loud type (such as the Columbia Talkie) will give the best all-round results, and surface noise is not unduly heard. With band or other loud records the volume control should be set before the lid of the cabinet is closed down (after inserting the needle) and the general level of volume will probably be found to be such that the control needs no adjustment after once setting. To facilitate needle changing it would be a worth-while refinement to fit two gramophone needle cups to the motor-board, one for new needles and one for old needles. These are obtainable from any gramophone shop, or Messrs. Bulgin will supply a complete unit ready to screw to the motor board. Fit the used cup immediately below the needle when the pick-up arm is placed in its normal rest position, and the needles may then be dropped straight into the cup merely by loosening the locking screw. It should be unnecessary to add that this cup should be provided with a lid having only a small hole so that used needles are not replaced in the pick-up with consequent damage to the record.

If it is felt that some further safeguard is required over and above that furnished by the fuse-plug a further fuse may be inserted in the H.T. circuit. One of the popular Microfuses may be used for this purpose, and it should have a rating of 1 amp. It should be joined in the lead connecting the A.C. terminal on the Metal Rectifier (see Wiring Diagram below) and the 200-volt terminal on the Mains Transformer. At present a single wire is used in this position, and it will only be necessary to cut this wire, screw the Microfuse to the base and then connect the cut ends of the wire to the two ends of the Microfuse. The failure of the receiver, should a short-circuit arise, will be indicated by a blown fuse, whilst the fact that there are also fuses in the mains plug should be borne in mind.



Wiring diagram of the mains section of the tablegram.

OLD WATERLOO BRIDGE

Interesting facts about its construction and some reasons for its decay.

THE failure by subsidence into the bed of the Thames of part of this famous bridge, the many arguments and discussions — often heated — in the Press, Council Chambers and Parliament, regarding the merits and demerits of the bridge, and its demolition and replacement by a new and modern bridge, causes us to reflect upon the traffic conditions that existed nearly a century and a quarter ago, and the scientific knowledge and materials in use then, and the conditions and knowledge of our modern times.

Mud, Clay and Timber Foundations

But few motorists who used Waterloo Bridge, and spectators who admired its nine spans of 120 ft. each, constructed with heavy granite arches and about 20-ft. thick abutments, gave much thought to anything else except what could be perceived *above* water level, and the conveniences of transit. The lay mind seldom gave much thought as to what existed *below* water level, and the ravages that were occurring in the foundations due to time, and the use of constructive methods and materials about 120 years ago that do not conform to present-day principles, which are considered to ensure a much longer life than 120 years for a bridge.

An outstanding feature of Waterloo Bridge is that the many thousands of tons of dead load of masonry, and the super loads of modern day traffic, with its considerable vibration, have foundations consisting of heavy timber platforms placed at about the level of the river bed, such platforms being supported by timber piles driven into the London clay under the river bed. The illustration will give a good idea of the method of construction.

An Interesting Point

Although certain timbers, when kept constantly wet, resist decay for a very considerable time, it is difficult, especially in the face of present-day knowledge, to fail to be surprised that the natural decay of the timber due to time, insects and worms that attack wood, and the rotting agents that must exist in mud and clay, has not caused an earlier failure of the bridge. These conditions must raise in the minds of many thinkers the vital question as to whether the designers of the bridge, John Rennie and his son, Sir John Rennie, used the best principles in their time. (*It is unlikely that Rennie designed the bridge. It is more probable that Rennie's capable predecessor in office—Dodson—designed the bridge, and that Rennie succeeded in getting Dodson removed from office, filching the credit really due to Dodson. The design of the arches is, however, open to severe criticism.*—ED.) A little thought and research brings to light some interesting facts which tempt one to conclude that materials and principles of bridge construction in use in about 1815 were different to those used nowadays. Prior to 1824, when Portland cement was first introduced, lime concrete was used, which was considerably weaker than the modern Portland cement concrete. Reinforced concrete, that is, concrete which is strong in compression and weak in tension, having combined with it steel to resist tensile stresses, is a comparatively recent principle of construction.

Reducing the Total Dead Weight

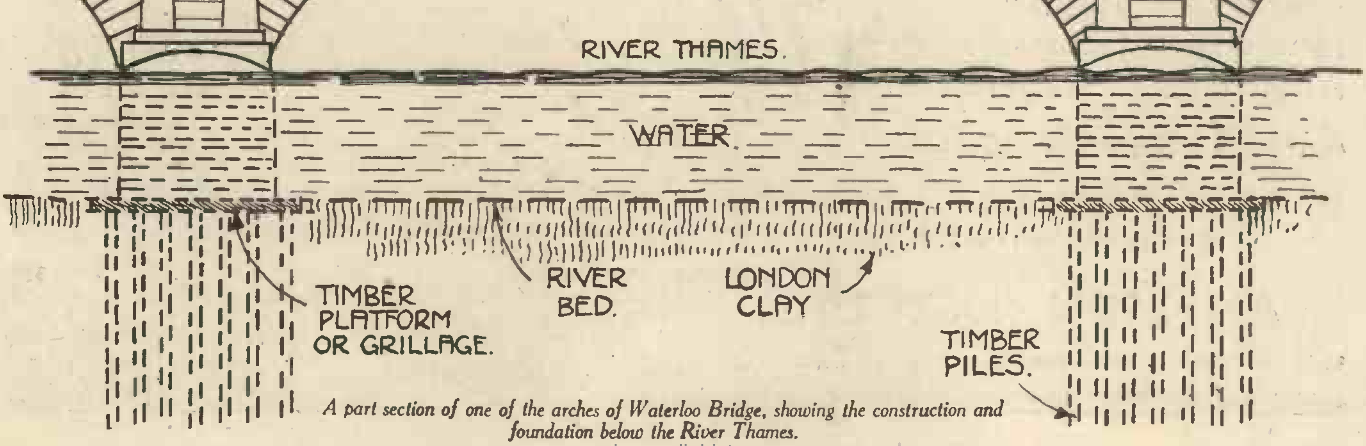
In summing up all the conditions, we feel that the methods and materials used in 1815 were in conformity with the principles that were then existent. It appears that it would have been possible to have reduced the total dead weight of the bridge, and still maintained an ample margin of safety, by reducing the size of the 20-ft. thick piers or abutments, and providing a greater area at the base of them, which would have had the effect of spreading the load over a greater area of river bed, and possibly eliminating the necessity of the timber platforms, and to allow the loads to be carried on the piles and clay only.

We favour the view held by some authorities that the timber foundations have rotted, and also feel that due respect must be given to the opinions of other experts who think that the weight of the bridge was too great for the foundations, and also that currents have swept away some of the gravel which appears to exist in addition to the clay under the foundations. It must be stated that there appears to be evidence that the woodwork is still quite sound, but too much reliance should not be given to this evidence, owing to the difficulties of carrying out tests before the bridge has been demolished.

At the present time no one can tell with certainty what is the cause, but when the old bridge is demolished it is certain that our great modern engineers will find the cause and take precautions to prevent the new bridge failing.

Old Rivers beneath the Thames

It is exceptionally interesting to be able to state that it is possible that the cause of the subsidence of Waterloo Bridge may be partly attributed to the action of a small river, the Fleet, which existed a very long time ago, and which, according to one authority, wended its way along a course (different to that which it does now) which went under the present positions of the Thames and the centre of Waterloo Bridge, and entered into one of the old courses of the Thames which was by the Elephant and Castle. A well-known geologist, Mr. F. H. Mackintosh, who was consulted regarding a problem which arose in connection with the foundations of Unilever House, Blackfriars Bridge, discovered, after boring operations, the old channel of the River Fleet, *its course being directed towards the centre of Waterloo Bridge!* The geologist advances the theory that the old channel of the Fleet caused disturbances in the geological formation of the ground under Waterloo Bridge, and that in consequence there are certain pockets of gravel and re-deposited clay that may have affected the foundations of the bridge.



A part section of one of the arches of Waterloo Bridge, showing the construction and foundation below the River Thames.

HISTORIC LOCOMOTIVES

PART V

By E. W. TWINING

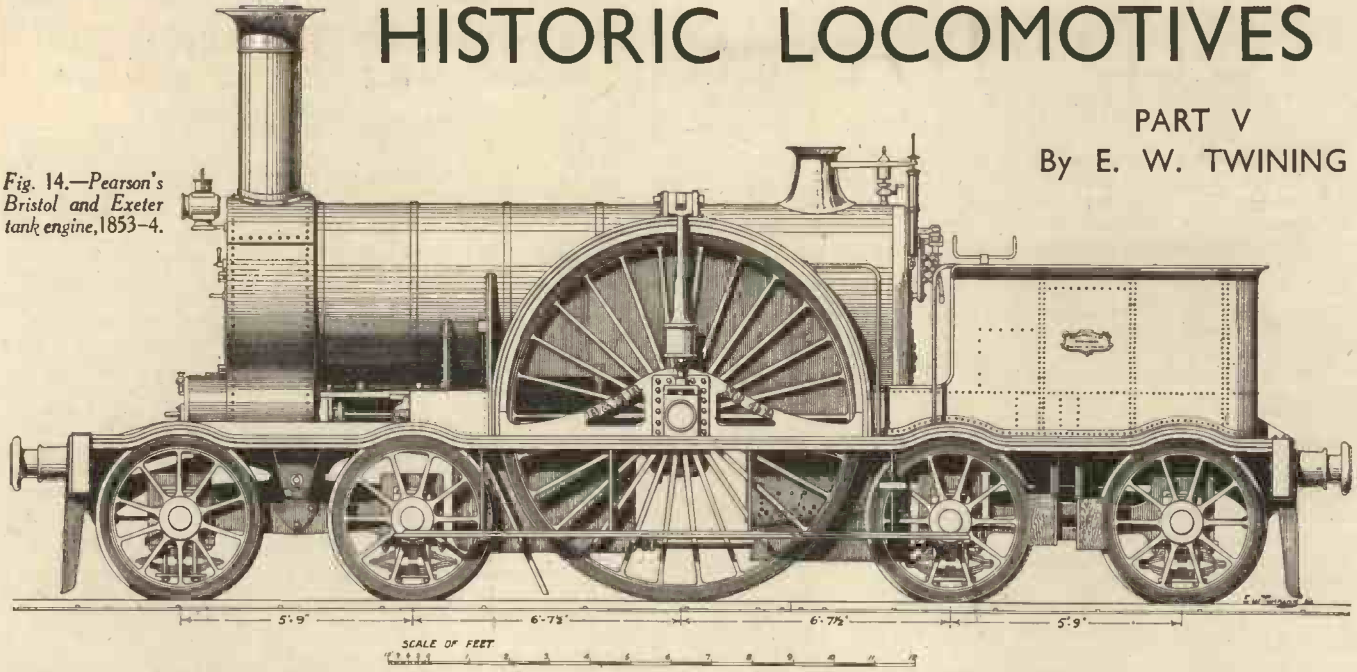


Fig. 14.—Pearson's Bristol and Exeter tank engine, 1853–4.

THE next class of locomotive which I think should be recorded as having outstanding characteristics is a batch of eight, numbered 39 to 46, designed by Mr. Pearson, the locomotive engineer of the Bristol and Exeter Railway, for working the express passenger trains between the two terminal points of his line. The railway was broad gauge and formed a continuation westward of the Great Western main line. These engines achieved world fame for themselves by putting up the high authenticated speed of 81 miles per hour, which was not exceeded until after the close of the nineteenth century.

They were of unusual design and of extraordinary construction. The wheel arrangement was of 4—2—4 type, as will be seen in the drawing (Fig. 14), that is to say, there were two four-wheel bogies, one at either end, which had no side play, being pivoted at their centres on ball and socket joints. The driving wheels were the largest ever successfully run and the largest made in Great Britain, with the exception of the two or three early freak engines of the G.W.R. in 1837. They were 9 ft. in diameter and had no flanges.

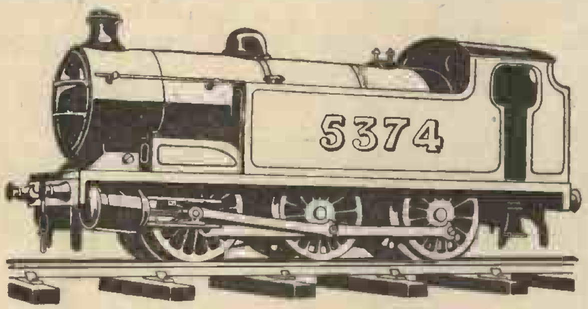
These Bristol and Exeter engines had no tenders. They were thus double-enders and carried their water in two tanks, one in the normal position behind the firebox and the other slung beneath the boiler in front of the driving axle and partly underneath and partly between the motion. They were constructed by Rothwell & Co., of Bolton, Lancashire, and were delivered in 1853 and 1854. Their weight loaded was 42 tons and the valves were operated by Gooch valve gear. There appears to be no record of the heating surface or of the firegrate area, but the first could not have been greater than 1,100 sq. ft., and the latter not more than 20 sq. ft. Although the boiler was small, it supplied steam to a pair of cylinders measuring $16\frac{1}{2} \times 24$ in. It speaks well for the efficiency of these engines when it is stated that the fuel consumption was only $21\frac{3}{4}$ lb. of coke per mile.

Turning to the construction, which I referred to as having been extraordinary, the frames were extremely light, measuring only 8 in. deep and terminating at the firebox, to which they were riveted. As will be seen in the drawing, there was an outside frame with axle boxes at the driving wheel, and the weight of the engine carried by the driving axle was transmitted through rubber springs from the top of the boiler; thus the light inside frames took up only the working stresses of the machinery. The leading bogie had its pivot pin attached to the cylinders, whilst the rear bogie was pivoted to the underside of the main tank. It will be seen, therefore, that the firebox had to take up all road inequality stresses, and the boiler barrel, through the front tube plate, took those occurring in front of the driving axle. Obviously, through the firebox also was transmitted the draw-bar of the train.

Perhaps even more extraordinary than the construction is the fact that these locomotives ran consistently well for fifteen years, that is to say, until 1868, when they were scrapped and new engines of similar type were built, having continuous frames

Fig. 15.—Gooch's broad gauge engine "Ivanhoe," 1855.

"HIGH SPOTS" from the BASSETT-LOWKE Model Works



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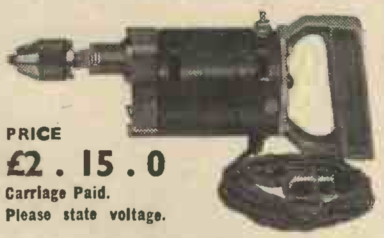

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from buffer beam to buffer beam and 8 ft. 10 in. driving wheels. It has been stated, and I have no doubt it is correct, that when first built, the springs to all the axle boxes were of rubber enclosed in cylindrical cases, but there is photographic evidence that

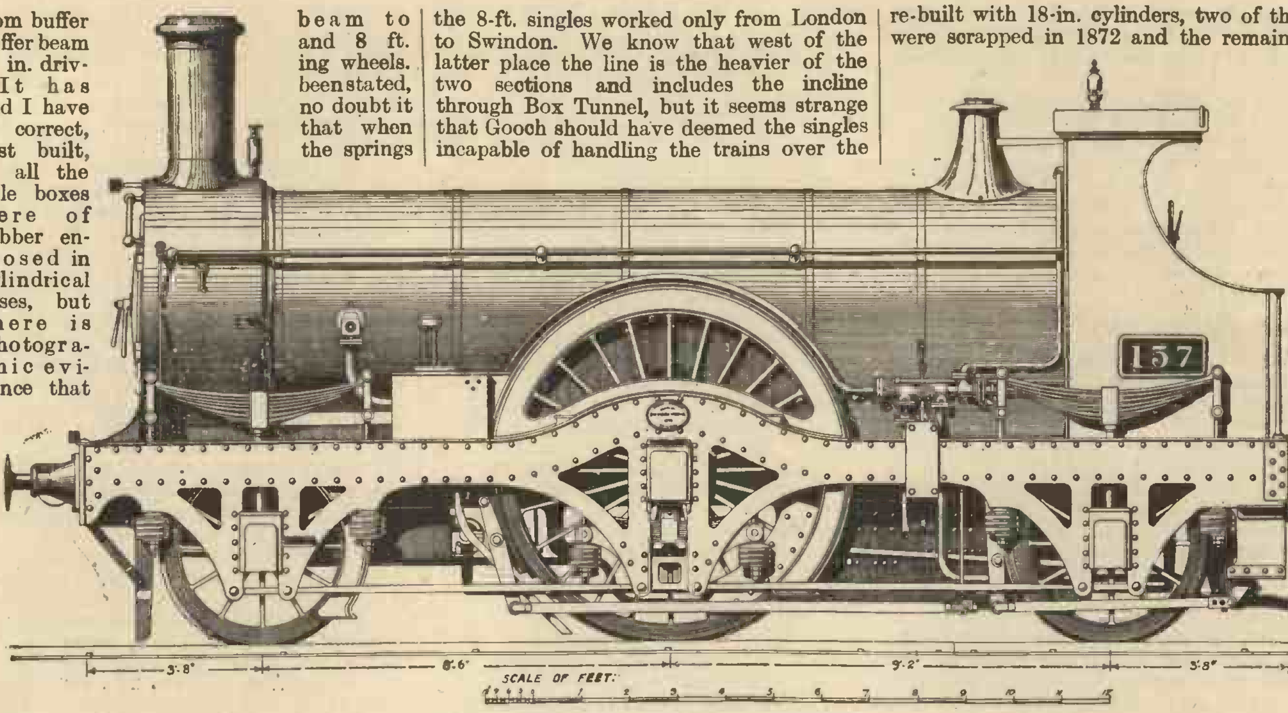

Fig. 16.—Dean's 7-ft. singles, nos. 157–166, 1879.

if this were so, they were removed from the bogies and double-leaf springs substituted, as shown in the drawing. There were axle boxes both inside and out of the driving wheel, and similar type springs were fitted to each, the rods rising upwards from their cases, being attached to a short equalising beam over the centre of the wheel, the beam being pivoted on the brackets carried out from the boiler.

Gooch's G.W.R. 4—4—0 Class

Reverting to the Great Western Railway, on which line trains must have been increasing in weight, we find that Gooch did a somewhat peculiar thing. He built in 1855, ten large eight-wheeled coupled passenger locomotives, with the 4—4—0 wheel arrangement named, with one exception, after the novels of Sir Walter Scott. These engines were put on to work the trains from Swindon to Bristol, and the 8-ft. singles worked only from London to Swindon. We know that west of the latter place the line is the heavier of the two sections and includes the incline through Box Tunnel, but it seems strange that Gooch should have deemed the singles incapable of handling the trains over the western gradients in view of the fact that, after these coupled engines were scrapped, the singles worked unassisted through to Bristol for twenty years prior to the abolition of the broad gauge, when the weight of trains had become still heavier.

The four-coupled engines, one of which is shown in Fig. 15 were splendid machines. The whole batch was built by Robert Stephenson & Co. in 1855. They had 7-ft. coupled drivers with 4 ft. 3 in. carrying wheels, which latter were not arranged in a bogie. The driving wheels, however, were without flanges. The cylinders were 17 in. diameter by 24 in. stroke. The heating surface was 1,574 sq. ft. and the grate area 19·2 sq. ft. The weight loaded 36 tons 13½ cwt. As will be seen, the frames extended the whole length of the engine and were of the sandwich pattern, but placed inside of the wheels. The foot-plating and splashers were one unit, and the face, seen in side elevation, was wholly of polished brass. Some of these engines were re-built with 18-in. cylinders, two of them were scrapped in 1872 and the remaining eight ran until 1876. From the few photographs which appear to be in existence, the majority seem to have had their name plates upon the boiler barrel towards the front end, but "Ivanhoe," at least, had the plates on the firebox as I have shown them.

I am sorry that, chronologically, I have now to leave a big gap between these coupled locomotives and the next noteworthy batch of engines. Strange as it may seem, nothing new of outstanding size or power for working passenger traffic was put upon either the Great Western or any other rails. I do not wish to imply by this that no fine engines were designed or built, but only that on no other line was there anything introduced which exceeded in size, weight and power the two classes, single- and four-coupled, which I have described

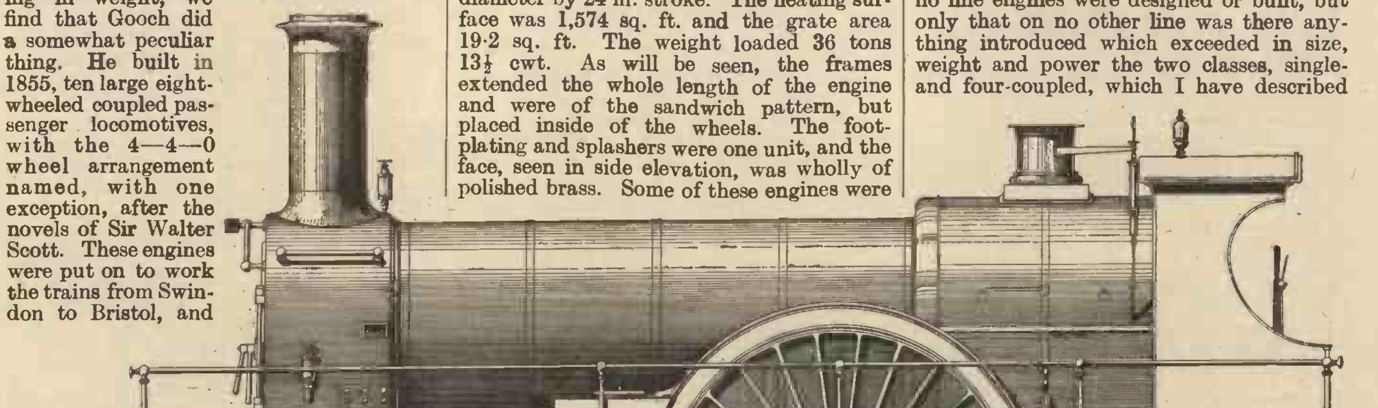

Fig. 17.—The last broad-gauge engine built, "Tornado" 1888.

in which Gooch reached his ultimatum. Many fine examples of locomotive engineering could be mentioned; for instance, there were Johnson's four-coupled bogies on the Midland, Patrick Sterling's 8-ft. bogie singles on the Great Northern, Stroudley's 0—4—2 class on the Brighton line, and Drummond's 4—4—0 on the North British, to give only a few, and although my next drawing shows a class which was perhaps no larger than the general British practice of the time, it was certainly well up to the average, and so I am adhering to the Great Western Railway.

Dean's 157—166 Class

In 1864 Daniel Gooch ceased his work at Swindon as locomotive engineer, and was succeeded by Joseph Armstrong, who remained in the position until 1877, when William Dean was appointed. Two years after taking up his duties, that is to say in 1879, Dean designed what has been described as the handsomest class of engine which ever ran upon the Great Western metals. These, ten in all, numbered 157 to 166, were built for the standard 4 ft. 8½ in. gauge, and succeeded somewhat similar engines which had been designed by Gooch and built by Sharp, Steward & Co. in 1862. The whole ten were constructed by the Great Western themselves at Swindon. They were of the 2—2—2 type, with 7-ft. diameter drivers and 4-ft. leading and trailing wheels. The cylinders were 18 in. diameter by 24-in. stroke, and these were supplied with steam from a boiler having 1,214·27 sq. ft. of heating surface, the grate area being 19·3 sq. ft. Their weight loaded was 36 tons 3 cwt. As will be seen from the drawing (Fig. 16), the frames were of the sandwich pattern, and the open splashers were polished brass of particularly neat design. Only one of them bore a name, No. 162, "Cobham," but it is only right to say I have heard or read somewhere that No. 158 was named "Worcester" for a very short time, the plate being removed after about two months' running.

So useful were these engines found to be that they stood re-boilering twice. The first boiler renewals were of the same type, but with a dome encased in brass. The heating surface was increased to 1,328·2 sq. ft. and the grate area to 21 sq. ft. The second batch of new boilers were placed in the frames by the late Mr. Churchward from time to time during the early years of the present century. These were of the Belpaire pattern, all domeless and with safety valves on the boiler barrel except No. 160, which had a very large dome and the safety valve was over the firebox. The last of them to go to the scrap heap was No. 165, which ceased work early in 1915. It was the last locomotive of the 2—2—2 type to run in this country.

These engines worked chiefly between Paddington and Wolverhampton, and one of the duties assigned to them on the opening of the London to Birmingham direct route was the running of the non-stop express trains, which for the period were particularly heavy.

The Last Broad-Gauge Engine

By 1855 the full complement of single express engines necessary to deal with Great Western broad-gauge passenger traffic had been built, and after that date no new engines were added to the stock until 1880, but during the years 1876–80 most of them were either re-boilered or scrapped and renewed. In both the renewals and in the re-boilered engines the heating surface, strangely enough, was reduced to 1,793·4 sq. ft. In 1880 one entirely new engine was added, bringing the total number up to thirty. By 1888 some new boilers were again required, and this time Mr. Dean increased the heating surface to a figure never before known in British locomotive history. Three of the older engines were scrapped and new ones took their place, whilst three others were re-boilered, all with 2,084·7 sq. ft. of area, with a corresponding increase of grate area to 24 sq. ft. These figures remained unapproached until well into the present century.

Of the three new engines, the very last to be built in 1888 was the "Tornado," which left the Swindon works in July of the year mentioned. I give a drawing of this in Fig. 17. The cylinders were of the same size as those introduced by Gooch, namely, 18 × 24 in. The boiler diameter was 4 ft. 10 in. inside, the working pressure 140 lb. per square inch and the weight 41 tons 14 cwt. Only four years after the construction of these magnificent machines the broad gauge was abolished, and they, with their sisters and all the rest of the other broad-gauge engines, were collected together on specially laid temporary sidings at Swindon to await their breaking up.

The reader may find it of interest to compare the outline of the "Tornado," shown in Fig. 17, with that of the "Lord of the Isles" in Fig. 13. Here he will see that the latest of the class was very much modernised, having a cab and a vacuum train pipe carried through with hose for coupling up at the front. The boiler was fed by injectors, the check valves being on the firebox back plate. The inside frames were carried right through to the rear buffer beam instead of terminating at the front corners of the firebox. All Great Western engines, as well as, I believe, most on other lines, after the introduction of the vacuum brake system on the trains, were fitted with steam brakes, as shown in Figs. 16 and 17, probably because the steam cylinder occupied very much less space than would the vacuum. The driver's valve was arranged to operate both systems simultaneously.

I believe I am correct in stating that the three 1888 broad-gauge singles were the last locomotives built in England fitted with Gooch's radial valve gear.

(To be continued.)

GROWTH IN THE VOLUME OF AIR-BORNE MAILS

In all the developments which are taking place in aviation, none is more important than the increases which continue to be recorded in the volume of letters consigned by air.

During a recent period of three months, for which figures have just become available, there was a growth of nearly 50 per cent. in air-mail dispatches from this country to destinations in Africa, India, and the East. And the air-mail from London to the Continent, during the same period, showed a very substantial increase, also.

At the present time, air-mail leaving London each Saturday for India and the East is carrying approximately 50,000 etters a week; while the total outward-bound by Wednesday's service to Africa exceeds 30,000 a week, and is increasing steadily.

The Time Saved

Accelerations on our services now enables them to show still greater time-savings over surface transport. Take a few examples from these quickened schedules. To Baghdad the air-mail now saves from three to four days, as compared with ordinary dispatch. To Khartoum the saving is six to nine days. To Cape Town it is eight days. To Delhi it has become nine days. To Calcutta and Johannesburg it is ten days, and to Singapore fourteen days.

Big banking institutions are now expediting more and more of their correspondence by earmarking it for air-mail. It is the same, too, with many business houses which have to keep in regular touch with similar organisations along their Empire routes. In some cases the bulk of the letter-mail between certain firms is now scheduled for air dispatch. Another point emerging, just recently, is that an increasing amount of private correspondence is being transmitted by air along the Empire routes. Home news is so much fresher when it comes in a few days by air; while the homeland appears so much closer when you can send a budget of overseas tidings by air, and get a reply from England, in the time taken in the passage of a letter in one direction only by surface transport.

A Steady Growth

Statistics have just been prepared showing how air-mail loads have been growing from year to year. In 1924–25, which was the first year of Imperial Airways, their machines carried 100,000 letters. A year later this total had increased to 200,000, by 1926–27 it was 400,000. In the following year it had jumped to approximately 3,000,000. Another twelve months saw an increase of roughly another million, and by 1929–30 the total had gone up to 5,500,000. For the two following years the increase was at the rate of approximately 1,000,000 letters a year. In 1932–33 the total stood at more than 8,000,000. And nowadays they are carrying letters by air at the rate of roughly 12,000,000 a year.

An interesting photograph showing the inside of Prof. Piccard's gondola, in which he explored the stratosphere.

THE HEALING OF WOUNDS IN METAL

MARVELS OF METAL SURGERY

THE first craftsmen to discover that metals could be homogeneously united were blacksmiths, who centuries ago found that if two pieces of iron were raised to red heat in a forge and then beaten together on an anvil they would become as one.

This original welding process is still being practised to-day, but its limitations, of course, are numerous, and its application is restricted to the roughest and commonest work in iron—such as the joining of cart-wheel rims.

There, in a nutshell, is the early history of welding, which has sprung from the village smithy and which is now the best friend of engineers in almost every industry. For the layman to obtain a grasp of the processes which are employed to achieve such seeming miracles as the repairs which are shown in the accompanying illustrations, it is necessary to have an understanding of the first principles of this new art of metal surgery. A simple analogy can be quoted and will help to emphasise the essential differences between the various means for uniting metals.

Everyone has seen a chemist sealing a parcel with sealing wax. He sticks one piece of paper to another by introducing an adhesive between them. The sealing wax is like the ham in a sandwich. The joining of metals by soldering is a similar process to the chemist's, and so is brazing. In both cases there is not unity but mere adhesion, and the tinman's solder or brazing spelter may be regarded as nothing more or less than metallic glue.

The Process of Welding

Welding is a process of an entirely different nature. If the chemist welded the folds of his parcel he would not use sealing wax, but paper! Metal surgery provides complete unity akin to the healing of a cut finger or the setting of a broken leg.

As a science, welding began when it was found that oxygen and acetylene, if mixed together in suitable proportions and ignited, burned at a temperature of some 2,000° C. Soon a welding blow-pipe emitting a tiny jet of this intensely hot flame was introduced for "burning" pieces of metal together and for flowing molten metal into cracks. Identical flames are used to-day, not only for such purposes as this, but for cutting through armour plating and for many industrial purposes.

Fig. 1.—The bedplate of a large crane which was broken when the earth subsided. When salving the crane one of the winding drum brackets was broken.

When working with an oxy-acetylene blow-pipe the operator uses both hands, holding the blow-pipe in one and the rod of new metal with which he is "filling" or "building-up" in the other. The work is exceedingly fascinating to watch and appears to be far from difficult. Actually, however, it calls for extreme delicacy of touch, and it takes years of experience for a man to acquire the dexterity which is necessary for him to be able to work on intricate or expensive castings.

Electric Welding

In the case of electric welding, all the work is done with one hand, the flame

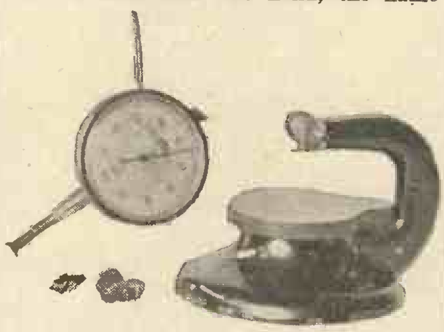

Fig. 3.—Not a job for a "ham fisted man." This is a thickness gauge, measuring in thousandths of an inch.

required for rendering the metal molten being in the form of an electric arc struck from the tip of a fusible rod. In many districts this process is employed for joining tram lines, and the welders, wearing masks to protect their eyes from the intense glare, can be seen at work in the streets.

The equipment of an electric welder consists of a heavily-insulated form of handle which holds a metal rod of identical analysis to the metal to be united. This rod is electrically connected to a source of current, the other terminal being connected to the part on which the work is being done.

To the lay eye, the welding operation, whether performed by the acetylene or electric process, appears in itself to be complete, but actually it is only one of an elaborate series of stages through which the parts have to pass. Reference is now being made, of course, not to simple butt welds, like the joining of tramlines, but to repairs to castings such as those which are seen in the accompanying illustrations.

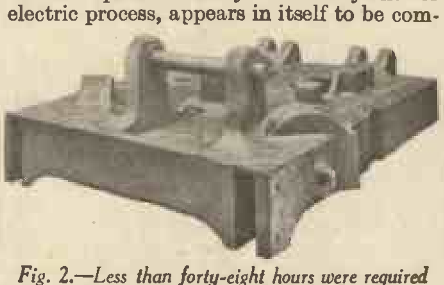

Fig. 2.—Less than forty-eight hours were required to repair this crack by scientific welding. An inexpensive repair that was completely successful and saved the owners a large sum.

Commencing on a Casting

When a damaged casting is first received at the factory of a specialist welding engineer, it is first inspected by an expert metallurgist, who determines its precise analysis and decides on the temperature to which it must be raised as a whole before the welding operation begins. This is vitally important, as the part may be hopelessly distorted by unequal expansion and contraction. For the heating, muffle furnaces of many special types are used, and in order to permit accurate control of the temperatures, some of them contain as many as a thousand gas jets, which can be controlled in ordered groups.

When the temperatures are correct the welding operation can begin with one expert operator watching over the general condition of the "patient" while another heals the wounds. Sometimes in the course of the work the casting has to go back many times into the muffle, and the instant that the last drop of new metal is flowed on, the return of the part to the muffle is a matter of paramount importance. From this moment the temperatures have to be most accurately controlled, or internal stresses would develop in the casting, leading to the formation of cracks and all manner of future troubles.

The operators have to possess an almost intuitional grasp of the characteristics of

Fig. 4.—Even this job did not defeat the skill of the modern welder. Here is the repaired gauge; it functioned perfectly.

castings, or when a repair was finished, the part would not be true to its original shape. Bolt holes would have moved a trifle, faces would no longer be flat and the housings for any bearings would have lost their alignment.

High-Class Craftsmanship

In work of this kind which calls for craftsmanship of such an exceptionally high order, it is gratifying to be able to record that Great Britain leads the world. Nearly all the most difficult welding operations are performed within the sound of Bow Bells, and in cases where this is impossible, British engineers frequently cross the sea to supervise or execute repairs of a specially awkward nature.

The saving to industry which scientific welding has made possible is, of course, incalculable. It is understood most vividly when a giant piece of machinery in a busy factory breaks or develops a crack. Its replacement might involve the plant being idle for weeks or months, and the cost might run into hundreds of pounds. By way of contrast, if the services of a specialist welding engineer are called in, the plant can be working again in two or three days and the defective unit will have been not only repaired, but reinforced in such a way that a further failure of a like kind cannot possibly occur.

Here it may be mentioned that the new welding processes employed for such operations are available for amateur mechanics and should certainly be very well worth their close investigation. They are invaluable for saving castings which have been accidentally damaged, and they can be employed with complete success for small simple operations such as filling blow-holes and rectifying machining errors.

For work of this kind it is very often possible to use either a recently invented low-temperature welding process or a special metallurgical process evolved for such operations as filling scores in engine cylinders.

Figs. 5 and 6.—(Left) A casting made of elektron, the wonderful magnesium alloy that is even lighter in weight than aluminium, and (Right) A recently invented welding process was employed for the repair of this casting—with the perfect result shown in the illustration.

Overcoming Difficulties

In mastering the art of accomplishing the more spectacular feats which scientific welding permits, almost overwhelming difficulties have had to be overcome. An excellent illustration is afforded by the recent conquest of elektron, the new alloy which is lighter and stronger than aluminium and which is coming into wide use in motor vehicle and aero engine construction. This metal contains a large proportion of magnesium, which, as every amateur photographer knows, is very highly combustible if it is raised to a considerable temperature. At first it appeared that elektron would be impossible to weld because, before the necessary local temperature was reached, the metal burned away to ash. After extensive laboratory research, however, a flux was discovered which isolates the molten metal from the oxygen in the atmosphere, and thus robs it of the essential element which is needed to support combustion. Nowadays costly elektron castings are being welded every day when they would have been fit otherwise only for the scrap heap.

Welding Wonders

Time no doubt will witness new welding wonders, but at present they are not in sight, for a stage has now been reached when there is no metallurgical repair which defies the specialist. It is even possible to weld a new tooth on to a gear-wheel or to cut a great section out of a giant high-pressure boiler and replace it with a new piece. Work of this kind, although impossible a few years ago, is being done as a matter of everyday routine, and every job that is undertaken is carried out under a firm guarantee.

WHAT A VISIT TO CROYDON REVEALS

To tour the freight department at Croydon at the present time, and to talk to the experts one finds there, is a revelation of the growing value of air transport in all cases where it is urgent that time should be saved. Not only is air speed increasing, but the growth in the number of aircraft flying in and out of Croydon now enables freight to be handled even more expeditiously than was the case some time ago. Take the case of any firm in London which may ring them up to say they have an urgent consignment awaiting dispatch. The load is collected at once by one of their airway vans, and brought direct to the air-port; after which, thanks to the many outward-bound services now available it starts its air journey immediately, and in a few hours has reached some point hundreds of miles distant across the Channel. Loads are in Paris in 2½ hours, in Cologne in 3½ hours, in Berlin in 4½ hours, or in Zurich in just over 6 hours.

A Wide Network of Routes

Air-freighters from Croydon connect at stations on the Continent with the departure of services for destinations still farther afield; which means that an increasingly wide network of routes is now being served. A consignment which is dispatched from London in the evening is, for example, delivered next morning at a point as far off as Copenhagen.

Almost every kind of load is handled by air nowadays. The use of their multi-engined machines, with their big freight compartments, enables them to deal with consignments of a size and weight which would have been impossible not so long ago. Among loads which figure frequently on their waybills are urgently-consigned fittings and spare parts for engineering plants. Many of these are rushed across to the Continent. Others go for thousands of miles along our Empire routes. They furnish convincing examples of time-saving which is also money-saving, seeing that the sooner these fittings come to hand the sooner some piece of machinery can be started again, and be in profitable operation. So far as journeys along our Empire routes are concerned, the use of the air may mean that, instead of standing idle perhaps for weeks, a plant can be got going again in a few days, thanks to the swift arrival by flying mail of some essential part which has been cabled for from England.

A Variety of Cargoes

Films, wireless valves, and gramophone records, and also such articles as urgently-needed medicines, are often to be found among their loads. It is not only the speed of air transport which is so advantageous. Fragile, easily-damaged goods travel so much more safely by airway than by any other means. They need not be packed in any elaborate or expensive way. They are handled throughout with special care. Such savings in the matter of packing, and also the lower insurance rates which apply to air-borne goods, are powerful arguments in favour of the flying routes.

There is a growing tendency among manufacturers to send samples by air. This applies not only to the continental service, but also to our Empire routes. Samples of the tobacco and coffee crops now reach London regularly by air; while there is a growing disposition to send gold to London by the air route from some of the big mines in Africa.

An interesting development in their freight department is the way in which the consignment of livestock by air is increasing. More and more pedigree animals, such as dogs and cats, are being sent over to the Continent by airway. There is also an established and successful traffic in the air dispatch of day-old chicks from poultry-farms in England to similar establishments throughout Europe. Tropical fish, in tanks, arrive by air from along the Empire routes. Not long ago they had a crate of live locusts from Africa, intended for experiments in this country in the extermination of this plague by chemical means.

The Transport of Livestock

As a method of transport for livestock the air is now recognised as being ideal. A valuable animal of the pedigree type makes its journey by air in a minimum of time, while during its period of transport it can be fed and receive special attention from the airway staff, arriving at its destination in a condition which gives it every chance of success if—as is often the case—it has been sent to take part in some exhibition or show.

Finally, to summarise the position at the present time, what may be said is that freight transport by air now offers an established and ever-growing facility, augmenting dispatch by land or sea in all cases where time is the chief consideration. To-day London finds itself linked by air with some 60,000 miles of continental flying routes, regular air connections being provided with 150 cities throughout Europe; while their Empire lines now extend for 16,000 miles, with fifty or more stations dotted along the trunk routes to Africa, India and the East. And the keynote of all this service is speed—speed not only in the air but also in the ground organisation, so that users of the services may obtain a maximum of time-saving on every stage of an aerial journey.

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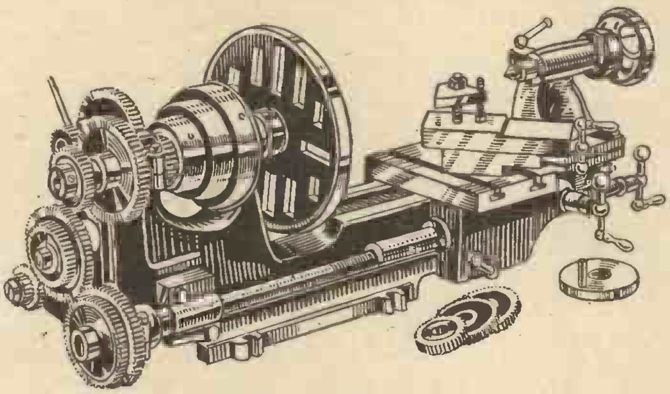

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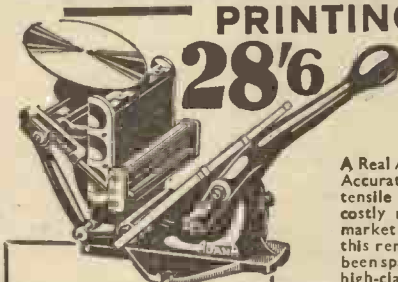

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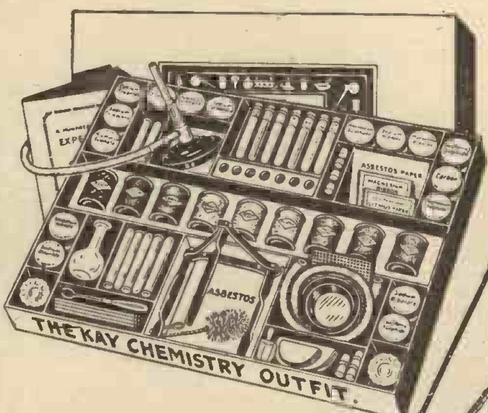

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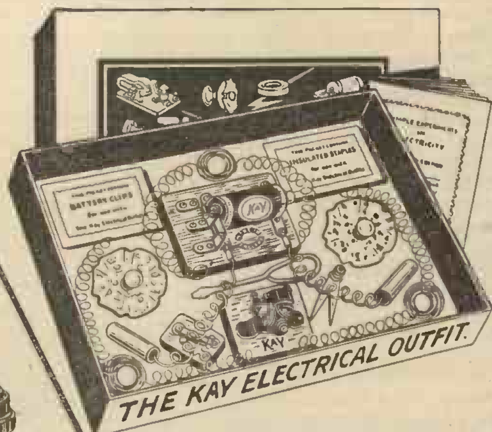

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MODEL AEROPLANE

With a few notes on

These notes on the all-important question of automatic stability of the subject, but rather, the aim is to discuss the question purely from a problem will be able to apply the principles given below when

IT is assumed that most model makers require a good climb followed by a "flatten out" at the top of the climb, with no tendency to stall; a period of cruising under reduced power, and finally, the most difficult of all, a good flat glide to a happy landing. Many models can be seen performing quite excellently until the power ceases, when they become erratic in a fore and aft direction, finishing up their flight in a series of zooms and dives. This trouble, of course, is due to the model having been designed and set so that all is well when under power. As soon as the power ceases a new set of conditions and pressures appear to confound these arrangements. It is essential, therefore, to give consideration to *all* the requirements when designing the model, so that, except for the alteration in speed of the model, there will be no other variations occurring, whether the power is on or off. The model must therefore be designed so that it is an excellent glider with no power on. The power must then be applied so that the model will travel faster under power, which will create a greater lift on the mainplane only, thus making the machine climb. As the power dies the speed will drop and the model therefore get into its gliding angle. Throughout this performance the tailplane should not be unduly affected by the propeller's slipstream, and should only come into violent corrective action when the model is getting into a dangerous stalling attitude with nose too high.

Fore and aft stability is dealt with first in a general sense, followed by three examples of layouts for a high-wing monoplane, a low-wing monoplane, and a biplane, giving a few tips on a useful method of laying the fuselage out on paper, followed by notes on construction.

Lateral stability will then be dealt with in broad terms.

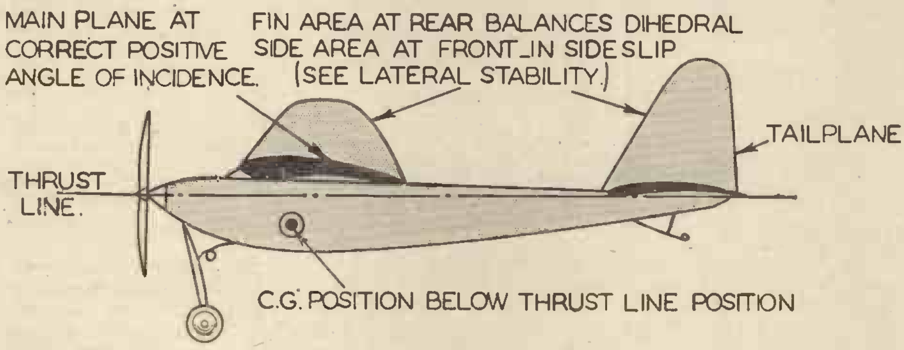


Fig. 1.—A high-wing layout.

Fore and Aft Stability

It may be said that to obtain stability on a really fast model aeroplane is more difficult than in the case of a lighter loaded and slower model. Thus a racing model aeroplane is a tricky sort of problem, but a useful tip, if you desire speed, is to have a really large tailplane. It may offer a little more head resistance, but it allows of a number of reliable flights at high speed on a fast model instead of the very occasional lucky one at a slightly higher speed.

So many people produce racing models with the most delightful little tailplanes, as in full-sized practice, but I have yet to see one of these models perform consistently.

They talk about having a large leverage at the high speeds they require. But in practice this does not often work. One has to remember there are intermediate speeds during acceleration and deceleration to be reckoned with, and without a pilot's correcting hand. The large tailplane of the correct type, set in the correct position, will look after these problems. In the model aeroplane world, even amongst the old hands, there is a great divergence of opinion on many things to do with stability, and often fierce arguments result.

It will be found that the petrol model is the most hard to get automatically stable, chiefly owing to its weight.

To correct the momentum of a heavy model sufficiently rapidly to avert trouble requires more careful attention to the stability problem.

This type of model, of which I have built seven, has shown me, in my own opinion, where I and certain others have sometimes gone wrong on certain points on lighter models, and yet got away with it.

Light and Heavy Models

Let me repeat that a fairly lightly loaded model is easier to make stable than a heavily loaded and fast model, and if the model does meet with any obstruction it is less likely to suffer damage, as its speed is less, and there is less weight to stop in a hurry.

It is obviously impossible in one short article to go into too much detail, so I will give a simple method of laying out a fuselage design that may appeal to the novice if not to the expert, and discuss the points of fore and aft stability.

Assuming that a simple type of rectangular fuselage has been decided upon, first obtain a roll of white kitchen paper and a roll of waterproof grease paper. Now lay the white paper on a board long enough and wide enough to take the full-sized drawing of the fuselage. Keep the paper in position on the board by drawing-pins.

Having decided before this the length and general shape of the fuselage, draw a centre line lengthwise.

This line will be the all-important thrust line that we are going to base all our design around—whether the model be High-wing, Low-wing or Biplane, Tractor or Pusher.

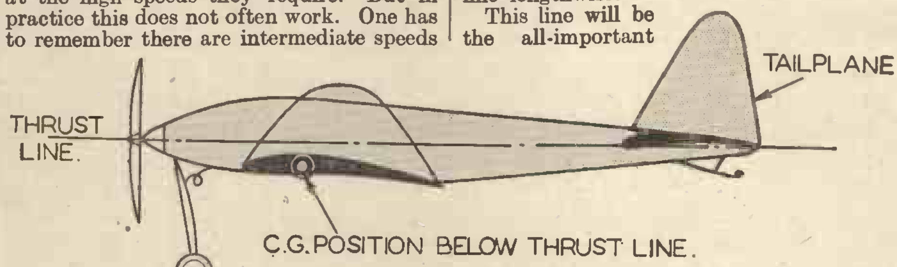


Fig. 2.—A low-wing layout.

The propeller spindle in the case of the rubber-driven model, or the crankshaft of the petrol model, must be a prolongation of the forward end of this line, whilst the tailplane leading edge and trailing edge should cut the line (see Fig. 1).

Whether the power is on or off, there should be no violent difference in effect on the tailplane set in this manner. But should the tailplane be tilted up at the rear, or locate it below the thrust line, *i.e.*, give it a negative angle of incidence to the thrust line, when the power is on a considerable force from the propeller slipstream will strike the top surface and tend to push the tailplane down. As the power dies away when the rubber fades or the petrol motor is switched off in the air, this thrust will also cease, and the tail will naturally rise and so get the model into a dive.

Now take the reverse position, *i.e.*, with the tail at a positive angle to this thrust line. The propeller slipstream strikes the undersurface when in flight and forces the tail up. The mainplane has therefore to be located further forward of the centre of gravity position in order to prevent a dive.

The model then flies nicely after this adjustment, but as soon as the power is cut off the force under the tail ceases and the

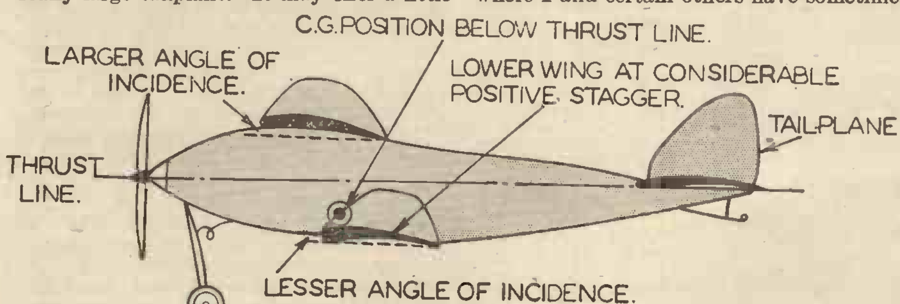


Fig. 3.—A biplane layout yielding good stability.

STABILITY EXPLAINED

design and construction

model aeroplane are not meant to be an exhaustive treatise on the practical point of view, so that anyone not quite conversant with the designing his models

By Capt. C. E. BOWDEN

tail drops, with the result that the nose comes up, still further accelerated by the fact that the mainplane is ahead of the centre of gravity position.

Figs. 4 and 5.—(Left) R.A.F. wing section which is stable but fast. (Right) Stable slow flying type of wing section should be flown at considerable angle of incidence.

There is a glorious stall, the model dives to regain flying speed, builds up speed, stalls and repeats the process all over again, each stall and dive becoming more heart-rending, until, generally in the middle of the most spectacular dive, it crashes.

Anyone who has watched model aeroplanes flying has seen many models carry out the above sequence of events through

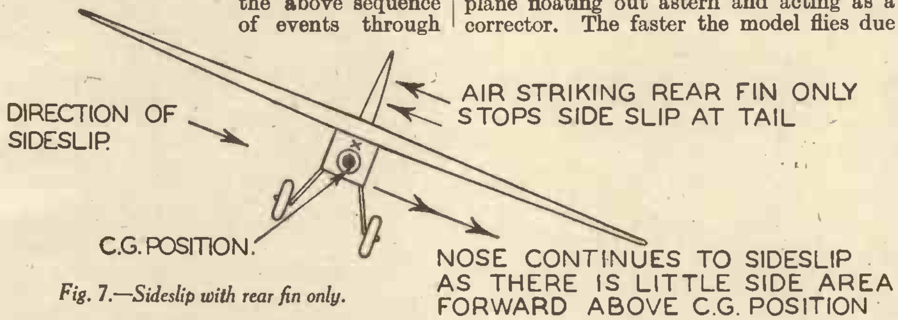


Fig. 7.—Sideslip with rear fin only.

the reasons already outlined. To design a heavy petrol model and allow it to perform in this way is a sheer waste of time. One flight, and there is little that remains of the model that is worth further consideration.

The V Angle

Most readers will know that it is necessary to have a V angle made between mainplane and tailplane, in order to get fore and aft stability, and many newcomers to the hobby have merely been told that this V angle is obtained by giving the tailplane a negative angle of incidence. I hope I have now made it clear that the V angle is required, but that to obtain a satisfactory glide after the power is off there must be no negative angle of the tailplane to the thrust line, but that the negative angle is obtained in relation to the mainplane, which is set at a positive angle to the thrust line.

This flying V fore and aft works in somewhat the same way fore and aft as the V angle or dihedral angle does in a lateral direction.

Now having robbed the budding designer of his favourite negative angle on the tailplane by requesting him to place his tailplane with leading edge and trailing edge along the thrust line—or shall we say centre line of our drawing of the fuselage—I will relieve his mind by suggesting and reminding him that he gets his flying V by putting the necessary angle of positive incidence to his mainplane, or mainplanes in the case of a biplane, to this centre line.

He now has his "flying V" and his tailplane floating out astern and acting as a corrector. The faster the model flies due to the power, the greater will be the lifting effect on the mainplane set at its positive angle of incidence; and so we get our climb (see Fig. 1).

A High-wing Monoplane

In the case of a high-wing monoplane, this positive angle of incidence of the mainplane will not require to be so great as in the case of a low-wing monoplane, but varies rather according to the wing section used.

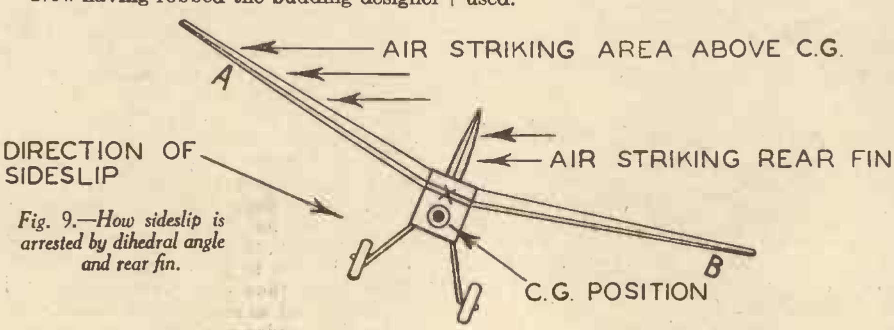


Fig. 9.—How sideslip is arrested by dihedral angle and rear fin.

In the case of the biplane (see Fig. 3) the top wing should be at about the same angle of incidence to the thrust line as in the case of the high-wing monoplane, *i.e.*, between 3 to 5 degrees, provided the wing is not placed too high above the thrust line.

The bottom wing should be at a slightly lesser angle, but set a considerable positive *stagger*.

This positive stagger will mean that the bottom wing is itself acting as a large tailplane at a slight negative angle of incidence. The tailplane will then merely assist matters.

This setting of the two planes at different angles of incidence is called décalage. As

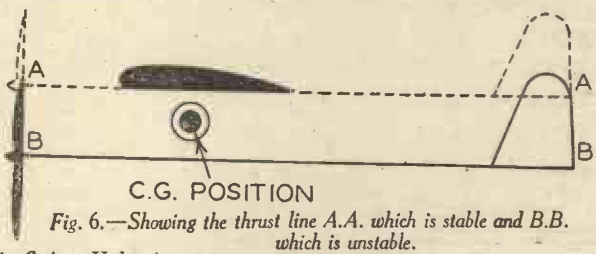


Fig. 6.—Showing the thrust line A.A. which is stable and B.B. which is unstable.

a matter of interest, a biplane can be made to fly without a tailplane if this system is adopted and a sufficiently large positive stagger is provided. By a positive stagger I mean the placing of the lower wing further back along the fuselage than the top wing. Many people recommend the reverse—that is to say, a smaller angle of incidence on the top plane and a greater on the bottom. They neglect, however, to use the positive stagger.

Those who have had uncertain results with biplanes should try the method I have outlined above.

At one period I had the biplane complex and built practically nothing else, because they were alleged to be so difficult. Certainly, owing to their extra head resistance, the model rubber-driven biplane is not so good on duration, and I was proud of a 66 seconds flight in an S.M.A.E. competition in the early days of the balsa model some years ago with a biplane. One seldom gets as good durations during competitions as outside competition work.

The petrol model of course does not

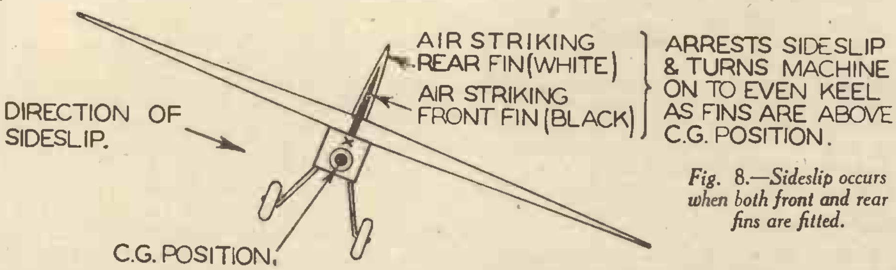


Fig. 8.—Sideslip occurs when both front and rear fins are fitted.

suffer from this disability of limited duration of power.

On Plane Construction

Now, having drawn the side elevation of the fuselage on our white paper and board, as in Figs. 1, 2 and 3, according to type of model required, put a piece of the grease-proof paper, previously mentioned, over the whole to prevent glue sticking to the drawing. It will then be a simple matter to put in pins along the longeron lines to keep the longerons in the desired position whilst they set, after steaming over the spout of a kettle. The following day the uprights and formers can be stuck in position. Having made up both sides of the fuselage in this way, one is assured of the correct placing of the nosepiece, thrust line and tailplane position, and also the correct angle of incidences where the wings meet the fuselage on top or bottom, or both. The fore and aft stability should therefore be assured. The mainplanes should be set so that the centre of gravity position of the model is located at about one-third of the chord of the mainplane from the leading edge.

The model should, when completed, glide well with these settings, but if under power it climbs rather too steeply, then a certain amount of down thrust should be given by tilting the engine shaft slightly downwards. Do not alter the tailplane. It now remains to consider the areas of surfaces and types of wing and tailplane sections to be used.

With regard to areas, this is a question which depends upon the speed required from the model. But it should be remembered that it is desirable to keep the leading edge of the tailplane at least one and a half times the chord at the root of the mainplane, from the trailing edge of the mainplane. Furthermore, a really large tailplane makes for stability, the only disadvantage of a large tailplane being the added head resistance offered. Therefore a happy mean has to be struck; but it is advisable to err on the large size, particularly in the case of the petrol model, which, owing to its weight, is slower to react to righting efforts.

The Mainplane Section

With regard to the mainplane section, it is important to use a stable type in itself, even if the designer's intention is a fast model. To put the matter very broadly, the R.A.F. 34 Section, or modifications of it, with its reflex trailing edge, is a stable but rather fast section (see Fig. 4). If a slower section is desired that is also stable, the old-fashioned concave undersurfaced wing section, but rather thick in front and thin behind, is excellent.

The centre of pressure does not move much in this type of wing section. The section has to be flown at a considerable angle of incidence, however, and for certain types of model offers a lot of head resistance (see Fig. 5).

This matter of head resistance does not matter in the case of a petrol model. In fact it is an advantage, as it all helps towards the valuable property of slow flying and landing speeds.

A compromise can be made between the two sections for a high performance duration rubber model. However, I am chiefly concerned here in the matter of stability, and will therefore not labour the question of drag too much.

For really good stability fore and aft, it is certain that a good stable-wing section, where the centre of pressure does not alter much at different angles of attack, is a great advantage.

The Tailplane

Having tried out all kinds of tailplane, I definitely favour, for most purposes, what is known as the "lifting" tailplane, but set, as I have already explained, in a position so that it does not really lift, more than float out behind, until the model gets its nose well into a stalling attitude. The cambered surface of the "lifting" tailplane then obtains lift by finding itself flying at a greater positive angle of incidence.

This lift then brings up the tailplane and thus restores the model to an even keel and reduces the unduly large positive angle of incidence on the mainplane that has now arrived at the "burbling point" where the air flow is breaking down.

I usually use a thinnish cambered section with concave undersurface for the tailplane. This combination, when double surfaced, does not produce undue head resistance, and has the merit of acting as a corrective quickly.

Before we leave the practical side of fore and aft stability to tackle lateral stability, it is worth examining the effect of thrust-line position in relation to the centre of gravity.

It has been found that the higher the line of thrust is located in relation to the centre of gravity, the greater the longitudinal stability of the model.

This can easily be worked out theoretically, but space forbids here. Nevertheless, it is an important point to remember when designing a model, and particularly so in the case of a low-wing model.

Fig. 6 shows, firstly, the thrust line marked A.A. higher than the centre of gravity, which is stable. In the second case, the thrust line marked B.B. is below the centre of gravity and is not stable, and when the machine noses upwards the thrust tends to aggravate matters towards a stall.

It will be noticed that in Figs. 1, 2 and 3 the centre of gravity position is shown in all cases below the thrust line.

Lateral Stability

This is, strangely enough, somewhat interconnected with longitudinal stability. For one must remember that when an aeroplane banks at over an angle of 45 degrees the controls become reversed; that is to say, the elevator becomes the rudder and the rudder becomes the elevator.

This is easily understood if a model is held in the hand on a bank of over 45 degrees. The rudder will now be seen to be nearly horizontal instead of vertical, and it is in practically the same position as the elevator was when the machine was on an even keel. It will be obvious that to push the rudder up in this position will depress the tail of the machine, whereas to push the rudder down will force the tail up and the nose down. In the case of a turn to the left with a bank of over 45 degrees it will also be clear that the elevator must be pulled up so that it forces the nose of the machine to the left and tail away. The turn really becomes a sideways loop if continued for a complete turn.

This little matter of reversal of controls often defeats the young pilot at the beginning of his flying training. But once one has been through the mill on full-sized machines many curious effects that take place with models when in a steep bank will be clear.

However, it is advisable to design a model so that it will quickly come out of a vertical bank should it inadvertently get there. I do not recommend the use of this method on the "Kanga," which was described on page 506 of last month's issue.

To ensure that a model recovers from a sideslip after excessive bank it is necessary to design the model with the correct side areas, both fore and aft *above* the centre of gravity.

Reference to Fig. 7 should make it clear that when a model without any side area forward gets into a bank it will sideslip inwards and downwards. The air will strike the fin at the rear, which will tend to push the tail upwards, whilst the nose will continue to sideslip inwards, thus getting the machine into a spin.

Now look at Fig. 8. In this case the model has a fin, both at the rear and at the front, above the centre of gravity.

As the model sideslips inwards the air strikes both rear and front fin, which are so proportioned as to balance each other. As these fins are *above the centre of gravity*, the model is arrested in its sideslip and at the same time pushed over on to an even keel.

The model shown in Fig. 9 has instead of a front fin a "dihedral angle," which offers a side area forward over the centre of gravity in lieu of a front fin.

It will be observed that the wing A offers a considerable forward side area to the air when the model is sideslipping inwards. This side area is above the centre of gravity, and so pushes the machine on to an even keel. The rear fin does the same thing for the tail end of the machine. In the case of the low-wing model aeroplane this dihedral angle must be greater in order to obtain a side area showing *above* the centre of gravity.

Fig. 10 should explain how the forward side area is obtained by a dihedral angle.

When arranging for correct side areas fore and aft to balance each other, the side areas of the fuselage must, of course, be taken into account.

To prove this theory, let any reader not conversant with it construct a paper glider with no dihedral, but with a rear fin only. The glider will easily spin and have no lateral stability. Now either add a front fin to balance the rear fin or sufficient dihedral on the mainplane to get the same effect, and he will notice how the model at once becomes stable laterally and refuses to spin.

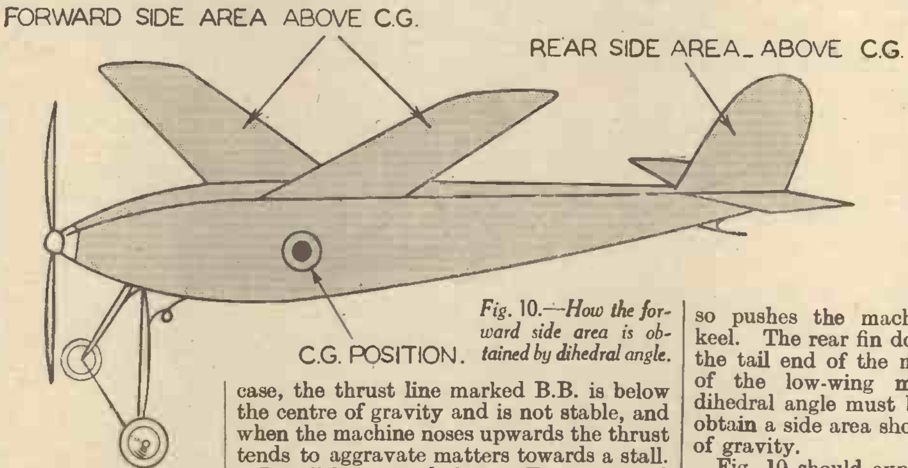


Fig. 10.—How the forward side area is obtained by dihedral angle.

LIQUEFYING GASES

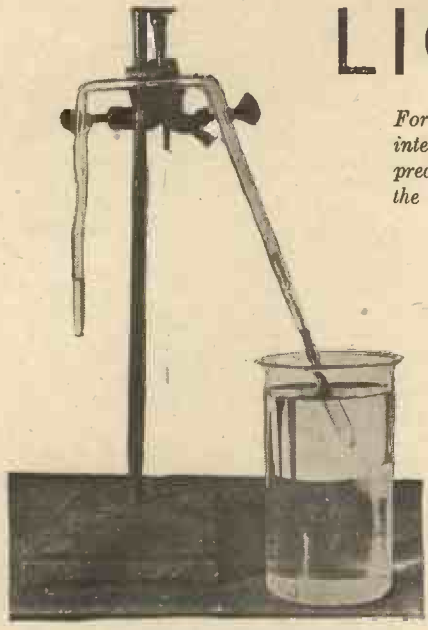


Fig. 1.—Apparatus for the liquefaction of sulphur dioxide.

For the amateur chemical experimenter there is hardly a field of work of more absorbing interest than that represented by the liquefaction of gases. Using merely common-sense precautions, quite a number of gases may be liquefied with the simplest of apparatus and by the easiest of means. What is more, the gases so liquefied can be preserved as specimens quite indefinitely.

ALL gases, as the reader no doubt will be well aware, can be liquefied by the application of cold and pressure. Every gas has what is known as a " critical temperature," above which no amount of pressure will cause it to liquefy. The critical temperatures of the gases enumerated in this article, however, are all well above the normal everyday temperatures of a room. Hence the existence of these critical temperatures will not bother the experimenter in his gaseous liquefactions.

One of the easiest gases to liquefy is sulphur dioxide, SO_2, a gas formed in large quantities when sulphur burns in air or oxygen. Sulphur dioxide is a colourless gas which possesses the smell of burning sulphur. The gas is not inflammable, and, owing to its sulphurous character it is sometimes used as a fumigant and disinfectant. Sulphur dioxide is also generated when hot concentrated sulphuric acid is allowed to act on metallic copper. This is the manner in which the gas is best prepared for liquefaction purposes.

Sulphur Dioxide

Obtain a length—about 18 in. or 2 ft.—of stout-walled glass tubing of about ¼-in. bore and seal up one end of this tubing in a bunsen or spirit-lamp flame. Cut up several inches of thin bare copper wire into small pieces and slide these down to the bottom of the tube. Now pour concentrated sulphuric acid down the tube so that the copper therein is covered, and take a tuft of cotton wool hooked on a piece of wire, and pass this down the side of the tube so that it may absorb and wipe away the sulphuric acid from the sides of the tube. Then, by means of a " batswing " gas flame, make two acute bends in the tube, taking care not to allow the sulphuric acid to flow along the tube.

The tube will now have two limbs, as shown in the photograph, Fig. 1. Keeping the tube in an upright position, hold the empty limb in a gas flame until the glass softens. Then carefully draw down the lower end of the empty limb so that it forms a narrow neck. Finally, seal up the open lower end of the empty limb, and the apparatus for liquefying sulphur dioxide will now be ready for use.

Clamp the tube firmly by some means, and, if possible, place around the empty limb of the tube a vessel containing melting ice or some other freezing mixture. If these are unobtainable, however, cold water will suffice, although the gas is much more easily liquefied and sealed off if this collecting limb of the tube is immersed in ice. Place a vessel of warm water around the tube limb which contains the copper and concentrated sulphuric acid. Almost immediately the chemical action will commence. If the sulphuric acid in the tube limb tends to froth up, remove the vessel of water for a time. If, on the other hand, the chemical action proceeds too slowly, increase the heat of the water until it reaches boiling point.

Sealing the Tube

Within a few minutes the pressure of the sulphur dioxide generated within the tube will cause it to liquefy and to collect as a clear, limpid, highly-refracting liquid in the receiving limb of the tube. This should now be cooled as strongly as possible and finally sealed off at the narrow drawn-out neck. Take care to make a good seal in a gas flame, rounding the seal off neatly so that there will be no danger of it breaking off afterwards. Your specimen of liquid sulphur dioxide will now be a permanent one—so long as the tube remains unbroken. At 0° Centigrade, sulphur dioxide liquefies at a pressure of 1·5 atmospheres; at ordinary temperatures the gas liquefies at about 4 atmospheres pressure. This latter, therefore, is the internal pressure within the specimen tube of liquid sulphur dioxide after it has been finally sealed off and allowed to return to normal temperatures.

The above experiment is quite a safe one because ordinary glass tubing is capable of standing pressures considerably above this limit. To be absolutely safe, however, it is always best to interpose a piece of wire gauze between the gas-liquefying apparatus and yourself during the experiment, just in case the tube should burst. This precaution should be taken in all gas liquefying experiments of this description.

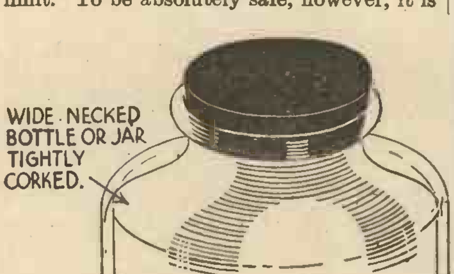


Fig. 2.—Illustrating the preparation of the silver chloride-ammonia absorption used for the generation of ammonia gas in the sealed liquefaction tube.

Liquefied Chlorine

Chlorine is another gas which can be liquefied by the home experimenter, although, in this instance, the pressure required is higher. The apparatus necessary is exactly similar to that required for the liquefaction of sulphur dioxide. In the gas-generating limb is placed *either* a mixture of manganese dioxide and strong hydrochloric acid or a mixture of potassium dichromate and strong hydrochloric acid. On the application of heat to the liquid in the tube, chlorine gas is evolved and in due course it will liquefy in the receiving limb of the tube. In this instance, however, the receiving limb *must* be surrounded by a freezing mixture of ice and salt, and it must be retained therein until the limb has been finally sealed off.

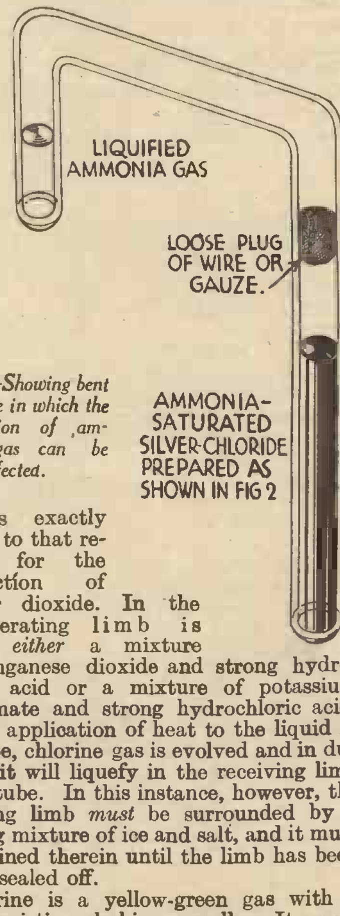


Fig. 3.—Showing bent glass tube in which the liquefaction of ammonia gas can be effected.

Chlorine is a yellow-green gas with a characteristic choking smell. It was, indeed, the first of the suffocating gases used in the Great War in April, 1915. Prepared in small quantities, of course, it is harmless. At 0° Centigrade, chlorine takes a pressure of 6 atmospheres to liquefy it, this pressure being correspondingly increased at normal temperatures. Hence, care should be taken to effect its liquefaction only in stout-walled glass tubing. The sealing off of the specimen of liquid chlorine *must* be effected while the limb of the tube containing it is immersed in an ice and salt freezing mixture.

Liquid Ammonia

What is usually known as " liquid ammonia " is, of course, merely a solution of ammonia gas in water. Ammonia gas, however, can be liquefied by the application of pressure in quite a simple manner. Place in one limb of a stout glass tube, shaped similarly to the ones described above, a mixture of sal-ammoniac (ammonium chloride), ammonium sulphate, or any other ammonium salt and slaked lime. Heat this mixture in the tube very gently, having the other limb of the tube immersed in ice cold water. The ammonia gas generated will condense to a liquid in the cold limb of the tube, whereupon it can be sealed off in the usual manner.

Another way of liquefying ammonia is to make up a small quantity of a strong solution of silver nitrate and add to it an equal amount of a similarly strong solution of common salt. A white mass of silver chloride will be formed immediately. This should be filtered off carefully, washed with cold water and dried.

Silver Chloride

Silver chloride has the remarkable property of absorbing comparatively large volumes of ammonia gas, forming the compound, $AgCl3NH_3$. Fill an egg cup half full with dry silver chloride and stand it on the bottom of a large stoppered or corked bottle or jar containing at the bottom about ½-in. depth of ordinary commercial "liquid ammonia." Allow the silver chloride to remain in contact with the ammonia fumes for about a week, stirring it every day so as to expose a fresh surface. After the lapse of this time it will have absorbed a good deal of the ammonia gas.

Now pack the ammonia-saturated silver chloride so prepared into one limb of a stout glass tube fashioned roughly into the shape of a "U." Place the empty limb of the "U"-tube in cold water and the limb containing the silver chloride in warm water. The heat will drive off the ammonia from the silver chloride, and, under the influence of the pressure generated within the tube, it will condense to a liquid in the opposite limb of the tube. As soon as the limb of the tube containing the silver chloride is withdrawn from the warm water and allowed to cool down, the silver salt will again absorb the ammonia, thus causing the liquefied gas to disappear from the other limb of the tube. This backwards and forwards passage of the ammonia from the state of absorption in the silver chloride to the state of liquefaction in the opposite limb of the tube can be thus carried out an indefinite number of times. It is best to place a small plug of fine wire gauze in the tube just above the silver chloride in order to avoid the possibility of loose particles of the material getting into the opposite limb of the tube.

Liquefied ammonia is colourless, mobile and highly refracting. At a temperature of 0° Centigrade it liquefies at a pressure of approximately 4 atmospheres. At normal temperatures its liquefaction pressure is just under 7 atmospheres.

There are a number of other gases which are easily liquefiable in glass tubes on lines similar to the above. Cyanogen, prepared by heating mercury cyanide, is one of these. Another is carbonyl chloride or phosgene. Such gases, however, ought never to be experimented with under home conditions, for they are excessively poisonous.

An Interesting Gas

Sulphuretted hydrogen, H_2S, is an interesting gas to liquefy. It is best generated for this purpose by heating antimony trisulphide with strong hydrochloric acid. Care should be taken, however, to use strong glass tube for the liquefaction of the gas, and to immerse the receiving limb of the tube in a strong freezing mixture. Also no attempt should be made to seal off the limb of the tube in which the liquefied gas collects. At normal temperatures the gas remains liquid under a pressure of 16 atmospheres. A good glass tube will stand this pressure, but under these conditions it will not permit of a seal being made to it.

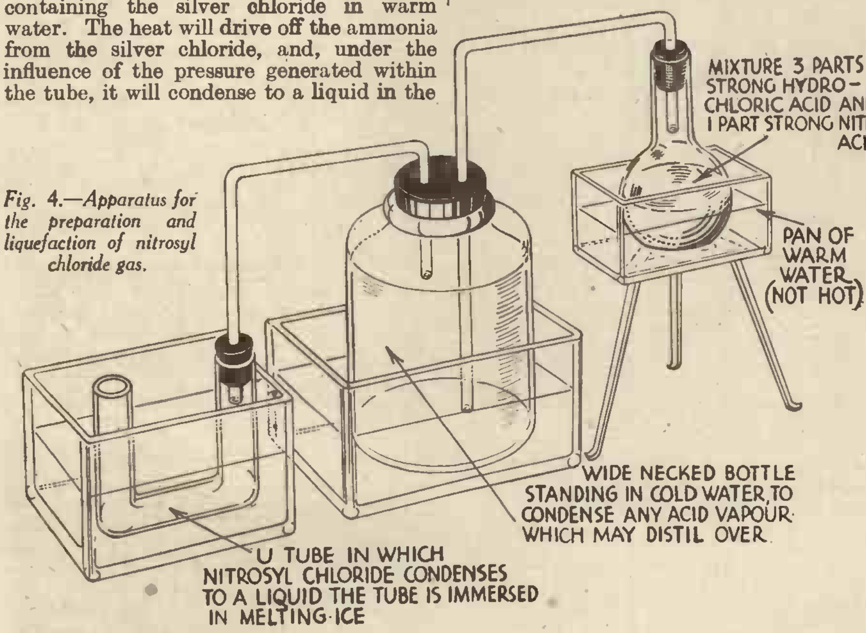


Fig. 4.—Apparatus for the preparation and liquefaction of nitrosyl chloride gas.

It may be mentioned that the red gas generated by the action of nitric acid on copper will condense to an orange liquid when a stream of it mixed with air is passed through a "U"-tube immersed in ice water. The nitric acid and copper generate nitric oxide, NO, a colourless gas which, when mixed with air or oxygen, is converted into nitrogen peroxide, NO_2 (or N_2O_4), which condenses to an orange liquid. This liquid boils just above normal temperatures. Hence, perhaps, it just escapes being correctly termed a "liquefied gas," such a term being applied more exclusively to condensed gases which boil below normal temperatures.

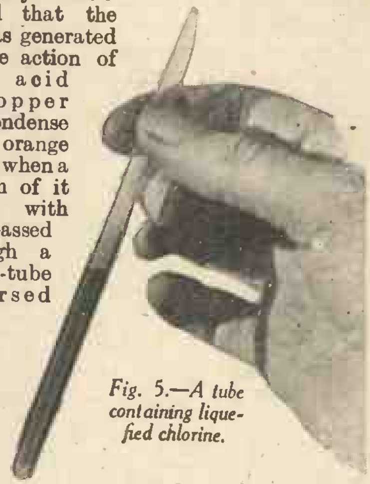


Fig. 5.—A tube containing liquefied chlorine.

Nitrosyl Chloride

Finally, there is nitrosyl chloride, NOCl, an orange-yellow gas which is best prepared by gently warming a mixture of strong nitric and hydrochloric acids. Passed through a "U"-tube immersed in a mixture of ice and salt, this gas will condense to an orange liquid. It may then be quickly poured into a dry thick-walled glass tube, the upper end of which can subsequently be sealed off. Nitrosyl chloride, at ordinary pressures, boils at − 8° C.

In preserving samples of liquefied gases in stout glass tubes it is best, as a precaution, to make a tightly-fitting "cage" of copper wire to surround the tube on the same principle as the wire wrappings are applied to some soda water syphons. This will prevent any flying pieces of glass in the rare event of the tube bursting owing to its inward pressure.

THE BRITISH GRAHAM LAND EXPEDITION

THE advantages of keeping in touch with civilisation while surveying uncharted land and sea in the Polar regions are too obvious to need description. Equally obvious is the fact that when the medium of communication is wireless, the equipment must be of the most reliable and sturdy type.

It says much, therefore, for the confidence placed in the productions of the G.E.C. that one of the Company's radio receivers has been selected by those responsible for the organisation of the British Graham Land Expedition, which is shortly embarking, with the support of the British Government and the Royal Geographical Society, on a cruise covering approximately 1,500 miles of unsurveyed coast line at the back of the Weddell Sea in the Antarctic. A G.E.C. superheterodyne battery receiver will be the sole means by which the Expedition will be able to keep abreast of world progress during the two and a half years it is engaged in its momentous task. The Expedition is taking with it an aeroplane, which will be piloted by the leader of the party of fourteen men, Mr. J. Rymill, a member of the Watkins Arctic Air Route Expedition.

A NOVEL BENCH GRINDER

THE bench grinder illustrated in Fig. 1 will be found a very useful addition to the mechanic's tool-room, and as it consists almost entirely of cycle parts, the cost of construction is very low. The whole assembly is built round the bottom bracket of a bicycle frame, the two tubes which normally run to the axle of the back wheel forming the front pillars of the grinder, with the tube to the saddle arranged as a back support.

The whole of the ball-bearing assembly is retained, the crank spindle being threaded at each end for attachment of the emery wheel and the driving pulley. By means of the adjustable ball races, the wheel can be run at high speed without rocking and with a very minimum of friction.

The local cycle dealer will no doubt be able to supply the demand for the parts required. If the complete frame can be purchased, so much the better.

The tubes forming the front supports are cut off 6 in. from the bottom bracket and the saddle tube left 10 in. long. The front

Fig. 1.—The finished bench grinder.

down tube of the frame is not required. It can be cut off short to the bracket and a cork fitted to form an inspection cover and a means for oiling.

Now remove the cranks and then the cotters which retain the cups of the ball races. Place a shallow tray under the bracket when unscrewing the cups to catch the balls as they fall out. Clean the spindle and have it turned and threaded. The wheel turns in an anti-clockwise direction when viewed from the right side in Fig. 1, so that both spindle ends must have right-hand threads to prevent unturning the nuts.

Great care must be taken to avoid splitting the tubes when flattening and bending the ends to form the feet. Make each end in turn red hot and squeeze it steadily in a vice. Repeat the heating as the tube cools. A flat of about 1½ in. long is required. After bending, which should also be done hot, the edges are filed off and fixing holes drilled. The back pillar may require a double bend, so that all feet will rest flat on the bench.

The driving pulley can be made from hard wood to suit individual requirements. Two rings of $\frac{3}{16}$-in. brass, each of 3 in. diameter, are clamped on either side of the emery wheel, which is of 8-in. diameter and ½ in. thick. An adjustable rest can be made very simply by bolting an iron support, suitably bent, across the two front pillars and clamping it with a smaller plate at the back. The idea could be adapted equally well for a small circular saw, polishing head, or other use where low-power drive is required.

What the Clubs are Doing

Club Reports for inclusion in this feature should not exceed 250 words in length, and should be received not later than the 12th of each month for inclusion in the subsequent month's issue.

THE MALDEN SOCIETY OF MODEL AND EXPERIMENTAL ENGINEERS

THE above Society would like to get into touch with readers residing in Malden and district who are interested in Wireless and Model Speedboats; of course we should also like to meet readers who are interested in any other branch of mechanics. We have a large and well-equipped workshop, including a 3½-in. lathe, and various other tools.

The Society has decided upon a system of special subscriptions; all members are allowed to have a key to the club, so that they can use it at any time other than club nights. We should particularly like to get into touch with readers who are interested in petrol-driven model aeroplanes. One of our members is starting on a one-quarter full-size model of a 8 h.p. Ford car, which will be complete in all detail, while another is converting his lawn-mower to motor drive. If any interested readers will get into touch with me, I shall be pleased to give them full particulars of subscriptions, etc.

THE NORTHERN HEIGHTS MODEL FLYING CLUB

THE Northern Heights Model Flying Club's Gala Day was held on the Fairey Aviation Company's Great West Road Aerodrome.

Twenty-five clubs from as far afield as Leamington, Birmingham, Brighton, Reading, etc., sent strong contingents to uphold the prestige of their clubs, and a most wonderful display of model planes of many types and variety of sizes was to be seen. About 350 to 400 models were present, and ranged from a 4-in. span miniature fighting plane, complete with machine-guns, engine and correctly coloured squadron markings to a very fine 15 c.c. petrol-engined specimen of a De Haviland "Puss Moth." There were duration planes weighing but a few ounces, medium-weight planes, typifying many kinds of full-sized aeroplanes, and giant 9, 10 and 12 ft. span rubber driven models weighing up to 12 lb., in fact every conceivable idea of a flying machine.

The most important contest of the day, the Inter-Club Team Contest, started at 1.30 p.m.

The teams consisted of one Lightweight Model, one Heavyweight Model, and one Flying Scale Model, which was required to represent some well-known full-size machine, and to be built to a 1-in. scale and correctly coloured and marked. This competition broke entirely new ground in this country with regard to the flying scale models, and unfortunately the wind was a little too fresh for the type, which, of necessity, is of somewhat delicate construction, and a deal of damage was done to them.

The competition resulted in a win for the Blackheath Model Aero Club with 320 points, and they therefore hold the Northern Heights Challenge Cup presented by Mr. C. R. Fairey, M.B.E., F.R.Ae.S., for one year, and receive £3 from the Gala Fund. The Model Aircraft Club were second with 305 points, and they received £1 10s. The Leytonstone and District Model Aero Club were third with 285 points, and they received 15s.

THE BRITISH INTERPLANETARY SOCIETY REPORT FOR JUNE

MEETINGS are held monthly in summer on the first Friday of each month. The last meeting was thus held on Friday last, July 6th.

Several new members were elected, including Mr. J. F. Darwin, of Southport, and Mr. Prugh, of America.

It was proposed and carried that a system of correspondence should be inaugurated between the more distant members of the Society, the correspondence to be about interplanetary travel in particular, and other scientific matters generally. This would be set in motion by an announcement in the next issue of the *Journal* if space is available. Members interested should write to the Secretary, stating particular interests, age, etc.

Discussion ensued about the future form of the *Journal* of the Society. It was decided to continue the *Journal* in its present form until the end of the year. Meanwhile investigations would be made with a view to improving the present arrangement.

The question of a subscription rate for non-members was discussed at the request of several non-members. It was referred to Mr. Binns, who would give a report on the matter. There may be certain difficulties in putting this into operation.

It was decided, also, to keep members personally informed of the proceedings at meetings, as many are unable to attend. Copies of future lectures may also be obtained after their delivery for a small nominal charge to cover costs.

Further particulars can be obtained by writing to Leslie J. Johnson, Hon. Secretary, 46 Mill Lane, Liverpool, 13.

The Latest Novelties

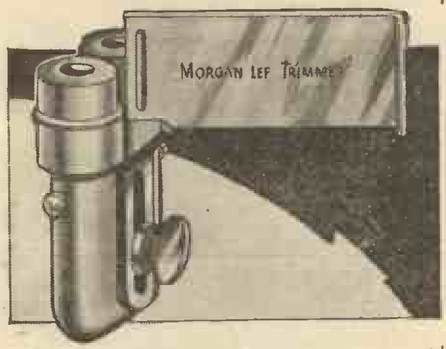
The address of the makers of any device described below will be sent on application to the Editor, PRACTICAL MECHANICS 8-11, Southampton St., Strand, W.C. 2. Quote number at end of paragraph.

An Ingenious Paper Trimmer

THE device shown in the sketch below this paragraph will prove a definite boon to those householders who do their own house-decorating and wall-papering. Known as the Morgan Lee Paper Trimmer; it enables the paperhanger, by means of a gauge, to alter the cut from a narrow selvedge, also to a wide selvedge, in a few seconds. The cutter will trim any kind of wallpaper with a dead edge for butting in a tenth of the time taken with scissors. It also has the advantage of being self-sharpening, and only requires to be kept clean. It costs 12*s.* 6*d.* [75.]

A Handy Wall Lamp

A TEMPORARY light is often useful in the workshop or other outbuilding, although it is seldom worth while to have an electric supply led on to the premises. The neat electric lamp illustrated on this page is of particular value in such circumstances. It takes a standard twin-cell dry battery, which gives many hours' service. The case is strongly made and finished with an anti-rust surface, whilst it is provided with a neat thumb switch. The price is 6*s.* 6*d.* [76.]



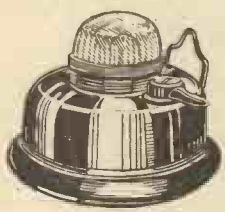
A useful paper cutter that will trim any kind of wallpaper in a few seconds and is therefore a boon to paperhangers.

A Comfortable Air Bed

THE pleasure of camping is enhanced if an air-inflated bed is included in the kit. There has recently been introduced to the market a novel light-weight cambric cover, treated with an air-proof rubber proofing, and intended for inflation with a pump. It may thus be folded into a very small compass, and it weighs only 2 lb. The dimensions are 5 ft. 6 in. by 2 ft. 6 in., and a satisfactory degree of inflation may be obtained with the mouth, although the pump will allow a much quicker inflation to be obtained. When used on the ground, care must be exercised that the bed is not placed on a thistle or other prickly vegetation, etc., owing to the risk of puncture. The rubber proofing is inside, and is, therefore, rather difficult to repair. Obtainable in several different colours, the price is 14*s.* 11*d.*

Uprooting Trees

LAND-CLEARING by ordinary manual methods is frequently not only slow and heavy work, but, owing to the time taken, extremely expensive. The monkey jack shown on this page, however, makes land-clearing a simple matter, and saves a considerable amount of time. With this jack, trees and stumps can be uprooted as shown, logs can be rolled, and walls, gate-posts and roofs can be supported whilst repairs are carried out. To operate, just move the lever shown in the same way as a pump handle. This causes the body, carrying the pointed lifting claw, to move up the main bar of the jack. A small trigger reverses the motion, and the load can be lowered steadily if required. A truly valuable time-saving feature allows the jack to be instantly adjusted up or down to any amount without a load. For trees and long stumps, an extension piece of spar is used; resting on the lower lifting claw, it rises with it. The tree is forced over bodily as the upper pointed end grips the trunk. Unless the tree has been dead for some time, it is usually necessary to cut the surface roots; the monkey jack will then tear out the top roots, usually quite a formidable obstacle, with comparative ease. For rolling logs, the upper claw on the body of the jack is used, by simply turning the jack round. It costs £8 15*s.* [77.]

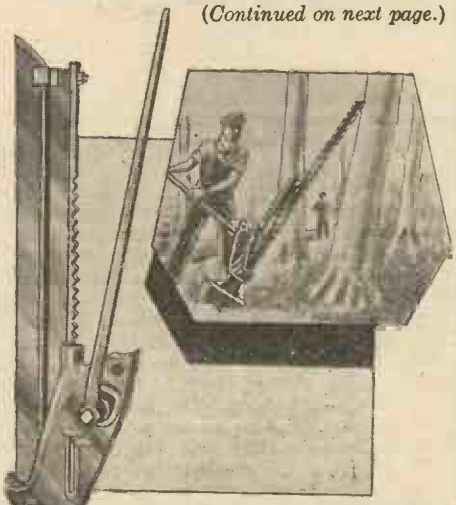


A neat electric wall lamp.

A Useful Weeding Tool

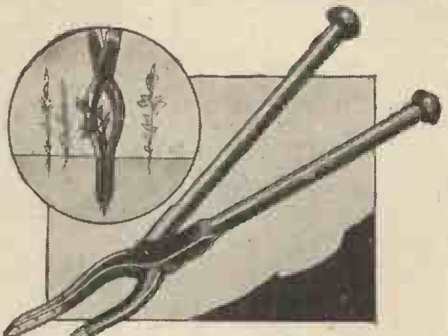
THE tool shown in the sketch on the next page is designed for the removal of both

(*Continued on next page.*)



An ingenious monkey jack for uprooting trees and (inset) how it is used. The tree is forced over bodily as the upper pointed end grips the trunk.

long and short-rooted weeds. The long semi-circular jaws embrace the whole root, the barbs on the inner faces preventing the tool from slipping and thus failing to remove the whole of the weed. Hold the weeder (one knob in each hand) in an upright position over the weed, with the jaws slightly apart, usually about ½ in. With the tool in this position, press downward through the earth to a sufficient depth to embrace the root and, holding the handles together, pull the

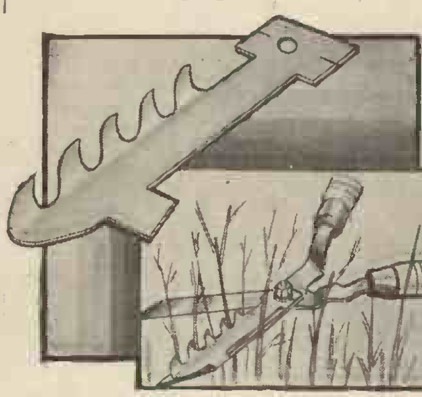


The speed with which weeds can be permanently removed with this weeder is amazing.

weeder upwards. The root will come out clean and whole in the jaws, leaving only a small hole, with no possibility of the weed growing again. It costs 3*s.* 11*d.* [78.]

A Garden Shears Attachment

GARDENERS will no doubt welcome the little device which can be attached to a pair of ordinary shears, as shown in the sketch. The hooks of this device prevent twigs and branches slipping out of the cutting edge, and so make the gadget indispensable for cutting evergreen hedges. It costs 1*s.* 9*d.* [79.]



This device, when fitted to a pair of shears, prevents twigs and branches from slipping out of the cutting edge while cutting evergreens, etc.

A Non-shock Saddle Pillar

IF you are a keen cyclist and spend your weekends touring the countryside, you often find it rough going when cycling along country lanes, and sometimes receive a severe shaking, through the inability of the saddle to absorb the shocks. If you wish to enjoy your cycling to the utmost, you should fit your bicycle with a non-shock saddle pillar which is now on the market. This sprung pillar is well made, and is guaranteed to absorb all shocks in the saddle, no matter how rough the road may be. It is obtainable in two types, the straight non-shock pillar costs 5*s.* 6*d.* and the bracket non-shock pillar 6*s.* 6*d.* Motor-cycles can be fitted with this pillar by special arrangement with the manufacturer. [80.]

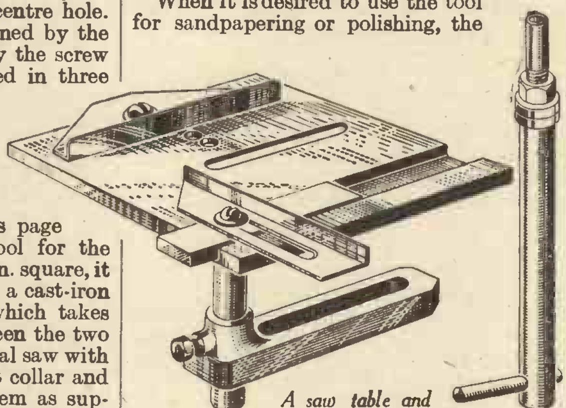
A Review of the Latest Devices for The Amateur Mechanic. *The address of the Makers of the Items mentioned can be had on application to the Editor. Please quote the number at the end of the paragraph.*

The Howkins Spot Facer

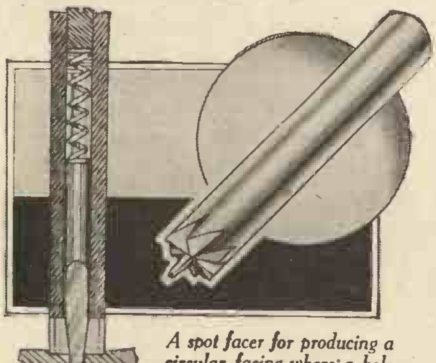
THE tool shown in the sketch below is for producing a circular facing where a hole is already drilled any size from $\frac{3}{32}$ in. to $\frac{3}{16}$ in. It is fitted with a self-adjusting taper pilot which automatically slides in and out of the cutter end of the tool; the taper adjusting itself to the hole. The pilot is steadied by the flat part working in the slot in the cutter and also by its cylindrical body sliding in the centre hole. Pressure on the pilot is maintained by the spring which can be adjusted by the screw plug. The spot-facer is supplied in three sizes, $\frac{3}{8}$ in., $\frac{7}{16}$ in., and $\frac{1}{2}$ in., all with pilot for holes varying from $\frac{3}{32}$ in. to $\frac{3}{16}$ in. The price of each is 6*s*. 6*d*. [78.]

A Saw Table and Spindle

THE saw table shown on this page will prove a very useful tool for the metal worker. Fitted with a 5-in. square, it has two fences with a $\frac{5}{8}$-in. stem, a cast-iron foot, and a 7-in. saw arbour which takes 3-in. wood saws $\frac{3}{8}$-in. bore between the two collars, or a $2\frac{1}{4}$-in. fine tooth metal saw with a 10 mm. bore between the first collar and the spindle body. The $\frac{5}{8}$-in. stem as supplied, is long enough for a 5-in. centre lathe, and one may have to reduce its length to suit a smaller lathe if the end of the lathe does not clear the bed. It is an advantage to have a short extra stem in order to bring the table top below the lathe centres when required. When the foot is fixed to a lathe cross-slide it will be reversed with its boss overhanging downwards. This same saw table can be used with polishing heads by mounting the foot on a wooden block. The table weighs $3\frac{1}{2}$ lb., and costs £1. Extra 3-in. wood saws, coarse, medium or fine, can be obtained for 3*s*. each, and metal saws, fine tooth hollow ground, for 1*s*. 6*d*. each. The 7-in. saw spindle alone costs 5*s*., and extra table stems 1*s*. 3*d*. each. [79.]



A saw table and spindle which can also be used with polishing heads by mounting the foot on a wooden block.



A spot facer for producing a circular facing where a hole is already drilled.

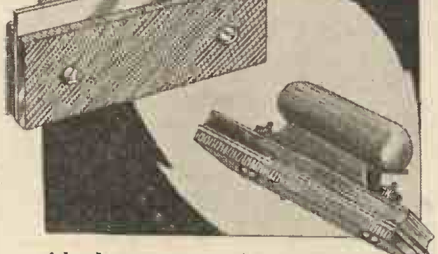
A Combination File

THE sketch at the foot of the second column shows a very handy combination tool, adjustable for a variety of purposes. It is designed for the purpose of rasping, filing and scraping wood and metals, and, by attaching suitable materials, may also be used for sand-papering, polishing, etc. The tool consists of three parts held together by nuts and screws, which can be readily loosened to make any required adjustment. The first part is a reversible steel rasp and file with different cuts on opposite faces and edges so as to be suitable for a variety of work. The second, a steel scraper which can be moved out either sideways or endways, so that any one of the four edges can be used for scraping and smoothly preparing the surface of wood, metal and other materials. This scraper, when projecting sideways, can also be used as a guide when it is desired to rub down small sections of material against the edges of the file; accurate right-angles may thus be maintained or produced by keeping one surface pressed against the side. The third part is a wooden handle conveniently shaped so that the tool may be readily used with one hand for preparing large surfaces, or held in the hand whilst small pieces are rubbed against it by the other.

When it is desired to use the tool for sandpapering or polishing, the nuts should be loosened sufficiently to permit of the edges of the emery, glass or sandpaper, or of the polishing cloth, being inserted between the scraper and the file along both sides. The nuts should then be tightened, whilst the paper or cloth is held stretched across the surface of the file. If the edges of the scraper blade are not used enough to become worn, the blade will serve also as a straight-edge for surface testing. Should the edges of the blade require sharpening for scraping purposes, this may be effected by drawing it a few times across another steel edge, or even across one end of the file if the tool is first dismantled. It costs 8*s*. 6*d*. [80.]

An Improved Bull-Nose Rabbet Plane

THE improved bull-nose rabbet plane shown overleaf is ideal for fine work where extreme accuracy is required. An improved adjustable mouth has been embodied in this plane by fitting two steel distance pieces in between the detachable



A handy combination tool that can be used for the purpose of rasping, filing and scraping wood and metal.

REPLIES TO QUERIES & ENQUIRIES

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

Conversion of Dynamos to A.C.

"IN the June issue of 'Practical Mechanics' you gave an article dealing with the conversion of dynamos to A.C. motors. I wrote you regarding one, a D.C. motor, I wished to convert, and I thank you for your prompt reply. I did as you suggested and re-wound the field coils with 1 lb. 8 oz. of wire, 26 D.C.C., and it ran straight off with a little adjustment of brush position. It was an old D.C. 25 h.p. 12-slot armature 24-bar com. 2-pole motor. Now its speed is 4,500 r.p.m., but there is no power behind it, as I can pull it right up by pressure on the shaft. (1) Can this be overcome in any way? (2) Would re-winding the armature do any good? (3) What wire and turns should I have to use? (4) Can you suggest anything? Your last letter was of great value to me, and I trust you will be able to help me further, as I wish now, having got so far, to make a useful tool of the motor. It will run half an hour and not get warm (at 4,500 r.p.m.)." (E. W., Northampton.)

In answer to your questions, the difficulty can be overcome by re-winding the machine with No. 18 D.C.C. wire, this will give you about eight times the present power output. We quoted the No. 26 wire before to be on the safe side, since we did not know the material of the machine and could not estimate the heating. After the re-wind, start the machine with the resistance in series; this will not be necessary when using the machine for short periods. Re-winding the armature will only improve the performance of the machine slightly.

A Transformer Query

"Will you kindly tell me if it would be practical to use a suitably wound transformer, on the spark coil principle, using a motor-driven mercury interruptor to supply H.T. to a radio receiving set from a 32-volt D.C. source. Would the resulting current have to be rectified?

"If it is practical, will you please give me details of the core size, winding and gauge of wire, etc., and if a rectifier is necessary will you kindly describe a suitable one, valve or otherwise? I wish to obtain an output of 50 to 60 m.a. at 200 volts, after smoothing, etc." (C. R., South Africa.)

There are sets on the market which work from a 6-volt battery and give the output you require, but they cost a little over 30*s*. We have seen these in operation and consider them more efficient than the average that the homeworker could make.

If you wish to make the apparatus, the following details should be sufficient.

Transformer of "Stalloy" stampings forming a box core, inside measurements being 3 × 3 in., and cross-section ¾ × ¾ in., primary 300 turns of No. 22 D.C.C. wire, secondary 1,250 turns of No. 28 D.C.C. wire. Rectify the output with a Cossor 506 B.U. valve. The output should be fairly smooth, giving about 200 volts 60 m.a.

Obtaining Water Power

"In the June issue of 'Practical Mechanics' there was an interesting article about small water-power installations. Unfortunately, with the type of wheel you described it is necessary to have a fairly large water pressure. There is a stream about 12 ft. wide passing through our land, and I have made several attempts to harness it, but unsuccessfully. The depth of the stream is about 1 ft., and it travels at about 12 ft. a minute, but it reaches a much greater velocity in winter. I am not allowed to make a waterfall higher than about 18 in., as there is danger of causing floods in winter. I would be much obliged if you would let me know what you would consider the best way to tackle the job again, and how to construct the water-wheel. I have a motor-car dynamo and it generates current at a fairly low speed." (M. D., Cork.)

We regret to say that we do not think it possible to arrange an electric installation driven by water power from the stream you describe. The difficulty is that there is not enough fall of water, 18 in. being altogether inadequate. A water-power installation is usually only possible when the stream flows down a steep hillside.

A Pond Fountain

"I wish to fix a fountain in a goldfish pond. Will you kindly supply me with some information with regard to the water?

"The tank is fixed in the top of a shed, and the difference in the levels of the tank and pond is 10 ft. Will this give me a 5-ft. spray. If not, how else could a 5-ft. rise be achieved with the tank in its present position, and what would the tank height have to be to give a 5-ft. rise.

"Water return to the tank will be effected by means of an electrically driven pump." (L. D., Newport.)

The arrangement suggested for your water fountain should be quite satisfactory, providing that the jet is not too big for the size of pipe. You can try jets of different sizes until the best result is obtained.

Infra-Red Photography

"Having read your very interesting book since the first edition, I would like the following information:

"(1) Is it possible to use a camera with a 7·7 anstig. lens in focussing mount for infra-red ray work?

"(2) What is the price of infra-red ray plates size 3¼ × 2¼?

"(3) What is the price of an infra-red filter to fit a 1-in. diameter lens?

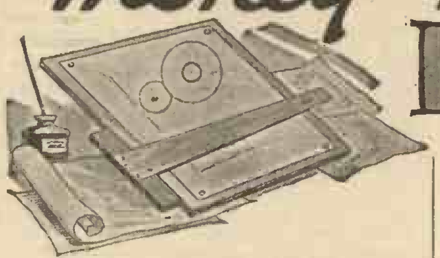
"(4) What sort of developer has to be used with ray sensitive plates?" (J. C., Newcastle-on-Tyne.)

(1) Your camera should give quite satisfactory results with infra-red photography.

(2) and (3) Any good photographic dealer will give you the price of plates and filters for infra-red work, or you can write to the manufacturers for full information. Address is: Ilford Ltd. (Photographic Manufacturers), Ilford, London, E.

(4) Use the developer formula given on the plate box, or on the little card inside the box.

Money Making IDEAS



SUGGESTED BY OUR READERS

Improved Cinematograph Picture Production

"I HAVE thought out an idea whereby it is possible to take and project stereoscopic cinematograph pictures, and would like you to give advice as to its validity, novelty and value." (R. P., Northumberland.)

The suggested arrangement for taking and projecting cinematograph pictures is, so far as is known from personal knowledge, novel and would form fit subject-matter for protection by Letters Patent, provided it achieves a more useful result than known methods. The inventor is, however, first advised to carry out certain experiments to prove the correctness of the theory on which the invention is based, and after being satisfied on this score to make a search amongst the prior Patent Specifications dealing with the subject to ascertain the novelty of the invention.

It is, however, a mistake to think that the proposed arrangement will give stereoscopic projection. It is probably true that the projected picture would be more brilliant, due to the double number of pictures taken and projected per second, but whether a more life-like projection would result is doubtful and could only be proven by experiment. In order to produce a stereoscopic picture, it would be necessary to have some arrangement whereby each eye of an observer is alternately masked in synchronism with the projected pictures. The mere alternate projection of two pictures taken stereoscopically will not produce a stereoscopic effect on the beholder. The "faithful" rendering of colour would most certainly not be achieved by the invention; it would probably be possible to obtain a result comparable with the now discarded system known as "kinemacolor." A further objection to the proposal is the duplication of taking and projecting apparatus and the double cost entailed in dealing with twice the amount of film ordinarily required.

Trade Marks

(1) What is the total cost of registering a Trade Mark or design or word? I have the pamphlet from the Patent Office, but I am not quite clear as to the cost. It would appear to be £1 on application and £2 on acceptance, making £3 in all, but then how does one know whether an objection will be raised, as if this is done it would appear that another £3 is payable, and is the money returned to me if the objector wins?

"(2) Would the word 'Nuglo' for application to furniture polishing cream be accepted, or is there a prior registration of this word?

"(3) I have noticed on some labels the words 'Copyright Design.' What is the difference between this and a Trade Mark and how does one copyright a design, and what is the cost?" (C. J. B., Moreton-in-Marsh.)

The Stamp Duty payable on filing an Application to register a Trade Mark in one class is £1. The Mark may consist of a device or a word. After the Application for registration is filed, the Trade Marks Office makes a search to ascertain if the same, or a similar Mark, has been previously registered or applied for in respect of the same or a similar class of goods. If the search does not disclose any such Mark and the proposed Mark is otherwise considered suitable for registration, the Application is allowed to proceed. It then becomes necessary, in the case of a device mark or a word mark printed in some particular way or type, to file a printing block for advertising the Mark in the *Official Trade Marks Journal*. This block is not returned, and if it exceeds 2 in. in width or depth a fee is payable for advertising. After being duly advertised for one month to allow for opposition to registration, the certificate of registration is issued on payment of a fee of £2. The Mark is then registered for fourteen years, renewable for like periods of fourteen years. If opposition to registration be raised by an interested party, and the opposition is successful after being contested, costs may be awarded by the Registrar to the successful party. In no case is any fee returnable by the Office. Provided the word NUGLO has not previously been registered in respect of "Polishing cream for furniture" it might be accepted for registration, but objection may be taken on the ground that it is simply the mis-spelling of two descriptive words NEW and GLOW. It is not possible to ascertain whether this word has previously been registered without first making a search, for which a fee is payable.

To register a design the procedure is quite different from that for registration of a Trade Mark, and the fee payable depends on the class of goods for which the design is required to be registered.

Automatic Record Repeater

"I have constructed a simple device which can be instantly attached to or detached from any gramophone record when laid on the turn-table, and which renders the action of the tone-arm automatic, inasmuch as one tune can be played twice or more without attention. This would be particularly useful for dance purposes.

"The device could be manufactured at a low cost and sold to the public for a few shillings only.

"Will you be kind enough to advise whether or no such would be of any commercial value? Should you wish I could submit drawings at a later date." (G. N., Surrey.)

The broad idea of fitting a device to a gramophone whereby a record can be repeatedly played is not thought to be novel. There have been many devices proposed and many Patented for accomplishing the object in view. It may be that the applicant's device is either less expensive to produce, or is otherwise more useful than those hitherto proposed, in which case it should have a certain commercial value which, however, will depend on the way it is marketed.

nose and the plane body, which gives four varying openings for fine or coarse work. The faces and sides of the plane are accurately machined and ground, and it can be used as a chisel plane by removing the nose. It has screw adjustment for regulating the depth of cut, and is fitted with tungsten steel cutters. The plane is 4 in. long, has

An improved bull-nose rabbet plane.

1¼-in. cutter and weighs 1½ lb. It costs 10*s.* 6*d.* [81.]

Petrol Blow Lamp

THERE are many occasions on which a convenient type of blow lamp is extremely useful to the owner-driver and home mechanic. A device of this nature can be used for hard soldering or even for doing small brazing jobs, especially if it is able to provide a reasonable amount of heat. The "Bladon" petrol blow lamp which is now on the market is of a particularly neat and handy type and, being operated entirely from petrol, it has a very special appeal to the motorist, who always has an ample amount of fuel ready to hand. The lamp under review is provided with a heat-resisting handle, and has a small clip which may be used for holding a stick of solder or spelter while the work is in progress. Although in every way a real, workmanlike piece of apparatus, this lamp retails at only 5*s.* 6*d.* [82.]

Double-Action Foot Bellows and Blowpipe

The home mechanic will no doubt be interested in the above type of gas bellows and blowpipe which are now on the market at a very reasonable price. They give a steady and perfectly controlled blast, with a sufficient volume for all the ordinary bench purposes of jewellers, dentists, opticians, etc. An important feature of these bellows and blowpipe is that they can be used with great comfort while seated; and the flame can be directed to any point, leaving the hand of the operator free to manipulate his work. The bellows, rubber balloon, with net and tubing complete, without blowpipe, cost 17*s.*, extra rubber pipe and nets 4*s.* 6*d.* each, and the blowpipe complete with stand costs 12*s.* 6*d.* each. [83.]

A Micrometer for the Workbench

THE micrometer shown below will be found to be well within the reach of the handyman's pocket. Obtainable in two sizes, it is sold complete with ratchet head, this head enabling a large number of measurements to be made with equal

A cheap and efficient micrometer.

precision by different people, owing to the fact that only a certain definite pressure can be exerted on the measuring surfaces. The price of each is—0 in. to 1 in. 21*s.*, and 1 in. to 2 in. 30*s.* [84.]

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A Splendid Kay Competition

KAY (Sports & Games) Ltd., of Pembroke Works, London, N.10, are running a grand competition this year. There are 185 prizes, and there is no entrance fee. The prizes are made up as follows: 10 first prizes, each a 21*s.* Kay chemistry or electrical outfit; 25 second prizes, each a 10*s.* 6*d.* Kay chemistry or electrical outfit; 50 third prizes, each a 5*s.* Kay chemistry or electrical outfit; and 100 smaller Kay chemistry or electrical outfits as consolation prizes. All you have to do is to write, in not more than twenty-five words the reason "why Kay chemistry and electrical outfits are best." Entries must be made on a postcard, which must bear a penny stamp, and competitors must also clearly state their full name and address, and also the name and address of their local Kay dealer. The completed card must be sent to Kay (Sports & Games) Ltd., Competition Dept., Pembroke Works, London, N.10, and must reach there not later than twelve o'clock noon on December 31st, 1934. The results will be announced in the March, 1935, issue of PRACTICAL MECHANICS. Write at once for their latest catalogue, which contains full details of this splendid competition, which will be sent free of charge upon application. [59.]

Special Optical Bargains

MESSRS. BROADHURST CLARKSON & Co., 63 Farringdon Road, London, E.C.1, the well-known optical manufacturers, have recently introduced a number of novelties and bargains which should appeal to all readers. They are listed in a well-illustrated 15-page catalogue, and consist of pocket magnifying glasses and microscopes, binoculars, slide rules, thermometers, telescopes, etc., etc. Of special note is a fine 3-in. astronomical telescope which is listed at a reasonable price. It is mounted on a stand, and is an ideal instrument for long-distance use. Write at once for this catalogue, which will be sent post free upon application. [60.]

Sundry Laboratory Equipment

LESLIE DIXON & Co., Electradix House, 218 Upper Thames Street, London, E.C.4, a name well known in the wireless trade, have recently published a list containing a number of bargains in high-grade apparatus for research and standardising work. Most of the apparatus is in a new condition, and has only been used once or twice; but all are in first-class order, and are offered to purchasers at low prices for cash only. Such an opportunity occurs seldom, and prospective purchasers are advised that there are no duplicates, and orders cannot be repeated. Write at once for the above list, which will be sent free of charge upon application. [61.]

"Goltone" Radio Components

MANY useful components and radio accessories for the set constructor are shown in the new season's list issued by Ward & Goldstone Ltd., Pendleton, Manchester. This 60-page booklet contains a fine range of H.F. chokes, including some heavy duty types suitable for A.C. or D.C. sets. Iron-cored tuning coils, H.F. coupling units, screened dual range coils, a switch unit chassis, condensers in bakelite or metal cases, compression type condensers, and switches of different types are also listed. Among the other materials given in this comprehensive list are instrument wire in all gauges, rubber and flex covered wires, voltmeters and ammeters, the "Goltone" screened down lead, accumulators charging boards, and a range of bakelite moulded adaptors and lamp holders. Every set constructor is advised to write for a free copy of this valuable list. [62.]

Hivac Valves

THE High Vacuum Valve Co. Ltd., 113 Farringdon Road, E.C.1, the well-known firm of valve manufacturers, offer to the public a fine range of first-quality valves at reasonable prices. In addition to existing types, they have recently introduced new A.C. mains valves for the first time, and these include H.F. pentodes, a general purpose triode, and a 3½-watt output pentode. Write at once for their valve list, which will be sent free of charge upon application. [63.]

A Model Engineer Exhibition

READERS interested in models and scientific novelties should not fail to pay a visit to the Model Engineer Exhibition, which is organised by Messrs Percival & Marshall & Co., from September 6th to the 15th. This year they have a wonder show of model engines, ships, speed boats, aeroplanes, electric and scientific novelties, lathes, tools and workshop equipment of all kinds, castings and materials for model making, steam and electric model railways running daily, and demonstrations of wireless and light ray control. The price of admission is 1*s.* 3*d.*, and the Exhibition will be opened daily from 11 a.m. to 9.30 p.m. The Exhibition is held at the Royal Horticultural Hall, Vincent Sq., Westminster, S.W.1.

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