HOW THE AUTOMATIC TELEPHONE WORKS

NEWNES

PRACTICAL MECHANICS

JUNE

6D.

HOW WATER-MILLS WORK · A POCKET PORTABLE 3-VALVER · INSTALLING ELECTRICAL DEVICES · PHOTOGRAPHIC SECTION · LATHE WORK TELEVISION · MODEL BOATS, AEROPLANES & ELECTRIC MOTORS · MECHANICS OF NAVIGATION · PATENT ADVICE · NEW TOOLS · NOVELTIES ETC. ETC.

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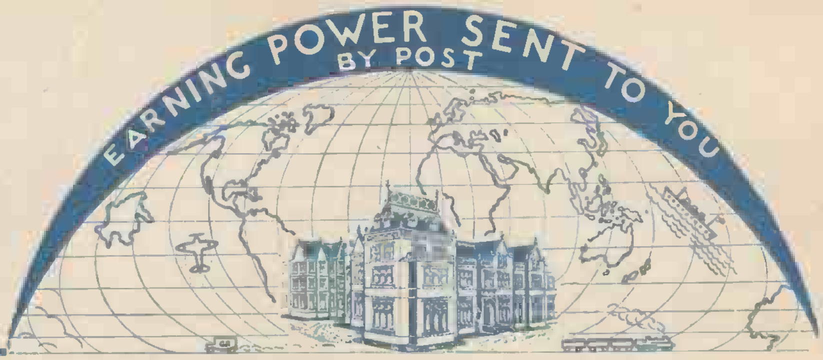
Jim Duck **Art Dept. 76.**



OPEN LETTER TO PARENTS

Dear Sir or Madam,—When your children first arrived they brought with them a wonderful lot of sunshine. Later you became proud of the intelligence they displayed, but still later you became anxious as to what would become of them in the future. Perhaps you were anxious when you visualised them as grown men and women. Even with plenty of money it is not always easy to select the right career, and a parent is sometimes inclined to ask advice of some relative and in ninety-nine cases out of a hundred that relative knows nothing at all about the possibilities of employment. Why not let me relieve you of some of your anxieties? In fact, why not let me be their Father? We do not profess to act as an employment agency, but the nature of our business compels us to keep an eye upon the class of men and women that are wanted and who wants them. There are some people who manufacture an article and put it on the market to sell. We do not do that, we work in exactly the opposite direction. We find out what employers want and we train our students to fill those jobs. We have to be experts in the matter of employment, progress and prosperity. If you have any anxieties at all as to what your sons and daughters should be, write to me, or better still, let them write to me personally—Fatherly Advice Department—and tell me their likes and dislikes, and I will give sound practical advice as to the possibilities of a vocation and how to succeed in it. Yours sincerely,

J. H. Bennett

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If you do not see your own requirements above, write to us on any subject.

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TO STUDENTS LIVING ABROAD

or on the high seas, a good supply of lessons is given, so that they may be done in their order, and despatched to us for examination and correction. They are then sent back with more work, and in this way a *continuous stream of work* is always in transit from the Student to us and from us to the Student, therefore distance makes no difference.

IT IS THE PERSONAL TOUCH WHICH COUNTS IN POSTAL TUITION

EVERY DEPARTMENT IS A COMPLETE COLLEGE. EVERY STUDENT IS A CLASS TO HIMSELF.

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Notes, News and Views

World's Largest Telescope

A TELESCOPE which is considered to be the largest in the world has just been completed at Newcastle-on-Tyne for the Dunlop Memorial Observatory, Toronto.

A New Airport

NEWCASTLE'S new airport on the municipal aerodrome will be officially opened by Lord Londonderry, Secretary of State for Air, on July 19th. The port will be under the control of the Newcastle Aero Club, which will remove its headquarters there from the present aerodrome at Cramlington.

A New Police Laboratory

A POLICE laboratory for the scientific detection of crime was recently opened at Hendon. Among the many scientific devices is a shock-proof apparatus which can take an X-ray photograph in three minutes ; the latest type of ultra-violet ray apparatus and cameras, and an ultrapak microscope, which allows the scientist-detective to view an object under ultra-violet light.

Along the benches in other rooms are dozens of microscopes for the examination of fabrics, wool and silk strands or any trivial clue which may become vital. There is also an instrument capable of cutting hair or skin to a fineness exceeding five-thousandths of an inch.

Television in France

SIXTY-LINE television broadcasts will shortly be in operation in France. It is understood that the exact picture ratio that will be employed will be either 3–4 or 5–6 scanning in a horizontal plane, as distinct from the B.B.C. broadcast of vertical scanning with a picture ratio of 3–7.

A Non-Stop World Flight

C. PANGBOURN and B. Griffith, two American fliers, are preparing for a non-stop flight round the world this summer. They hope to take three days off Wiley Post's record of seven days eighteen hours. Their aeroplane, an Uppercu Burnelli, with two 720-h.p. engines, will have a cruising speed of 200 m.p.h. It will have a tank capacity of 25,000 gallons. The aviators hope to start from San Diego (California) in August and fly the northern route of 15,000 miles round the world in four and a half days without touching land.

A New Light 'Plane Engine

WE learn that Sir John Carden, a well-known engineer, has designed a remarkable new type of light aeroplane engine which may revolutionise private flying and make possible the production of the £100 "family" aeroplane. It is a four-cylinder, water-cooled engine, developing about 30 h.p., and has been specially designed to provide a cheap but reliable power plant for the smallest types of light aeroplane.

The price of the new Carden engine will be under £50.

THE MONTH'S SCIENCE SIFTINGS

Mr. R. L. Butler, the South Australian Premier, is investigating the possibilities of an England-to-Australia air race for passenger-carrying machines.

Professor Tonna Barthet has recently constructed a device which allows note vibrations up to 1,000 per second to be visible on the screen of an ordinary television receiver.

A De Havilland Comet recently flew from Croydon to Le Bourget in 53 minutes at an average speed of 254 m.p.h.

The construction of a new Western high-power transmitter near Plymouth is proposed by the B.B.C.

A demonstration of cinematograph films taken of persons exposed to X-ray shows a picture enlarged 17,000 times the size of the original.

"World's Biggest Explosion"

ONE hundred tons of explosive, planted in twelve deep shafts, was recently exploded in the Ural Mountains, so as to strip off the covering of earth over iron ore deposits. The shock was registered on instruments 1,000 miles away. It is considered to be the biggest explosion which has ever taken place.

Motor Car Headlights

TESTS have been made with the object of determining whether colouring the beam of motor car headlights enables the driver to pick up objects at a greater distance in foggy weather. The colours tested were red, light orange, dark orange and blue-green.

It was found that the effect of colour filters on the range was simply due to the reduction in the intensity of the beam. In other words, the revealing power of a coloured headlight beam is the same as that of a white beam of the same intensity.

A Boon for the Blind Writer

A NEW kind of machine to write Braille in a way that allows the words to be read while the paper is still in position is being made by the National Institute for the Blind.

On earlier models, owing to the hammers descending upon the upper surface and so embossing the underside, any checking could only be done by removing the paper and examining the reverse side. On the new machine the hammers operate from below.

In some respects the apparatus resembles a typewriter, but it is worked by only six keys. Each of these corresponds to one of the six dots of the Braille system. Another difference is that the paper lies flat.

An "Unstallable" Biplane

THE aerodynamic department of the National Physical Laboratory at Teddington, has discovered a new type of biplane which is claimed to be "unstallable." It can fly at very low speeds without becoming unsteady and dropping a wing and crashing. This department have also had installed this year a tunnel where the behaviour of aeroplane wings at any speed up to 650 miles an hour can be accurately observed on a miniature scale.

A Record Parachute Jump

MR. G. JOHNS, who holds the amateur record for a delayed parachute jump, has completed arrangements for an attempt to beat the late John Tranum's professional record of 17,000 ft.

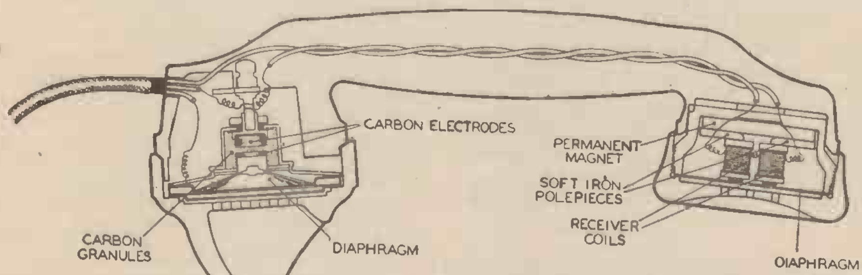
Mr. Johns plans to fall 18,000 ft. Special apparatus is necessary, and tests in a pressure-chamber have to be undergone for some time before the jump.

How the Automatic

IT has become a commonplace to say of machinery that the only thing it now lacks is a brain. Fantasies have indeed been written in which such a brain is supposed to have been evolved, usually with unhappy results for us mere remnants of another age, who find that we are to be systematically exterminated by man-like assemblies of wheels, cranks, and levers, creatures of our brain, which are determined, nevertheless, that our earth shall be their heritage.

Some time ago there was demonstrated in London a species of railway truck which might be said to have a " brain " of a sort, capable not only of receiving and carrying out instructions, but also of conveying further instructions to its fellow trucks.

As briefly as possible the process may be described as follows. A man presses a certain key, or a series of keys, on a keyboard which applies to a moving truck, which may be called truck No. 1. Truck No. 1 is at that time quite "unaware" that it is to be called into operation, and passes on its way. Its " mind " is, for the time being, a blank. On passing a definite point, however, a certain "instructions," which, for convenience, may be roughly translated thus: " On your journey you will be overtaken on a parallel track by fellow trucks numbered 2, 4, 6, 8, and so on, not necessarily in that order. Take no notice of any one of them until you are overtaken by truck No. 24. It is then your duty to unload your burden on to truck No. 24, at the same time conveying to it instructions to transfer the load in turn to (say) truck No. 103, together with further instructions that truck No. 103 is to unship the load at Platform M."

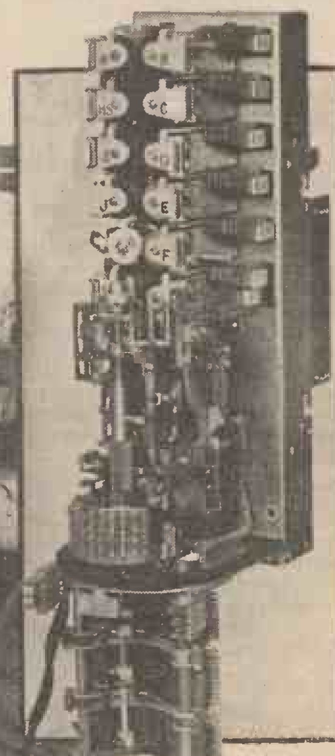


Showing a cross-section of a hand microtelephone in which the internal construction may clearly be seen.

From Truck to Truck

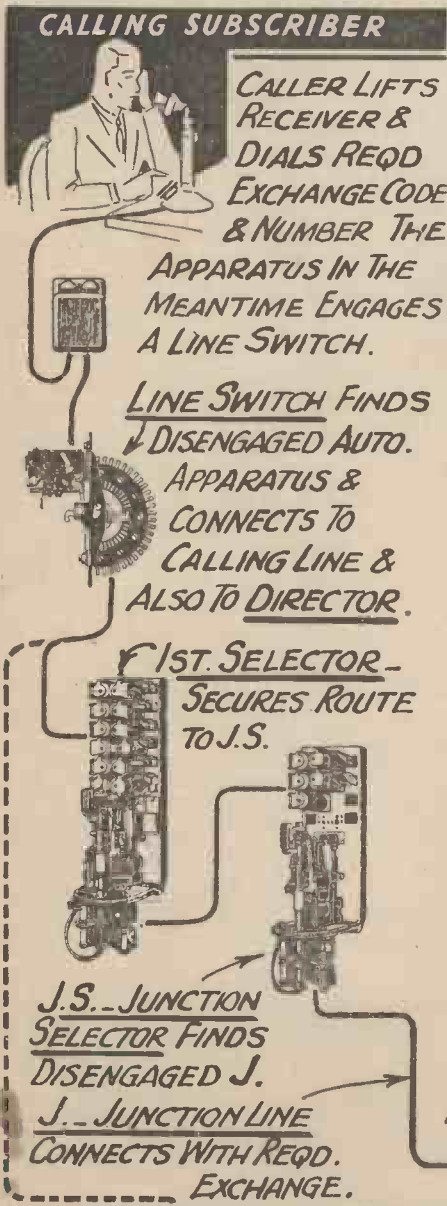
Truck No. 1 accordingly continues on its way now imbued, as it were, with a fixed resolve. It is overtaken by a succession of other trucks until about to be overtaken by truck No. 24, when it unhesitatingly transfers its burden and at the same time " instructs " truck No. 24 as to what, in turn, is expected of it. The " mind " of truck No. 1, its duty completed for the load, or burden, is automatically passed to it while it is still in motion together with

An instructor describing the functioning of the automatic exchange.



An enlarged view of a selector switch.

Telephone Works



time being, again becomes a blank ready for the next time it is called upon to perform its function, and truck No. 24 continues on its way, primed to deliver up its newly-shipped burden to truck No. 103, and to no other truck, and at the same time to transmit to truck No. 103 instructions which will be implicitly obeyed as to the platform destination of the load it has borne.

Perhaps the example just given conveys the most startling idea of how near an approach to thought can already be expected of a mechanism. The linotype machine, automatically separating a mass of mixed matrices, the A's from the B's and C's and so on, and replacing each in its proper compartment, provides another. Change machines to be seen at some underground-railway stations which will distinguish half a crown from a florin, or a shilling, and deliver the right change constitute a third. They, too, can recognise a counterfeit coin, though, at the moment of going to press, they are unable to deliver up the tenderer into police custody and state a charge!

Approaching the Power to Think

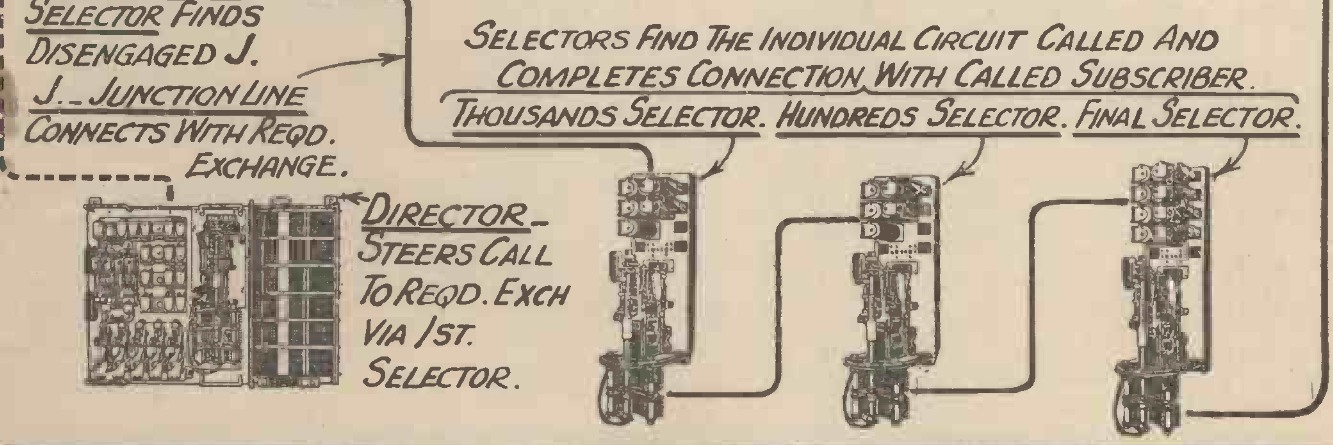
It is safe to say that the nearest approach to the manifestation of thought on the part of a mechanism in common use, however, is exhibited by the automatic telephone exchange, the function of which it is the purpose of this article to outline.

It is assumed that nearly all readers are familiar with the operation of "dialling." Though the dial-switch or "impulse transmitter" (as it may more severely be called) is simple in appearance, its construction is complex. It performs its function of transmitting series of impulses, not while it is being rotated by the operator, but while it is returning to rest under the action of a mainspring. The speed of return is accurately controlled by means of a governor of the centrifugal type.

Separation of Electrical Contacts

If the finger is placed in the hole numbered, say, "7," and the finger plate rotated to the extremity of motion, the dial will naturally be turned through a definite distance. The release of the finger plate then allows it to return under the action of the mainspring to its normal position, with the result, in this case, that a pair of electrical contacts are separated seven times. If "2" had been dialled, the points would have been separated twice, and so on. If "0" is dialled, ten interruptions of the circuit will take place. The dial is so designed that when it has come to rest, the contact points are closed. During the actual impulse sending, both microphone and receiver of the calling subscriber's instrument are short-circuited by a further ingenious device. This not only prevents annoying clicks, but also serves to cut out the additional resistance which would have an opposing effect.

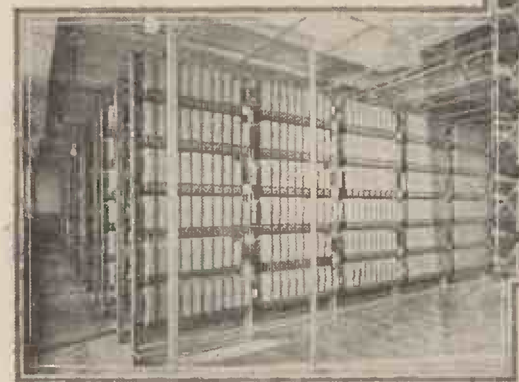
The sequence of action of the dial-switch for any one number being operated, may be briefly summarised as follows. The finger is placed in the appropriately-numbered hole and the plate pulled round to the finger stop, thus "shorting" the microphone and receiver, and storing power for the return. The finger is now removed and the dial returns, electrical impulses thus following at accurately-spaced intervals



under the control of the centrifugal governor. Finally, the dial comes to rest against its stop, opening the instrument and bringing the contacts into juxtaposition as it does so.

Automatic Selectors

To pass now to the automatic exchange



(Left) A view of the auto exchange and (above) A group of auto selectors.

proper. After the calling subscriber has lifted his receiver he is immediately connected by a rotary line switch with a relay-controlled device known as a selector, which consists of a number of pairs of contacts arranged in arcs of circles, there being ten pairs of contacts in each of ten arcs of circles per selector. The arcs of the circles are placed one above another. In a position where it is able to make contact with any one of the hundred pairs of contacts is a " wiper " mounted on a spindle. The movements of this spindle are actuated by electro-magnets controlled by relays, which in turn are actuated by the electrical impulses received from the dial switch.

Obtaining a Number

The vertically-moving relay comes into action first, and the dialling of the first figure of the called number determines the level in the bank of contacts which will be searched for a suitable first connection. Thus, if the desired number is 7294 (neglecting preliminary exchange designation for the sake of simplicity) the dialling of " 7 " actuates a " first " selector at the exchange, and the wiper is raised vertically until it is opposite the seventh or " 7000 " level of contacts. The wiper now sweeps automatically over the " 7000 " level, all the contacts in which give access to the wipers of the " second " selectors serving the " 7000 " group of subscribers' lines. The first disengaged channel encountered is seized, and thus the connection is extended to the wiper of the " second " selector.

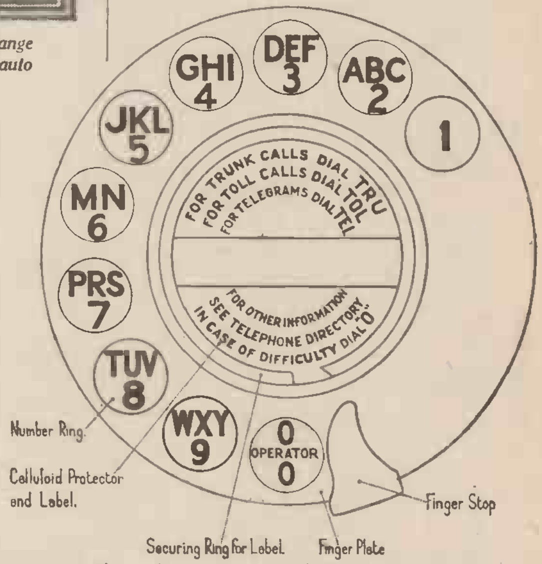
On receiving the impulses corresponding to the second figure—" 2 "—the wiper of the " second " selector is raised to the second or " 200 " level of lines and searches over this level to find a disengaged channel leading to a wiper of a " final " selector serving the 72nd group of 100 subscribers' lines, namely, the group " 7200–7299."

On receiving the impulses corresponding to the third figure—" 9 "—of the number, the wiper of the " final " selector rises to the ninth or " 90 " level of lines but does not move horizontally until the impulses from the last figure to be dialled—" 4 "—are received, whereupon the wiper is stepped round to the fourth contact of the " 90 " level, upon which terminates the called subscriber's line, namely, " 7294."

When the subscribers hang up their receivers, all switching apparatus returns to normal in readiness for the next call.

Accurate Timing Essential

It is essential for both the breaks and makes of the dial to be of correct duration. If even one of the makes is too long it may result in the vertical motion of a selector being changed into a rotary motion too soon, so that the wiper moves over an arc of contacts at a lower level than the correct one, while if the breaks are too long they may cause the release of relays and the return of selectors to their normal position, namely, the position occupied when the receiver is replaced on its fork. Again, if it is made possible to dial figures too rapidly, the first and second selectors may not have time to find suitable free contacts, while in



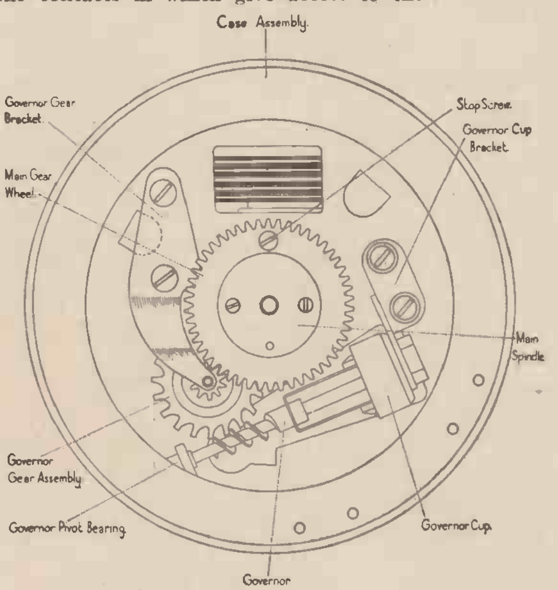
Showing the dial of an automatic telephone.

the case of the final selector the too rapid arrival of the final set of impulses may completely upset its action in finding the correct vertical level.

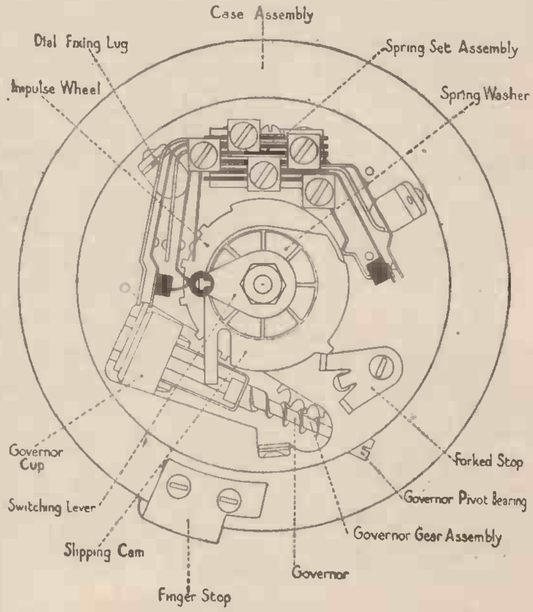
The factories assembling the dials are equipped with a remarkably accurate testing and timing apparatus. There is even a checking instrument which deals in milliseconds, which each dial has to pass before being passed for service.

The relays and selectors must also be tested and set for accurate timing to conform with the standard timing of the dials. The normal dial speed provides for ten impulses per second, the length of each break being 66·6 milliseconds, and the length of each make 33·3 milliseconds.

The type of dial switch described was developed by Siemens Brothers for the Post Office, and has also been standardised by many overseas administrations.



What a subscriber would see if the dialling plate was removed.



A rear view of the mechanism shown on the left.

(Left) Haughton Mill, Hunts, and (right) overshot wheel, Dartmoor.

HOW WATERMILLS WORK

An Interesting Article Dealing With Numerous Types of Watermills, From the Earliest Type to the Present Day

THE invention of the water-wheel was the first great triumph of the mechanical mind, and by it millions of poor slaves and humble working women were released from daily toil of the hardest and most monotonous kind.

Before this discovery, grinding flour by means of small hand-mills was a daily task. In Bible lands it fell to the women, but the Romans largely employed slave gangs. The work was toilsome and very inefficient, because the meal was often filled with bits of grit.

Those who remember the story of Joseph will recall that, when in prison, he foretold the execution of Pharaoh's baker, and it is believed that this punishment was inflicted upon the unfortunate man because he had baked bread full of grits, and so had given his royal master a raging toothache! Some of the mummy skulls of that period have the teeth badly worn down through masticating millstone grit. The first watermill was made in Greece about 85 B.C. It was very inefficient, and only suitable for tiny streams. The millwheel was like a mushroom, the head of which—fitted with paddles—revolved in the stream, while the stalk—or main shaft—passed upwards through a hole in the lower millstone and was fixed to the upper stone which turned with it.

Cockethorpe Mill, Oxon.

A Modern Watermill

Mills of this kind were used for a thousand years, until superseded by the present type, in which the wheel is set at right angles to the stones and turns them by gearing. This means that it is also set vertically to the stream, which makes it much more efficient, and it will be interesting to trace the various types and the difficulties which had to be faced.

Men who strive to harness natural forces, whether of wind or water, find their greatest problem is in the wide variation of power available from week to week, month to month, or even hour to hour.

Thus the wind miller would see his mill made idle for weeks by prolonged calms, and again shaken by gales which would do a month's work in a day. The water miller likewise dreaded the droughts of summer which might lay him idle for weeks or months, and the rushing torrents and mighty floods of winter which might sweep the mill bodily away. Both these dangers were countered probably before the Norman Conquest, and the very name of the inventor is lost.

POINTS OF INTEREST

There are Four Main Types of Water-wheel: The Overshot, The Undershot, The Breast, and The Turbine.

The First Watermill was Made in Greece about 85 B.C.

Before the Discovery of the Watermill, Grinding Flour by Means of Small Hand Mills Similar to that Shown Overleaf was a Daily Task.

The tiny stream, which might disappear in a dry summer, was dammed up and formed a mighty lake. A good example of this kind can be seen at Alresford (Hants), where a lake of 60 acres has been formed by the construction of a great dam 20 ft. high, and nearly 800 years old. Below it is a mill which is still working and has never failed for water, though the stream is very small.

The Mill Leet

The flood peril was countered by the mill leet, controlled by hatches and a tumbling weir. The usual method was to erect the mill right across the stream and thereby raise the level of the river above the mill by 6 ft. or more. When the mill is working a large part of the water is held back, since the whole stream cannot pass through the mill-wheel—except in the case of very small brooks. The surplus falls over the "tumbling weir" into the mill leet, an artificial stream which flows into the main river

Guys Cliffe Mill, Warwick, was mentioned in the Doomsday Book.

Westmoor Mill.

again below the mill. The level of the tumbling weir is carefully adjusted to give the right head of water to work the mill, so when the stream is low no water can pass over the tumbling weir, and if further control is needed it is done by hatches which also discharge into the mill leet. By these clever ideas the tiniest stream can be made serviceable, and large rivers are so controlled that they no longer endanger the structure of the mill.

There remains the problem of large rivers, too wide and deep to be held back by a mill straddling the stream and yet swift enough to turn a wheel. This was met by the clever idea of the floating mill, which was held fast by cables anchored to the bank and had one or more wheels which were turned by the river as it flowed beneath.

The original discovery was a good example of the idea that necessity is the mother of invention. When the Goths were besieging Rome in A.D. 536 they intercepted the water on the Trajan Aqueduct and so stopped the mills upon which the city depended for its daily bread. The people were in danger of actual famine, when a clever man named Belisarius got the idea of fixing two boats in the river with a mill-wheel between them and setting it to drive the stones. The plan was a complete success, and the discomfited enemy soon retired.

In bygone years there were floating mills on the Seine and Rhône in France, but the only place where I have seen them during the last decade is on the River Danube. During a recent trip I counted more than twenty of these interesting mills, most of them busily working.

Four Main Types

We now come to the subject of the water-wheel itself. There are four main types, the OVERSHOT, the UNDERSHOT, the BREAST

The earliest type of mill dates from first century B.C.

and the TURBINE. As its name implies, the Overshot Wheel is one in which the water is applied near the top of the wheel and falls over with it. This type is used where the stream is small and the fall considerable. These wheels are often very large, and being situated in deep dingles or rocky glens are usually very picturesque. It will be noted that they make use of both the *impulse* and the *weight* of the water; but they are much less efficient than the turbine.

The Undershot Wheel is found on larger and more sluggish streams, where the drop is much less. The water is applied near the bottom of the wheel and acts mainly by impulse, and the speed of the stream is usually increased by leading it through a bricked channel which narrows as it nears the wheel.

The Breast Wheel is a rare type, and is an attempt to combine the actions of impulse and gravity. The water is applied below the crest at the side of the wheel and then flows under. To do this it is necessary partly to enclose the wheel in a culvert, and much water is wasted by spilling over the culvert without driving the wheel.

The Pitchback Overshot

There is another kind of Breast Wheel which is called the Pitchback Overshot, and it differs from the Overshot because the water flows back and under instead of falling over the wheel. The Turbine is by far the most effective type when there is a good head of water, but is unsuitable for streams having only a small drop.

This is because the whole of the water working it *must actually pass through it*, and so where there is plenty of water but hardly any fall the turbines would have to be unmanageably large.

It is an ideal arrangement in mountainous districts, where a comparatively

Showing an overshot mill.

small stream falls for hundreds or thousands of feet. Under such conditions the water may attain a velocity of *hundreds of miles an hour* at the outlet, and the jet may exert a pressure on the blades equal to *one ton per square inch* for every inch of *diameter* of the spouting water. Such figures have actually been recorded where the head is in the neighbourhood of 5,000 ft.

THE INTERNATIONAL "COUPE DE FRANCE"

Model Aircraft Competition held at Vincennes, Paris

VINCENNES is a large wooded "jardin" on the outskirts of Paris. Normally it is a picnic ground for tired parents and lively children, who stream thither from all parts of the capital town. Recently a large proportion of this multitude, together with many notables and dignitaries of France, went a little further still, being guided by streamers across the roads, notices on trees and advertisements in the Paris Press, to a large open space called the Champs des Manœuvres, or the Artillery range, to witness a model aircraft competition.

Generally speaking, in this country, if you dare to fly a largish model in a London Park, or on common land in any part of the country for that matter, a voice from the depths of a large person dressed in something like a bobby's uniform will growl "'ere, what's this?" The Paris meeting was well organised, loudspeakers were used to marshal and "class off" the entrants and to deter covetous French infants from running off with the models!

Prizes were donated by such celebrities as the French Air Minister (other Air Ministers please note) and well-known full-size aircraft designers, etc. What of the British team? They did not bring home the Cup, but they did win the Air Minister's bronze plaque, a fine ashtray from Monsieur Henri Potez, designer of the well-known Potez war-aircraft, and a silver tiepin.

But, what was better still, a violent thunderstorm at midday having completely eliminated most of the 200 models, the afternoon was almost exclusively an all-British show of model flying and aerobatics. If anyone expected to see lace and frills round the wings of any of the French models they were severely disappointed, as, for instance, a sailplane put up five minutes duration before finally disappearing altogether!

In fact, the Wakefield cup contest will see a very stout team from France. Incidentally, the Coupe De France drew entrants from as far away as Japan!

TELEVISION MADE EASY

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

THE conversion of the scene or object to be televised into a disintegrated but truly electrical signal representation has now been covered by embracing descriptions of the most important mechanical and electrical scanners which have been developed for this specific purpose. It is now necessary, therefore, to trace what happens before this generated signal is converted into a modulated electromagnetic wave radiated into space for reception on appropriately designed receiving equipment.

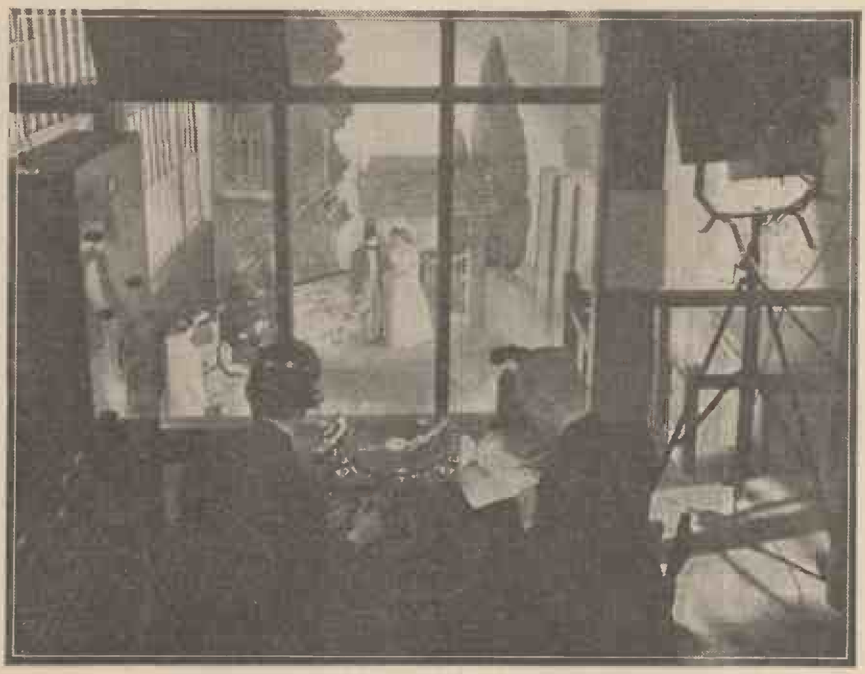


Fig. 1.—Television control engineers watching a studio scene being televised and at the same time following the script.

Complete Control

Just as in the case of ordinary aural broadcasting, a number of different studios are required for the purpose of staging the separate items in the complete programme service, so with television a similar state of affairs must exist. Several studios, all equipped with separate scanners, become necessary, and these must be linked by "loaded" lines, capable of handling the vision signals without any amplitude or frequency attenuation, to a central control room. Here must exist an elaborate arrangement of signal lines to give cues, and, if necessary, telephonic instructions to the studios in connection with the timing and dovetailing of the televised items. At the same time the vision, sound and synchronising signals must be handled (the first and last named are combined through the medium of injector valves feeding the generated H.F. and L.F. pulses into the output from the vision signal amplifiers at the correct stage in their process of magnification), so that they are fed to the radio transmitter modulation amplifiers at their proper amplitude levels.

Both line and radio check monitors, indicate to the engineers whether the results are satisfactory, and where necessary adjustments can be made by fader and potentiometer controls. In addition, for television studio production it is advantageous to have the control room located in such a position that the scenes in the studios can be watched by the one or more producers, and some of the control engineers. This aspect of the work is shown in Fig. 1, where the sound section engineers, with part of their control equipment, are keeping a close watch on the televised scene being enacted in the studio below. An efficient scheme of this nature does much to ensure the best results and in any case, unified control must be a feature of any worthwhile television service.

The Next Step

The sound signals, either from the studio microphones, cinema projector, sound heads or incidental music from gramophone records (a turn-table for this latter purpose is seen in Fig. 1), are fed direct to the modulation amplifiers of the sound radio transmitter, and after passing through the transmitter itself are injected into feeders to be led to the aerial, where they are radiated into space as an electro-magnetic wave.

Synonymous with this, the combined vision and synchronising signals pass from the control room over loaded lines to the modulation amplifiers associated with the vision radio transmitter. A particular example of this, as used in the Baird installation at the Crystal Palace, is seen in Fig. 2. The meter panel behind shows the working conditions of the various amplifier valve stages, while in the foreground are the paralleled valve stages, and below this the power pack equipment shelf. After amplification the signals then pass to the modulator stage of the radio transmitter itself, where they vary the amplitude of the generated carrier frequency to be fed ultimately to the transmitting aerial.

High Frequencies

In the case of high-definition television signals, owing to the degree of line dissection of the picture and the number of picture frames per second combined with the picture ratio, the frequency range embraced is enormous, being of the order of a million cycles per second. A sound broadcast radio transmitter, such as used by the B.B.C., is limited by European convention to a sideband spread of 10,000 cycles, so that it is impossible to use them for television transmissions in their present state without an almost complete mutilation of the signal to a state of unrecognisability.

Even assuming that such a radio transmitter was designed to work on the medium or long wavebands, the sideband spread would be so large that it would necessitate the closing down of every radio transmitter over a wide area. For example, if the London National wavelength was used as the carrier, the television signal would extend from below 200 metres to nearly 500 metres on the assumption that it could accommodate the modulation. This, of course, is a preposterous state of affairs, and the solution has led to the development of quite a new radio technique, that is, the use of ultra-short waves (those below a wavelength of 10 metres). In recent years these wavelengths have been employed for the transmission of sound, but then it was unnecessary to deal with such high frequencies of modulation, and it is only the rapid development of television that has lent to them such a degree of importance and necessitated a thorough investigation into their peculiar propagation characteristics.

U.S.W. Peculiarities

As an example we can take the very extreme case of a wavelength of 5 metres (corresponding to a frequency of 60 million cycles per second), being fed with a positive and negative modulation of $\pm$ 2 megacycles. This carrier would then only spread from 4·8387 to 5·1724 metres, so the reader will see how readily this can be done without causing neighbouring interference.

The main trouble associated with work in this region is that the range over which these ultra-short wave signals can be received with a service consistency of adequate strength for operating receiving equipment appears to be very limited. They are prone to the shielding effects of steel buildings, high trees, changes in ground contour (hills), and furthermore, do not appear to be reflected back to earth from the upper ionised layers surrounding the earth.

Strictly speaking, therefore, the signals do not extend much beyond the horizon, and it is for this reason that the transmitting aerial must be located in the highest possible situation, if the area to be embraced is to be large. Assuming this is done, then a circle of radius between 25 to 35 miles has been given as the probable *service* limit of the radiated signals. Quite a lot has been written of late stating that this rather small range of ultra-short waves is not correct, it being cited in support that signals have been received over distances of 150 or more miles. This is perfectly true, but either the conditions of environment have been of a very special character, such as reception on a high mountain over an uninterrupted path, or alternatively the waves have been directed between two distant points by the simple expedient of using well known directional antenna arrays.

Difficulties

Communication between one or two isolated points does not constitute a broadcast service over a given area, however, and until further evidence is brought forward to substantiate the protagonists of an anti-quasi-optical range for ultra-short waves the reader can accept the radius figure of 25 to 35 miles as being the correct one for good signal reception.

Even then difficulties can arise from hill shadows or screening, and this requires the receiving aerial to be located as high as possible, that is, to all intents and purposes within sight of the transmitting aerial. As an example of the high location of transmitting aerials reference can be made to the two previously illustrated dipole aerials on the balcony of the Crystal Palace South Tower, with a third high-powered broadcast type aerial right on the Tower top.

Added to this, it has been found that these ultra-short waves are prone to interference from the ignition systems of motor-cars. No doubt ere long, legislation will be introduced to make compulsory the fitting of suppressors to this part of motorcar equipment, although it should be placed on record that many manufacturers are including them as standard practice with the object of allowing car radio reception to be indulged in. Provided one is situated about 50 yards from an arterial road or main thoroughfare, however, no interference will be experienced whether suppressors are fitted or not.

New Equipment

Although there are many other points which, strictly speaking, merit description in connection with the generation and propagation of the dual television and sound signals which constitute the service provided for potential users of receiving apparatus for looking in, this side of television's problems must now give way to a consideration of what happens at the receiving end. It is here that the reader will make practical and theoretical acquaintance with apparatus which in the majority of cases is unfamiliar.

Fig. 2.—An experimental form of modulation amplifier which "accepts" the vision signals from the control room and feeds them to the ultra-short-wave transmitter.

There are several forms which the equipment for reproducing the television pictures can take, and controversy still exists concerning the advantages and disadvantages of both mechanical and wholly electrical apparatus. Up to a limit of about 120 lines of picture dissection mechanical scanners using discs, mirror drums, mirror screws, oscillating mirrors, and so on, gave exceedingly good results without much difficulty, but the proposal to use a minimum of 240 lines for the first high-definition television service has complicated matters for protagonists of mechanical methods.

It must not be assumed that solutions to these difficulties will not be forthcoming, and on many sides the hope is expressed that they will be found so as to extend the scope and work of the amateur constructor who is waiting his chance to participate in the new and fascinating hobby of television. At the moment, however, the best results of high-definition television pictures have been obtained from the use of cathode-ray tubes, a device first suggested for this purpose nearly thirty years ago, when these early inventors predicted the state of affairs which has only now come to the first stage of fruition.

Cathode-Ray Tubes

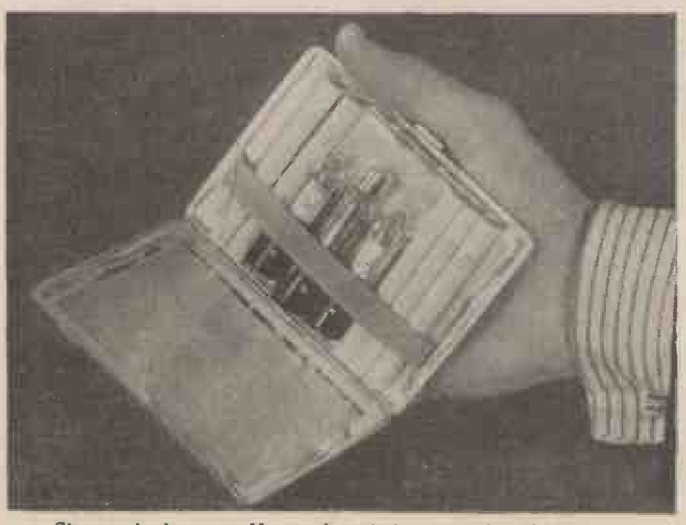
Cathode-ray tubes function through the medium of an electronic bombardment on a screen which causes a varying degree of visible fluorescence. They have no standard shape, but, in general, consist of a glass vessel having a conical body which terminates at the wide end in an almost flat but circular and coated surface, while at the taper end it joins to a cylindrical tube in which are accommodated the various electrodes necessary for the tube's proper action. The top of the tube is the screen on which the images are built up, the chemical composition giving the greyish white surface being sprayed or "cemented" on the inside as a thin but uniform layer during the course of manufacture. Tubes are available in 6⅜ in., 10 in., and 12¼ in. diameters, and a choice of two screen materials is possible. The first renders a picture impression closely approximating to black and white, and the other gives a sepia-toned picture.

TO ROME IN EIGHT HOURS, FIFTY MINUTES

By a new air service which recently came into operation, Rome will be reached from London in less than nine hours, and Brindisi in eleven and three-quarter hours.

These times compare with approximately forty hours to Rome, and approximately fifty hours to Brindisi, if the journey is made by the fastest surface transport. This new air service, operated by Imperial Airways with four-engined express air-liners, is scheduled to continue until September 30th. It will fly twice weekly in each direction, services leaving London for Brindisi on Sundays and Thursdays, and from Brindisi for London on Saturdays and Wednesdays.

To fly to Rome by the new air route will not only save approximately thirty hours, but will be cheaper than a similar de-luxe journey by surface transport. The London-Rome air fare has been fixed at £18. A first-class de-luxe boat-and-train journey from London to Rome, with sleeper from Calais, costs just over £20.



Showing the diminutive Hivac valves which are one of the features of our midget portable described on page 413 of this issue.

Its Purpose

This new service will carry passengers and freight between London and Paris, London and Rome, and London and Brindisi, and between Paris and Rome and Paris and Brindisi, and also from Marseilles to Rome and Marseilles to Brindisi. But no traffic can be accepted between London and Marseilles and Paris and Marseilles, while traffic can only be accepted from Rome to Brindisi if it is booked to destinations beyond Brindisi on the Empire routes.

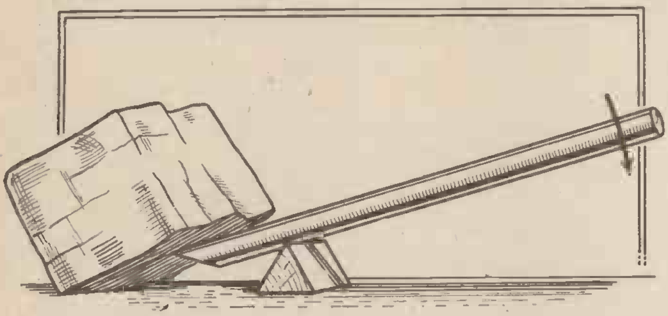
This new service from London will overtake the southbound Australia and Africa services at Brindisi, and the inward service from Brindisi will connect with the northbound services from Africa, and certain Empire passengers may be carried.

The facilities provided by the new service will also be taken advantage of in transporting between London and Brindisi, certain outward-bound traffic for Australia and certain traffic to and from the Union of South Africa. But it should be emphasised that the train link will still remain the Paris-Brindisi stage for the bulk of our Empire traffic.

MASTERS OF MECHANICS

THE MECHANICS OF THE ANCIENTS

THE unknown inventor who devised the first cutting implement and used it for fashioning materials into a desired shape was undoubtedly one of the world's first mechanics. In the great civilisations which history records and which flourished at various eras in power and glory, mechanical appliances were by no means unknown. In the Scriptural account of the building of the Ark evidences of considerable mechanical skill are disclosed. The great Chinese civilisation which flourished centuries before the rise of the Western nations acquired great mechanical powers. So also did the ancient Persians, who appear so prominently in the Biblical record. The Greeks, the Arabians, and last, but not least, the Egyptians, were, in many respects, masters of mechanical arts. In the latter instance one has but to consider the vastness of the Egyptian pyramids to realise the great amount of engineering skill which must have been required to erect such memorials. It was, indeed, only with the



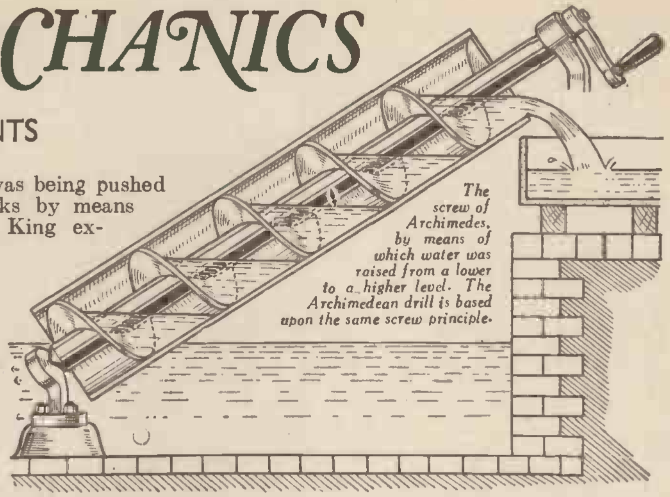
Archimedes has been credited with the discovery of the lever.

rise of the Roman nation to power that engineering and mechanical arts began to be discouraged, the notion of the Romans being that anything devised, constructed or otherwise wrought by the hands was menial and undignified.

Although mechanical principles and arts have been practised from the very beginning of the human race, it was only during the ancient Greek civilisation, some 500 years before the birth of Christ, that mechanical ideas first began to receive what we would now term "scientific" investigation. Among the many names which stand out in the records of this period, the greatest, perhaps, is that of Archimedes. Archimedes was born in 287 B.C. at Syracuse, a town in Sicily. It is said that he was related to King Hiero of Syracuse. Be this as it may, there is no doubt that the King encouraged him greatly in all his mechanical pursuits. His great powers of mechanical invention have formed the basis of many tales, perhaps the most celebrated being that of his discovery of the famous principle of specific gravity which bears his name.

The Discovery of the Lever

Archimedes is the first engineer whom history records. He has been credited with the discovery of the lever, although this, no doubt, is claiming too much on his behalf. He certainly, however, made great use of the principle of the lever in his inventions. The famous story runs to the effect that Archimedes, in the presence of King Hiero of Syracuse, was supervising the launching of a ship. The ship was being pushed away from the stocks by means of levers. Upon the King expressing admiration at the ease with which the levers did their work, Archimedes is supposed to have uttered his famous dictum: "Give me but a place to stand on, and I could thus move the earth!"



The screw of Archimedes, by means of which water was raised from a lower to a higher level. The Archimedean drill is based upon the same screw principle.

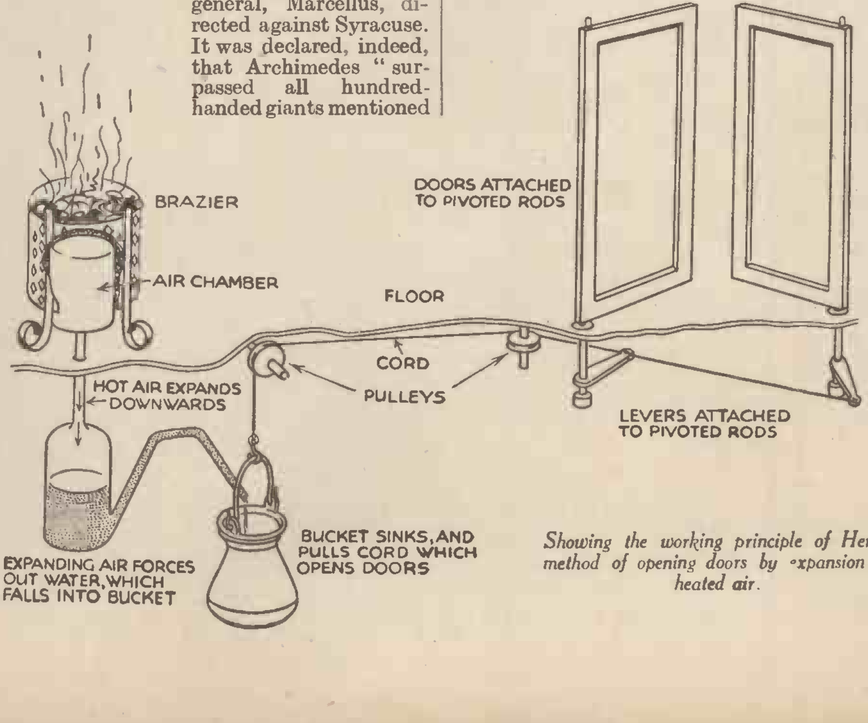
The science of mathematics, which is in many ways inseparable from that of mechanics, received fresh additions from the work of Archimedes. It was Archimedes who made the discovery concerning the ratio of the circumference of a circle to its diameter, a ratio which we now universally designate by the Greek letter π (Pi) and which is equal to 22/7 or 3·1416.

The full extent of Archimedes' mechanical works will never be known, for many of his writings perished during the period of the downfall of his civilisation. So far as it is possible to ascertain, however, Archimedes remained ignorant of the tremendous power of steam. By means of his famous screw he was able to raise water from lower to higher levels, but the notion of employing steam for water-raising purposes never dawned upon him.

Ancient history records Archimedes' prowess as a military engineer. For three long years he was able, by means of his mechanical catapults and other devices, to repel the attacks which the great Roman general, Marcellus, directed against Syracuse. It was declared, indeed, that Archimedes "surpassed all hundred-handed giants mentioned in poets' fables." One of Archimedes' contrivances at this critical period was an arrangement of mirrors which directed the sun's rays on to the sails of the invading ships and which thus set them on fire. When at last Syracuse did succumb to the invaders' attacks, Archimedes met his death by the misdirected zeal of some Roman soldier. The slaying of this famous mechanician, it was said, caused great sorrow to the victorious Marcellus, who held him in great respect. Archimedes, therefore, was probably the first "martyr of science."

Euclid

The inventive period of the pre-Christian era should not be passed over, particularly on its mechanical side, without brief reference to the celebrated Euclid, that sworn and truly hated enemy of generations of innumerable schoolboys. Euclid lived from about 340 B.C. to 260 B.C.—neither dates being certain. He was the first professor of mathematics in the University of Alexandria, which had then been newly created and endowed by Ptolemy the Guardian, King of the Egyptians, and it is probable that he was well acquainted with Archimedes, since the latter was a pupil at the University of Alexandria. It was in the latter world-famous centre of learning that Euclid's "Elements" of geometry were written. Euclid, of course, did not discover



Showing the working principle of Hero's method of opening doors by expansion of heated air.

all the geometrical propositions which have been of such incalculable value to engineers of all ages. Many of them he merely codified and arranged in sequential order.

The greatest practical engineer and mechanician of the period immediately preceding the Christian era was Hero (or Hiero), who rose to the zenith of his fame at the University of Alexandria about the year 120 B.C. To Hero of Alexandria is credited the first application of steam power, although, so far as we can tell, the power of steam was known to the Egyptians centuries before Hero's birth. In such times, however, it was customary to keep all mechanical inventions and discoveries close secrets. Such secrets were only revealed to the Egyptian high priests and other workers of the so-called "mystic" arts. Hero of Alexandria, although he may not have actually discovered the principle of the famous "æolipile," as the primitive steam engine which is inseparably associated with his name is sometimes termed, was certainly the first to describe it clearly.

Hero's "Æolipile"

Hero's "æolipile," or ball of Æolus, comprises a hollow metal sphere fitted with two oppositely-projecting jets. The globe is free to revolve on pivots consisting of two hollow tubes communicating with a steam boiler underneath. Steam from the boiler fills the sphere, and, in escaping through the jets, gives a "back push" to the sphere, thus causing it to revolve at a high speed, "as if," wrote Hero himself, "it were animated from within by a living spirit."

Hero's book on "Pneumatics" shows us that the ancients were acquainted with many fundamental mechanical principles. They knew all about levers, beams, air conduits, toothed wheels, spur wheels and many other mechanical parts. They even appear to have had some device very similar to our present cylinder and piston. Hero describes an apparatus for blowing a trumpet on the opening of a door, a device which would, of course, completely awe and mystify the Egyptian worshipping sects. Hero's trumpet-blowing apparatus functioned by the opening door being caused to operate a series of rods, cords and pulleys, which resulted in a hemispherical cup, to the upper part of which a trumpet was attached, sinking into a vessel of water. This caused the water to compress the air in the cup and thus to force it through the trumpet, thereby creating sound. Hero also mentions an apparatus for causing doors to open when a fire was lighted in a certain place. Such was effected by the compression of air and water by heat.

THE NEW BROWN TUNER

Interesting Details of a New Permeability Tuner Designed to Cover the Broadcast Bands with Maximum Efficiency. It is a Complete Unit, and Eliminates the Variable Condenser

The complete Brown Tuner, showing the control, trimmer and wave-change switch.

THERE have been many interesting schemes put forward for utilising the powder-iron core in tuning coils, and we have seen some interesting types of coil developed as a result of various trains of thought. The permeability tuner, in which the movement of the iron core affects the inductance of the surrounding coil and so carries out tuning without the necessity of a variable condenser, has been developed in several patterns and some of these are still on the market. So far, however, a more or less standard type of coil has been used with the iron core and thus the full advantage has not been taken of the benefits which this core gives to the coil designer.

A Novel Idea

Mr. S. G. Brown, whose name is well known in the radio world, has spent a great deal of time experimenting with this tuning scheme, and as a result of his experiments a new tuner has been developed and is shown in the illustrations on this page. The actual coils used in the unit are incredibly minute, and may be seen in the interior view arranged in two rows of six coils. The complete tuner, by the way, measures about 4½ in. long by 3½ in. wide and is only an inch or so in depth, yet it incorporates the complete tuning system for an H.F. and detector stage, with wave-change switching, slow-motion drive and also includes an inter-circuit trimmer.

The Actual Coils

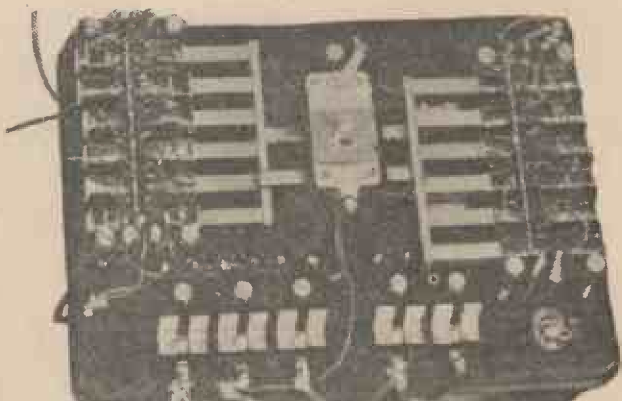
The coils used in this tuner measure only ⅞ in. in length and are of square section, each side measuring under three-sixteenths of an inch. A paper former is employed upon which the coils of enamel-covered wire are wound, and a very special method of winding is employed, in which full advantage is taken of the nodal points of the coils, as this is productive of certain results when incorporated in a receiver. By utilising this arrangement, and winding the coils in a certain manner, it is claimed that a much sharper tuner is obtainable than has hitherto been thought possible, without cutting side bands. The unit gives four times the separation which is at present obtained by other arrangements, and it is claimed that even twenty times the present separation is possible, with the result that instead of requiring a separation between stations of 9 kcs, there will be no need to have a greater separation than 1 kc. The reasons for this will be explained when full details of the coils are released.

The Tuning Arrangements

The control of inductance, or the tuning control, is carried out by sliding the small iron cores in and out of the coils, and for that purpose the cores are attached to small cross-bars which are fitted to small racks. A pinion on the central control spindle imparts to both sets of cores a similar and opposed movement, and thus each circuit is tuned. The matching is accurately carried out by the manufacturers, but a small trimmer is fitted for balancing out stray capacities, and this is controlled from the front by the small spindle projecting from the centre of the main tuning dial. A slow-motion device is fitted into the side of this dial and is intended for finger operation, and it provides a clean, smooth movement. For wave-change purposes a sliding bar is employed, and five separate contacts are changed in the process of passing from the medium- to the long-wave bands. The ranges covered at present are from 180 to 600 metres and from 800 to 2,000 metres.

To obtain maximum results from the tuner it is necessary to observe certain precautions. The front portion of the unit is of bakelite, and it is thus necessary to screen this efficiently to prevent erratic effects, although the rear portion of the unit is of metal and may thus be earthed by any simple method. A metal panel is thus essential for the receiver incorporating one of these tuners. Furthermore, the leads from the tuner (no terminals are at present fitted) must be kept reasonably short, and in certain cases it may be desirable to screen some of them.

Further details concerning the tuner will be given at a later date, when we have had an opportunity of thoroughly examining it and trying it in various circuits.



The interior of the tuner. Note the compact arrangement and size of the coils.

MAKING AND USING A SMALL CHARGING SET

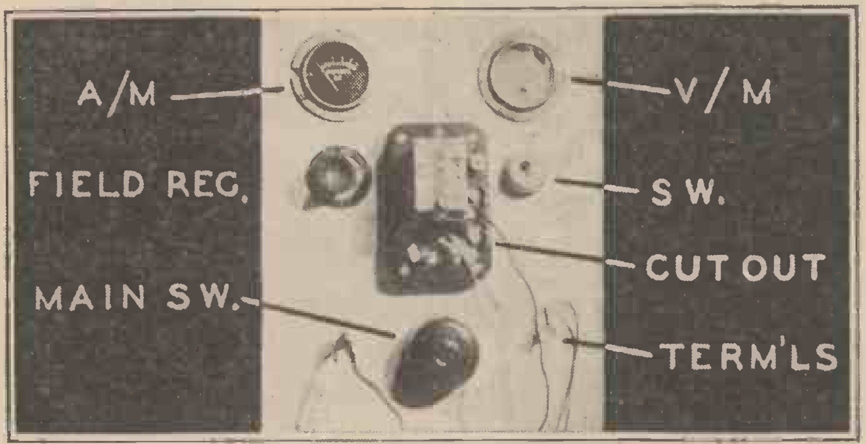


Fig. 1.—A photograph showing the front layout of the charging set.

An efficient and easily constructed home-made charging station

MANY readers have written for details of circuits and materials necessary for making up a simple home charging station, and although different requirements were laid down, the essentials were all very much the same. It must be cheap both in initial cost and when working, silent in operation and be semi-automatic, thus enabling it to be left for long periods without attention. An experimental switchboard was set up on a fairly heavy base, complete with volt and ampere meters, behind which was mounted a small car dynamo and A.C. motor. The components were built for experimenting, and various speeds and drives were tried. The results of many hours experimenting are given below, and readers who follow these notes can be sure of obtaining satisfactory results. The various sketches and photographs show the apparatus that was used during the experiments.

The dynamo used was a small 6 volt, 5 ampere machine, and was fitted with ball-bearings, a third brush, and a large pulley for a V-belt drive. The motors to hand varied from converted car dynamos to large squirrel cage machines. One of the series-commutator type was selected, because they are fairly common, and it had a pulley suitable for a ¼-in. round leather belt. The original dynamo pulley was dispensed with, and a smaller one turned from a piece of hard wood and grooved for the belting. When the machines were mounted and started for the first time, the speed was so high that the whole apparatus seemed likely to leap off the bench on to the floor, but on loading up the dynamo the voltage rose to 10 and the current to 8 amperes, and consequently both machines overheated, and had to be closed down after half an hour. The obvious solution was to turn a large pulley, and one 5 in. in diameter was made and fitted; this allowed the plant to run at the best speed with the dynamo giving 6 amperes and not overheating (see Figs. 1 and 6).

The Circuit

The circuit used is almost identical to that used on a motor car, except that a field regulating resistance is used; this allows the output of the dynamo to be controlled so that 2-, 4-, or 6-volt batteries may be charged. The original field regulator is a filament resistance of fairly heavy make, and is admirable for this purpose as it takes up very little space. The ampere meter reads 0–10, and the voltmeter 0–12. Two cut-outs were tried, one for 12 volts and one for 6, they both worked excellently and prevented any damage to the battery or dynamo in cases when the motor was accidentally switched off.

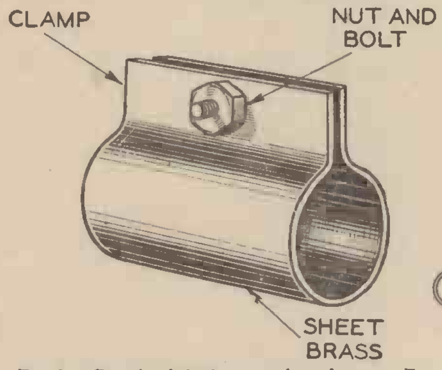


Fig. 2.—Details of the hose-coupling clamp.

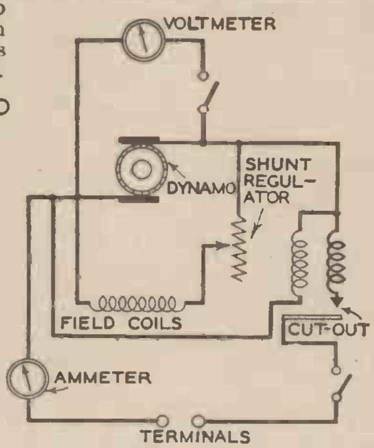


Fig. 3.—An ordinary circuit for a shunt dynamo.

The series switch and volt-meter switch are really unnecessary, but were fitted so as to obtain almost every possible running condition (see Figs. 3 and 4). A sketch of a clamp is shown in Fig. 2.

If a cut-out is not fitted, then a field switch and a series switch must be incorporated. It should be noted that, when starting, have both switches open and the battery connected up, and then close the battery switch and then the field. When stopping, open the field first, then the series, and finally stop the dynamo. If the machine is started without a battery connected it will stall the motor, or, if this is sufficiently powerful, the dynamo will burn out. Always start up with all the field resistance in circuit, as this does not put such a great strain on the belt.

A larger set was then made up and experimented with, this being a 12 volt, 10 ampere machine driven from a squirrel cage motor. The dynamo connections are the same, the only difference being in the starter for the motor. The set originally ran as a belt-driven one, the motor pulley giving a speed increase of 2 : 1, so that the dynamo ran at just under 2,000 revolutions. Unfortunately this was rather high, as the belt slap caused the bench to vibrate, but the noise was easily cured by placing a penny rubber under each leg. Direct-drive has since been installed and the differences in every respect are astonishing. The dynamo gives its full output at a much lower speed, and hence belt slap, vibration, etc., are all eliminated. Line up the motor and dynamo carefully on a heavy wooden base and pack either machine until the shaft heights are the same, spot the holes for the fixing bolts, remove the machines, and drill the holes for substantial bolts. Although it may sound rather incredible, the whole of the power is transmitted through a 3-in. length of garden hose, with speeds up to

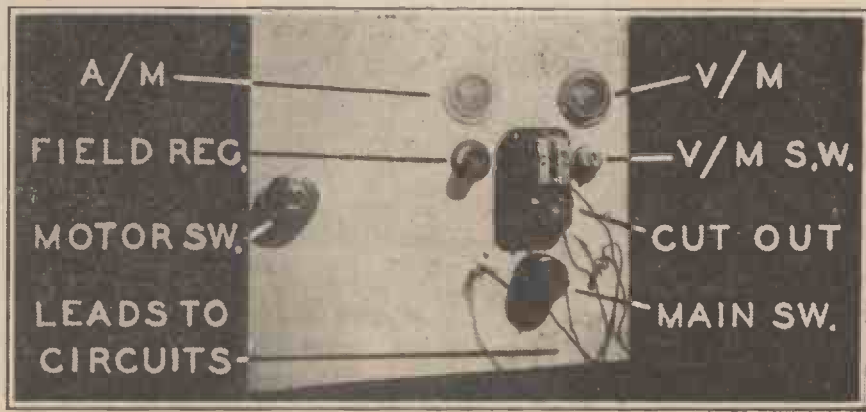


Fig. 4.—A further view of the charging set.

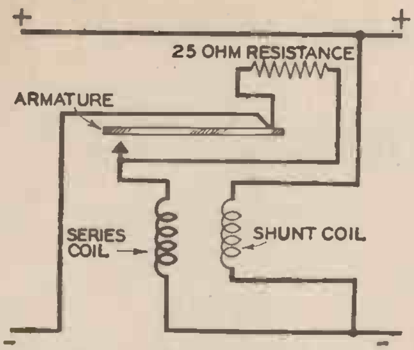


Fig. 5.—The cut-out connections.

3,000 revolutions and powers to $\frac{1}{3}$ h.p. The hose is pushed on to the shaft for 1 in. and secured by a clamp (see Fig. 2), the distance between the shaft ends and the free hose being not more than $1\frac{1}{2}$ in. This must be allowed for when aligning the machines. The best tubing to use is the corrugated anti-kink variety.

Another machine was driven through a flexible joint similar to that on a motor car, the material being two thicknesses of old inner tube, but this dynamo had an output of 150 watts at 1,500 volts, and ran at 3,000 revolutions from a series motor. Twice through faulty condensers the dynamo has been virtually shorted and the motor stalled, but the drive still remains perfect.

Running a Dynamo without a Battery

Many readers have asked how to run a dynamo without a battery, having found to their sorrow that disastrous happenings occur when it is removed. It is a well-known fact that when a dynamo of this type is run without a battery, the dynamo voltage rises and generally stops the motor, or if the power is sufficient to drive the dynamo, then it burns out. It was to solve this problem that the following experiments were undertaken. The same apparatus was used as before, namely, the 6 volt, 5 ampere dynamo and the series motor. Arrange the dynamo with the external circuit complete and all connected up; the load should approximately equal the output of the machine; in this case two 12-watt lamps were used. On starting up nothing happens, except in rather exceptional cases, as a shunt machine will not build up with a low external resistance. If a large resistance is placed in series with the lamps and connected with a shorting switch, then the dynamo will cut in every time, but if the shorting switch is immediately closed, the load will probably stall the machine or it may run slowly, giving an output of only a few watts. Regulation of the field strength does not help very much, as the voltage rise is almost instantaneous. Three 12-watt lamps were wired up so as to overload the dynamo. They were connected up as a permanent installation, each being complete with a switch and about 5 yd. of double cable; this represents the working conditions of a small direct plant. The cut-out is arranged to short circuit a series resistance of about 25 ohms (see Fig. 5). When starting the machine all the lamps are switched on with all the field resistance in circuit, and on watching the voltmeter the voltage immediately begins to rise and the needle slowly goes over to 8·5 volts. At this point the cut-out shorts the 25-ohm resistance, bringing the load on to the dynamo and the voltage drops to about 6, and remains constant. Adjust the field resistance until about 6 amperes are passing; the lamps will then be burning normally, and the voltage across the dynamo stand at 7·5.

Working the Machine

Once the machine is running steadily, two lamps may be switched out with very little voltage change, which, of course, can be corrected by the field regulator. If all three lamps are switched out the dynamo will stall the motor. A set like this would prove ideal for workshop lighting as the dynamo would only be switched on when the lamps were needed. In closing down, the motor is switched off with the lamps still burning, the cut-

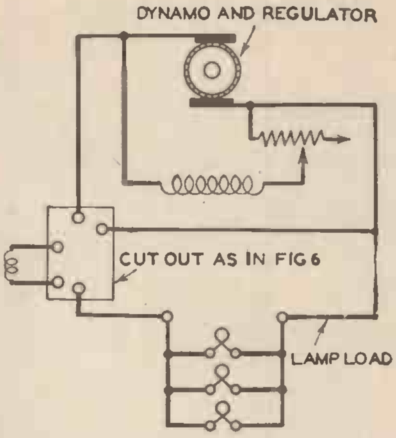


Fig. 7.—The connections for a lighting dynamo.

out works as before, so that for the next start it is only necessary to switch the motor on, and the lamps then come on automatically. With a set driven from a small petrol engine used for other purposes, so that the lights are only needed at night, then it will be necessary to have a switch in the shunt circuit. If a filament resistance is used here, then it can be turned to the off position, and will have to be re-adjusted when next the machine is started.

If the dynamo is wanted for plating and other purposes, it must be run on a balanced load, that is to say, with a variable resistance in series with the bath. With a large machine, however, it may be necessary to have several lamps in parallel, as well as the plating. One large variable resistance would serve instead of the lamps, and the voltage and current could be adjusted to suit any special requirements. The great advantages of running a direct lighting plant is that there are no batteries to keep charged; thus the machine is only running when the lamps are needed, and the voltage can be so adjusted that the resistance and voltage drop in the circuits is negligible.

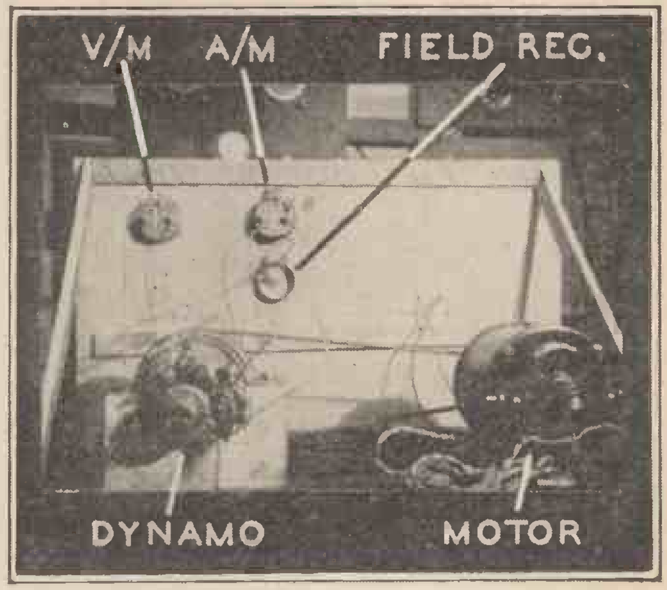


Fig. 6.—A rear view of the charging set.

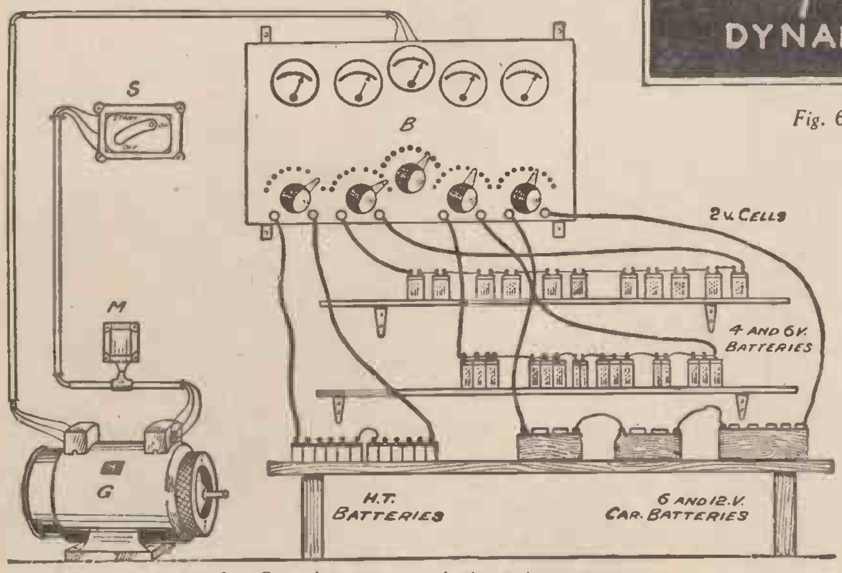


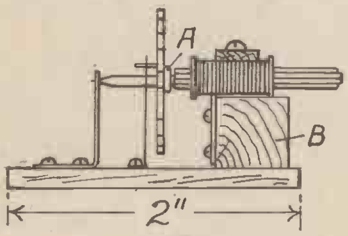
Fig. 8.—General arrangement of a home charging station.

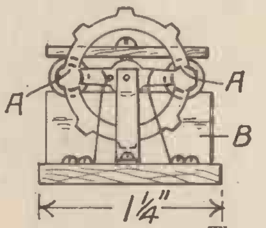
A MINIATURE ELECTRIC MOTOR

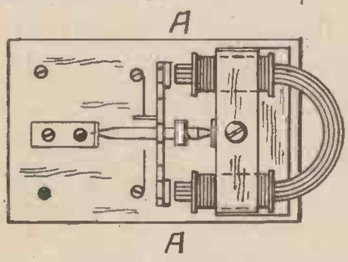
This Easily-made Working Model is built Round the Balance Wheel of an Alarm Clock. It Runs at About 1,000 r.p.m., and the Supply is by means of a 4-volt Flashlamp Battery.

THIS novel form of electric motor, which can be made in a couple of hours, runs at high speed when connected to an ordinary flash-lamp battery.

Many interesting models have had their origin in the junk box, and the tiny motor shown in the accompanying illustrations is no exception, as the chief part, the armature, is a balance wheel taken from the works of a discarded alarm clock.







Figs. 1 to 3.—Side, end and plan views of the miniature electric motor, designed round the balance wheel of an old alarm clock.

Preparing the Rotor

To prepare the armature, or rotor, two soft iron discs are sweated to the side of the rim of the wheel at the ends of the two radial arms, as shown at A in Figs. 1, 2 and 3. These discs are $\frac{5}{32}$ in. diam., and were cut with a hacksaw from the shank of a wood-screw. They are filed to a thickness of $\frac{1}{20}$ in. before being sweated in place.

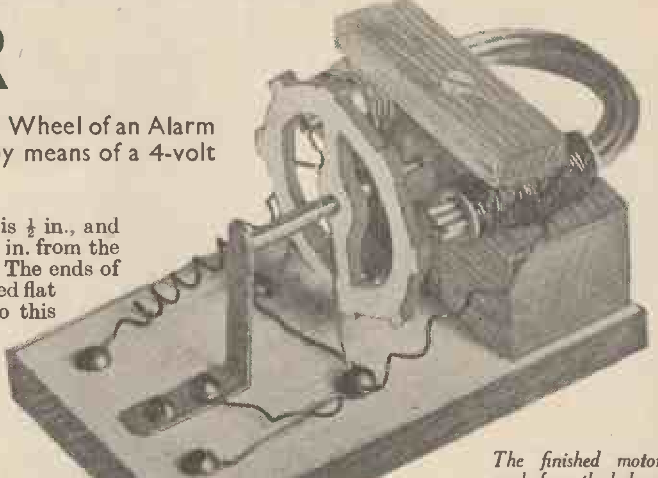
The bearing plates are cut from a strip of 22 gauge sheet brass to the sizes given in Fig. 4, and two holes are drilled in each to take small brass round-headed screws. Near the top end of each bearing a deep centre-punch mark is made to take the pointed ends of the armature spindle.

The supporting block, B, is a piece of $\frac{1}{2}$-in. square wood $1\frac{1}{8}$ in. long, and is fixed to the baseboard with two countersunk screws driven in from underneath.

The short bearing plate is screwed to the block, B, while the longer plate is bent at right angles and screwed to the base, as shown in Figs. 1 and 2. The distance between these plates must be such that the rotor revolves easily when the pointed ends of the spindle engage in the centre-punched holes made to receive them.

The Magnet

The magnet consists of eight pieces of 16 gauge soft iron wire $2\frac{3}{8}$ in. long, each bent to a horseshoe shape and then bunched together. The ends of the magnet must be the same distance apart as the soft iron discs, A, A, on the rotor. Two brass washers, about $\frac{1}{4}$ in. diam., are slipped on to each magnet limb to form the cheeks for the coils, as shown in Fig. 4. The distance between the washers is $\frac{1}{2}$ in., and the end washers are $\frac{1}{8}$ in. from the ends of the magnet. The ends of the magnet must be filed flat and square, and to do this bind each end tightly with copper wire and use a fine cut file.



The finished motor, made from the balance wheel of an old alarm clock.

The magnet is wound with No. 30 gauge enamelled wire, 3 yd. being wound on each coil. After winding one coil, the other one is wound in the reverse direction, as indicated at C, Fig. 4. A few inches of wire should be left at the starting and finishing ends of the winding for connecting-up purposes.

A thin strip of oak is used for clamping the magnet in place, a hole being bored through the centre of the wood to take a $\frac{1}{2}$-in. round-headed wood screw which is driven into the block, B. Before tightening the screw the magnet must be adjusted so that its ends clear the soft iron discs on the rotor by about $\frac{1}{32}$ in. The smaller this space the better, provided, of course, that the parts do not touch when the rotor revolves.

Making the Connections

The circuit diagram is given in Fig. 6, from which it will be seen that the wire from one magnet coil is connected to one of the screws near the front corner of the baseboard. The wire from the other coil is connected to one of the screws at the foot of the L-shaped bearing plate. The two "brushes," with which the small pin on the rotor makes contact, consist of pieces of No. 28 gauge bare copper wire, clamped under the heads of two screws near the rotor. A wire from one of these screws is connected to another screw near the front corner of the baseboard, as indicated in Fig. 6. By having two brushes connected as shown, two impulses per revolution are given to the rotor.

The wire "brushes" should be inclined towards the spindle so that they press lightly against the contact pin when the rotor revolves. It is also necessary to slightly bend the top end of each wire so that the pin just makes contact as the iron discs approach the ends of the magnet. Contact must be broken the moment the discs come opposite the magnet ends.

Final Adjustments

On connecting up to a flash-lamp battery the little motor will run at a fast rate after the necessary adjustments to the wire "brushes" have been made. A touch of very fine machine oil should be applied to the ends of the rotor spindle before starting up the motor.

As an alternative to using a balance wheel for the rotor, a strip of tinplate with a soft iron disc soldered to each end would answer the purpose. A piece of steel knitting needle of the required length, with both ends filed to a point, will do for the spindle. Drill a hole in the centre of the tinplate strip, put it on the spindle, and solder it in place after making adjustments so that the whole runs truly when placed between the bearings.

Concealing the Battery

The battery could be conveniently concealed by mounting the motor on a hollow plinth in the form of a box, so arranged that the battery lies flat within it. Suitable connections could be made through the top of the box to the screw terminals on the baseboard, and a small switch could be fitted to the side of the box.

This type of motor, which gives very little power, is only intended to demonstrate the principle of electro-magnetic attraction, as applied to large electric motors.

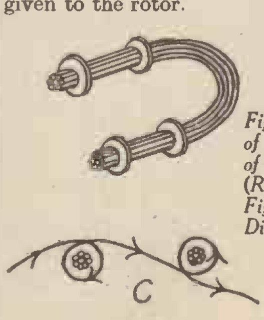


Fig. 4.

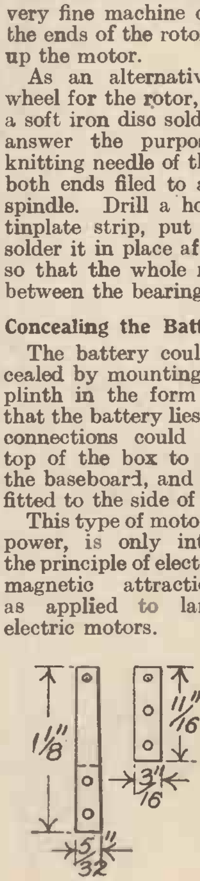


Fig. 5.

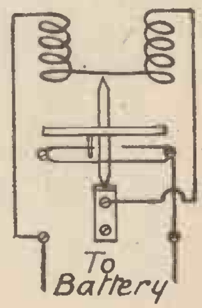


Fig. 6.

Fig. 4.—(Left) Details of magnet and direction of winding. Fig. 5.—(Right) Bearing plates. Fig. 6.—(Extreme right). Diagram of connections.

MECHANICS OF NAVIGATION

The Wonders of Modern Navigational Science, with a Brief Description of Some of the Early Types of Sea Travel Devices

Showing the gyro compass.

HAVE you ever noticed, when studying the attractive programmes of the various cruising ships, that they are all planned to run to time like a train ?

The date and hour of arrival is given for every port, and in spite of contrary winds, gales and fog it is rare for a British ship to fail to keep to her schedule.

Still more wonderful is the way in which the navigator can steer his ship over thousands of miles of trackless ocean, and after being out of sight of land for days, or even weeks, pick up a tiny speck of land no bigger than the Isle of Wight !

Speak of it to a ship's officer and he will reply, "Oh, it's quite easy; it's only a matter of navigation," and probably most ocean travellers treat it as a matter of course. If, however, we are permitted to go on the bridge and study the amazing instruments which the scientific knowledge and inventive genius of many clever men have placed at the disposal of the modern seaman, we shall understand, as never before, what a background of scientific theory and practice lies behind the safety, comfort and punctuality of the modern liner.

Early Navigators

If we go back a couple of thousand years, when there were neither charts nor compasses, we shall find that the early navigators steered their frail craft from headland to headland as they skirted the coast of the Mediterranean, and seldom dared to pass beyond the dreaded Pillars of Hercules (Straits of Gibraltar) into the unknown terrors of the outer ocean.

It is true that they sometimes ventured out of sight of land when crossing the Mediterranean from north to south, but the usual course was *viâ* Malta from Sicily, which did not involve being out of sight of land for long. During this time they used the sun by day and the stars by night to guide their course, and were cheered by the knowledge that the sea was landlocked, so that they must presently reach the shore. Even then, when the sky was overcast for several days and nights, their peril and terror were very great, as we can learn from the graphic description of St. Paul's shipwreck in the Book of Acts.

Consulting the magnetic compass.

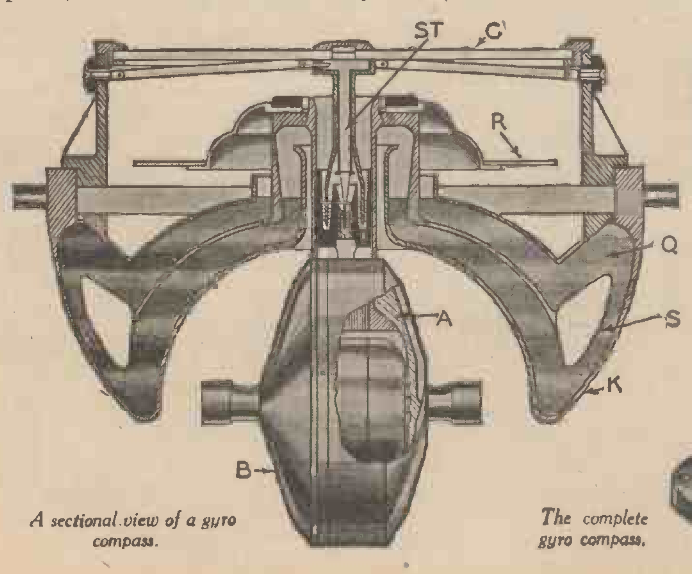
Showing the Hudson patent dead beat compass.

So far as the outer ocean is concerned, it is certain that most of the early voyagers who were blown out to sea were lost, never to return. Sometimes a ship reached an undiscovered land and her crew remained there; more often they perished in the trackless wastes of ocean. There were some romantic happenings in those early days. Thus in 1344 an Englishman named Robert Machin eloped from Bristol in a small boat with Anna Harford, and being caught in a tempest was driven for many days out of sight of land, and finally was cast up on the coast of Madeira, where he and his wife subsequently died. It is supposed that they were buried by other members of the crew, and an altar and cross were placed on the spot and it was named Machico after them. The island was uninhabited when they reached it, and was again uninhabited when discovered by the Portuguese nearly a hundred years afterwards. If there had been several women on board the colony might have become populated and British.

In the same way Danish sea-rovers were storm-driven from near Iceland to the mainland of North America, and a canoe-load of South Sea Islanders was cast by a tempest on the coast of New Zealand and became the founders of the Maori race.

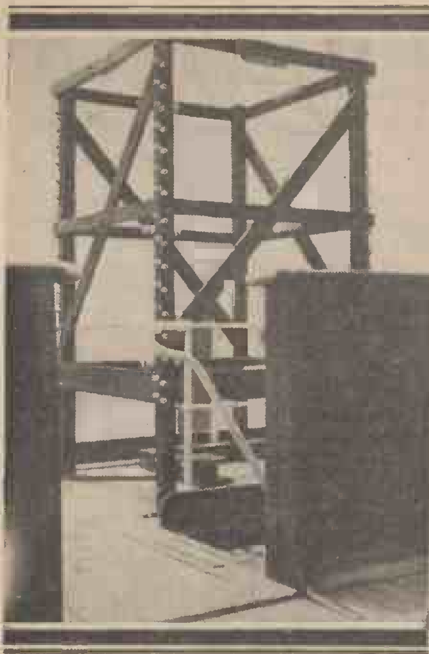
Early Sea Travel Devices

Perhaps the earliest sea travel devices were the log and the lead, both of which—in a vastly improved form—are in use to-day. The first log was exactly what its name implies—a small log of wood attached to a length of line. It was heaved overboard, and (care being taken to keep the line slack) remained where it fell, while the ship sailed on. The time it dropped was carefully noted, and when the end of the line was reached it is clear that the ship had travelled a distance equal to the length paid out, and from this her speed could be calculated. The unit of nautical measurement is the "knot" (6,080 ft.), which probably took



A sectional view of a gyro compass.

The complete gyro compass.



A direction finding wireless cage.

its name from the knot at the end of the early log lines, and the speed and distance travelled were entered in the log book, as they are to-day. There is, of course, a possible error in this method, owing to sea currents, which may be with, against or across the ship's course; the speed of such is given in modern charts and can be allowed for.

The modern log is a marvel of ingenuity. It is like a motor-car speedometer and mileage recorder and works in the same way. We know that if we place a screw-propeller behind a boat and cause it to revolve, the boat will be driven forward at a certain speed; and if we tow a small propeller of similar pitch behind a boat it will revolve at the same speed, providing of course the boat is going at the same pace. This propeller is attached to a long stiff cord and turns the mechanism in the same way as the speedometer drive of a car.

The Lead

This is another instrument which has been improved out of recognition during recent years. Originally it was a piece of lead weighing 7 lb. attached to a line, and having a hollow in the bottom filled with tallow which would pick up material from the sea floor. This is often a useful guide to a mariner: it is said that a North Sea fisherman can tell his position to within ten miles from examining a sample brought up by the lead. The leadsman stands near the bow of the ship, swings the lead twice round his head, and hurls it forward as far as he can; other seamen stationed behind him along the side of the ship pay out the line till bottom is touched, and the depth can be quickly seen from the pieces of bunting placed at known intervals along the line. It is obvious that there is a risk of considerable error with the lead, because it only gives an accurate reading when vertical, and either the ship's motion or currents may cause it to strike bottom in a slanting position. The modern scientific lead indicates depth by the pressure of water registered there, and so is always accurate. The lead is useful in uncharted waters to prevent running aground, and can be used to check position by comparing soundings with depths shown on charts.

But it is up on the bridge that the most remarkable examples of scientific seamanship are to be found. Let us begin with the compasses, of which modern ships carry two. The old form, or magnetic compass, works on the known principle that the magnetic needle points to the north. In steel ships elaborate corrections are made to check errors which would otherwise be caused. Large masses of steel in the ship would deflect the needle to a greater or less extent, and each compass is set right on its own ship. This is done by small balls or pieces of soft iron placed near to counteract the pull of the ship's metalwork. The modern magnetic compass is not a needle, but a card with magnets underneath, which swings in a fixed bowl. The bowl turns as the ship swings, leaving the card always pointing north. But the magnetic compass cannot be used beyond lat. 70 N., and errors are caused by masses of magnetic or ironstone rock in other places.

The Gyro Repeater Compass

The beautiful Sugar Loaf Mountain in Rio Harbour upsets the working of every magnetic compass which enters the harbour. This fault of the magnetic principle has been overcome in a wonderful way by the invention of the Gyro Repeater Compass. It is based on the known scientific fact that an object which is spinning at a very high speed will set its axis parallel to that of the earth. We see an illustration of this in the toy known as the gyroscope top, and the advantage of the principle is that being non-magnetic it is not affected by those forces which destroy the efficiency of the magnetic compass.

A modern Gyro Compass has a wheel weighing about 4½ lb. and rotates by means of an electric motor at the giddy speed of from 14,000 to 16,000 revs. per minute.

The "Zero Hour" for the navigator is noon, when he shoots the sun with a sextant. By noon is meant noon at the place where he is. One calculation of meridian altitude gives the latitude, and longitude can be obtained by two shots, providing that the difference between the sun's bearing at first and second shot is 20 degrees or more.

We show on the previous page a vertical section of the gyro compass. B is the case carrying the gyro bearings and is supported by a vertical spindle ST below the float S. K is a circular bowl full of mercury in which the metal ring, etc., floats. R is the compass card rigidly attached to the system. The gyro axis is under the north and south line of the card. Position can be calculated from the fixed stars by using the sextant in a similar way. Longitude can also be ascertained by means of the chronometer. This is a very accurate clock, set to Greenwich mean time. When the navigator shoots the sun at noon he also consults the chronometer. If it also registered 12 noon the longitude would require no calculation, as he would know he was on the Greenwich line, but if the chronometer should be fast or slow it is a matter of calculation to find the longitude from the time registered.

A recent and valuable aid to the navigator when cloud obscures the sky or fog blots out everything is the "Direction Finding Wireless Cage." This is a wireless receiver something like a bird-cage, which by the varying intensity of signals received from different sending stations enables position to be calculated.

Showing the apparatus used for "shooting" the sun.

Details of the engine-room telegraph.

THE ORIGIN OF

An Article of Historical Interest, Dealing
the Conditions Under

Joseph Nicéphore Niépce, 1765–1833.

THE invention of photography is usually ascribed to the French artist and scenic painter, Louis Jacques Mande Daguerre, who, on January 9th, 1839, first communicated to the French Academy of Sciences full details of his process of taking pictures upon sensitised silvered copper plates. It is seldom, however, that the practical working out of any basic scientific idea is due to the workings of one individual. Photography was no exception to this rule either. Three names stand at the beginnings of photography. They are Joseph Nicéphore Niépce, Louis J. M. Daguerre and William Henry Fox Talbot. The two former individuals were French, the latter being an Englishman.

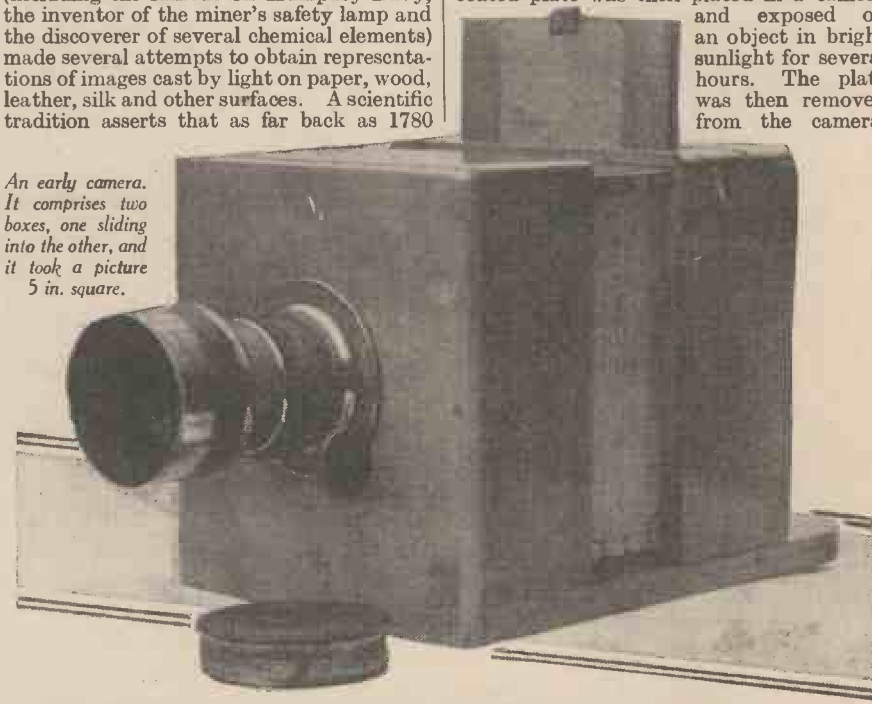
Although Fox Talbot was not the first individual to conceive the idea of making pictures by the agency of light, he was, nevertheless, the first to make any practical success of his attempts. This year is the centenary of the taking of the earliest photograph which has survived the lapse of time. It was made by Fox Talbot in the summer of 1835, and it depicts a view of an oriel window at Laycock Abbey, Fox Talbot's home. This is the very earliest photograph on paper which the world possesses. Previously—in 1834—Fox Talbot had made some successful attempts at photography, but these essays in " photogenic drawing," as Fox Talbot termed it, no longer exist.

Louis J. M. Daguerre, 1787–1851.

The world's earliest photograph is little bigger than a postage stamp. It was taken by means of a spectacle lens fitted into a crudely made camera and the exposure required for its taking lasted several hours.

Although, as we have just seen, the British pioneer, Fox Talbot, was the first to take photographs on paper, he was not the first experimenter in photography. At the beginning of the nineteenth century, and even before that time, several workers (including the famous Sir Humphry Davy, the inventor of the miner's safety lamp and the discoverer of several chemical elements) made several attempts to obtain representations of images cast by light on paper, wood, leather, silk and other surfaces. A scientific tradition asserts that as far back as 1780 a certain Professor Charles obtained photographic silhouettes by coating a large sheet of paper with silver nitrate and, by means of a strong ray of light, throwing the shadows of his students' heads on to it. If this assertion is correct, then Professor Charles was certainly the first to make an outline photographic image. However, much controversy has taken place over these celebrated " Charles' Silhouettes," and it is doubtful whether they were ever produced at all.

Another individual who is supposed to have produced early photographs is Thomas Wedgwood, a son of the famous potter of that name. All that Wedgwood did, however, was to obtain photographic outlines by coating a sheet of paper with silver salts, and, after laying a leaf or some other opaque object upon it, then exposing it to light. In this way the portions of the paper exposed to light darkened, leaving an imprint of the leaf on the paper. Wedgwood, however, despite all efforts, was quite unable to fix his images. Consequently, no examples of his work have remained for us to examine.



An early camera. It comprises two boxes, one sliding into the other, and it took a picture 5 in. square.

Joseph Nicéphore Niépce

The first individual to take up the task of producing photographic images was undoubtedly Joseph Nicéphore Niépce, who discovered—no one knows how—that bitumen of Judea, a golden-yellow or brown pitch-like substance, found, originally, on the shores of the Dead Sea, possesses the property of becoming insoluble in oils after it has been exposed to light.

Working on this discovery, Niépce dissolved purified bitumen of Judea in oil of lavender and poured the bitumen solution on to a metal plate. It dried quickly, covering the surface of the plate with a thin brown layer. The bitumen-coated plate was then placed in a camera and exposed on an object in bright sunlight for several hours. The plate was then removed from the camera, placed in a dish and oil of lavender poured gently over it. The lavender oil dissolved away the bitumen which had not been light-impressed. In this way Niépce succeeded in obtaining an image traced in bitumen upon the metal plate.

Niépce went even farther than this. He treated his metal plates carrying bitumen images with etching fluids, and thus succeeded in actually engraving the metal with a replica of the image. Such plates he termed " heliographs," or sun-drawings, and he is known to have shown examples of such heliographs to his acquaintances as early as the year 1826. Of Niépce's heliographs, the earliest now extant is a copy of an engraving of Cardinal Amboise, which is dated February, 1827. As an example of the very earliest photographic engraving and the parent of all photographic reproductions, it is a perfect masterpiece of technique.

It was about this time that Daguerre began his investigations in photography. Daguerre heard that Niépce had been successful in producing permanent images by means of the agency of light and he suggested the formation of a partnership with Niépce, each of the parties to go on working in his own particular line but, at

PHOTOGRAPHY

With the First Photographs Ever Made and Which They Were Taken

Henry Fox Talbot, 1800–1877.

the same time, agreeing to communicate to the other the results of his experiments. Eventually the proposed partnership was entered into. Daguerre, however, was guilty of very sharp practice. Not only did he take Niépce's results and withhold his own, but, also, when his work was made public, he took the whole of the credit.

Nicéphore Niépce died in 1833 and Daguerre formed another partnership with Niépce's son, Isidore, four years later. Daguerre had, in the interim, accidentally discovered another photographic method. It was the celebrated "daguerreotype" process which took the civilised world with such storm in the 'forties of the last century.

The Daguerreotype Process

This was based upon the fact that when a highly polished silver or silvered copper plate is exposed under carefully controlled conditions to the vapour of iodine, an exceedingly thin deposit of silver iodide is formed on its surface. Silver iodide is light-sensitive, and Daguerre found that when he exposed his iodised plates in a camera for several hours a very faint shadowy representation of the object was produced on them. The photographic representation was faithful and accurate enough, the main trouble being that it was too faint and shadowy to be of any practical use.

It was at this juncture that Daguerre made an accidental discovery of the greatest magnitude. Chancing to look upon some exposed iodised plates which had been put away in a cupboard as being useless, he was amazed to find on them a perfectly strong and clear image. Since the image had not been present when the exposed plates were put away in the cupboard, it became evident to Daguerre that the vapour of one or more of the many chemicals which were stored in the cupboard must have been responsible for bringing-out, or "developing," as it afterwards came to be termed, the image on the plate. Daguerre at once began a long series of experiments, placing exposed iodised plates in his cupboard, and on each occasion withdrawing some of the chemicals. At last the culprit was discovered. It was a dish of mercury whose vapour had acted upon the exposed iodised plate and had, by attaching itself to the very faint image on the exposed plate, built up the image with great clearness.

Thus came the daguerreotype photograph into being. The first daguerreotypes were made by Daguerre in 1837, but the process was not commercially undertaken until 1839. The French Government made Daguerre an officer of the Legion of Honour and it also awarded him a large pension on

A "heliograph" print made by Niépce from an engraving of Cardinal Amboise.

the condition that he gave his daguerreotype process and, also, any improvements which he made in it, freely and unrestrictedly to the world. One of Daguerre's first actions, after receiving the above awards, was to patent his process in England and to grant licences for its practice. Such was the character of the man.

"Photogenic" Drawing

Curiously enough, with the announcement of Daguerre's discovery came also that of Fox Talbot's process of "photogenic drawing." Daguerre's photographs were produced on silvered copper plates and for each exposure made in the camera only one picture could be taken. Fox Talbot, however, gave to the world the negative by means of which an indefinite number of pictures could be printed. Fox Talbot called his pictures "Calotypes," a term which signifies "beautiful pictures." Subsequently, photographs on paper taken by Fox Talbot's method became known as "Talbotypes."

Fox Talbot's method was simple enough and it had, also, the advantage of being relatively inexpensive. Paper was soaked in a weak solution of common salt and then dried. Subsequently, one side of the paper was brushed over with a solution of silver nitrate and again dried. If the paper was required to be extra sensitive, this process was repeated two or three times. Paper prepared in this manner, as we have already noticed, when exposed in the camera for a sufficient length of time, showed a clear image

(Left).—First photograph made on paper. Inside view of an oriel window at Laycock Abbey, Wilts.—taken by Fox Talbot in the summer of 1835. This year constitutes the centenary of its production. (Above).—The world's first daguerreotype photograph. Made by Daguerre in 1837. (Right).—The first portrait ever made by photography. A photograph of Miss Dorothy C. Draper taken in 1839 by her brother, Prof. J. W. Draper, of New York University.

of the object focused by the camera lens. By combining gallic acid with the silver nitrate used for coating the paper, Fox Talbot succeeded in increasing the light-sensitivity of his papers very much indeed. This was especially the case when the paper was exposed in the camera in a moist condition. Fox Talbot also worked out a method of developing his pictures by immersing the exposed paper in a warm solution of gallo-nitrate of silver.

For six years Fox Talbot kept his process a secret, working on it at all available opportunities and perfecting it in every way possible. Hearing, in January, 1839, the announcement of Daguerre's discovery, he immediately divulged his own process, and, on January 25th, 1839, the great Michael Faraday, then Professor at the Royal Institution, described the Fox Talbot method of "photogenic drawing" to the assembled members of that great body.

Note that neither Fox Talbot nor Daguerre used the word "photography" to describe their processes. As a matter of fact, this word was first put forward by Sir John Herschel. Incidentally, it was this scientist who first suggested the use of the now generally used "hypo" as a photographic fixer. Previously photographs had been fixed by immersing them in a strong solution of common salt.

After the Talbotype and the Daguerreotype, came the "glass positive." Such, usually, are the neat little pictures which are still to be found in a large number of households and which are often erroneously termed Daguerreotypes. The glass positive was the invention of an Englishman, Frederick Scott Archer. In these photographs the sensitive silver salts are contained in a film of collodion and coated upon the surface of glass. It was not until years after that Dr. R. L. Maddox, of Southampton, introduced the first gelatine-coated dry plate and so laid the foundations of modern photography.

The First Human Portrait

Curiously enough, although Fox Talbot, Niépce and Daguerre were the three originators of practical photography, not one of them was the first to make a portrait of a human. The first portrait of a human being ever made was taken by an Englishman—born in St. Helens, Lancs.—who had emigrated to America. He was a famous medical man and scientist—Professor John William Draper, M.D., LL.D., Professor of Chemistry in New York University. Professor Draper had long been interested in the chemical effects of light. Thus, when Daguerre announced his discovery, Professor Draper at once began to put his method into practice. He and Professor Morse (the originator of the Morse code) built a little photographic laboratory and studio on the roof of the university and here they began their first photographic experiments. They constructed a camera out of a cigar box and a spectacle lens and with this primitive instrument they were successful in taking photographs of a distant spire, a brick wall and other similar objects.

The apparatus used by Nicéphore Niépce for his early work in photography.

Using an improved camera containing a properly constructed lens some 5 in. in diameter, Professor Draper, towards the end of 1839, made, as we have noted before, the first portrait photograph in the world. This was a portrait of his sister, Miss Dorothy Catherine Draper. The lady was evidently as enthusiastic as her professor-brother, for she submitted to having her face lightly dusted over with white powder in order to increase its light-reflecting power. Thus arrayed, she sat as motionless as possible in bright sunshine for half an hour while the exposure was being made. The exposure was a successful one. It was made on a Daguerreotype plate and, fortunately, it has been preserved for future generations to examine.

A Remarkable Prophecy

It would, perhaps, be of interest to bring this article to a conclusion by a reference to a most remarkable prophecy which was written years before photography was ever thought of. In 1760, a Frenchman, Tiphaigne de la Roche by name, published a light imaginative novel which he entitled "Giphantie." In this romance, the hero is guided through a strange land inhabited by strange people. He enters a room which is panelled with large pictures. The pictures are extraordinarily lifelike. In modern language we would call them photographs. The hero at once demands an explanation of their production. And the following is what is written—in the year 1760:—

"You know," the guide remarks, "that rays of light reflected from different bodies make a picture and paint the bodies upon all polished surfaces, on the retina of the eye, for instance, on water, on glass. The elementary spirits have studied to fix these transient images: they have composed a most subtle matter, very viscous and very proper to harden and dry, by the help of which a picture is made in the twinkle of an eye. They do over with this matter a piece of canvas and hold it before the objects they have a mind to paint. The first effect of the canvas is that of a mirror; there are seen upon it all the bodies far and near whose image the light can transmit. But what the glass cannot do, the canvas, by means of the viscous matter, retains the images. The mirror shows the objects exactly, but keeps none; the canvas shows them with the same exactness and retains them all.

"This impression of the images is made the first instant they are received on the canvas, which is immediately carried away into some dark place. An hour after the subtle matter dries and you have a picture so much the more valuable as it cannot be imitated by art nor damaged by time."

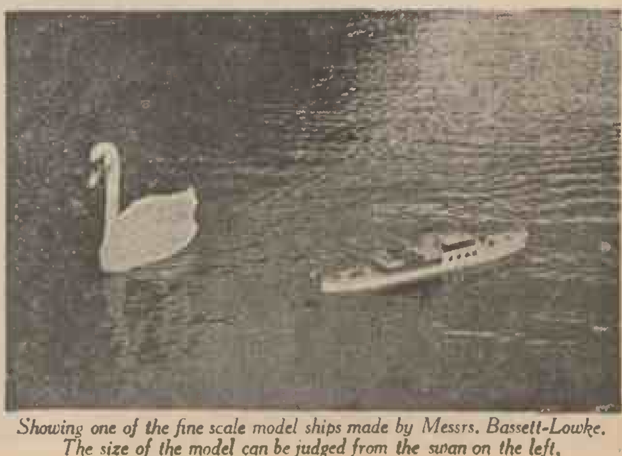
A more accurate or amazing scientific prophecy does not exist. Even in this, one of the earliest of photographic centenary years, the prophecy still holds with great exactitude. Photography, therefore, the handmaid of the sciences and the world's pictorial recording angel, was at least dreamt about by a novelist and romancer nearly a century before it was made practicable by men of science.

MODELS OF RIVER MOUTHS

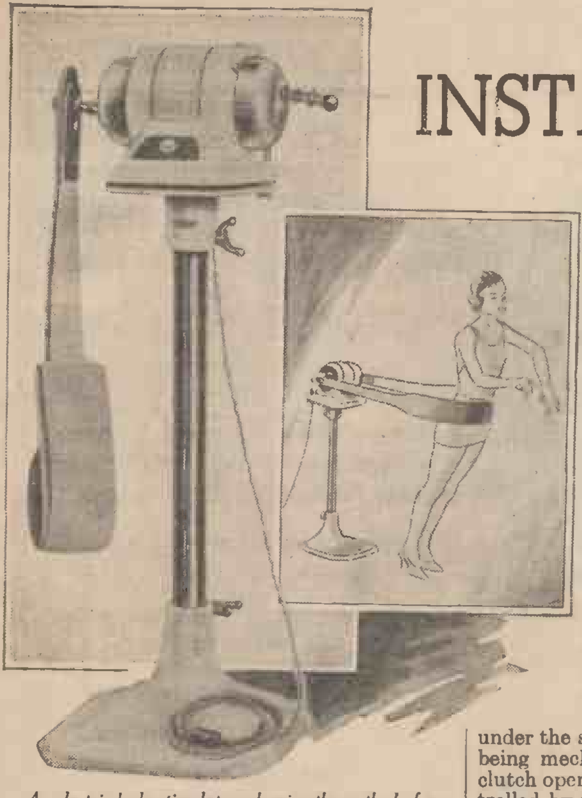
THE bore of the Severn and the eagre of the Trent have once again been receiving attention, for some of the problems to which they give rise have not been solved. Why does the eagre affect the Trent and avoid the Humber, which would seem to be the more natural channel for it to affect. I think there must be a spit of land directing and reflecting the tidal wave into the Trent. It would be an interesting hobby if models of the mouths of the Severn and the Humber could be made to scale from large scale maps with the depths correct from the contour lines.

The model could be made in clay and afterwards coated with plaster of paris or other material which would make it impervious to water. Pegs of the proper length placed in the contour lines would facilitate the correct formation of the bed of the river.

A large tank should be formed at the mouth to represent the sea—and this could be flooded with water from tubes which track the bottom of the tank, in order to prevent eddies. The water flowing down the river would come from taps which could be regulated for high and low water. Marks denoting high and low tide should be marked at the mouth of the river. If the scale of the model is say, $\frac{1}{5000}$ of the natural size, then the time of the tidal wave from low to high water would have to be shortened in the same ratio—for if one took six hours on the model, there would be little chance of a bore forming. The time would probably be in seconds, and watching the formation of the waves would form a fascinating pursuit, and might even add to our knowledge of bore and eagre.



Showing one of the fine scale model ships made by Messrs. Bassett-Lowke. The size of the model can be judged from the swan on the left.



An electric body stimulator, showing the method of use. The motor employed is either A.C. or D.C.

MORE ABOUT INSTALLING HOUSEHOLD ELECTRICAL DEVICES

The Use of Fractional Horse-Power Electric Motors

By "Home Mechanic"

HAVING previously dealt with fractional horse-power motors as applied to a small type of house, we now come to the applications of such motors in a larger household. Some of the examples mentioned below, even though more costly than some of the types mentioned previously, are equally labour-saving, yet may be looked upon by many readers as something in the way of a luxury, and probably beyond their means.

Polishing and Buffing Motor

This type of motor consists of a universal, dust-proof motor, fitted with a double-ended taper spindle, rotating at high speed, to which can be attached various forms of polishing pads for cleaning cutlery, silver, electro-plate and many other articles which need polishing. This polishing motor can also be used for cleaning boots and shoes or can be fitted with a grinding wheel for grinding small tools. Although this small type of polisher is not an expensive one, it is not, perhaps, of sufficient service to justify its purchase in a small household.

Mixers and Beaters

For the purpose of mixing and beating, a universal motor is again employed, fitted with speed control by means of a series resistance. The motor, mounted on a convenient base, has a special shaft extension running vertically, to which can be attached a variety of fittings to perform operations such as mincing meat, extracting juice, grinding coffee, cracking ice, slicing vegetables, apart from the ordinary work of mixing and beating flour or mixing drinks.

Here again, unless there is a sufficient variety of work for this machine to do, its purchase would not be warranted.

Sewing Machine Motors

The application of an electric drive to sewing machines instead of hand or treadle operation simplifies matters tremendously for the operator, making the work much easier to carry out. Quite a good percentage of the small households possess one of the usual hand- or treadle-operated machines to which an electric motor can be attached without going to the expense of a new and complete electric sewing machine.

The universal motor supplied for this work is fitted with brackets or attachments to fit all the leading makes of sewing machines. There are two general types of drive, the first being a belt-drive for a motor located under the sewing machine table; the speed being mechanically controlled by a friction clutch operated by means of a lever controlled by the treadle. In the other type of drive the motor is fixed to the frame of the sewing machine as illustrated last month, power being transmitted directly to the driving wheel by a friction pulley on the motor shaft end. Speed regulation is effected by a variable resistance in the circuit and operated with a foot switch or controller.

Health Motors

The application of an electric motor in contributing to one's health is made possible by an appliance known as the electric stimulator. This is an ingenious massage device which affords exercises to muscles, tissues and vital organs of the body. Instructions for their use include a large variety of exercises for men and women, and their effect can be obtained by consulting the sales literature available for these body stimulators.

Showing an electric washing and wringing machine.

Another type of washing and wringing machine driven by electricity.

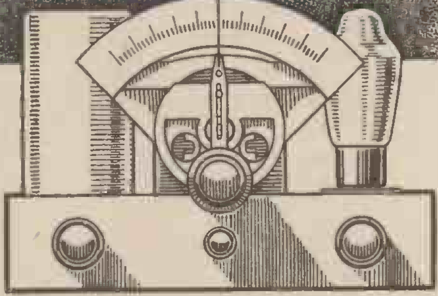
The motor for this purpose is not universal, but a separate motor for A.C. and another for D.C. By means of special grooved pulleys mounted eccentrically, one at each end of the motor shaft, as shown in the illustration, a vibrating movement is imparted to the belt attached to the two pulleys. By means of the grooves in the pulleys a varied degree of vibration, from a vigorous action to a gentle massage, can be obtained according to the particular exercises. The ball-bearing motor, running at a constant speed of about 950 r.p.m., can be operated from a table or a special pedestal, a safety switch being incorporated in the base of the motor. The price of one of these motors with pedestal and belts, etc., is nearly £20, and is an example of fractional horse-power motor work in the all-electric home.

Washing and Wringing Machine

The labour-saving of electric washing and wringing machines does not require detailing; they save time, work and expense.

(Continued on page 426.)

The PRACTICAL MECHANICS WIRELESS EXPERIMENTER



THE GENET MIDGET THREE

An Efficient, Easy-to-Construct, Midget Portable Receiver Employing the Latest Type of Midget Valves, and Designed for Headphone or Loudspeaker Reception.

WITH the arrival of the summer weather it is the desire of everyone to get out into the open air. The attraction of the wireless programmes weakens, and it very often happens that a particular item is being broadcast which would be very interesting, but is finally missed owing to the listener finding that the weather is too good to warrant his staying indoors. There is also the occasion when a hike or ramble in the country is undertaken, and during halts or even whilst strolling down some quiet country lane, a little music will relieve the monotony or encourage the walker to carry on for a few more miles. Obviously it is out of the question on such occasions to carry an ordinary type of broadcast receiver, and if some really convenient receiver is available the necessary items need not be missed, and at the same time a very useful service will be carried out by such a piece of apparatus.

Battery Problems

We have carried out many experiments with a view to producing a receiver which could really be called "portable." In the past this term has been applied to any receiver which was convenient enough to be carried, and no limit was placed upon the actual weight. Many commercial receivers are known as portables, but they are more suited to be carried in the car than to be taken on a long country ramble. There have been many reasons for the bulkiness and weight of the portable in the past, but with the increased knowledge which has been obtained during the past few years in the design of radio apparatus, the actual size of parts has materially decreased. The latest development, and the one which has led to the design of the receiver described in this article, is the production of a midget valve, measuring only 2 in. long by $\frac{5}{8}$ in. in diameter. In spite of these minute dimensions, the electrodes are arranged in a perfectly orthodox manner and the valve functions quite well. Notwithstanding their small size, their performance compares favourably with a standard valve, and will give a very creditable performance. When used in the correct manner, these valves prove ideal for the purpose of building a really midget receiver.

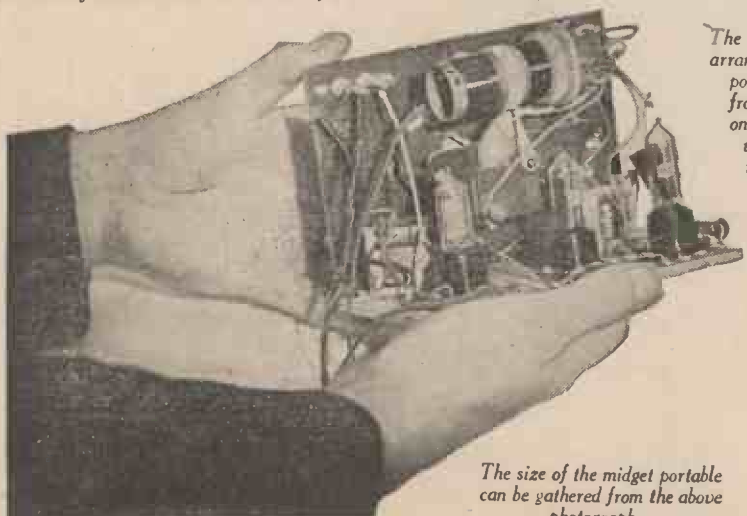
A front view of the midget portable, showing the simple tuning control. Reaction and tuning are incorporated in the single knob shown.

The battery supplies must, of course, be considered, and it would be useless to build a receiver from midget parts only to spoil the entire design by utilising ordinary batteries. Messrs. Exide have produced some neat little accumulators delivering the standard 2-volt output, but naturally of small capacity. Similarly, the Vee Cee Dry Battery Company have experimented and produced really small H.T. batteries. Owing to the physical dimensions of these parts the actual capacity, or length of service which will be given, is small, but it is ample for the purpose for which the receiver is intended. It is not intended that the portable should be built and used every night in the home for the reception of all the European stations.

Carried on a ramble, however, or taken into the garden when some particular item is being broadcast, it will give good service, and, as will be shown later, either a loudspeaker or a pair of headphones may be employed.

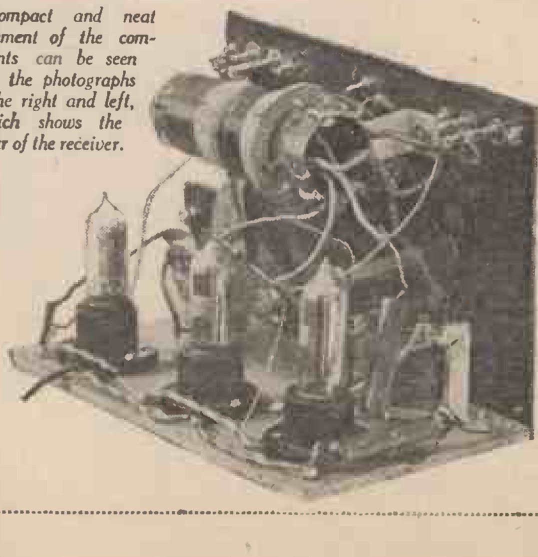
The Circuit

The circuit employed in this receiver is shown on p. 416, from which it will be seen that quite a standard arrangement of detector and two L.F. stages has been incorporated. The novelty lies in the arrangement of the tuning condenser, reaction condenser, wave-change switch and on-off switch. All these parts (and the wave-change switch is of the three-point type) are incorporated in one component and this is the only component which is mounted on the panel. It is a Lissen product, and the two condensers are mounted in the centre, with a single sliding member at the bottom of the escutcheon which carries out the on-off switching as well as the wave-change switching. The escutcheon is suitably engraved so that no doubt will arise as to the actual band being employed at any moment. Every endeavour has been taken to avoid unnecessary

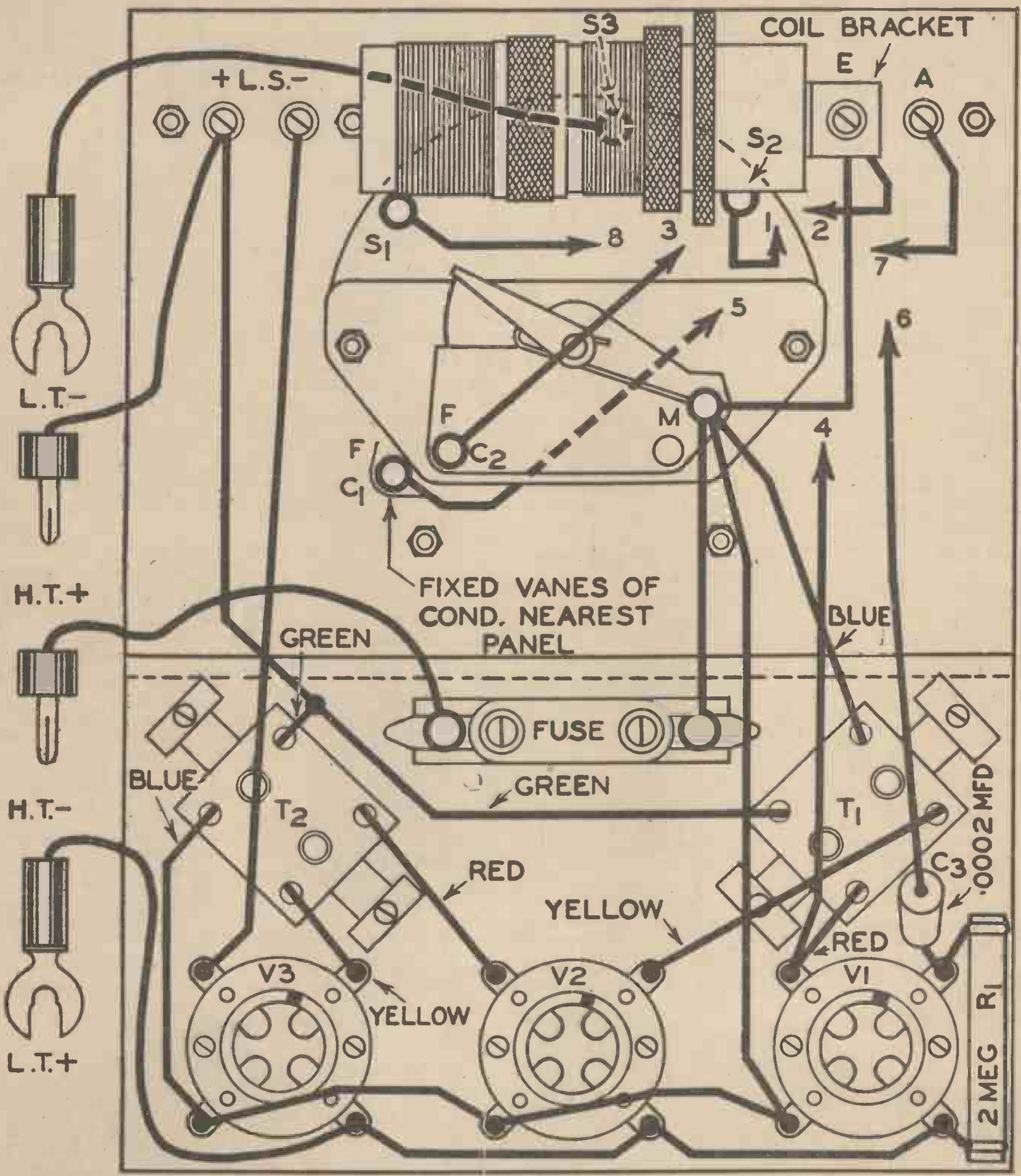


The size of the midget portable can be gathered from the above photograph.

The compact and neat arrangement of the components can be seen from the photographs on the right and left, which shows the rear of the receiver.



FULL-SIZE WIRING DIAGRAM OF THE GENET MIDGET THREE



and large components, and thus there is no decoupling or other trimming. Efficiency has not, however, been sacrificed in the interests of neatness, and the receiver may be relied upon to give a really creditable performance.

The two L.F. transformers employed are B.T.S. products and are extremely small but efficient. To reduce weight and to provide reliable contact, socket strips are mounted on the panel in preference to the ordinary type of terminal. By using this method of mounting, the constructor may build any desired type of cabinet or containing box, and the aerial and earth and loudspeaker sockets will always be readily accessible.

The paxolin panel should be prepared by cutting out the large central hole and drilling the remaining holes as shown on page 416. When carrying out this operation, mark the actual points on the face of the panel so that drilling will be commenced from that side. If you work from the back, the front of the panel will burr up and some difficulty might be experienced in making a neat joint between the various parts and the screw holes. When the holes are made, use a much larger bit on the rear and slightly countersink them so as to enable a flush mounting to take place.

To mount the condenser the maker's instructions should be carefully followed. It will be seen that the entire assembly must be dismantled, and, in addition, a screw must be removed from the rear portion of the small front control knob. If this is not done, the two condensers will rotate as one.

(Continued on page 416.)

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3	HIVAC Midget Valves	1	11	6
	PETO-SCOTT Portable Cabinet	0	17	6

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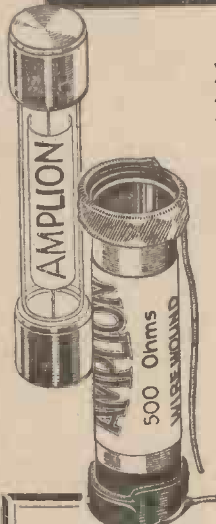

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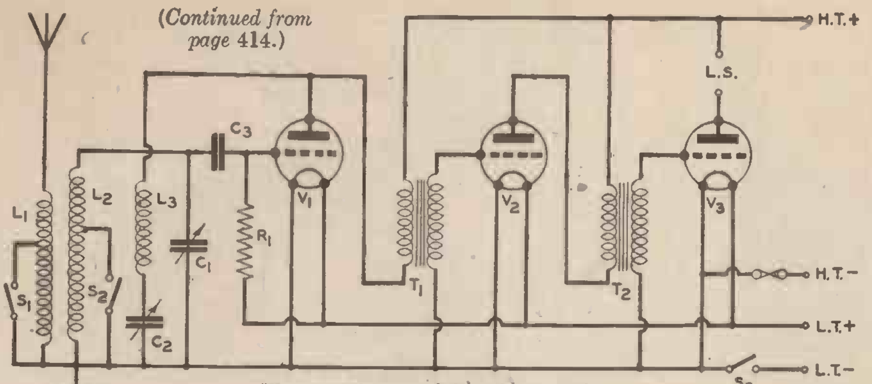
(*Continued from page* 414.)

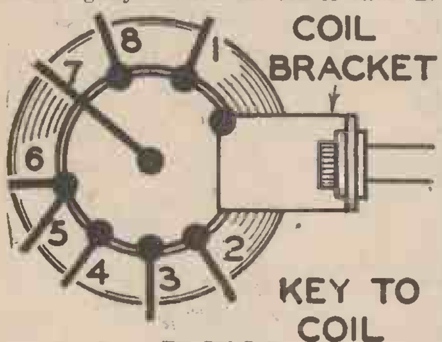


The circuit diagram of the midget portable.

Mount the valveholders and transformers on the small baseboard, and place the fuse-holder in the space between the transformers. Wire the filament tags on the valveholders, and solder the grid leak and small grid condenser to the first valve-holder. Connect the transformers to those parts on the baseboard indicated in the wiring diagram, and when as much of the wiring as possible has been completed, the panel may be placed in position.

Coil Wiring

It will be found that assembly and wiring is simplified if the coil is mounted on the earth socket before the panel is mounted. The coloured leads from the coil should be joined to the variable condensers and switch terminals, taking great care to connect the correct colour to the various points. If unduly handled it may be found difficult, for instance, to distinguish between yellow and white and dark blue and black. The small bracket on the coil might require to be bent slightly to allow the coil to clear the



The Coil Code.

reaction condenser moving vanes, but this will be more readily seen when assembly is complete. In most cases the flexible leads provided on the transformers, etc., will just reach to the various connecting point, but they may, of course, be cut or joined as necessary.

The Cabinet

The cabinet may be chosen to accommodate a loudspeaker and batteries, or simply to accommodate a pair of headphones in the lid. In this case it will not be much larger than a camera, and the control panel may form the upper part of the box or may be placed at an angle inside and covered with a lid.

A length of flexible wire may be coiled and stowed inside the box to act as an aerial when desired. A stone should be tied to one end and the other end plugged into the aerial socket. The stone should then be thrown up over a branch of a tree or similar object, and when listening is completed the plug should be removed from the socket and the wire released. The weight of the stone will cause it to fall and thus the aerial may be retrieved and replaced in the box. A short wire with a metal rod attached (an ordinary meat skewer may be used) will act as an earth connection. The rod is simply pushed into the ground, or laid in a pool of water if such is handy.

LIST OF PARTS FOR MIDGET PORTABLE.

One Condenser Assembly (Lissen).
Two Midget L.F. Transformers (B.T.S.).
One ·0002 mfd. Tubular Condenser (Amplion).
One 2 meg. Grid Leak (Amplion).
Three Midget Valveholders (Wright and Weaire).
One Hall Mark Aerial Coil (B.T.S.).
One A.E. and One L.S. Terminal Socket Strip (Clix).
One Midget XL (Hivac).
One Midget XD (Hivac).
One Midget XD (Hivac).
One H.T. Midget Battery (V.C. Dry Cell Co.).
One L.T. Battery (Type P.R.F. 3) (Exide).
One pair Headphones (Ericsson).
One Loudspeaker (Amplion).
Four Clix Wander Plugs (H.T. + H.T. − L.T. + and L.T. −).

WIRELESS AND TELEVISION NEWS

Television at Olympia

IT has been announced, at the time of going to press, that television will, after all, be represented at the Radio Exhibition in August, although television apparatus will not be seen on the stands of individual manufacturers and exhibitors, but the demonstrations will be held jointly by members of the Radio Manufacturers' Association. It is hoped that visitors to the Show will be enabled to watch the actual reception demonstrations in addition to seeing the equipment. This should be a good thing, for it will clearly show to the wireless public that television reception of real entertainment value is here, and that it has passed through the preliminary experimental period when, despite its interest, it did not represent final practice.

Incidentally, it has also been suggested that a separate Television Exhibition may be organised by interested firms, but this has not been either confirmed or denied.

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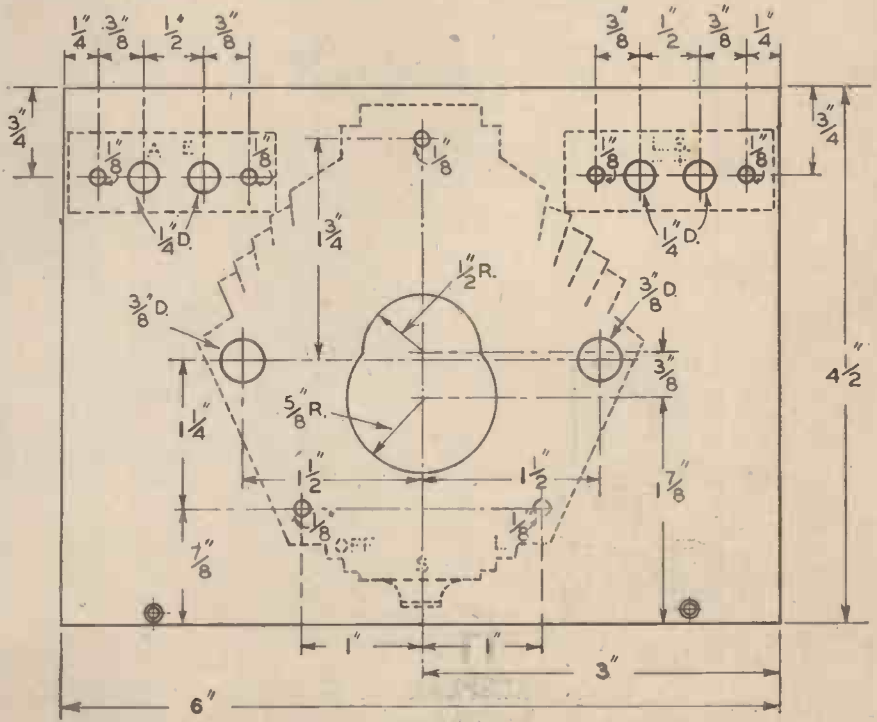
Television in America

We learn with interest that ultra-short-wave television tests on a large scale are shortly to be commenced in America. At a recent meeting of the Radio Corporation the President explained to stockholders that his company had agreed to spend a sum equivalent to £200,000 to establish television on a firm commercial basis.

* * * * * *

The Two-Guinea Three-Valver—Correction

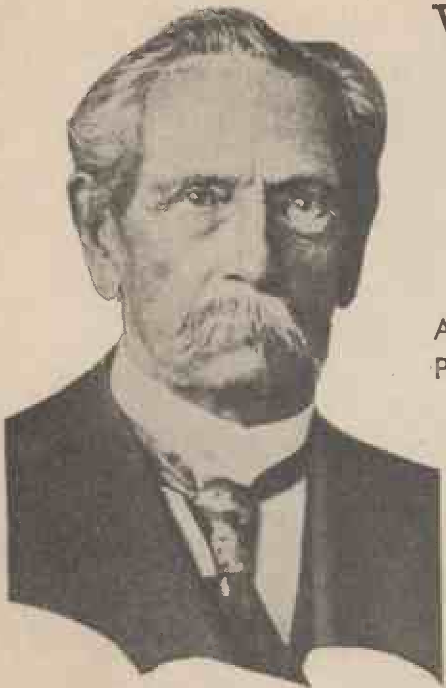
Will readers who are building the Two-Guinea Three-Valver described in the February issue of PRACTICAL MECHANICS, note that Messrs. Peto Scott's price for Kit A does not include the Polar Arcuate Drive. Readers who wish to add this refinement, which, of course, is far better than the direct knob, should include a further 5*s*. 9*d*. when ordering their components.



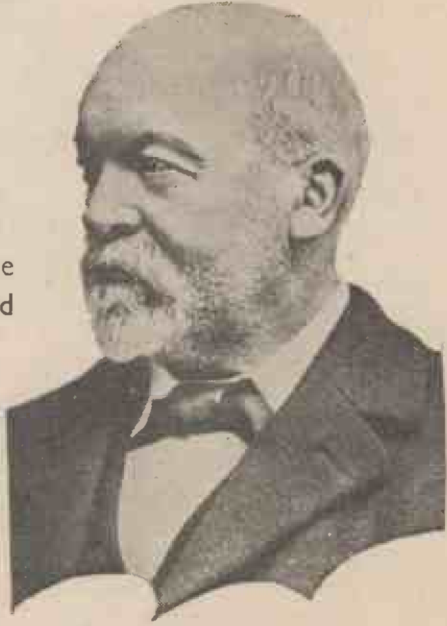
Details for fitting the condenser dial to the panel and also the aerial, earth and loudspeaker terminal strips.

WHY PETROL REIGNS SUPREME

An Interesting Comparison of the Power Sources Available for Road Transport



Dr. Karl Benz.



Gottlieb Daimler.

WHEN Roger Bacon wrote, in the now far-away thirteenth century, "We will be able to propel road-carriages with incredible speed and without the assistance of any animal," he surely little dreamt that the era of horseless transport on our country's roads would come about as the result of the application of the latent energy contained in an inflammable liquid, brought in vast quantities to our shores from overseas. Petrol, in Roger Bacon's time, was quite unknown to the then civilised world. So also, to all intents and purposes, was steam power. Electrical energy was an entirely unknown quantity too. In Bacon's day there were only the four sources of power which had been used from time immemorial—man power, animal power, water power and wind power. Nowadays petrol and its substitutes hold entire sway over a very large proportion of the world's methods of transport. Petrol power has ousted the power of steam, and even the energy of electricity, for the work of road vehicle propulsion. What is more, it has attained this position of road transport supremity well within the confines of a man's lifetime. Leaving for the moment the more practical considerations of the modern car and its working, it will be interesting to consider briefly the fundamentally different types of mechanically-propelled vehicles which have been put on the road at different times, and to contrast their advantages and conditions of operation.

"Freak" Mechanically-propelled Vehicles

During the ages quite a number of what we may now term "freak" mechanically-propelled vehicles have been tried out on the roads. Such vehicles include carriages propelled by wind power acting on sails, cars projected along roads by rocket power, clockwork vehicles, compressed-air waggons, and so on, all of which have proved useless in actual practice. To-day there are available four, and four only, power sources for the propulsion of mechanical vehicles. They comprise the well-known agents—steam, electricity, crude oil, and petrol.

Steam power and electricity were well known before the utilisation of petrol power. Yet they never attained the universal success of petrol as propelling agents for mechanical vehicles. Even nowadays, with all the perfection to which the application of steam and electrical power has been brought, steam and electrically-propelled vehicles form an exceedingly small proportion of road traffic, while for pleasure vehicles the application of such sources of power is entirely unheard of. For all such vehicles, petrol, or one of its substitutes, reigns supreme as a motive power, and until an entirely new source of energy, together with a completely new means of utilising it, is discovered, petrol or its substitutes, either in the natural or synthetic form, are likely to dominate the road transport of the civilised world.

Steam power applied to road vehicles has quite a number of excellent advantages. For one thing, a steam engine is an exceedingly flexible power unit for a road vehicle, and it will produce power in exact proportion to the amount of steam which is admitted to its cylinders. Thus, when additional power is required, as, for instance, in hill climbing, the steam-cock is opened wider, additional steam passes to the cylinder, greater force is exerted upon the pistons and thus the engine's power increases.

Particularly advantageous properties of the steam locomotive unit are its powers of self-starting, reversing and variation of working speed, all of which controls may be obtained by manipulation of the one steam-cock and reversing lever. The steam thrust applied to the pistons of a steam engine is of a steady, forcible variety. In the petrol engine the energy thrust on the pistons is of an explosive nature, more or less entirely lacking in control once the initiating spark has fired the gaseous mixture. For such reasons the steam engine is smoother and "silkier" in drive than the petrol engine, no matter how refined in detail the latter may be.

Steam Locomotives

Such manifest advantages, however, bring in their train many drawbacks. For instance, a steam locomotive requires coal-fuel and water for its working. Firing up—a skilled operation in itself—is necessary to work a steam locomotive. Frequent replenishment of the water supply is necessary in a steam engine. There is also the necessity of having continually a naked flame or fire under the steam boiler, a condition which introduces some element of danger and also renders necessary the task of lighting the fire when, after a period of rest, the steam vehicle is again required for use. Altogether, the use of steam power for pleasure and light vehicle propulsion is undesirable and impracticable. The utilisation of steam for such purposes is too dirty and messy a task, and, although the steam engine is itself a flexible power unit, the conditions under which it is brought into operation are just the reverse of being flexible. For the propulsion of heavy waggons, of course, the tale is different. Steam power for waggon use has been popular for years, and for this particular purpose it has a number of advantages.

The electrical propulsion of road vehicles is, in many respects, more satisfactory than are methods of steam traction. For one thing, electrically-propelled vehicles are cleaner in working. Like steam-propelled vehicles, electrical road cars are flexible in operation. Electrical vehicles are self-starting, self-reversing and their speed can be controlled by governing the amount of current supplied to the electric motor. Such vehicles run quietly, and, compared with steam cars, they possess the enormous advantage of being available at a moment's notice, there being no boiler-firing and steam-raising preliminaries to be undertaken.

Electrical Traction

Electrical traction for light road vehicles necessitates the carrying of a bank of storage batteries or accumulators, and it is in this connection that the electrical method of road vehicle propulsion meets with an enormous disadvantage. Accumulators are heavy components and they take time to re-charge. An electrically-propelled vehicle is never able to run for more than about 80 miles or so without requiring an accumulator re-charge. Often the accumulator range of an electrical vehicle only extends to 40 or 50 miles. From considerations such as these it will be evident that electrically-propelled vehicles of any ordinary road type are quite unsuitable for serious touring. Should it be necessary to undertake a tour on such a vehicle, accumulator re-charging stations would have to be situated at frequent intervals along the route. There would not, of course, be time for the vehicle to stop whilst its own accumulator was being re-charged. It would therefore be necessary to have some arrangement whereby the exhausted accumulator could be exchanged for a charged accumulator, this method of exchange being adopted throughout the tour.

For local runabout and light haulage purposes the electrically-propelled vehicle is a very useful means of traction, and for this purpose there is no doubt that a future of success and extension of activities awaits it.

We come now to the third system of road-vehicle propulsion, and to the only system of the four which has literally changed the face of the world's roads. The internal combustion engine, applied to road vehicles just fifty years ago, possesses many decided disadvantages and drawbacks. Yet, despite these, it has, by virtue of its great convenience and of the portability of its power supply, attained a degree of popularity and universality previously unheard of in the history of mechanical invention.

Steam Engine and Electric Motor

In the steam engine and electric motor the motive power is supplied from a source external to the engine. The steam engine is an "external combustion" engine. So, in a way, is the electric motor. Hence, in both these forms of power suppliers, the power source, being fed externally to the engine, can be carefully controlled in amount. In the gas or petrol engine the combustion of the fuel takes place within the engine itself. Such engines are "internal combustion" engines, and, as such, very little direct control can be exerted upon the rate at which the combustion of fuel, with the resultant liberation of power, takes place. Consequently, for this reason alone, all internal combustion engines are more or less inherently inflexible power units. It is their nature to run jerkily, explosively and without the smoothness which is characteristic of the steam engine and electric motor.

Internal combustion engines are not self-starting. What is more, they cannot easily be started under load. For these reasons car engines have to be provided with starting devices and with clutches, which serve to disconnect the engine from its load and thus enable it to be started in a free-running condition. Electric motors and steam engines will start perfectly well under load.

Reversing Action

Again, unlike steam engines and electric motors, petrol engines are not self-reversing. To reverse the direction of motion obtained from the working of a petrol engine it is necessary to interpose a system of gear wheels between the engine and the driven mechanism. Petrol engines will not run at low speeds. For this reason, again, a gear mechanism is necessary for the purpose of gearing down a relatively high speed engine and of rendering it capable of propelling a vehicle slowly. A petrol engine has a very poor overload capacity. Thus gears become necessary for hill-climbing purposes or when the vehicle is travelling under heavy loads.

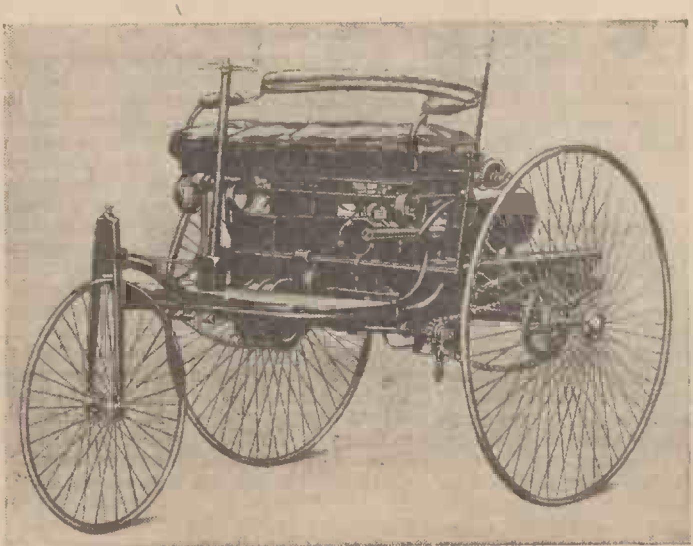
Written down on paper, the above appear to be severe disadvantages. Yet in many respects they are drawbacks which the ingenuity of inventors has been able to overcome to a very large extent. Gear changing, that bugbear of all inexpert car drivers, is being made yearly more easy, whilst, owing to careful attention to the details of engine design, the modern car engine is approaching more and more closely that smoothness which is characteristic of the steam engine's running.

The first Daimler car, and, incidentally, the first four-wheeler. Constructed by Gottlieb Daimler in 1886. This photograph, taken some years after the construction of the car, shows Daimler in the rear seat. His son is at the tiller.

The Most Economical

Apart from its drawbacks, enumerated above, the petrol engine is a very efficient prime mover. It is easily the most economical form of road engine to operate. Its fuel is portable, relatively inexpensive, and cleanly. A car engine will go on running as long as its fuel and its lubrication supplies hold out. The average car holds in its fuel tank enough petrol to enable it to run for a couple of hundred miles without stopping. Furthermore, the refuelling of a petrol engine is a very simple and speedy matter, far different from the re-charging of an electrical accumulator or the re-coaling of a steam engine's supplies. Internal combustion engine fuels, such as petrol and benzole, are easily graded and standardised. They are light in weight and do not take up much room on the vehicle. Nowadays, of course, such fuels are available in any part of the world.

On account, therefore, of the ready availability of its fuel supplies, their portability, cleanliness, and also in view of the easy control of a petrol engine and its adaptability for small power units, the high-speed internal combustion engine, originated 50 years ago by Benz and Daimler, has superseded all other forms of mechanical traction for the majority of road purposes. The present age is becoming increasingly one in which the power of petrol is dominant.

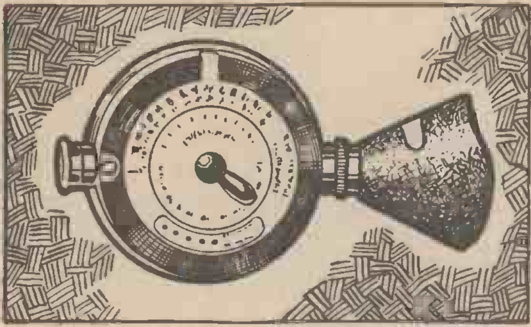


Claimed to be the first car in the world, this was constructed by Dr. Karl Benz in 1885.

The first hooded car, the Daimler model of 1894. Its design marked an important advance in commercial car construction.

AN A.B.C. OF PHOTOGRAPHY

THE SECOND ARTICLE OF A SERIES



A typical meter of the extinction type.

Diaphragm—Another term for stop (which see).

Diffused Light

Illumination which is not direct. Thus a cloudy day will offer diffused light (in contrast to direct, or sunlight). In an interior scene diffused light is offered when the illumination source is screened in some way.

Embossing Board

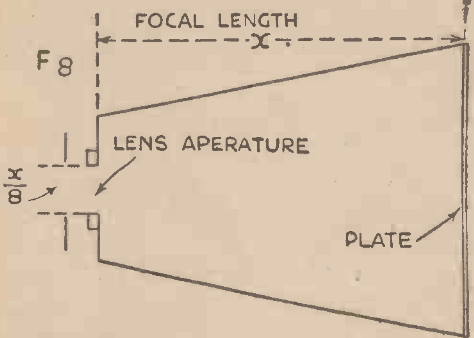
An arrangement for producing a countersunk margin on a print.

Emulsion

The sensitised coating of a plate, film, or printing paper.

Enlarger

An apparatus for producing large prints. It is, in effect, a small magic lantern, and the image is projected from the negative, through a lens, to the paper. A special form of enlarger takes the form of a cone-shaped box which



carries the negative at one end and the paper at the other, the lens being fixed in a central position.

Enlargement

A print which is made from a smaller negative. A special piece of apparatus (the enlarger) is usually employed, and the image from the negative is projected on to a sheet of paper in the same manner as with a magic lantern. The degree of enlargement is varied according to the respective positions of the negative, lens, and paper.

Equivalent Focus

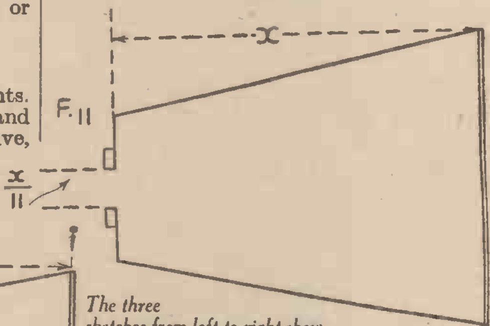
The distance from the optical centre of a lens to the ground glass when focussed on a distant object.

Exposure

The action of permitting light to fall on a sensitised surface. Thus the opening of the camera shutter is termed "making the exposure," whilst in the case of printing paper the exposure is obtained by permitting light to fall on the paper through the negative.

Exposure Meter

A device for calculating the exposure required under various conditions in order to obtain a correctly exposed negative. The simplest form consists of an actinometer (which see). At the present time there are many ingenious forms on the market, the majority being of the visual type. The general pattern is on the lines of a small telescope, and the view is examined through a lens. Usually a piece of blue glass is fitted inside the device and the adjustment is made until the view just vanishes. The exposure may then be read off from the body of the instrument. Another form has a number visible in the field and the adjustment alters the number, and the



The three sketches from left to right show the relation between the "F" number and the focal length of the lens. Thus, F8 means that the diameter of the stop is one-eighth of the focal length of that particular lens, and so on.

last number which can be seen before total darkness is used as a basis for the table supplied with the device. These are generally referred to as "extinction meters."

"F" Number

The method of expressing the size of the diaphragm or stop. The figure which follows the letter "F" denotes its relation to the focal length of the lens. That is to say, F8 means that the diameter of the hole bearing that number is one-eighth of the focal length of the lens with which it is used.

Ferric Ammonium Citrate

Brown or green flat crystalline substance. Keeps well in dry or liquid form.

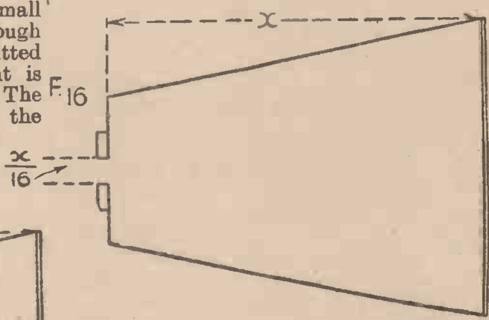
Ferricyanide of Potash—See Potassium Ferricyanide.

Ferrotype Plate

A special polished plate used for glazing prints. The print (on glossy paper) is squeegeed into contact with the ferrotype plate and, when dry, is stripped off, resulting in a highly enamelled surface.

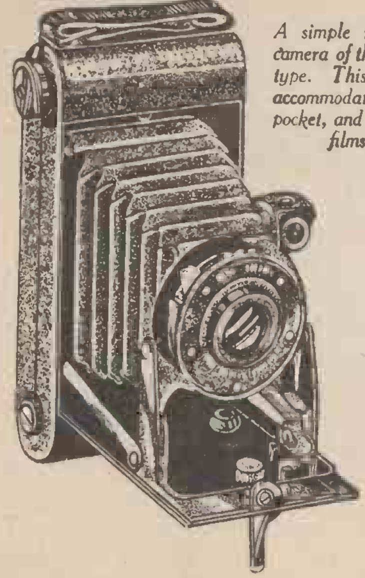
Film

A celluloid strip upon which is deposited



a sensitive emulsion. In most cameras the film is rolled round a metal roller, and thus it is possible to obtain six or eight pictures on one strip of film. A light-proof paper is used as a backing to the film to prevent halation and to enable the camera to be loaded and unloaded in ordinary light without the necessity of a dark room.

A typical artificial light enlarger. The bromide paper is placed on the lower board, and the negative is placed in the special carrier of the upper portion. This may be raised or lowered to provide the required degree of enlargement, and exposure is controlled by the switch in the cable lead.



A simple roll film camera of the folding type. This may be accommodated in the pocket, and uses roll films.

Film Pack

An arrangement for holding a number of separate films. The films (of the same dimensions as normal plates) are separately attached to pieces of light-proof paper and held in a special case. Tabs project at one end and the whole is held in a film-pack holder fitted to the back of the camera, as in the case of plates. When the exposure has been made the tab is withdrawn, in the course of which the exposed film is drawn to a position at the rear of the pack. This leaves the next film ready for exposure, and the process continues until the whole pack has been exposed. The pack usually holds twelve films.

Fixing

The process of dissolving away unaffected salts from an exposed negative and rendering permanent the silver deposit which is left after development. The usual fixing medium is hyposulphite of soda, either alone or in combination with a hardener, to render the celluloid and emulsion sufficiently strong to resist moderate degrees of warmth. The hardener usually consists of alum, acetic acid, citric acid, alone or in combination.

Flare Spot

The light patch which is sometimes found on the centre of a picture and is caused by the light being reflected from a defect in the lens.

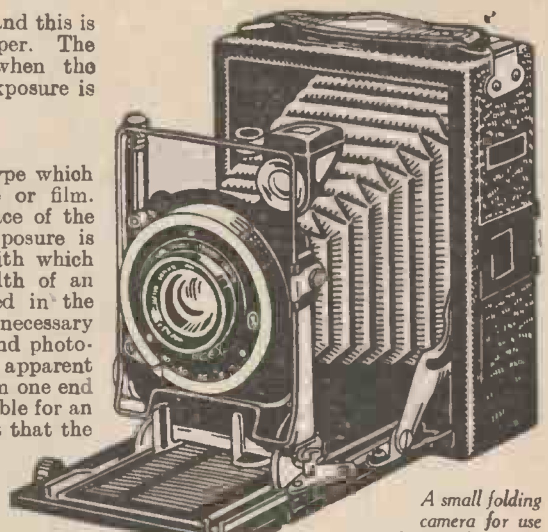
Flashlight

A method of taking photographs in a poor light. A preparation containing magnesium powder is employed, and this is ignited by a spark or touch paper. The camera lens is opened, and when the magnesium powder flashes the exposure is automatically made.

A cinema camera which uses sub-standard film. Clockwork mechanism drives the film and the winding key may be seen on the side of the camera.

Focal Plane Shutter

A shutter of the roller blind type which operates close against the plate or film. The blind is drawn across the face of the plate and the length of the exposure is governed either by the speed with which the blind travels or by the width of an adjustable shot which is situated in the centre of the blind. Great care is necessary when using this type of shutter and photographing moving objects, as it is apparent that whilst the slot is moving from one end of the plate to the other it is possible for an object to move to such an extent that the movement will be visible as a series of complete separate positions. This cannot occur, of course, with a shutter which is situated in front of or immediately behind the lens.



A small folding camera for use with plates or film pack. The front of this camera may be raised or lowered for adjusting the taking angle.

Focussing Scale

A graduated scale fitted to the camera in order to enable the lens to be adjusted to a position to bring objects at various distances in accurate focus.

An ingenious rigid type of camera employing a reflex principle.

Focussing Screen

A piece of ground glass fitted to the rear of a camera on which the image is focussed before exposing the plate.

Fog

A deposit of silver all over a negative resulting in parts of the negative which should be clear having a slightly hazed effect. In the print this is evidenced by a greyness all over the picture, no acute contrasts being obtained.

Formula

The table showing various proportions of chemicals required to make up a developing solution. Some standard formulæ are given in the next paragraph.

Formulæ

The following are standard developing and fixing formulæ, but before making up any of these the various notes under the heading of the different chemicals should be read.

Developers

PYRO-SODA

A

Pyrogallic acid . .	1 oz.
Sod. sulphite (cryst.) .	2 oz.
Citric acid . . .	40 gr.
Water, to . . .	10 oz.

B

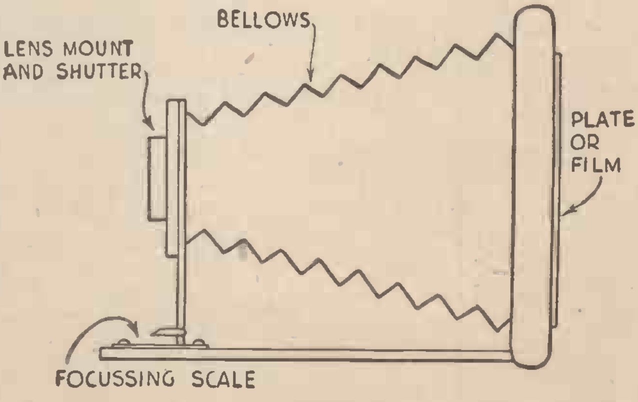
Sod. carbonate (cryst.) .	8 oz.
Sod. sulphite (cryst.) .	8 oz.
Water, to . . .	80 oz.

For normal work take 1 oz. of B and 1 dram of A with 1 oz. of water. The proportions may be varied slightly according to the particular plate and subject. Suitable for plates and films, but not suitable for papers.

METOL-HYDROKINONE
(Metol or M.-Q.)

Metol	20 gr.
Hydrokinone . . .	60 gr.
Sod. sulphite (cryst.) .	700 gr.
Sod. carbonate (cryst.) .	700 gr.
Potassium bromide . .	6 gr.
Water, to . . .	20 oz.

(To be continued.)

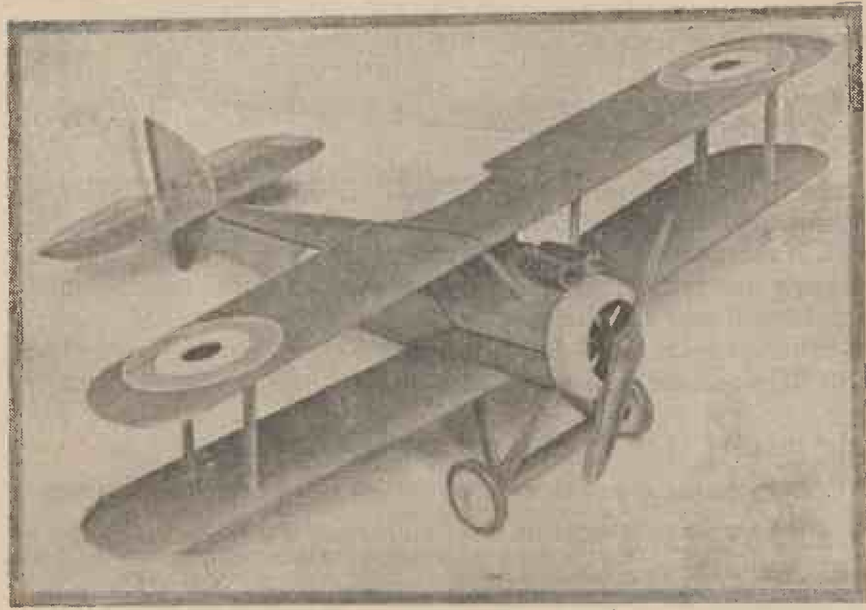


A diagram showing the arrangement of the standard folding camera. The various main parts are identified.

SCALE MODEL AIRCRAFT—No. 5

A SCALE-MODEL SOPWITH CAMEL

This Month we Deal with the Construction of a Plane that Owes its Name to the Hump on the Fuselage



A photograph of the finished model.

THIS machine is perhaps the most famous of a number of machines produced by the Sopwith Aviation Company during the War. It was in use by fighter squadrons on the Western Front and overseas for several years, and was followed by the Sopwith Snipe, which was probably the best machine produced during the War, although it was issued so late that no real service experience was gained. The Sopwith Camel, which owes its name to the hump on the fuselage, under which the two Vickers guns were mounted, was not universally liked as it was a little tricky to fly, but all the same, at that time was a machine with an exceptional performance.

Simple Construction

The construction of the model is very simple, there being no minute details which are incapable of reproduction. As usual, start by shaping the engine cowling. This may be turned out or a disc cut from a piece of flat wood and finished off in a handbrace with sandpaper. The front of the cowling may be left flat, and later painted black or some engine detail inserted into a hollowed-out cowling. This may be done by turning out the back of the cowling and fitting a disc of thin wood into the back, on which are glued a number of cylinders and short lengths of wire representing valve rods, etc. The fuselage should next be shaped, and the cockpit cut out. The two maxim guns may be fitted at this stage, and are made by fluting a round rod with a knife or a file, shaping off the back and gluing down to the fuselage. A cut-off pin inserted into the end of the gun will closely resemble the barrel, providing the end is filed off square and not left rough.

The tail piece is next shaped, the rudder either being made with it as one piece and a deep score made on each side to denote the hinge, or separately and hinged with small pieces of tin pressed into fretsaw slots cut into the wood and pivots made of very thin pins. The elevators are then shaped and glued to the fuselage, and a pin passed through the sides of the fuselage, helping to strengthen the glued joint. At this stage the tail skid can also be inserted into a hole drilled into the fuselage below the tail unit.

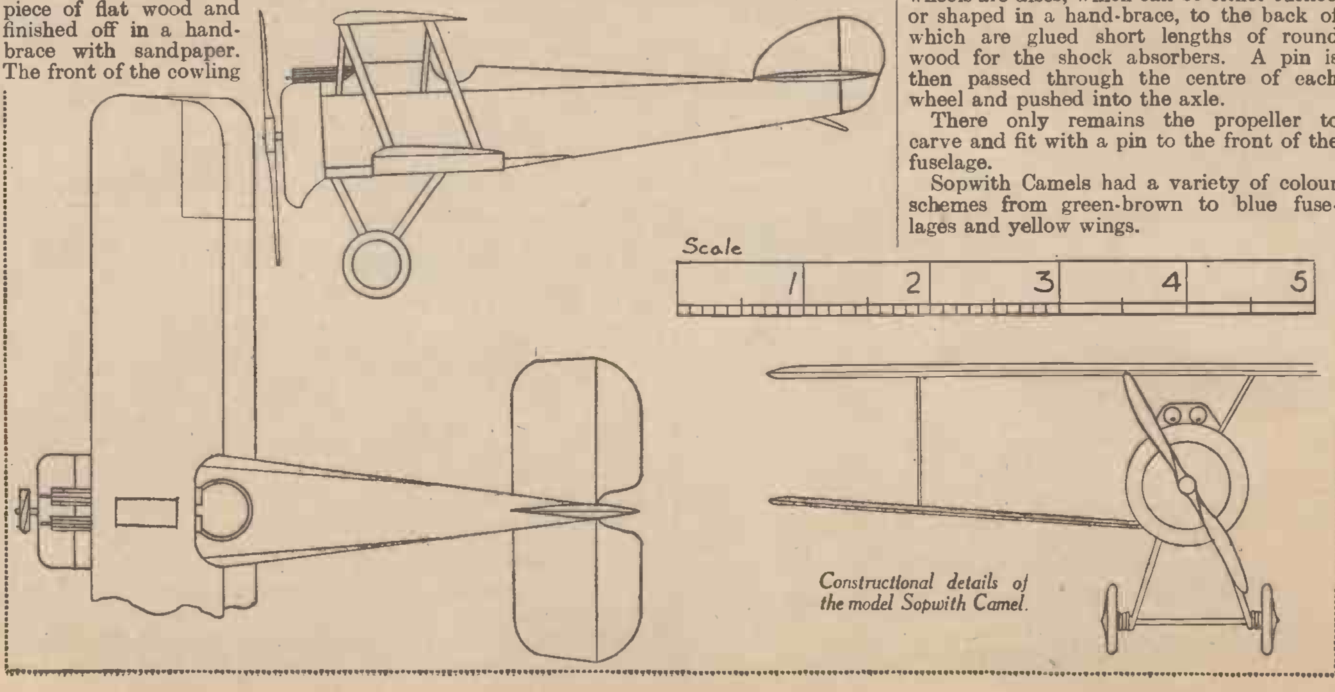
The Wings

The wings and interplane struts can now be prepared and four holes drilled into the fuselage to carry the centre struts. Glue in the four centre struts, which are longer than actually required, and glue and fit on the top plane, which is in one piece. The level of the plane should be carefully adjusted and the correct gap obtained by sliding the plane up or down on the struts, these being thin enough to stand considerable bending, especially if they are made slightly wet. The lower wings are glued and pinned to the fuselage, the inner edge of the wing being shaped to fit the fuselage at an angle, in order to obtain the dihedral. The four interplane struts are then glued into holes drilled in the upper and lower planes, and the whole machine left to harden off.

Next cut the struts for the undercarriage and insert the ends into holes drilled in the underside of the fuselage, bringing the ends down to a mitre at the axle position. The axle can also be glued in position. The wheels are discs, which can be either turned or shaped in a hand-brace, to the back of which are glued short lengths of round wood for the shock absorbers. A pin is then passed through the centre of each wheel and pushed into the axle.

There only remains the propeller to carve and fit with a pin to the front of the fuselage.

Sopwith Camels had a variety of colour schemes from green-brown to blue fuselages and yellow wings.



Constructional details of the model Sopwith Camel.

LATHE WORK FOR AMATEURS

BUILDING A 15-c.c. MODEL TWO-STROKE PETROL ENGINE. By W. H. DELLER

In this Concluding Article the Contact Breaker, Tappet, and Carburetter are Dealt With

THE remaining parts to be finished and fitted, apart from the carburetter, are those for the contact breaker. Parts Nos. 14, 15, 16, 17, 18 and 20 are the details required, and of these the insulator bush, part No. 14, tappet-rod, part No. 18, and tappet bush, part No. 20, have to be made, the other parts being supplied ready for fitting.

The Insulating Bush

A piece of red fibre rod is supplied from which to make this bush, and as designed, is intended to be pressed into a reamed hole in part 3. If this method is adopted, the writer is of the opinion that the bush will not remain secure, unless a cross-pin that will just cut the shank of the bush is fitted, for it must be remembered that if the main bearing housing gets warm the fibre will shrink and cause endless trouble.

Fig. 1.—The crankshaft bearings, with the cone locking nut, propeller flange, and tappet.

Fig. 2.—The engine, with the back cover-plate removed.

In the engine under construction, this bush was screwed in. An apparently sound job having resulted, the suggestion is one that might profitably be adopted. Should this be done, turn the shank of the bush to take a No. 1 B.A. thread, using a very keen edged tool, and turn to ·190 in. diameter. This will not, of course, give a full thread, but as the die is most likely to pull the tops off the threads if an attempt is made to screw on the correct diameter, the resulting thread will be cleaner. After screwing, turn the $\frac{1}{4}$-in. head diameter back about $\frac{1}{16}$ in. and drill the centre hole, using a No. 46 drill. Remove the partly finished bush from the lathe, leaving the tapping and cutting off until later. There is one point to be mentioned before it is forgotten, that is, the thread on part No. 17 is No. 7 B.A., not No. 6 as indicated. Therefore, remember this when tapping the bush.

Tappet-Rod and Bush

These are simple parts requiring very little work. Cut the $\frac{3}{32}$-in. diameter silver steel to length for part No. 18 and clean up the ends and remove sharp edges.

Silver steel, $\frac{3}{16}$ in. in diameter, is supplied for the bush. After facing to length, drill the $\frac{3}{32}$-in. diameter hole in which the rod must be a sliding fit. File and polish a slight lead on one end of the bush, and remove the sharp corner from the opposite end. Harden the bush and temper to a dark brown colour. The tappet-rod is left soft for the moment, in case the length requires adjustment.

Fitting the Contact Breaker

The contact breaker is fitted to part 3, but before this can be done, a little drilling is necessary. Referring to the drawing of this part, it will be seen that three holes are required in the rib at the top of the casting. Clean up the top surface of the rib by filing, and run a centre line along the whole length. As regards the positioning of the holes, it will be better to work from the 6 B.A. tapped hole. Providing that the flange has been made $\frac{1}{8}$-in. in thickness, the highest portion of the rib will not hold up to the length given, by $\frac{1}{16}$ in., in which case ignore the dimension of $\frac{3}{32}$ in. from the face of the flange to the centre of the hole, and make it $\frac{1}{8}$ in. away from the opposite edge. From this centre, mark another point $\frac{3}{8}$ in. away on the lower rib, and that for the next hole, $\frac{3}{32}$ in. farther along. Spot up the holes and drill the No. 6 B.A. tapping hole with a No. 43 or 44 drill to a depth of $\frac{3}{8}$ in. Drill the hole shown as $\frac{3}{16}$-in. diameter with a No. 18 drill as deep as possible, without piercing into the $\frac{11}{16}$-in. bore. The last hole must be drilled with care, as it accommodates the tappet bush, which must be a tight fit. Drill a pilot hole about $\frac{3}{32}$ in. in diameter, follow through with a No. 13 drill and ease out with a $\frac{3}{16}$-in. reamer until the bush enters the hole. Smear the outside of the bush with oil and tap in (lead end first) until the end is as close as possible to the bottom of the hole, without projecting into the $\frac{11}{16}$-in. hole. Tap the other holes, Nos. 1 and 6 B.A. respectively. Next take the fibre bush and screw into the shoulder, taking care not to twist it off in the hole. Cut off to leave a $\frac{1}{16}$-in. head to the bush, and file up flat. Now tap the centre hole, No. 7 B.A.

Take the tab, part 15, and secure it to the face of the bush by means of the contact screw with the terminal part lying at right angles to the rib.

Filing the Cam

Pass the boss on the cam adapter into the housing as far as it will go. Push the tappet-rod into the guide and hold it tightly against the adapter boss with one finger, at the same time rotating the adapter. This should clearly indicate the position of the slot forming the cam. File a flat-bottomed slot along the mark with a fine $\frac{1}{8}$-in. square file, overlapping equally at either side of the track of the rod until it is $\frac{1}{32}$ in. at the deepest place. Now extend the slot on either side of the deepest point, but gradually diminishing the depth until a $\frac{1}{16}$-in. radius gauge with seat on the bottom of the slot (see Fig. 1). Assemble the crankshaft and bearings in the housing, and secure the cam adapter in place temporarily, by means of the coned nut. Drop a $\frac{3}{32}$-in. hardened steel ball into the tappet guide, and insert the tappet-rod.

Attach the contact spring so that the contact points are facing and in line. Turn the cam adapter until the rod drops to its lowest position on the cam face, and observe that the contacts are making over their whole surface. If touching at the edges farthest away from the tappet, remove the rod and ease down in length until the faces seat correctly, when the tappet-rod may be hardened and tempered. Before leaving the contact breaker, see that the boss on the tab is well clear of the tappet bush.

The Throttle

The machining of the throttle, part 2, calls for little comment, beyond the fact that as the material supplied is very soft, paraffin will have to be used as a lubricant. Also the $\frac{3}{8}$-in. diameter requires to be a good running fit in the body, the $\frac{3}{32}$-in. hole must be true with the outside and the flat-bottomed hole bored to clear $\frac{1}{4}$ in. diameter. The 6 B.A. taper hole lines up with the slot in part 1, and after the throttle lever, part 8, is passed through the slot and into the tapped hole, it is moved to the extremity of the slot, when the $\frac{1}{16}$-in. hole can be drilled in line with the one in the body casting.

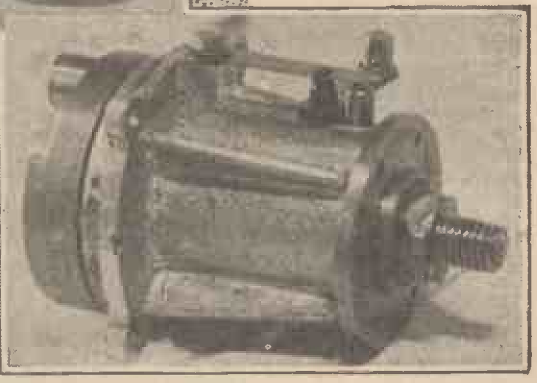


Fig. 3.—The front bearing with contact-breaker mechanism assembled.

The valve, part 3, is made in two parts, the stem being of silver steel and the head of brass. Face, turn and drill the head $\frac{3}{32}$-in. diameter, and part off to leave the back face flat. Turn the stem in one setting to ensure that both of the $\frac{3}{32}$-in. diameters are true, one with the other. Make the bottom guide of the stem fit the head tightly, and after fitting ease down both guides to slide freely in the respective holes in the body and throttle.

Hexagonal brass rod $\frac{5}{16}$ in. a/f is supplied for the jet tube, part No. 4. This is turned back at one end to ·185-in. diameter, and screwed with 2 B.A. thread. The thread is relieved at the back end for a $\frac{1}{4}$ in. to a shade below the core diameter of the thread. A No. 6 B.A. tapping hole is drilled $\frac{7}{8}$ in. deep through the centre and tapped with a full thread for $\frac{5}{8}$ in. On the opposite end a $\frac{1}{4}$-in. B.S.F. thread holds a cap nut, part No. 7, a centre hole about $\frac{1}{32}$-in. diameter is drilled through to meet the 6 B.A. tapping hole, and is coned out to take a small pipe nipple. The petrol passes through the No. 60 holes drilled across the relieved portion of the thread.

Just a word about turning part No. 5! After turning down the $\frac{1}{2}$-in. diameter brass to $\frac{1}{4}$ in. diameter for a distance of $1\frac{5}{32}$ in., reduce at the front to $\frac{1}{8}$ in. diameter by $\frac{1}{2}$ in. in length. Work on the 20 degree point and finish back to the first shoulder to $\frac{1}{16}$ in. diameter. Finish to the second shoulder to ·110 in. diameter and thread. Cut off after forming and coarsely knurling the head. Fig. 5 shows the parts after machining.

Part 6 is merely a gland nut for part 4, and requires no explanation, and the soft brass rod supplied for part 8 will flatten out by squashing in the vice.

When assembling the carburetter, slip a thin packing washer between the shoulder of the jet tube and the body casting. Make certain that the needle valve definitely "shuts off" and pack the gland round the thread. Do not forget to grind in the valve (part 3) lightly before assembling, as in Fig. 6.

Interpose a jointing washer between the flange of the carburetter and the engine before fixing.

The finished engine is seen at Fig. 4.

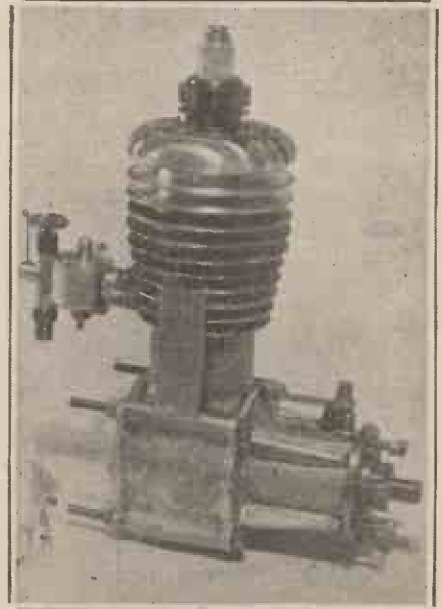


Fig. 4.—The complete engine.

Fig. 5.—Various parts of the carburetter.

Fig. 6—The complete carburetter.

Final Assembly of the Engine

The engine parts are now ready for final assembly. First, wash all the parts thoroughly in petrol, and dry off. Smear the cylinder bore and piston with thin engine oil, and also half fill the inside of the piston with oil and work the con-rod to make certain that the small end bearing is well lubricated, then drain out the surplus oil. This advice may seem superfluous, but none of the moving parts should be assembled dry, or the chances are that the lubricant will never properly reach the bearings. Enter the piston and con-rod into the cylinder so that the baffle on the piston head is nearest to the transfer port. Incidentally the radiused side of the big-end bearing in the con-rod comes on the side opposite to the induction port. Help the piston rings into the cylinder by compressing with the fingers, and push the piston downwards until the big end almost touches the bottom of the crankcase.

Lubricate the ball races, and tap them down hard against the shoulders on the crankshaft. Push the shaft and bearings into the housing and pass the cam adapter on to the shaft at the opposite end, and hold lightly in position by means of the coned nut. Reassemble the tappet-rod and contact-breaker spring.

After rotating the crankshaft to line the pin up with the big-end bearing, push the bearing housing home on to the crankcase and hold in position with a couple of $\frac{1}{8}$-in. nuts. Rotate the crankshaft until the piston travels to its highest point and carefully measure the distance from the top of the liner to a point on the top of the piston. Turn the shaft again in a clockwise direction, looking from the tail end of the shaft, and arrest the piston at a point $\frac{3}{32}$ in. before the top of the stroke. Hold the balance weight in this position and slack off the cam adapter nut with the fingers. Now turn the cam adapter in a clockwise direction until the points are just about to break. Lock up the cone nut finger tight and remove the shaft and housing from the crankcase (Fig. 2). Tighten the cone nut up hard by holding on to the crank web in the vice. Check up timing again to make sure that the cam adapter has not slipped while tightening, and if satisfied that it is correct, smear the joint faces with gold-size and assemble the crankshaft and housing to the case, nutting it up tightly. Lock the retaining screw into the end of the crankpin and close the crankcase with the rear cover (Fig. 3).

Apply a little gold-size to the end of the liner and pull the cylinder head down evenly. Cut a thin leather or soft fibre washer to fit under the head of the drain plug screw before inserting. Place a spare nut on the threaded end of the crankshaft to protect the thread and run the engine for a time in the lathe to make certain that it runs freely, feeding a little thin oil through the sparking plug hole from time to time while so doing.

This brings us to the concluding item, namely, the carburetter.

Making the Carburetter

The carburetter parts are so small that photographs do not clearly indicate the methods of machining, but; although small, the parts are, if tackled properly, fairly simple to machine when broken up into a proper sequence of operations.

Commencing with the body casting of part 1, catch in the chuck by means of the appropriate chucking boss to machine the hole for the jet tube. See that the short boss at the front runs true before centre drilling. Face the front of the boss down until it is only $\frac{1}{32}$ in. proud of the small web running across the bottom, drill a hole (No. 24 drill) slightly deeper than $\frac{23}{32}$ in. to the lips of the drill, and counterbore at the mouth to $\frac{3}{16}$ in. diameter and depth.

Remove from the chuck, cut off the chucking boss flush with the top of the casting and re-chuck by means of the bottom boss. Set the casting to run true, face the front down until the length over the small boss, previously machined, measures $\frac{23}{32}$ in. Centre drill and drill a $\frac{1}{2}$-in. diameter hole to a depth of not more than $\frac{15}{32}$ in. to the lips of the drill. Bore out cleanly to $\frac{5}{8}$ in. diameter and $\frac{15}{32}$ in. deep, leaving a square corner. Drill the bottom of the hole out a shade deeper with a $\frac{3}{8}$-in. diameter drill, ground to an included angle of about 150 degrees. Set the top slide round to 45 degrees and bore out from the corner of the $\frac{5}{8}$-in. hole to form the valve seating. Carefully spot up the bottom of the hole with the point of a centre drill, and drill a $\frac{3}{32}$-in. hole to a depth of $\frac{3}{8}$ in. With a fine boring tool face the bottom of the $\frac{3}{8}$-in. diameter hole below the seating until it breaks through. Continue facing with care until the point of the tool is projecting through $\frac{1}{32}$ in., leaving the bottom boss supported by a bar formed by the web.

Drill the $\frac{5}{16}$-in. hole and face the flange by catching on the boss opposite. Mark out and drill (No. 32) two holes in the fixing lugs to suit the studs in the cylinder. The $\frac{7}{64}$-in. slot controlling the throttle opening is made in accordance with the enlarged portion of the print. Cut off the remaining chucking lug to length, and drill a hole through the boss to hold the wire spring that maintains the head of the jet screw in adjustment with a No. 64 or $\frac{1}{32}$-in. drill. Drill the No. 70 hole through from the seating to the jet tube hole; it must be covered by the coned face of the valve.

FINISHING OUR SPEEDBOAT

This Month We Put the Final Touches to Our Fast Motor-boat *Streamlinia*, the Construction of Which Has Been Dealt With in Preceding Articles

Showing "Streamlinia" under way.

BY this time I expect you are well acquainted with all the mechanical details and have completed the heavier work, but finishing off is quite as important, and makes just that difference between an amateur and a professional-looking boat.

Amateurs often remark on the fine finish of commercial models, and wonder how it is achieved, but it is not a difficult matter if a few simple rules are followed.

In the case of *Streamlinia*, I think it is best to remove the steam plant before finally painting the hull, as the inside needs to be well covered, and it is easier to work on the bare hull than to try to paint round steam and exhaust pipes.

Give the inside two good coats of enamel. Warm brown is a useful shade and will clean up better than most colours after a run.

Assuming that the outside of the hull has had four coats of lead paint, sandpaper this down to a smooth finish, and stop up any rough places with putty, which must be allowed to harden before painting.

The Deck-house and Roof

Now apply a coat of white under-coating, which should be brushed out very evenly. Besides the hull, you may also give the deck-house and roof a layer of under-coating, but in painting them, be careful not to leave any "runs" at the window corners, as these will show badly on the finished surface.

Let this coat dry for at least twenty-four hours, and before you apply another, make this test. Lightly sandpaper the hull, deck-house and roof with a fine grade (say No. 1). If there are any signs of the paint "pulling up" (that is to say, if it is at all soft under the surface) you will know it is not yet ready for recoating, until this has thoroughly dried out. You cannot hurry this job of painting. Many a marine model enthusiast knows the tragedy of peeling enamel, one of the consequences of hasty daubing

After another coat, the boat is ready for enamelling. The sides will be white, and the bottom of the hull warm brown, the same colour as you are using inside the hull.

There are many quick-drying enamels on the market, but in boat work it is our experience that the longer an enamel takes to dry, the longer it wears. The enamel used on the *Streamlinia* model we have built is Ripolin, but you are at liberty to choose the colour and brand you prefer.

Enamelling the Boat

The enamel should be brushed on with a fairly stiff brush, and if it is "worked" well, will flow out to a beautifully smooth finish. Two coats of enamel are advisable, sandpapering between each coat, and when the enamel is quite dry you can proceed to put on the decorative line.

With a pencil, mark a neat line ¼ in. down from the top of the hull, and then another ⅛ in. below this. Fill in carefully between these lines with blue enamel, and this forms a very pleasing break in the hull line, and gives the boat a flattering appearance of length. Do not carry this line right to the stem, but leave room for the name *Streamlinia* in letters ¼ in. high. A transfer of this name can be obtained from Bassett-Lowke, or you can do it yourself with gilt paint. The blue line can also be improved by finishing off at the stern with a gilt arrowhead, as shown on the drawings published in the March issue. This gives *Streamlinia* a remarkably professional appearance.

Now we come to the deck, which is marked out, following the hull shape, to represent planking, as is the general practice with this type of boat, and certainly looks well. You can mark this out with a sharp pointed tool held close against a template made to the shape of the deck, or better still with a carpenter's gauge. This is first set ¼ in. in and a line marked right round the deck. Then set it at ½ in. and again mark to the shape of the hull down each side, taking care not to run over the line at the after end. So you continue resetting ¼ in. in from each line previously marked, until the deck planking is completed flush with the line of the deck-house.

After this, both sides of the deck should be given two coats of copal varnish, for it is necessary to varnish the underside of a steam model to prevent any steam saturating into the wood, with the obvious result of warping.

Marking out the deck with a carpenter's gauge.

Assembling the Parts

At last all the parts are completed and painted, and we now begin assembling. First put back the plant into the hull, screwing it down firmly. Next fix the deck-house to the deck. This should be screwed on from the underside of the deck, keeping the inside of the house flush with the edge of the hole cut into the deck. In this operation it will be found necessary to drive the screws in at a slight angle, but this is made easier if the holes are first drilled at the required angle.

At an early stage two small holes were made in the deck-house roof. Now the enamelling is complete you can put on the ferrules. Pencil in the two outlines of the pressure gauge and steam valve holes and cut them out with a coarse fretsaw. The ferrules can then be pushed in. After painting you may find that the two small wood blocks, which position the deck-house roof, fit tightly, but rubbing with sand-paper will ease this.

Next come the small fittings, such as bollards and flagstaffs. These should be mounted on the places indicated, with the special pins provided. The flags flown are the burgee at the bow and the red ensign astern, unless the "commander" of the boat is a naval reserve, when he may fly the blue ensign.

The complete deck is now ready for fixing to the hull, and should be screwed on with ½-in. brass screws (steel screws are used for the under-water work, but brass ones look better on the deck) all round the edge, but it must not be glued. It is sometimes necessary to take off the deck, and if it is glued you will find you require a new one.

Next the rudder should be pushed up into the tube, and the tiller arm fixed, and then we are ready for the final test.

Do not try to get up steam with the model out of the water or the result will be blistered paint underneath.

Light the burners, with the model on the bank if it is difficult to reach in the water, but immediately you have seen they are burning correctly, put her in. Keep the boat as level as possible, so that you do not upset the level of the spirit. You will find once she is in the water she will never roll or pitch sufficiently to matter.

Another little hint which may be welcome to model-boat owners is never lift the stern of a model to clear a weed-fouled propeller. When you lift the stern the bow goes down. Take her right out. It is safer, and can be done just as easily.

When you have raised steam sufficiently, say from 40 to 60 lbs., give her a first run.

Any helm trouble can then be corrected.

The Steering

It is a peculiarity of V-bottom hard chine hulls that they will keep a perfectly straight course with no rudder on, but as soon as a rudder is fitted, they become very sensitive. A little experimenting with this will soon give you what a sailor calls the "feel of the helm," and you will be able to send *Streamlinia* just where you want. She will certainly make a good show in steering competitions.

The maintenance of *Streamlinia* is simple. After each day's running, dry and clean the model inside and out. Fill the displacement lubricator with clean oil and give the engine a few turns to draw the oil into the cylinder. Occasionally draw out the burners from the firebox and renew any wicks which have become charred. They should be bunched out of the top of the burners a little to get a good flame, but make sure they go right down the tube so they can pick up the spirit as it flows down.

Streamlinia has been tested in all weathers, on a calm sunny day and in a wind when she tossed about like a "hove-to" trawler, but never has she given trouble with either lamp or engine, and she always makes a good consistent run of from twenty-five to thirty-five minutes at a speed of anything from 7 to 8½ knots.

These tests were made in the winter and early spring, so there is every hope that she will give better performances during summer running.

Painting the hull of "Streamlinia."

INSTALLING HOUSEHOLD ELECTRICAL DEVICES

(*Continued from page 411*)

Perhaps the most popular type of electric washer is known as the agitator type. In construction this type of washer consists of the usual type of tub mounted to a substantial frame with feet and accommodation for the wringer at the top. At the base of the tub is the agitator, usually in the nature of a metal dolly carrying three or four blades and so constructed and connected to the motor that it oscillates from 50 to 80 half turns per minute. The actual power transmission from the motor (which is not universal) may be either belt-drive or direct-shaft drive.

For operating the wringer a direct drive is taken from the motor separately through a housing at the side of the tub, and equipped with gearing for wringing from the washer to the sink or tub. The wringer may be used either independently or together with the washing action.

It should be noticed in this example of fractional horse-power motor use, the complete washer and motor frame are earthed, a three-pin plug and three-core cable being necessary.

Electric Refrigeration

Electrically-operated refrigerators for domestic use are now becoming a standard appliance in the all-electric house. The requirements for the ideal preservation of food is a maintained temperature of 40° to 50°, and the air to be dry and pure, and free from dust and dirt. All these conditions are fulfilled by the electric refrigerator.

Refrigeration is the process of cooling, and is based upon the fact that all gases, when subjected to sufficient pressure and cold, become liquefied and liberate their latent heat. Conversely, when the pressure is reduced and the liquid gas evaporates, heat is absorbed from the surroundings, resulting in a lowering of the temperature in those surroundings.

TYPE.	Approx. H.P.	Watts Consumed.	Hours running for 1d. at 1d. per unit.
Sewing motor	1/40	50	20
Mixer and beater	1/15	100	10
Polishing motor	1/8	200	5
Stimulator	1/6	250	4
Washer and wringer	1/4	300	3½
Refrigerator	1/6	250	10

In the refrigerator operated by a fractional horse-power motor (not universal), the refrigerant usually employed is sulphur dioxide gas, which is subject to pressure in the compressor driven by the motor, and cooled by a current of air produced by a fan, also operated by the motor. This process liquefies the gas and when passed to the evaporating unit, it evaporates and so absorbs heat from the food storage chamber in which it is fixed. Following this, the vaporised gas is drawn into the compressor and reliquefied, these operations being automatically repeated. The motor operating the compressor is either belt-driven or direct-coupled, and is controlled by a thermostat, thus maintaining the predetermined temperature necessary for the storage, that is to say, the motor is automatically switched off when the temperature falls below 40° and switched on again when the temperature reaches 50°.

Remaining examples of fractional horse-power motors for use in larger establishments include potato peelers, meat, food and vegetable choppers, and dish washers, but space does not permit to deal with these.

In the centre column is appended the consumption in watts, operating hours for one unit, and the approximate horse-power for the motors described above.

Referring to figures for the refrigerator, the ten hours is not the running time of the motor, but the operating hours of the refrigerator, the motor only running intermittently.

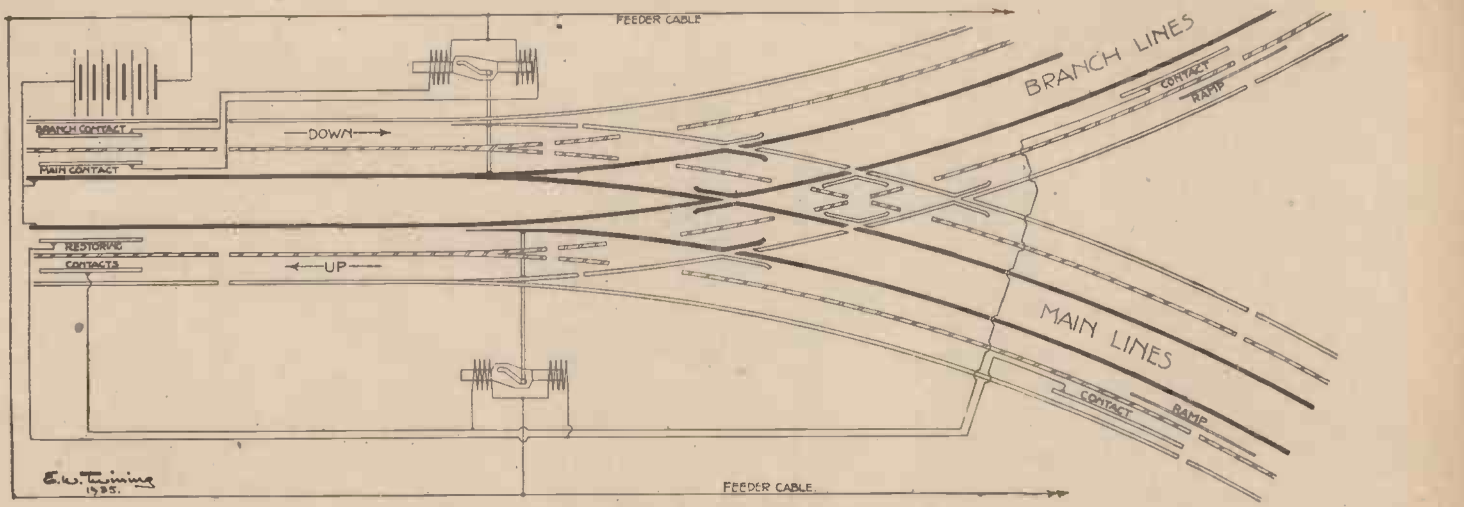


Fig. 6.—Diagram of automatic setting of points by trains.

MODEL ELECTRIC RAILWAYS

By E. W. TWINING

An Automatic Control and Signalling System

IT was stated in the last article that the leads from the coils of the point-operating solenoids would be taken to two-way switches on the control panel. This was for moving the points as required by the operator of the system. If, however, they are to be worked by the trains themselves, automatically, the current to the coils must obviously be derived from other points where the circuits can be opened and closed by the passage of the trains.

In the case of both up and down lines, short contact rails will be provided over which will pass either rolling brushes, spring brushes, or flat shoes attached to and not insulated from the frame of the locomotive or motor coach bogie. But the arrangement of these contact rails will be different in the case of the up lines from that on the down lines, because the conditions for operating are by no means the same.

Point Selecting on Down Lines

For convenience we will consider that the down lines are those involving facing points, and that trailing points are on the up lines, as was shown in Fig. 4.

The arrangement of contact rails for the moving of *facing* points is, perhaps, somewhat the more simple matter, although two rails are needed, but the selecting gear on the train requires to be pre-set, manually, before it starts on its journey from the terminal station or from some other convenient point. Details of this gear will be described presently.

In Fig. 6 the layout of the tracks is repeated from Fig. 4, but all relays, electrical gear and circuits are omitted except those which concern the operation of the tongues of the points. The two contact rails for the down facing points are shown between the running rails, one on either side of the third rail, but they can quite well be placed outside the running rails. Their lengths, which will, of course, be equal, will depend upon the scale or size of the railway; at least 6 in. will be advisable for 1¼-in. or 1¾-in. gauge.

The left-hand rail is connected to the coil of the solenoid, which puts the points open to the branch line, and the right-hand rail to the other coil, which opens the points to the main. The other ends of the windings of both coils are tee'd into the feeder cable. A circuit is completed through one of the coils by the passage of the selector over either the right-hand or the left-hand contact; the current passing through running rail No 1, through frame of engine, selector roller or brush, contact rail, solenoid coil, feeder cable and back to battery.

Point Selecting on Up Lines

A reference to Fig. 6 will show that these points are trailing and they must be capable of being operated from two positions: one on the up main line, and one on the up branch. The contact rails are to be placed at the entrance to the sections which include the points or at the ends of the preceding sections. Actually, the exact positions do not matter so long as they are far enough back, yet not too far, but they should be approximately the same distance from the points. In each case a ramp is necessary, placed just before the contact rail, the object of which is to ensure that the selector on the engine is down on the correct side required to touch the contact rail.

The reader is here referred to Fig. 7, which shows the rocking selector on the train, the contact rails and a profile of the ramp. Alternative arrangements of the mechanism are shown, but these will, for the moment, not be considered. The point to be brought out is that the selector can rock to either side, and an examination of Fig. 6 will show that on the up branch and up main lines (at the right-hand end of the drawing) the ramps are placed on opposite sides of the contact rails. Suppose now that two up trains are approaching the points, one on the main and the other on the branch, one or both of them may have the rocking selector set over on the wrong side for making the required contact, the ramp, therefore, is needed to correct this, and, if it is not already down, bring the brush or roller on to the contact rail. If it is already on the correct side the ramp simply does nothing.

We have just supposed that *two* trains are approaching the points; now what is going to happen? One of them, the first which reaches the contact rail, will operate the points: what will the other do? Well, it will be stopped. In Fig. 4 it is seen that on the up trailing point rod there are contact leaves E, which render the third rails, behind the points, dead according to the positions of the points; so if a train on the main up line reaches its contact rail before another train on the branch, the latter cannot proceed because the current supply is cut off. Now, if the main line train did no more than move the points for itself, the branch train could never start again, so, after the passage of the main train over the points, that is to say, after it has cleared the next section, it is necessary that it should return the points to their original condition. This it does by means of the restoring contact rails which are shown at the left-hand end of Fig. 6. These rails are connected up to the opposite coils of the solenoids to those approaching the points, and so the same brush or roller which actuated first one solenoid coil will, through the restoring contact, actuate the other coil. The points will therefore move over for the branch up train and the branch third rail will again become alive.

Point Selector on Train

This apparatus may be fixed on any part of the front of the train, the locomotive, the tender or motor coach, as the case demands. At A the contact rails are shown inside of the running rails with the ramps outside. The rocker must be spring controlled, and this control is, at A, by a cam fixed above the rocker with a spring-loaded roller pressing upwards upon it. At B the contact rails are outside with the ramp, or ramps, between. The control is by a toggle gear, also spring loaded. This pattern control is perhaps the better of the two. At C the contact rails and ramps are between the wheels, which makes the neater arrangement; here the ramp operates on the rollers which are also the contact makers. D shows a profile of the ramp with the position of the same relative to the contact rail. In setting out the curvature of the ramp care must be taken to make the angle of rise of the top surface not too sudden or the shock may tend to lift or overturn the vehicle. An even greater length and smaller angle than that shown will be all to the good. The spring control, too, should not be too powerful.

A New Design for Electric Locomotive Motor

The sectional sketch, Fig. 8, shows an idea which the writer has had in mind for some years, and which seems to be specially applicable to very small scale railways, such as the now popular "00" gauge, where it is difficult to make a motor of sufficient size and power and yet get it within the limits of the dimensions of the locomotive with ordinary steam outline. It will be obvious from the drawing that the "boiler" and the return piece under the axles form a horse-shoe magnet with a comparatively large armature between the poles. These poles swell out to accommodate the armature and form what is normally the wide firebox of a Pacific type engine.

The magnet portions would, of course, be machined from cast steel, the upper half finished after hardening and magnetising with lagging bands, etc., and enamelled. Boiler mountings might be in brass knocked into holes prepared for them.

If an electro-magnetic motor is preferred the boiler barrel may have a core only and be wound as a coil; in other words, have a field winding: reversing would then be done by changing the direction of current through this field winding.

This locomotive, as an electric motor, has been registered as a copyright design, and must therefore not be manufactured on a quantity production basis except by arrangement with the writer of these articles, but no objection will be raised to a private individual making such a motor to the design for his own use.

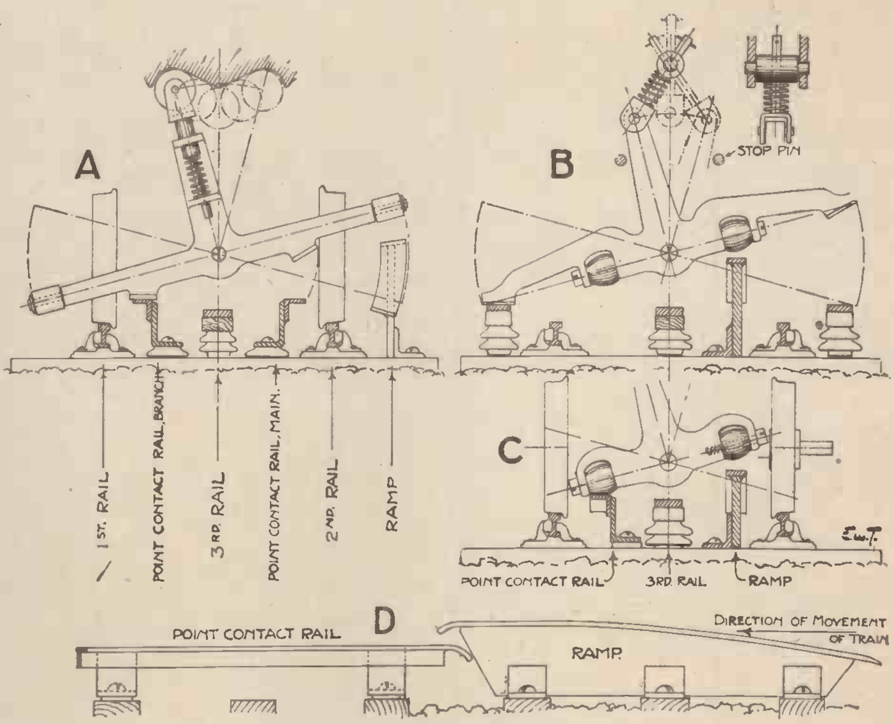


Fig. 7.—Automatic point setting apparatus.

FACTS ABOUT MODEL LOCOMOTIVES

BROADLY speaking, apart from differences of size, model locomotives may be divided into three classes. First, there is the perfect scale model intended, perhaps, for placing in a glass show-case and which purports to be a facsimile of either an existing prototype or a possible prototype. Next we have the working model which also follows prototype design by scale, but is modified to suit the requirements of working conditions, and, thirdly, we have the free-lance design, which is probably original and follows no prototype. Then there is the working engine which, in general, departs so much from actual practice, except as regards a somewhat similarity of form and colour of painting of a particular prototype, that it is not strictly a model but a toy and, therefore, is not included as a fourth class.

The Three Classes

Each of the types of models under the three classifications mentioned above have their uses. Of the perfect scale model it may be said that the chief purpose it serves is to hand down to posterity tangible records of what was done in railway engineering before steam locomotives became a thing of the past. Models of the second class, although they may be most useful and are certainly charming, are perhaps the least commendable of the three, since they are, after all, but imitations of something which has been done before in full-size practice, and possibly, also, a number of times on model form. The third class may be sub-divided into (a) models to demonstrate something new in the way of design, or (b) models built primarily for hard work. Of exhibition models little more needs to be said. Their construction is to be most strongly recommended, but to be really useful in the years to come the builder should aim to select something for reproduction which is out of the common, or else, if he chooses a type which everybody is modelling, his workmanship and finish must be of the very highest quality.

Famous Models

It is a very great pity that so few people ever think of making models of engines which have long been scrapped; engines which made railway history. For instance, one could count all the models in existence of the famous 8 ft. singles, designed by Sir Daniel Gooch for the broad gauge of the Great Western Railway, on the fingers of one hand. Or again, there are the splendid bogie singles of Johnson's design on the Midland, and Dean's on the Great Western, to say nothing of such beautiful machines as the 8 ft. 2 in. singles of the Caledonian, and Stroudley's 0-4-2 and 2-2-2-types of the London, Brighton and South Coast.

Of class two it may be said that, if the scale is large enough, the models may perform useful work of hauling and of amusing children, but generally the scale model is not sufficiently strongly built to give a heavy draw-bar pull.

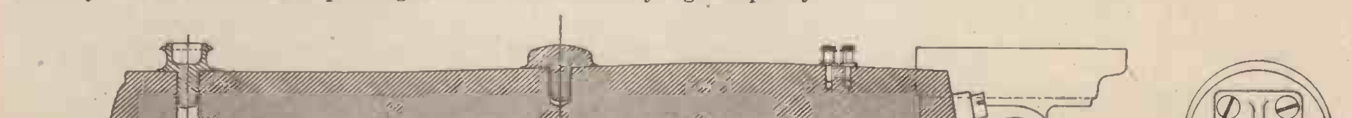
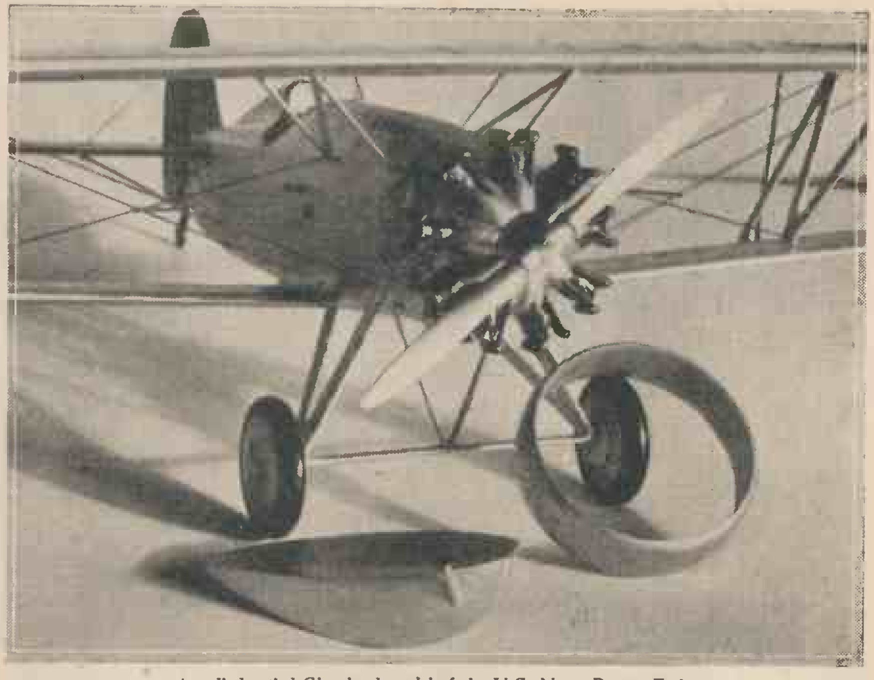


Fig. 8.—A new design for an electric locomotive motor.

MODEL AERO TOPICS



A well detailed Cleveland model of the U.S. Navy Boeing Fighter.

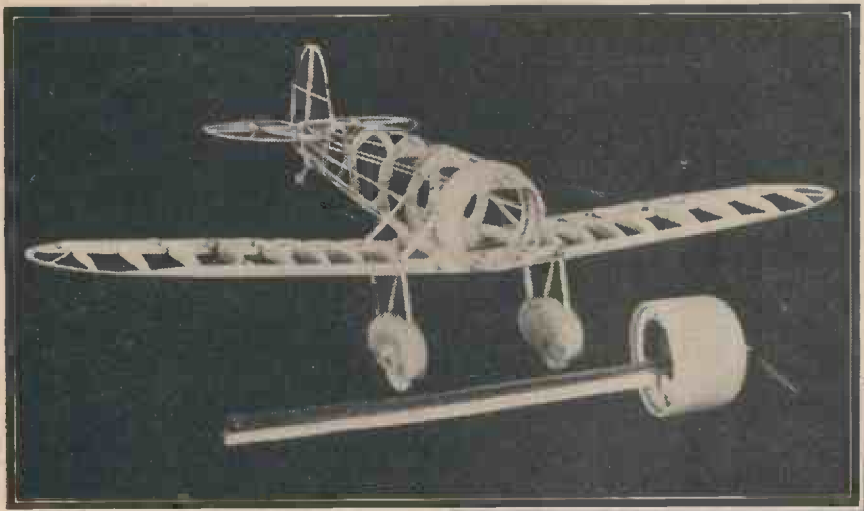
American Balsa Wood Model

THE illustrations on this page show how truly realistic are models made of balsa wood. Scale model aircraft built in this way are extremely popular in America, and these models, built from materials and designs supplied by the Cleveland Model and Supply, Inc., of 1866 W. 57th Street, Cleveland, Ohio, U.S.A., show the great degree of realism which can be obtained. Kits for making such models are obtainable from the English firm—Model Aircraft Supplies, whose address will be found in the advertisement pages. Materials are also available from A. E. Jones, Ltd., another of our advertisers. It is difficult to tell the models from their prototypes.

Perfect Models

In America, scale model aircraft has reached a very high degree of perfection, and there are hundreds of firms catering for the needs of model makers. You may obtain dummy engines of all the power units used in aircraft, scale model propellers, panted wheels, model bomb dropping devices, model dashboards and all of the insignia in the form of transfers further to add to the realism of the finished product. America, however, is far behind us in the construction of power-driven models, and only a few American aero-modellists seem to be interested in this branch of the hobby. It is difficult to find a reason for this since many American units, such as the Brown and the Wall, are available.

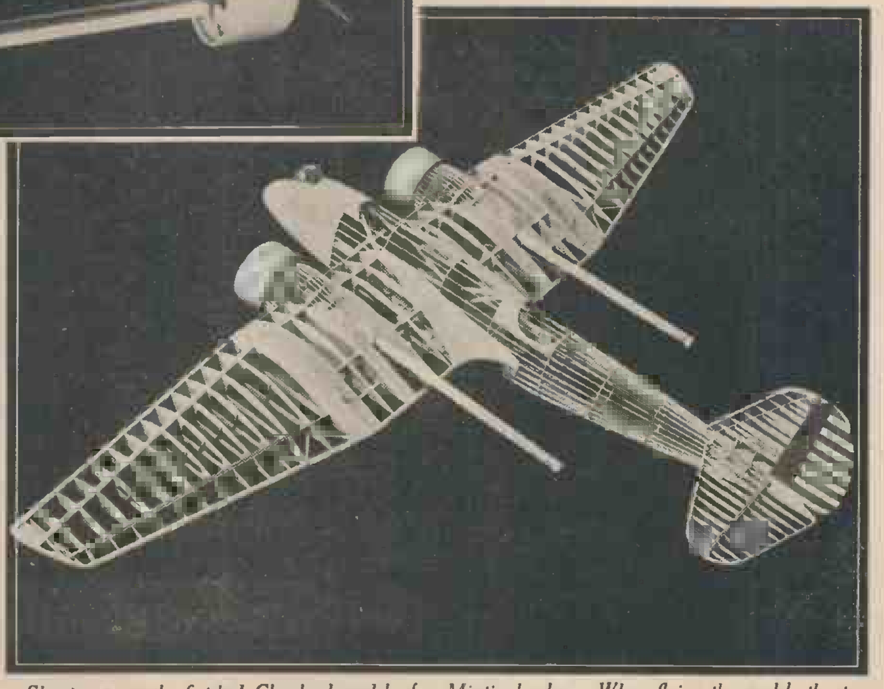
The photograph at the top of this page shows a Cleveland model of the U.S. Navy Special Boeing fighter, and indicates the wealth of detail which is built into the model. The photograph below it is of the American, a mystery aeroplane which is reputed to be capable of extremely high speed. The duration of this model is twenty seconds. The photograph at the bottom right-hand corner is of a model of the U.S.A. Martin Bomber, with the covering removed to show the details. The two projecting motor spars behind the nacelle are quickly detached and the spaces are filled in with covered blocks for exhibition purposes. Wide-bladed propellers are used for flight of course, the scale propeller for exhibition only.



A Cleveland model of the mystery aeroplane which is capable of flying at a very high speed. Its usual duration is about 20 seconds.

The Practical Mechanics Petrol-driven Monoplane

I hope to be able to include next month the preliminary article on the Petrol Engine Monoplane to which I referred last month. The design is completed and the construction well in hand. Any modifications which I find after test to be necessary I shall, of course, incorporate.



Showing a partly finished Cleveland model of a Martin bomber. When flying the model, the two projecting motor spars behind the nacelles can be easily detached and the spaces filled in with blocks of wood.

SMALL TOOLS AND CUTTERS

This Article Deals with Standard and Special Types of Tools, also their Use, Maintenance and Methods of Making

SMALL tools are an essential part of all mechanical engineering equipment, whether the work engaged upon is large or small. The uses for them are, however, greater in smaller work and model making in general, for whereas in the prototype

Fig. 1.—A split ring die.

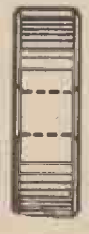


Fig. 2.—Die blank.

parts are of such dimensions as to permit being machined by lathe or borer, the same parts in the model, owing to small scale reduction, call for different treatment as regards machining, and the model maker is forced to rely upon the use of small tools to perform the same operations.

Such tools include drills, reamers, dies, taps, and all kinds of cutters, and it is proposed to deal with the various types, their uses, methods of using and keeping in condition. Although many of the tools are standard productions, it frequently happens that a tool or cutter of a special nature is required. As a matter of fact, in many cases, the use of a special tool, even for jobs that may be regarded as machinable by other methods, is desirable on account of accuracy and time saving, particularly where several identical articles are wanted. While it is true that in most instances, providing that a certain amount of discrimination has been used regarding the machining treatment, the time saved will more than compensate for that lost in making the tool or cutter, in others the intricate character of the work may make the use of such cutter indispensable. Thus the fact emerges that an apparently difficult machining operation may be rendered easy by the provision of certain tools or cutters, and, therefore, the greater part of each article will be devoted to information concerning the making and using of special tools.

Threading Dies

Of all small tools, the greatest diversity of types or patterns occurs in those used for the production of screw threads. Included among these are engineers' pattern, ring, solid, button or acorn, spring, chaser and full mounted types. Of the adjustable dies different makes of ring dies vary as to the method of adjustment.

Engineers' Pattern

These dies, although still manufactured, are what may be described as an old-fashioned type. They offer certain advantages inasmuch as they withstand severe service, and also the amount of adjustment (over or under size) is practically unlimited. A full thread cannot be cut at one screwing, and in use the adjusting screw is slacked back to permit the rod or part being screwed, entering completely between the halved dies. After closing the dies hard on to the job, the thread is run on for the required distance and wound back to the start again, further cuts taken until a full thread is formed. Oil is used as a lubricant for steel, and as the thread approaches complete formation, it is advisable to break the chips by occasionally reversing the direction of rotation as the die is being fed downwards, in order to prevent portions tearing out. It may be mentioned that the front of the dies are relieved and this is the part where the cutting take place. Also the dies are assembled in the stock in such a manner as to permit both sets of markings to line up. After much use the leading edges of the thread lands become rounded and can be restored by careful grinding and stoning. Special dies are comparatively simple to make. A pair of tool steel blanks slightly larger than the patterns are made to fit the stock. Secure in position and drill a correct sized tapping hole (exactly equal to the core diameter of the thread) through the centre of the blanks on the parting line. Proceed to finish as for a ring die as regards lead, tapping, land and relief, but file the butting

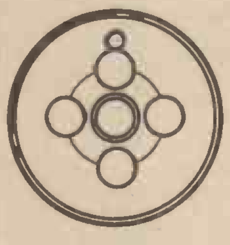


Fig. 3.—The die blank drilled.

Fig. 4.—The holes elongated to provide "spring."

faces to length after tapping and reproduce the cutting edges and chip spaces on these faces to the pattern.

Ring Dies

The pattern shown in Fig. 1 is known as a ring die. These may be either solid or split for adjustment, but with both types a full thread is produced at one screwing, and where split, the amount of movement obtainable is only sufficient to permit a thread being produced within a few thousandths either way of correct size. As previously mentioned, various methods of obtaining the adjustment exist, but in all cases the difference lies only in the manner in which the slot is opened and closed.

Where the adjuster is incorporated in the die, it is in the form of a taper pin or screw acting in the slot or a jack screw tapped through the side of the die and bearing on the opposite wall of the slot to force it open. Dies in this class are tempered so that the natural spring of the tool steel tends to close the slot when the adjuster is removed.

The die illustrated requires provision to be made in the holder for the purpose of effecting adjustment. This may be in the form of three screws passing through the side of the holder; the centre one being pointed to an angle of 60 degrees, seats into a countersink in the mouth of the slot and the other screws, arranged at an angle of 45–60 degrees on either side, are flat ended.

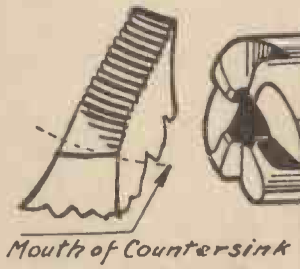


Fig. 5.—Backing off for die "lead."

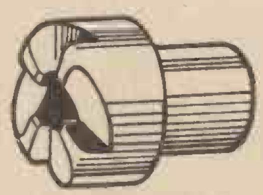


Fig. 6.—Button die.

Pressure applied by the centre screw opens the slot and the side screws locking down on to the edge of the die maintain the adjustment under cut. Naturally, when a closing action is necessary the adjustment is effected by slightly withdrawing the centre screw and tightening the side screws.

Ring dies are obtainable as standard in the commonly-used thread systems. Whitworth, B.S.F., B.A., Metric, etc. The dies are made in several sizes as regards outside diameter, in the following range: $\frac{5}{8}$ in., $\frac{13}{16}$ in., 1 in., $1\frac{7}{16}$ in., $1\frac{1}{2}$ in., etc. The maximum size of thread that the dies in each range will cut is restricted by the diameter of the die, and this point requires watching when purchasing; as, for instance, the largest size of thread in the 1 in. diameter range is $\frac{1}{2}$-in. diameter. While such a die is suitable for thread correction or running down purposes, it is, in the writer's opinion, too weak to give reasonable service (particularly if the thread form is deep) for thread cutting and the next larger size should be selected. The most popular range of dies for threads up to $\frac{1}{4}$-in. diameter is the $\frac{13}{16}$ in. size, and for a set of Whitworth, small sizes or B.A. threads is the handiest.

If a greater range is required, say from $\frac{3}{16}$–$\frac{1}{2}$-in. diameter, it is preferable to use two different diameters of die to cover the range, as the die holder will be too massive for sensitive control on the small sizes. In use the die must be started true with the work, or a drunken thread will result and a lead filed truly on the end of the bar will greatly assist in this direction. Care must be exercised in attempting to correct the die for squareness with the work by applying unequal pressure to the stock handles, as, if only one or two threads have been cut, the mouth of the die is very liable to chip badly. Once this has happened the die is ruined for cutting clean threads.

When the cutting edges become dull after repeated use, a certain amount of re-sharpening can be done in the larger sizes with a round oil stone and in the smaller sizes by lapping. This is done by filing down a suitable piece of brass rod to such diameter that it will seat on both flanks adjoining the thread in the chip slots. The lap thus formed is suitably driven and charged with grinding paste. Each cutting edge is dealt with in turn by passing the chip slot over the lap and

Fig. 7.—Blank for hollow mill.

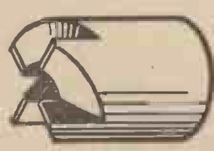


Fig. 8.—Hollow mill for cutting brass.

Fig. 9.—Hollow mill for cutting steel.

applying pressure to the die to force the lap towards the centre.

Making Special Ring Dies

A cast steel blank is prepared in accordance with the size of die in use. When drilling the tapping hole, select a drill that will allow the tap to cut a full thread and see that it is drilled square with the face of the blank, Fig. 2 showing this first stage. Carefully tap the hole, and with a centre drill, countersink on one side until the mouth of the hole equals the diameter of the thread. The reverse side is also countersunk, but only slightly to break the sharp edge and run the tap through again to remove any burrs. Now refer to Fig. 3 before commencing the next stage. This operation consists of drilling the holes to form the chip spaces which break the thread up into the cutting edges.

The blank shown is drilled with four holes for this purpose, but the actual number will depend on the size of the tapped hole in the blank. This is a point that may be explained in the following manner: To provide ample strength and to ensure that the finished die will cut freely, the finished thread lands (width of thread left standing between the gaps) are made proportionate to the diameter of the thread in close approximation to the ratio of 1 : 4. Thus the lands of a die to cut ¼-in. diameter thread would be about 1/16 in. in width. With a thread that is larger in proportion to the outside diameter of the blank it might not be possible to drill four holes large enough in diameter to give a sufficiently narrow land, in which case five holes may be drilled. On the other hand, where the thread is small, it may be more advantageous to drill only three holes of larger diameter. When this course is adopted it is not always necessary to drill the "spring" hole, and in the case of ⅝-in. and 13/16-in. dies having three holes, the aim should be to leave the wall of the die with a minimum thickness of 3/32 in.

However, in all cases the procedure is the same, and will be dealt with on the lines of Fig. 3. After selecting a drill that will give what is required, mark off and drill four equally spaced holes on a pitch circle diameter that will bring the edges of the holes very nearly into the top of the thread. Immediately below one of them drill a smaller hole for springing. Next elongate the chip holes with a fine round file until they run into the thread sufficiently to give the correct land, as shown in the lower half of Fig. 4. Saw a slot opposite to the spring hole from the inside, extending to within 3/64 in. to 1/32 in. of the edge. The small bar of metal that is left acts as a tie, and will do much to overcome distortion while hardening. As the actual cutting of the thread takes place on the mouth of the die it is necessary to relieve the countersunk portion of each land to form a cutting edge. Do this by filing the rear edge of each lower than the front with a suitable sized fine crossing file. An enlarged view (Fig. 5), which, by the way, is for a R.H. die, will explain what is meant better than text, but avoid doing this operation with a round file, as a weak tooth will result.

Harden and temper in the usual way and draw the temper further to a dark blue behind the spring hole by holding the die against a red-hot piece of bar iron. The bar at the top of the slot is removed by grinding on the corner of a sharp wheel. The foregoing remarks apply equally as well to solid dies in which the slot is omitted.

Button Dies

Another form of die is seen in Fig. 6, and is a type very suitable for lathe use. The blank is made to the shape shown and is held on the small diameter. The thread extends for a depth proportionate to corresponding sizes of ring dies, the back of the tapping hole being counterbored to clear the thread. After tapping, the teeth are filed on radial lines. Follow the same rules regarding land and relief given for ring dies. Button dies have an advantage in the fact that they are easily sharpened by grinding on the flat face of each tooth. A left hand die is cut in the opposite direction to that shown.

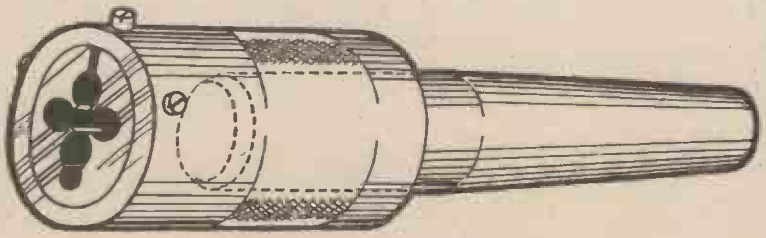


Fig. 10.—Useful die holder.

Spring Dies

Spring dies are a varied form of the above type, the difference being that the blank is tubular. The teeth are cut deeper and are supported at the front by an encircling split collar. While possessing the properties of the former type these have an added advantage in the fact that adjustment is obtainable through the agency of the split collar.

Full Mounted Dies

Made in the larger sizes only, these dies themselves are similar to engineers' pattern, but each pair of dies is mounted in a round collett at the bottom of which is a guide accommodating the correct diameter of material screwed. This guide serves to keep the dies in line and square with the rod. The thread is cut in one screwing, and adjustment is by means of a screw bearing on the end of each half die.

Chaser Type

Usually mounted with a guide also, this type of die is provided with four flat chasers. All of the chasers adjust simultaneously by means of a coned ring operated by two pairs of screws. Here again is a type which covers only the larger threads.

Hollow Mills

One of the most ticklish jobs on a lathe is that connected with the turning of small diameters, and where the length of the work in proportion to the diameter is great, it becomes by ordinary means an extremely difficult task. It is such jobs as the making of small special bolts, screws, or parts of a similar nature where the use of a suitable hollow mill will be invaluable. As its name implies, the hollow mill is really an end milling cutter with a hole through the centre. The size of the cutter is determined by the centre hole, a ⅛-in. diameter cutter producing work of that diameter. In use the cutters are held in line with the work and fed on to it, the work only revolving. To start the cutter it is essential to taper the end of the bar to an included angle of about 60 degrees, the front end of the taper being made slightly smaller than the size of the hollow mill. For preference the tapering is done with a cutter similar to a hollow mill, with the teeth arranged round the face of a 60-degree countersink. Resharpening is carried out by stoning the front edges of the teeth, which should have a back slope of 5 degrees. If grinding becomes necessary the cutting edges must all be level when finished, but excessive grinding will increase the cutting diameter as the hole is back tapered.

Making Hollow Mills

The largest special hollow mills likely to be required can be made from blanks ⅝ or ¾ in. diameter, × 1 or 1¼ in. in length, respectively. Turn and face the blank and at the same setting drill the centre hole slightly smaller than the required size. Taper ream from the back with a standard ¼-in. per foot taper reamer, until the small end or front is opened out to correct size—Fig. 7 shows a blank in section. Mark centre lines across the face at right angles to each other. Cut the teeth according to the nature of the material to be worked, straight fronted for brass as in Fig. 8, or with a rake of 10 degrees for steel as in Fig. 9, the fronts of the teeth in both cases being smoothly finished on the radial lines. File the backs of the teeth to leave parallel lands 1/16-in. wide, and back off at 5 degrees. Harden and temper in the usual way and stone the fronts and tops of the teeth.

Holder for Dies and Hollow Mills

A useful holder for making small bolts and screws on a centre lathe is seen in Fig. 10. A plain plug is turned taper at one end to fit the tailstock, a hole being drilled in the front end to clear long pieces. The holder portion is bored to slide on the plug and counterbored in the front to take a die or hollow mill. Time will be saved by having a separate holder for each class of tool.

In use a piece of bar is held in the chuck, and the end tapered as described. Feed the hollow mill with the tailstock screw until the required length has been stripped down, the knurled body being held while so doing. Slide the hollow mill and holder off the plug and substitute the die and holder. Again holding the knurling, the die is fed forward by sliding along the plug and when the face of the die is approaching close to the shoulder, the holder is released and allowed to run round with the work. Such an attachment on small work will pay for the work involved in no time.

The LATEST Novelties

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

The "Hohner" Chromatic Harmonica

READERS who have heard Larry Adler's entertaining broadcasts and recordings will be interested in this instrument. The ingenious variable key control enables the player to change key and gives the same flexibility of performance which is obtained from a violin or piano.

The harmonica is made in two models—the "Chromonica," which supplies half-notes and has forty tuned reeds, while the "Super Chromonica" has three complete chromatic scales and forty-eight tuned reeds. The prices are 6s. 6d. and 10s. 6d. respectively, post free. [123]

Noise-free Wireless Reception

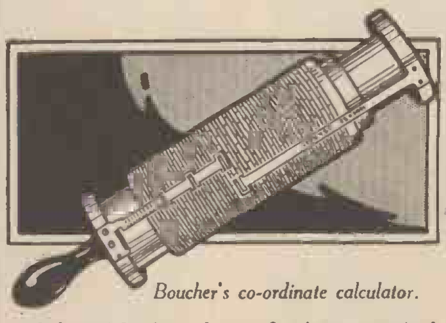
THE use of short waves for television and sound reception necessitates a considerable degree of freedom from man-made

The "Hohner" chromatic harmonica.

static for satisfactory reproduction. This does not, of course, take into account the desirability of providing noise-free reception of existing short-wave broadcasting stations, of which there are a large number, many possessing good programme value. Overseas listeners now look to the short wavebands for radio entertainment, especially in tropical zones, as these waves are singularly free from atmospheric static (which is not curable). In city areas, however, man-made static is prone to affect short-wave reception to perhaps a far greater extent than is generally supposed. Electrical interference which affects the receiver is usually created by local electrical appliances or machines and is mostly picked up on the aerial and downlead. To overcome this difficulty you should use the Goltone "Metocel" low-loss air-spaced screened cable, a 20-ft. length of which costs 13s. 4d. This cable reduces to a minimum most electrical noises from outdoor devices, and is well worth a trial. [124]

A Useful Calculator

AN extremely useful device for the mathematician is the co-ordinate calculator shown on this page. About one-third of the calculating cylinder only is used for the logarithmic scale of numbers, and the remaining portion carries other scales. Thus, in addition to multiplication, division, proportion, continuous fractions, powers, roots and logarithms, the natural



Boucher's co-ordinate calculator.

and logarithmic values of trigonometrical functions of any angle can be determined by inspection with the same accuracy as in numerical computation. Also, the products, quotients, etc., of these functions by lengths or numbers, integral or fractional, are obtained with equal ease, rapidity and precision. The device is obtainable in a mahogany case, complete with a book of instructions, and costs £7 10s. [125]

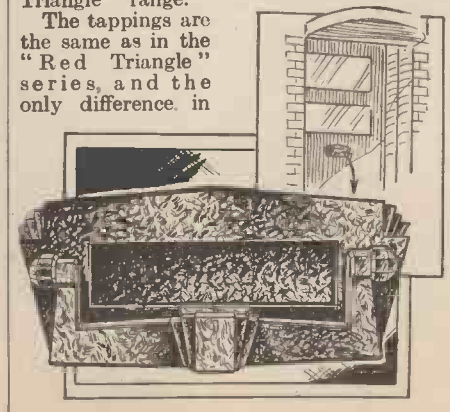
Bakelite Letter Plates

EXTREMELY neat in appearance, these letter plates, in moulded bakelite, are substantially constructed and are a novel and labour-saving fitment for the "Ideal Home." Moulded with precision, they are obtainable in walnut, oak, mahogany and black finishes, and cost 5s., post free. If required, a bell-push may be substituted in place of the knocker striking plate under the handle. [126]

A New Drydex Battery

A NEW dry battery, known as the Drydex "Challenger" super capacity, has been introduced by Exide Batteries to cover the range of 60, 100, 108 and 120 volts and to replace the corresponding "Red Triangle" range.

The tappings are the same as in the "Red Triangle" series, and the only difference in



A neat and attractive bakelite letter plate.

(Continued on page 435.)

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

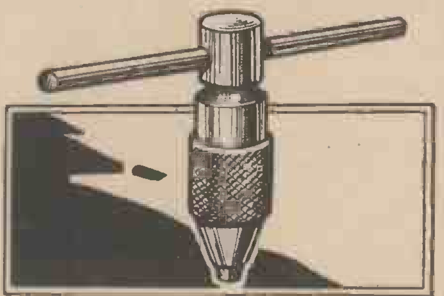
A Universal Tap Wrench

CAPABLE of holding taps up to $\frac{7}{32}$ in., the chuck pattern wrench shown dispenses with the necessity of having several different sizes of holder. It is of British manufacture and costs 2*s.* 9*d.*, post free. [129]

The Alumilite Process

ONE of the most interesting and important of modern additions to metal finishing is to be found in the possibilities opened up by the Alumilite Process, which provides a special protective and decorative finish for aluminium produced articles, with the enormous added advantage that it permits, if desired, the finishing of aluminium in colours. The process is operated in this country by Messrs. Alumilite, The Thames Factory, Rainville Road, Hammersmith, London, W.6, and its exhibition at the recent British Industries Fair attracted outstanding attention.

Something of the catholicity of application possessed by the process may be gathered from the fact that it is now applied to aircraft engine parts, aircraft propellors, outboard motors, novelties of all kinds, architectural work, builders' hardware, toilet goods, household appliances, toys, cameras, and a thousand and one other articles in which there is aluminium to be protected and rendered more decorative.



A universal tap wrench.

The Alumilite Process is a commercially proved electrolytic method of applying a protective and decorative finish to aluminium and its alloys, either in plain finish or in a large range of highly lustrous colours. Articles produced from aluminium sheets, sand castings, drop forgings and extrusions are successfully treated by the process, with marked good effect.

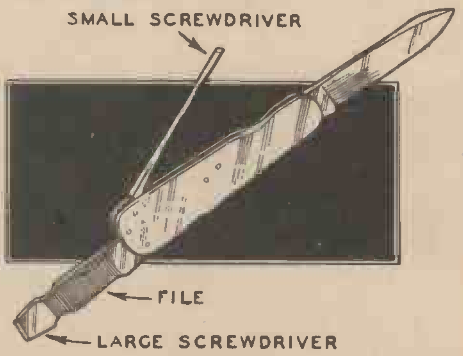
The plain Alumilite coating is dielectric, and a number of electrical manufacturing companies are experimenting with aluminium wire and ribbon, treated with Alumilite, for special purposes. [130]

A Radio Knife

THE knife illustrated will be found an extremely useful accessory for the radio enthusiast's tool-kit. Of sturdy all-metal construction, it incorporates two screwdrivers—the larger being useful for general purpose work and the smaller one handy for grub-screws, adjusting trimming condensers, etc. A file (always useful in radio work) is included besides a strong cutting blade. The price is 4*s.* 3*d.*, post free. [131]

A Handy Pocket Kit

EXTREMELY well-finished, this pocket kit, containing a two-bladed knife, a 9-in. folding rule and a pair of callipers, will appeal to every "Practical Mechanic." Each tool fits into a separate compartment of the wallet, which is easily slipped into the vest pocket. The set illustrated costs 6*s.*, post free, but various combinations of tools may be obtained. [132]



An extremely useful knife for the wireless enthusiast's tool-kit.

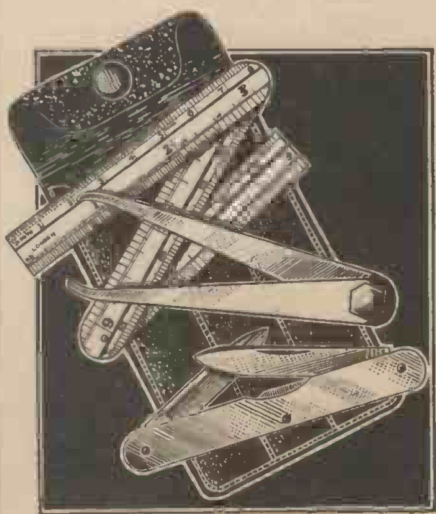
A Universal Cleanser

A PREPARATION has made its appearance on the market which is described as a universal cleaner for glass, concrete, machinery, greasy clothes, etc. It is mixed with water in various stated proportions, according to the work to be carried out. It is free from caustic and has six to eight times the strength of soda. There is no injurious effect on fabric or skin and it is extremely economical in use. It is supplied in 7-lb. bags at 3*s.* 6*d.*, larger quantities costing proportionately less. It is known by the trade name of "Spotless." [133]

Soldering Simplified

EVERY practical-minded man knows of the uses of Fluxite, and now there is the new Fluxite gun to simplify its operation still more. This gun is a neat and handy contrivance, always ready to put Fluxite on the soldering job instantly. A little pressure places the right quantity on the right spot, and one charging lasts a considerable time. The gun also projects grease into bearings, etc., and is used for grease like an oil can for oil. It is clean in use and only costs 1*s.* 6*d.* [134]

(Continued at foot of next page.)

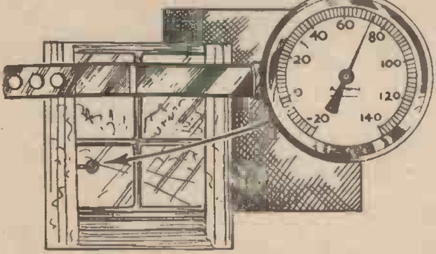


A useful pocket tool-kit for the handyman.

THE LATEST NOVELTIES

(*Continued from page* 433.)

dimensions is the increase from $2\frac{7}{8}$ in. to $3\frac{3}{16}$ in. in height, but the capacity of the "Challenger" is approximately $33\frac{1}{3}$ per



An ingenious outdoor thermometer which can be screwed on to the window pane as shown, and will give accurate readings.

cent. greater—the comparative figures, when discharged at 10 milliamps, three hours per day, seven days per week, to 0·75 volts per cell being: "Red Triangle," 159 hours; "Challenger," 211 hours.

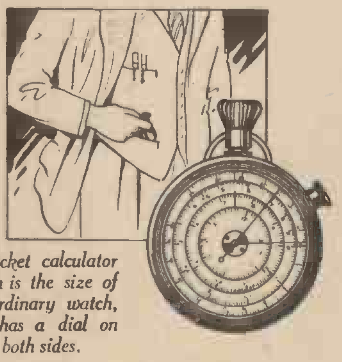
The maximum recommended discharge rate is 12 milliamps. The retail prices are: Type Super 60, 60 volts, 5*s.* 6*d.*; Type Super 100, 100 volts, 9*s.*; Type Super 108, 108 volts, 9*s.* 6*d.*; Type Super 120, 120 volts, 10*s.* 6*d.* [127]

An Outdoor Thermometer

IT is sometimes necessary and always interesting to know the temperature outside as well as inside the home. By screwing the "Rototherm," illustrated on this page, on to the window frame the outside temperature may be read at a glance. The instrument is of copper and heavily chromium plated to withstand exposure to the weather. The price complete with bracket and fixing screws is 4*s.* 9*d.*, post free. [128]

A Pocket Calculator

AS can be seen, the pocket calculator on this page is similar in size and shape to an ordinary pocket watch, and can easily be slipped into the vest pocket. It is equivalent to a 10-in. slide rule, and has calculating scales on both back and front. Those on the front dial give logarithmic numbers, sines and squares, or square roots. Those on the back give scale of equal parts, cubes and cube roots. It costs 17*s.* 6*d.* [129]



A pocket calculator which is the size of an ordinary watch, and has a dial on both sides.

NEW TOOLS, GADGETS & ACCESSORIES

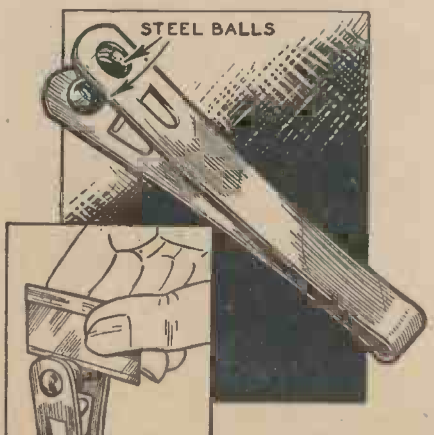
(*Continued from page* 434.)

A Novel Razor-blade Sharpener

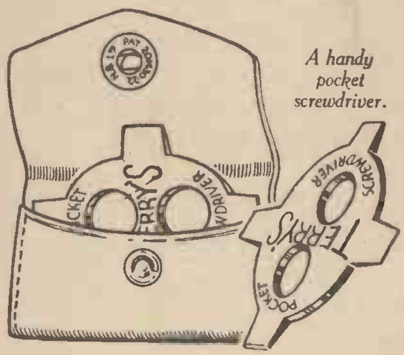
TWO hardened steel balls are employed in this sharpener. By holding in an upright position and drawing the razor blade lightly two or three times between the steel balls a new, keen edge is given to the blade, whilst a safety trigger prevents the blade from coming down too far and cutting the fingers. The sharpener, which is suitable for any type of blade, costs 1*s.* 3*d.*, post free. [135]

An Efficient Electric Drill

A STURDY and thoroughly workmanlike tool for the workshop is the Unicorn electric drill which is now on the market. The powerful electric motor (for A.C. or D.C. working) suits the following voltages: 100–110, 200–220, 230–250. All gears are accurately hobbed to ensure long life and enclosed in a strong, grease-tight metal housing, incorporating substantial bearings. The armature shaft is of ground alloy steel, and the main shaft is fitted with a Hoffman ball thrust-bearing. The keyless chuck, of robust design, has a capacity up to $\frac{1}{4}$ in. drills. (The use of larger drills invalidates the six months' guarantee.) The switch is in a convenient position. Current consumption, using $\frac{1}{4}$-in. drill on mild steel, is 175 watts. The price (all voltages), complete with flex and bayonet cap adapter and earth wire, is £2 15*s.* [136]



An ingenious razor-blade sharpener.



A handy pocket screwdriver.

A Handy Pocket Screwdriver

THE sketch on this page shows a handy little gadget in the form of a combined screwdriver, having four blades of different width, mounted circumferentially for the sake of compactness. Its price alone is 3*d.*, but in some stores it is sold complete in a case, in which case the price is 6*d.* [137]

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 SHEFFIELD AND DISTRICT MODEL AERO CLUB

A MODEL Aeroplane Flying Competition will take place on Sunday, June 23rd, the following events taking place:—

(1) Biplane Fuselage Pusher Type Model R. O. G. (minimum flight of 90 seconds). Longest Duration. Motive power can be Rubber, Compressed Air, Petrol, etc. (except spring motors).

(2) Climbing Contest, R. O. G. Longest Duration. Any type Fuselage Model. Rubber motive power. Fuselages must comply with the S. M. A. E. formula.

(3) Hand-launched, any type of Fuselage Model. Longest Duration.

The above events are Open Contests, with an entrance fee of sixpence each entrant.

A Silver Aviation Medal will be presented to the Winner in each event, and a Bronze Medal will be given as second prize in event (3) providing sufficient entries forthcoming.

Further particulars and flying ground, time of commencement, etc., may be obtained from the Competition Secretary, Mr. C. F. W. CUDWORTH, 25 Randall Street, Highfields, Sheffield 2.

THE PARK MODEL AIRCRAFT LEAGUE

THE objects of the League are: To encourage and develop the sport of building and flying model aircraft, to instruct and assist the novice, to help one another and generally to foster the spirit of friendship and co-operation amongst Model Aero engineers as a whole and especially amongst the Juniors.

Flying meetings take place every week-end (weather permitting) on Mitcham, Tooting and Wimbledon Commons and also at New Malden. The Organisers are also willing to start Groups on other grounds and to give the benefit of the League's central organisation, wherever there are a number of model flyers who would like a club.

Frequent competitions, meetings with other clubs and outings to places of interest, such as visits to Aerodromes, Aircraft works, Exhibitions, etc., are arranged during the season. In the winter months there are various lectures and social meetings arranged at short intervals.

All types of Model Aircraft are catered for, flying and non-flying Model Aeroplanes, Airships, Balloons, Gliders, Seaplanes, etc. There is an entrance fee of 2s. 6d., which includes Official Badge, membership card, rules, etc., and the annual subscriptions are as follows: Patron members, 10s.; Senior members, 5s.; School members, 2s. 6d.; Provincial members, 2s. Full details may be obtained from F. H. DILLISTONE, Hon. Secretary, 112 Rodenhurst Road, Clapham Park, S.W.4.

INSTITUTE OF SCIENTIFIC RESEARCH

ON Wednesday, April 24th, a visit was paid to Kirkstall Electricity Power Station, Leeds. After seeing the coal-drying and grinding plant, we were shown the automatically-fed boilers, the various accessory plants, the turbo-generators, and finally, the switch-room and transformer house.

On Saturday, May 4th, a meeting was held, at which Mr. W. Stone gave a lecture, illustrated by experiments, entitled "Pyrotechnics."

On Saturday, June 1st, a meeting will be held, at which Mr. R. Robson will give a lecture on "Rocketry," and on Monday, June 17th, we hope to pay a visit to Thorne's Toffee and Chocolate Works.

The English section of our Correspondence Section has now a sufficient membership, but we still have room for some overseas members. Those interested should write to D. Mayer, 20 Hollin Park Rd., Leeds 8.

STREATHAM COMMON MODEL RAILWAY CLUB

JUNE 7th and 8th are the dates of our Fourth Annual Exhibition, which we are holding at 70 Conyers Road, Streatham, S.W.16 (the Waterworks) from 6.30 p.m. to 9.30 p.m. on the first day, and 2.30 p.m. to 9.30 p.m. on the second day. We hope that a large number of friends will be able to visit us, and we are arranging many attractions, including a ride on a passenger-carrying railway round the grounds, a length of about an eighth of a mile. Tickets of admission, price 6d. each, can be obtained from the Secretary now.

The Rocket, our quarterly magazine (June issue), is now ready, and can be obtained at the Exhibition, price 4d., or through the Secretary, price 5d., post free. A full account of the Exhibition held at the Central Hall during Easter week is given, together with hints on building models, reports of visits, etc.

Secretary: L. J. Ling, Brooke House, Rotherhill Avenue, Streatham, S.W.16.

BOOKS worth READING

British Warships Illustrated

BY A. C. HARDY, B.Sc., F.R.G.S., A.M.Inst.N.A. 3s. 6d. *net. A. and C. Black, Ltd., Soho Square, London, W.1., 95 pages.* The writer of this well-illustrated book is well qualified to speak on this subject, having carried out researches into all matters connected with ship types. The present volume is, in fact, a companion to his *British Ships Illustrated*, in which he dealt authoritatively with merchant ships. Warships of all types, from big battle cruisers like H.M.S. *Hood* to small sloops like the *Harrier* are illustrated, and their main particulars as regards armament, machinery, and so on, tabulated in convenient form. A description of British warship types in general shows how the various classes of fighting ships have been evolved.

ITEMS OF INTEREST

The Science of Success

THOSE readers of PRACTICAL MECHANICS who wish to make a successful start in business should take advantage of the revised and enlarged Pelman course. Pelmanism strengthens and expands your mental powers in every direction. A great feature of the course is that there are no classes to attend. Half an hour a day is given to the study of one of the fifteen "Little Grey Books," which are printed in a handy pocket size. Their enlarged course is offered to students of Pelmanism without any increase in the fee already charged for the course. Write for particulars to 130 Pelman House, Bloomsbury Street, W.C.1.

An Accurate Hydrometer

A HYDROMETER, known as the "Neverstick," will prove ideal for the accurate testing of wet batteries. Reliance is sometimes placed on hydrometers which merely indicate whether a battery is fully charged, partly charged or discharged, but this method is obviously vague, and a wise person will prefer a more accurate diagnosis. The single float of the "Neverstick" hydrometer adjusts its height between the two extreme positions in exact proportion. The surrounding glass tube has a four-point guide keeping the float perfectly central, which, combined with the projections on the float bulb, prevents sticking or leaning. An extra large resilient rubber bulb is fitted. The full-charge, half-charge and empty positions are clearly indicated on the float, which is also graduated from 1,000 to 1,300 specific gravity. Packed in a strong case, with full instructions for use, the price is 3s.

A Correction

OWING to a printers' error the article in our April issue on "How an Escalator Works" was credited to the Otis Elevator Company. This should have read Waygood Otis Ltd., who very kindly supplied the photographs and technical information.

MONEY MAKING IDEAS REVIEWED BY OUR PATENT EXPERT

TESTING FLAT SURFACES

"I propose by the use of a mercury tube to determine, at a glance, the accuracy of supposed flat surfaces. When the mercury is evenly disposed along the tube it makes contact with two leads attached to a small lamp. Thus when the lamp lights the surface under test, will be level. The whole thing can be made from bakelite. When one has taken out a Provisional Protection are they compelled to follow it up with a full Specification?"

The proposed construction of level is thought to be novel and forms fit subject-matter for protection by Letters Patent. The details given of the invention are somewhat meagre, but it is presumed that the invention consists in the use of mercury within a tube as a connecting link between two contacts in its ends, so that when the tube is placed on an even surface the mercury is so arranged with respect to the contacts that an electric circuit will be completed in which is included a lamp, bell or other signalling means.

When an inventor has applied for a Patent with a Provisional Specification, there is no necessity for him to follow it up by the filing of a Complete Specification unless he desires to obtain a full Patent.

It is not thought that the above invention has very much chance of being a commercial success, particularly as it would appear that the inventor would have to seek outside assistance in marketing his invention.

A NUMBER OF INVENTIONS

"I should be very pleased if you could tell me whether it would be possible for me, living in Egypt, to patent an invention in England, and whether, in your opinion, the following inventions have any commercial value, and, if so, are they patentable?

"(a) A flashing electric lamp worked by a switch actually inside the bulb, which is operated by the heat from the filament.

"(b) Bakelite model boat hulls which would be lighter and could be given a better shape than metal or wooden hulls; also, as they would require no paint, they would be cheaper to produce in quantity.

"(c) A New Method of independent front-wheel springing for cars.

"If any of these inventions are patentable, would it be necessary to have a model constructed, or would a drawing be sufficient?" (R. W., Egypt.)

It will be quite possible for the inventor, though living in Egypt, to Patent an invention in England either in his own name or in the name of a friend resident in this country as a communication from him.

In reply to the specific queries:—

(*a*) It would probably be possible to obtain a Patent for the particular construction of the flashing electric lamp, but it is not thought that such a construction is likely to be successful commercially, since the same effect could probably be more readily obtained outside the lamp, in which case the switching of engines would not be rendered useless on failure of the lamp filament.

(*b*) It would not be possible to obtain a valid Patent for making model boat hulls from bakelite in place of metal or wood. Generally speaking, no invention is required to substitute a known material for another equally well-known material.

(*c*) The broad idea of independent front-wheel spring for motor cars is not novel. It may be that the particular arrangement proposed to be employed is novel, but it is not possible to express any opinion since no details of construction are given. It is not usually necessary to have a model constructed of an invention, drawings being usually sufficient, together with rough particulars to enable a reputable Patent Agent to draft the required specification.

A PENDULUM MACHINE

"I thank you for the advice given me last month, and would be pleased if you would enlighten me a little further concerning the same matter, which I will try to explain more fully. The single pendulum machine (sketch enclosed) was the original idea. This machine was made in France and a few were sold in England, but the idea was not patented here. It has since been made and sold by an English firm without any protection whatever. What I want to know is this, (1) Could this English firm prevent me from making this same machine? (2) Could I obtain some measure of protection for it? (3) If I could not obtain protection for it as it stands, would it be possible if I were able to add some slight improvement? Incidentally, as I mentioned in my last query, the double pendulum machine (sketch enclosed) is the patent of the English firm mentioned above, but is a much later idea than the single one. I think from your reply you thought the double pendulum machine was the original and the single pendulum a recently suggested alternative idea. This is not so." (R. N., Leeds.)

(1) The English firm making the single pendulum weighing machine in this country could not prevent you, nor anyone else, from making it here provided the facts in connection therewith are as stated.

(2) It is not possible for you, or for anyone else, to Patent the machine which has now become public property, so that anyone can make, use or sell it without let or hindrance.

(3) It would be possible for you to obtain protection for an improvement on the single balance machine, provided the improvement actually is an improvement, *i.e.*, serves some useful purpose. You will, of course, understand that any Patent you may obtain for the improvement will only cover the machine with that improvement and will not give you any right to prevent others making or using that machine if they omit your improvement. The writer certainly understood from your previous enquiry that the double pendulum machine was the original idea and that the single pendulum machine was a suggested improvement.

PRACTICAL MECHANICS
Replies to Queries and Enquiries

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

A QUESTION OF PRESSURE

"An air compressor, where the effective piston area is 10 sq. in., is acted upon with a total pressure of 150 lb. to force air into a reservoir. If the effective area of the valve into the reservoir is 1 sq. in., at what pressure will the valve in the reservoir refuse to open?" (J. M., Glam.)

With regard to your query, it is not possible to give the details you require. Upon reflection, you will agree that the pressure at which the valve of the compressed air receiver or container will just refuse to open is not dependent upon the aperture of the container, the diameter and stroke of the compressing piston or on other similar factors, but, as was pointed out in our previous reply, is dependent almost wholly upon the spring tension of the valve which closes the air container. (It is also dependent to a slight extent upon the type of valve used, upon the physical formation of the air receiver or container and upon the actual position of the container.)

Now the spring tension of the valve will vary with temperature, use and design, thus making it very difficult, nay, almost impossible, to work out accurately the internal pressure of the receiver at which the valve will refuse to open. To work out this figure even roughly, however, requires some knowledge and statement of the type of valve and its normal tensional strength.

HOW A CREAM SEPARATOR WORKS

"Will you kindly explain the principle on which the ordinary cream separator works, and how the 'cream scum' affects the thickness of the cream. Also, what occurs in the cream when it is agitated to produce butter?

"Is there any practical way for an amateur to make a refrigerator?" (C. R., South Africa.)

There are several types of cream separators. Usually these appliances work on the following principle:—

A metal bowl or cylinder is provided. This rotates at a high speed, being worked either by hand or, as is now more usual, by being coupled to an electric motor. A tube passes into the bowl or cylinder. Down this tube the milk is poured into the revolving bowl. Owing to centrifugal force the heavier milk is flung to the sides of the bowl or cylinder. The lighter portion of the milk (*i.e.*, the cream) remains near the centre of the vessel and rises to the surface, from which it is subsequently removed by hand. The "cream screen," as it is sometimes termed, acts as a sort of grader for the cream, allowing the lighter cream to pass through it freely, but obstructing the heavier cream.

In the making of butter by the agitation of cream-milk in a churn, all the little fat globules in the milk are broken up by the violent movement imparted to them by the wooden "dasher" of the churn. All the fat globules, therefore, become joined together after about half an hour's churning, thereby producing visible lumps of milk-fat which we call butter. The thin fluid which remains after the separation of the butter-fat is called "buttermilk." It is the remainder of the milk from which all the butter-forming particles of fat have been removed.

The reason why the churning of the milk-cream results in the formation of butter is not difficult to grasp when we realise that each fat globule in the milk or cream is surrounded by a sort of skin. It is this skin which is broken down by the churning, after which all the tiny globules of fat unite together, forming butter.

A book on refrigerators is obtainable from Messrs. Cassell & Co., La Belle Sauvage Yard, E.C.4.

ESCAPING FROM THE EARTH

"I beg to disagree with the paragraph concerning Cyrano de Begerac in 'Escaping from the Earth' in the current issue of 'Practical Mechanics.' In the play, 'Cyrano de Begerac,' by Edmund Rostand, who obtained his information from Cyrano's books, Cyrano says definitely that he did not copy 'the stupid eagle of Regiomontanus, or the timid pigeon of Archytas.' He further states that he copied nothing which had been done before (this includes Daedalus's idea of wings). Instead he invented seven methods which were undoubtedly very clever for the middle of the seventeenth century, and to us they have certainly an amusing touch! The seven methods are as follows:—

"(1) Since the sun sucks up the dew in the morning, it would presumably suck Cyrano up with it if he wore a harness of glass bottles filled with dew (this is probably what he is doing in the picture you show).

"(2) The meaning of this method is a little obscure, but I think he intended to use a vacuum in a cedar box to lift him up.

"(3) Here he uses a mechanical 'grasshopper' to start him off and is then aided further by successive firing of rockets from the machine. (The origin of the rocket plane?)

"(4) Smoke has a tendency to rise. Therefore a globe filled with enough of it will lift a man off the earth.

"(5) According to an old French legend, the sun sucks up the marrow of bulls at certain seasons. Cyrano conceives the idea of annointing himself with bull's marrow at the right time.

"(6) Cyrano sits on an iron platform and then hurls a magnet up into the air. The iron immediately follows the magnet, and when it catches it up Cyrano simply throws up the magnet again. 'On peut monter ainsi indéfiniment.' (Cyrano thinks this is the best method, and I quite agree with him!)

"(7) Since the moon attracts the sea to form tides, Cyrano thought that by sitting on the beach after a bathe in the sea the moon would attract him also!" (E. H., Kent.)

(*Continued on page 440.*)

REPLIES TO QUERIES AND ENQUIRIES

(*Continued from page 438.*)

It is quite true, as you point out, that, according to his biographers, Cyrano de Bergerac formulated at least five or six schemes for flying through the air. It will be appreciated, however, that, without making the article in question a purely historical one, or without going to great lengths upon the matter, it would be impossible to include a description of Cyrano de Bergerac's aeronautical formulations. His biographers seem to agree upon the fact that one of his propositions was to fly upwards by means of wings to which special incantations had been applied. We are unable to obtain any references to or confirmation of the statement in Edmund Rostand's play, "Cyrano de Bergerac," that Cyrano opposed the projected method of flying upwards by means of wings, feathers, etc. It is fair comment, however, even allowing for the ignorance of the period, to say that Cyrano de Bergerac was a crank of the worst type, without knowledge of even the elementary principle of anything. It is possible that he was mad. Our article was intended to show that he has no claim to fame or posterity.

AN ELECTRICAL QUERY

"I would like to have any advice you may be able to give about the following :—

"I have a Fractional Horsepower Motor which ran very well off D.C. 240 volts. We have recently changed over to 240 volts A.C., 50 cycles. Now this motor has lost a considerable amount of its power and runs very hot.

"This motor has bolted-on field pieces, attached to the case, which apparently is made of cast iron. I have been wondering if I could drill the case horizontally (the case is about ¼ in. thick) and place iron wire in the holes.

"Also if the fields could be helped in a similar way by iron filings. I may add that the field pieces themselves are partially laminated." (H. B., Liverpool.)

Both the methods which you suggest are impracticable, and actually the machine will always heat up when used on A.C. You can, however, connect the fields in parallel and then put them in series with the armature. Adjust the brushes slightly to give maximum efficiency. The whole field should be laminated and not just the poles. The motor will not be as efficient on A.C. as on D.C.

CURRENT FOR CINEMATOGRAPH

"In the coming season I wish to tour with a 16 mm. cinematograph in districts where there is no electricity supply.

"The projector I intend to use will have either a 750-watt or 500-watt (120-volt) bulb and a 120-volt motor.

"Would a 120-volt dynamo generating 1 electrical horse-power give sufficient amperage for the purpose, and, if so, would it be suitable in every other way? Assuming that it would be possible to attach the dynamo to a light car (Austin 7 or Morris 8) in such a position that the wheel which drives the fan in front of the engine could be connected to it so as to drive it at the right number of revolutions per minute, would the engine run steadily enough to keep the current from the dynamo sufficiently steady as to give a flickerless picture? Would the idea of running the dynamo off the fan wheel be satisfactory?" (W. M., Monaghen.)

You do not mention the consumption of the cinematograph motor. You merely state the voltage. It is necessary to know what current it takes in order to arrive at the final output of the dynamo. In any case, the 120-volt dynamo which you have, which is delivering 746 watts, would be totally inadequate for the purpose you have in mind. The fan-belt would not drive such a motor in any case.

FREE SERVICE FOR READERS

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

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

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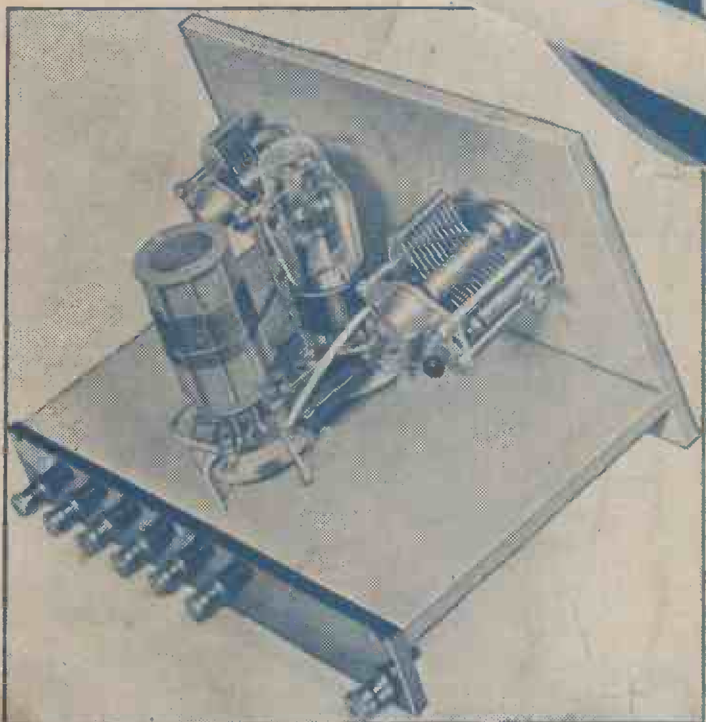
This coupon is available until June 30th, 1935, and must be attached to all letters containing queries.
PRACTICAL MECHANICS, JUNE, 1935

2 SPECIAL DESIGNS

The "P.T.P. THREE"

In this outstanding number of "WIRELESS MAGAZINE and Modern Television" you will find exclusive details of a "straight three" battery receiver built on a new and improved system. It employs a highly efficient combination of high- and low-frequency pentodes, gives exceptional selectivity and sensitivity, and sets a new standard of efficiency of layout combined with ease of construction.



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"Five Hours Back."
By L. W. Hayes, of the B.B.C. Engineering Staff.

The Gordon Magnesium Battery.
Described by R. W. Hallows, M.A.

Fading and the Non-fading Aerial.
By J. H. Reyner, B.Sc., A.M.I.E.E.

Keeping High-frequency Where It Belongs.
By Marcus G. Scroggie, B.Sc., A.M.I.E.E.

How the Valve Detects and Amplifies.
By Percy W. Harris, M.I.R.E.

First Details of a New West of England Regional Station.
By T. F. Henn.

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By the "W.M." Set Selection Bureau.

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