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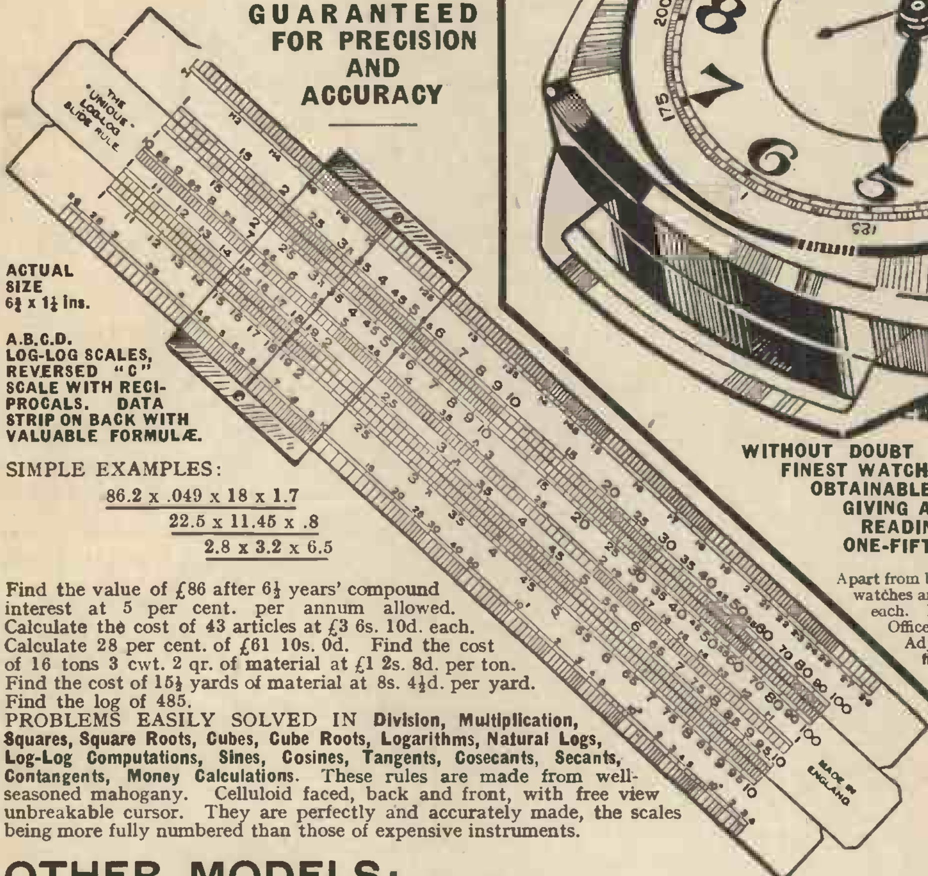

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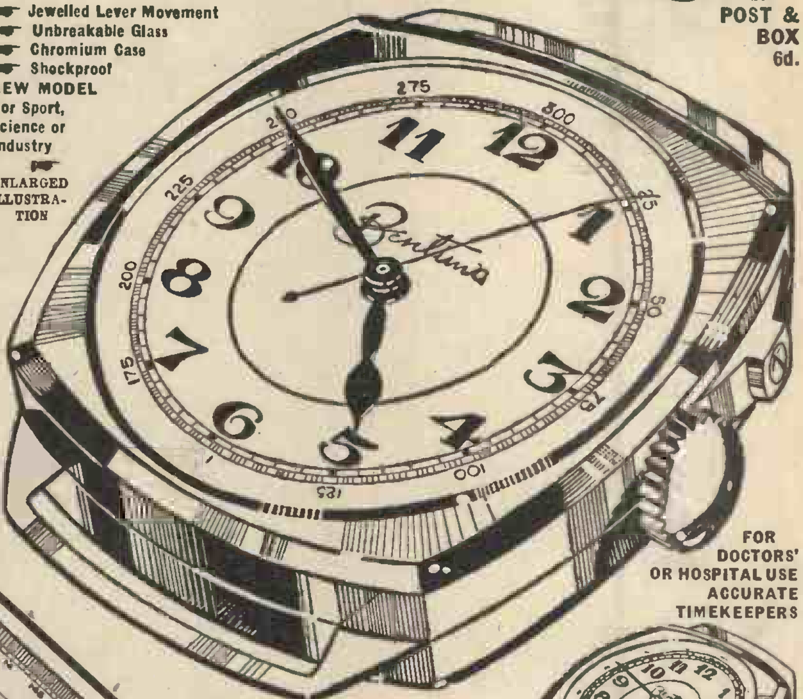

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PRACTICAL MECHANICS

VOL. V. FEBRUARY, 1938 No. 53.

Fair Comment

By The Editor

Jubilee of an Important Invention

ON 20th July, 1888, John Boyd Dunlop took out his provisional patent for the pneumatic tyre; thus, on July of this year will be celebrated the Jubilee of that important invention which probably more than any other has benefited the entire population of the world. In many respects it was a simple invention, but it provided what I might term the missing link to a chain of inventions which awaited its arrival. Almost everyone knows that the old Ordinary was originally a solid tyred development of the Velocipede and the Boneshaker introduced into this country from France by Roly B. Turner in the year 1869. Cycling was then the fashionable pastime of Society, and schools were started to teach the new pastime. It may seem incredible to-day that it was necessary to teach anyone how to ride a bicycle, but the heavy and cumbersome machines which introduced the pastime were by no means as tractable as those we can buy to-day. The modern bicycle weighed from 20 to 30 lb. Bicycles of those days weighed anything from 50 to 70 lb., and you needed to be something of an acrobat in order to vault upon the saddle. They were direct driven in the early days by means of cranks and pedals attached to a live front axle. The bicycle chain together with the pneumatic tyre helped to produce what we know as the safety bicycle. Ten millions of people in this country use bicycles—one in five of the population. The bicycle has become an accepted part of civilisation. It is one of our leading sports, and, incredible though it may sound, nearly 80 miles have been ridden in one hour on a pedal-driven bicycle behind a motor pace. On December 31st, 1937, ended one of the most spectacular bicycle performances ever attempted in the history of the pastime. Two riders—Menzies in this country, and Nicholson in Australia—both completed rides in excess of 61,000 miles. They rode continuously with but minor delays due to accident or illness, for each of the 365 days of the year. Last year Ferris rode from Land's End to John O'Groats in the remarkable time of 2 days 6 hours 33 minutes. The modern bicycle is, indeed, a remarkable piece of mechanism, perfected after more than half a century of intensive thought into a lively device, noiseless, trouble-free and inexpensive.

Healthy Exercise

THERE can be no doubt that of all forms of exercise the bicycle is the most beneficial from the point of view of health and physical fitness, for both Menzies and Nicholson finished their ride in remarkably sound physical condition. It was my good fortune to see Menzies at midnight on December 31st, and he was a glowing tribute to the virtues of cycling.

It is interesting to recall that in the execution of this ride Menzies made 39 million leg strokes and each link of the chain travelled 7,100 miles. The individual ball bearings in the wheel hubs revolved 165,000,000 times.

In the course of the years fortunes have been made and lost in the bicycle industry. Hordes of inventors have besieged the Patent Office with patents for taking the effort out of cycling. There have even been patents for clockwork bicycles. The scientist has taken the effort out of pedalling. He has produced ultra-light steel alloys, duralumin, electron, lighter tyres, the tangent spoked wheel, the ball bearing, and scientifically designed frames. Thus in weight reduction alone a great deal of the effort required has been reduced. If every person in this country regularly used a cycle illness would vanish, and 3,000 doctors from every part of the country recently expressed in their answers to a questionnaire their unanimous verdict that if everyone cycled the medical profession would go out of existence.

Looking Ahead

PERFECTION is never reached, and it may be that some invention in the future will make cycling even easier than it is to-day. It is impossible to forecast in what direction it is possible further to reduce the weight of a bicycle. Certainly with modern roads even lighter high-pressure tyres are possible. When we remember that the average life of a bicycle is at the very least 5 years, that it weighs 25 lbs. or so, and may be purchased for as little as £4, it will be agreed that it is impossible to find in any other industry a device or a commodity which gives such unfailing and trouble-free service and such high value for such a small unit of money spent.

So, in July of this year, we must spare a thought for John Boyd Dunlop, whose experiments to lessen the labours of his son, who had to ride a solid tyred vehicle over the stone setts of Dublin, set his mind in the direction of the pneumatic tyre. The story has been told many times, but it loses nothing in value by the retelling.

The pneumatic tyre is an invention as great as the wheel itself. We do not know what genius first thought of the rolling wheel, but it has served mankind for mechanical locomotion for as far back as history records. Nothing can ever replace the pneumatic tyre, and the Jubilee which we now celebrate is merely the first of a series of Jubilees which will continue till the crack of doom.

In the early days of air tyres, they were much more expensive than they are to-day. You may now buy a thoroughly reliable pneumatic tyre for a few shillings, whereas formerly they cost as much as £3. The work of repairing the early tyres was a skilled job. Nowadays punctures are so rare as to be almost negligible, due to the joint efforts of the road makers and the tyre manufacturers. Tyres are now so troublefree that they are accepted as a commonplace.

The pneumatic tyre provides one of the greatest romantic stories in the history of industry.

CHARGING METHODS FOR CAR BATTERIES

Various methods of Charging 6- or 12-volt Car Batteries at Different Rates from A.C. and D.C. mains are Described, and Constructional Details are Given of Easily made Chargers.

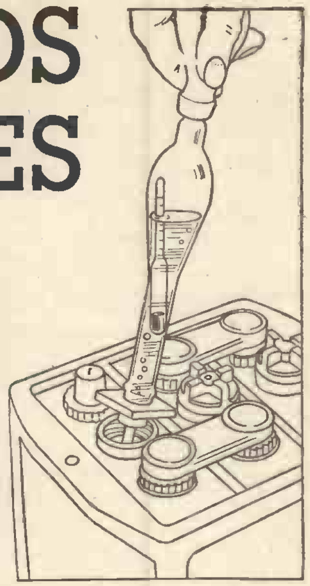


Fig. 1.—The method of testing an accumulator by means of a hydrometer. A reading of about 1·300 should be obtained when the battery is fully charged.

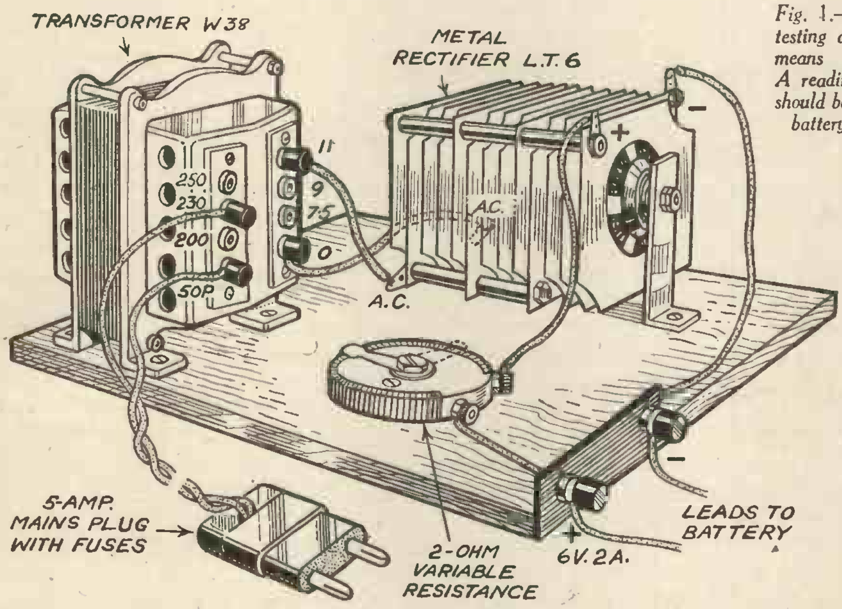


Fig. 2.—Constructional details for a simple and easily made charger, using standard components. The slider is connected to the right-hand terminal.

IT is not very often that the battery becomes completely discharged, but when it does it is a great convenience to be able to charge it at home, or at least in the home garage. After all, it is a bulky and heavy item to have to carry to a charging station, and the modern car with coil ignition cannot be run without it.

A charging rate of 2 amps is adequately high if the battery is to be given merely a " refresher " at frequent intervals, but it is rather low when the accumulator has been completely exhausted—due to leaving the ignition switched on or to having made too much use of the starter, for example. In such a case as this it is desirable to recharge at a rate of at least 3 amperes, whilst a good deal of time can be saved if about 5 amperes can be passed through the battery.

Charge and Discharge

This point can be best appreciated when it is remembered that as much power must be put into the battery whilst charging as is taken out during discharge. Thus a battery rated at 50 ampere-hours, for example, would require to be charged for 50 hours at 1 ampere, whilst it could be brought up to full capacity by charging for 25 hours at 2 amperes or only 10 hours at 5 amperes. Actually, these figures assume that the process of charging is 100 per cent. efficient, and it is generally most satisfactory to charge for a few hou. s longer than the theoretically correct length of time.

Rather than charge for any calculated or estimated time it is best to continue charging until the specific gravity of the acid attains the correct figure which is quoted on the case or in the car instruction manual; this is generally about 1·300, and is measured by means of a hydrometer, as shown in Fig. 1. Another method is to continue charging until the cells gas freely, so that bubbles can be seen, and heard, coming through the surface of the acid. After bubbles first appear, charging should be continued for a few more hours.

Charging at 6 Volts 2 Amperes

The main purpose of this article, however, is to describe the construction of one or two different types of battery charger which can be easily assembled from standard parts. In the first place, it will be assumed that a supply of alternating current (A.C.) is available in the garage or in an outhouse, and that a charging rate of 2 amperes is required for a 6-volt battery. The only parts required are a couple of 1-ampere fuses, a mains transformer, a metal-oxide rectifier, and a controlling resistance; a pair of terminals can be added as a convenience if desired. The method of connecting the parts together is shown in Fig. 2. Where the rectifier is a Westinghouse, style L.T.6. The transformer is a Heayberd type W.38, and the resistance a Heayberd 0–2 ohms variable one. The fuses are contained in the two-pin 5-ampere plug, which is a Bulgin type P27; the terminals may be a pair of ordinary wireless type mounted on a strip of ebonite or on a Belling Lee mount.

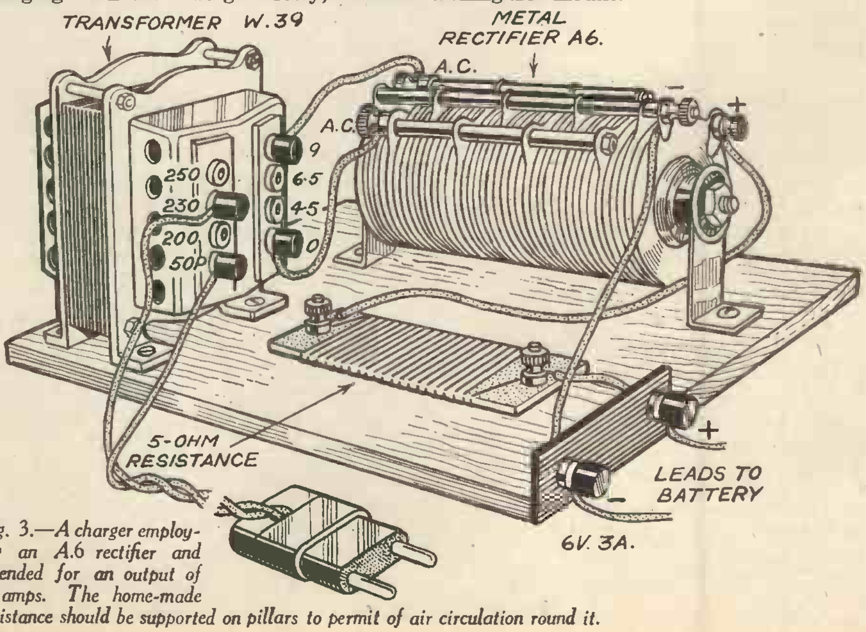


Fig. 3.—A charger employing an A.6 rectifier and intended for an output of 3 amps. The home-made resistance should be supported on pillars to permit of air circulation round it.

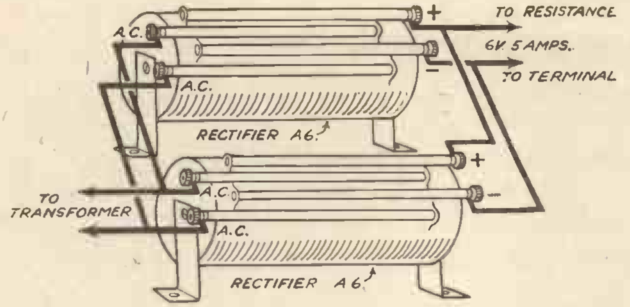


Fig. 4 (above).—*When other means are not available, a 12-volt car battery can be charged in two halves.*

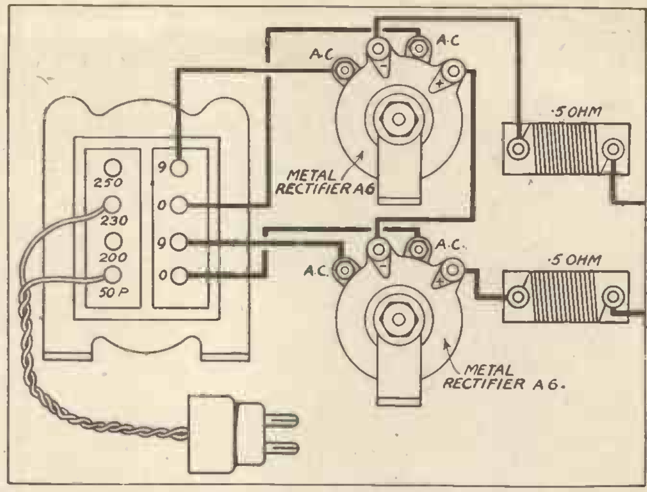


Fig. 5 (right).—*A diagrammatic circuit for a 5-amp. charger for a 12-volt battery.*

Connecting the Components

All the parts can be mounted on a small wooden baseboard, and connected together with short lengths of flex similar to that used for making connection with the mains power point. The wire, incidentally, should be of good quality. Normally, the slider on the variable resistance should be set to the approximate position shown, and it can be left in that position afterwards. It will be seen that there are four output terminals on the transformer, but only the two indicated are required in this case; these are alternative primary terminals for the mains-lead connections, and that marked 50P should be used in conjunction with that marked to correspond with the voltage of the mains supply. Generally, the 230-volt terminal will be used, but the voltage of the mains can be ascertained by examining the plate on the supply company's meter.

Modifications for 12 Volts

Precisely the same arrangements can be used for charging a 12-volt accumulator at 1 ampere by using a Westinghouse style H.T.5 rectifier in conjunction with a Heayberd type W.37 transformer, and setting the slider of the variable resistance to the position indicated by broken lines in Fig. 2.

A Higher Charging Rate

The above chargers are in the nature of trickle-chargers, but a 6-volt accumulator can be charged at 3 amperes by employing the circuit shown in Fig. 3, where the Westinghouse rectifier is a style A.6 and the Heayberd transformer a type W.39. In this case a small fixed resistance of ·5 ohm and capable of carrying 3 amperes is required, and this could be bought ready made or it could be constructed by winding 30 in. of 20-gauge Eureka resistance wire on a strip of hard fibre or asbestos as shown. The turns of the wire should be slightly spaced and the ends of the winding should be joined to a pair of terminals passed through the former. Were it desired to charge at a still higher rate, a charging current of about 5 amperes could be obtained by connecting two A.6 rectifiers in parallel, as shown in Fig. 4, and using a special transformer obtainable from the makers previously referred to. Those who have some knowledge of electrical apparatus might expect the charging current to be doubled by using two rectifiers in parallel, but there is a slight loss of efficiency when this system is employed, and this accounts for the theoretically low current mentioned.

When it is desired to charge a 12-volt accumulator at 3 amperes, this can be arranged by connecting two A.6 rectifiers in series as shown diagrammatically in Fig. 5. In this case a special transformer is required, and can be obtained at slightly extra cost, which has two secondary windings, since each rectifier must be fed separately. It will also be seen that two controlling resistances are employed.

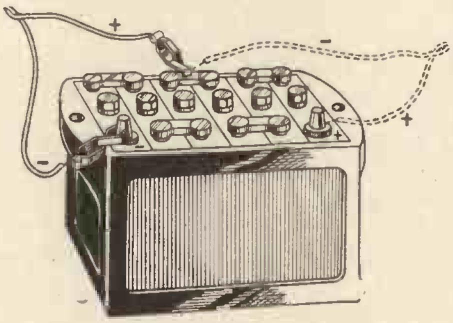


Fig. 6.—*A 6-volt accumulator can be charged at about 5 amps. by connecting two A.6 rectifiers in parallel, using a special transformer.*

Charging at a Higher Rate

If a 12-volt accumulator is to be charged at a higher rate than 3 amperes, the problem is not quite so easy of solution, because there is no standard rectifier available except at a rather high price; consequently it would probably not be thought worth while by the average owner-driver who wishes only to charge his own car battery and, perhaps, the wireless batteries, at comparatively infrequent intervals. The simplest method is to charge the complete accumulator in two halves—this is often a simple matter due to two separate batteries being employed. When the single unit is used, the method of connection for each half is as shown in Fig. 6, where it will be seen that connection is first made to the positive lug and to a bus-bar and to the negative lug.

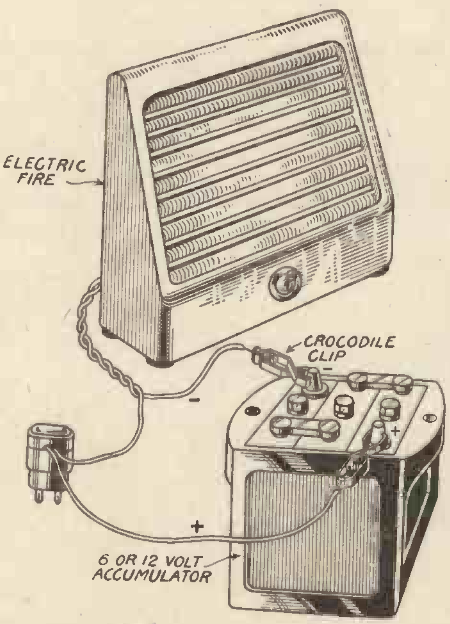


Fig. 7.—*A method of charging from D.C. mains. Great care must be exercised in doing this.*

Using D.C. Mains

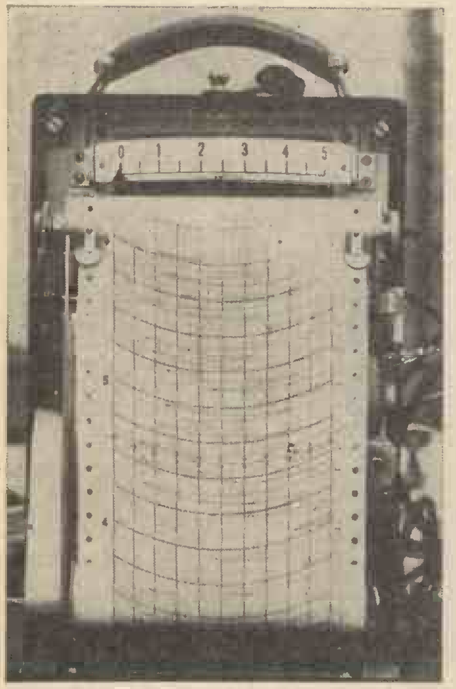
When D.C. mains are run into the garage or house either a 12-volt or 6-volt battery can be charged with equal ease, although less efficiently. This is because the voltage of a D.C. supply cannot be "stepped down" by means of a transformer, but must be "wasted" or "dropped" by including a resistance in circuit. A very simple method of charging is as shown in Fig. 7, where an electric fire is connected in series with the battery and the mains supply. If the fire is of the 1-unit type the charging rate will be nearly 5 amperes, and it can be increased to nearly 10 amperes (this higher rate is recommended only for a very large battery) by using a 2-unit fire, or by switching the second element into circuit when the fire is of the 1-unit or 2-unit pattern.

It is scarcely necessary to mention that this system must not be adopted in the garage, where there would be a danger of causing conflagration due to the use of the "open" fire. And when charging is carried out in the house the battery must be well away from the fire and from naked lights and must also be placed on a sheet of lead or large enamelled plate to avoid possible damage to the floor covering by the acid spray which is liberated when the accumulator is nearly fully charged. Another point to be watched is that the correct polarity be applied to the battery terminals, and this must be determined by the use of the pole-finding paper. Even this must be carried out with care, and for this reason persons whose knowledge of electricity is very limited are strongly advised against the use of D.C. supplies for charging purposes. If pole-finding paper is used care must be taken that the bare ends of the wire are not touched by the fingers; for this reason the leads should be held with strips of rubber from an old inner tube.

The "Lie-Detector" and Other Recording Instruments

By F. W. BRITTON, D.Sc.

A Previous Article on this Subject Appeared in "Practical Mechanics" Dated October, 1935



(Right) A suspect being questioned by means of a "lie-detecting" machine. (Above) A close-up of the "lie-test" recording device.

DURING the past year or so, we have heard a great deal about the "Lie-detector," an instrument which presumably registers certain physiological changes occurring in the body following some emotional stress—no matter how insignificant. The particular type of detector known as the "polygraph" devised by Dr. Keeler of the North-western University, U.S.A., is the one which has received most notice in the press on account of the number of cases which have been tested in the criminal courts. The principle upon which it is based depends on a minute increase in blood-pressure resulting from a momentary psychical disturbance following a series of test questions to probe the truth of the subject's answers. Some little time ago there appeared a letter in a daily paper querying the absolute truthfulness of such an instrument, and the implication of an anomalous reading was raised. Indeed, this is of vital importance, for an innocent subject may easily register a "jump" in blood-pressure when a specific point in a serious question was raised. As was mentioned, "To rely upon a machine where a moral issue is involved is highly dangerous."

Measuring Fatigue

It is with the other type of "lie-detector" that I wish to deal, however, because in 1930 I carried out a number of tests with the object of measuring fatigue following mental effort. The part of the apparatus which I used was identical with that form of "lie-detector" developed by W. G. Summers of Fordham University, and consisted of a galvanometer in series with a battery and the subject to be tested. In other words, by measuring the resistance of the person it is possible to determine the minute changes in blood-pressure through their affecting the surface tissues of the body—the pores—so that an increased secretion of sweat occurs thus bringing down the resistance. My tests were conducted on a class of boys whose resistance was measured before and after a set task. Mental fatigue was found to send up the resistance.

HOW RADIO MAY DETECT OUR PSYCHOLOGICAL REACTIONS

These experiments were given a wide publicity in the press of this country and abroad, and one enterprising reporter suggested that it might be possible to

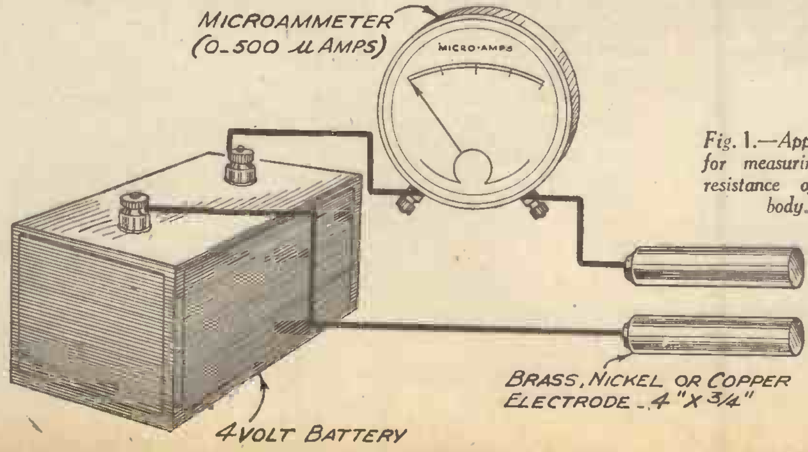


Fig. 1.—Apparatus for measuring the resistance of the body.

record the thoughts of a person. Evidently he was thinking of some similar tests to those of the "lie-detector." But I must confess that the idea of using such an instrument for recording these things never occurred to me at the time. Of course, the tests are ridiculously simple when one comes to think of it—anyone can carry them out with suitable apparatus. A circuit for a simple lay-out is given in Fig. 1. One condition should be observed however, that any suspicion of "shock" is best avoided by using a sensitive galvanometer. I inserted a Ferranti micro-ammeter—reading to 500 microamps full-scale deflection—in series with a four-volt accumulator; two ordinary cylindrical electrodes (such as those used with shocking coils) being held in the hands.

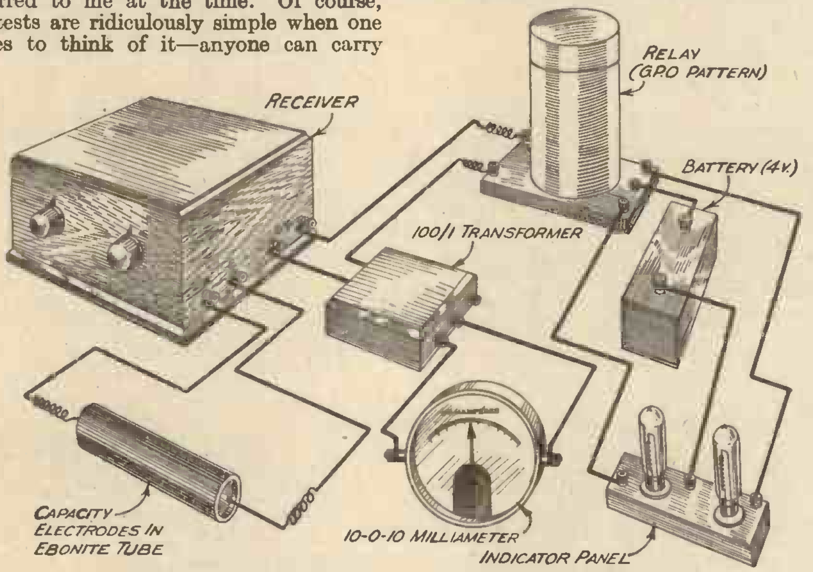


Fig. 2.—Layout of apparatus for showing body capacity effects.

Recalibrating the Scale

For a more straightforward reading, the scale may be recalibrated in ohms so that a direct resistance measurement might be taken. This is purely a matter of choice, however. Naturally, if a milliammeter is used it will be necessary to use higher voltages and then the sensation of slight burning may be a rather unpleasant accompaniment apart from the fact that an incorrect reading might be given, it is best to keep therefore, to low-measuring instruments, of which there is now a good range from which to select.

Another piece of apparatus which I have found interesting is based on the principle of variability of body-capacitance, when coupled to an oscillating circuit. Most readers have, I expect, seen those penny-in-the-slot machines which purport to tell character, etc., through the intermediary of valve amplifiers arranged in a complicated looking arrangement of condensers, transformers, chokes, coupled to an imposing electro-magnetic device for recording the actual written characteristics of the subject. All that is required to work this impressive-looking "robot" is a penny, and the raising of a horizontal electrode. Now, whether there is any actual circuit here, I do not know, but the idea set me thinking that it would be possible to construct an apparatus which really did respond to the body's capacity. The result was the instrument shown in the sketch, which, I think is sufficiently descriptive to warrant very little explanation.

An Oscillator

The oscillator used in the above experiment consisted of an ordinary A.C. mains-operated two-valve set incorporating a metal rectifier. No doubt, any type of amplifier could be used and modified in the manner shown. The aerial and earth terminals of the set are connected to two small sheets of copper-foil bent in a cylindrical form so as to slide into the ends of a 1-in. diameter ebonite tube, leaving a space of about 2 ins. inside the tube between them; this tube is 12 ins. long. Grasped in the hands, the ebonite tube forms a condenser electrode and forms a capacitative coupling to the input stage of the amplifier. The output terminals (the L.S. of set) are connected in series with a polarised relay (G.P.O. pattern), and the primary of a 100-1 transformer (the one actually used was a bell-transformer with the usual 3, 5, and 8-volt tappings on the secondary). Notice here that the transformer primary when used as a bell-transformer is the high-resistance side (240 volts), the secondary being the three tappings mentioned above; used in the output stage it must be reversed so that the secondary now becomes the primary. The tapping side of the transformer—the 3-volt tapping—is now connected to a milliammeter reading up to 10 milliamps (the one employed being a moving-coil instrument).

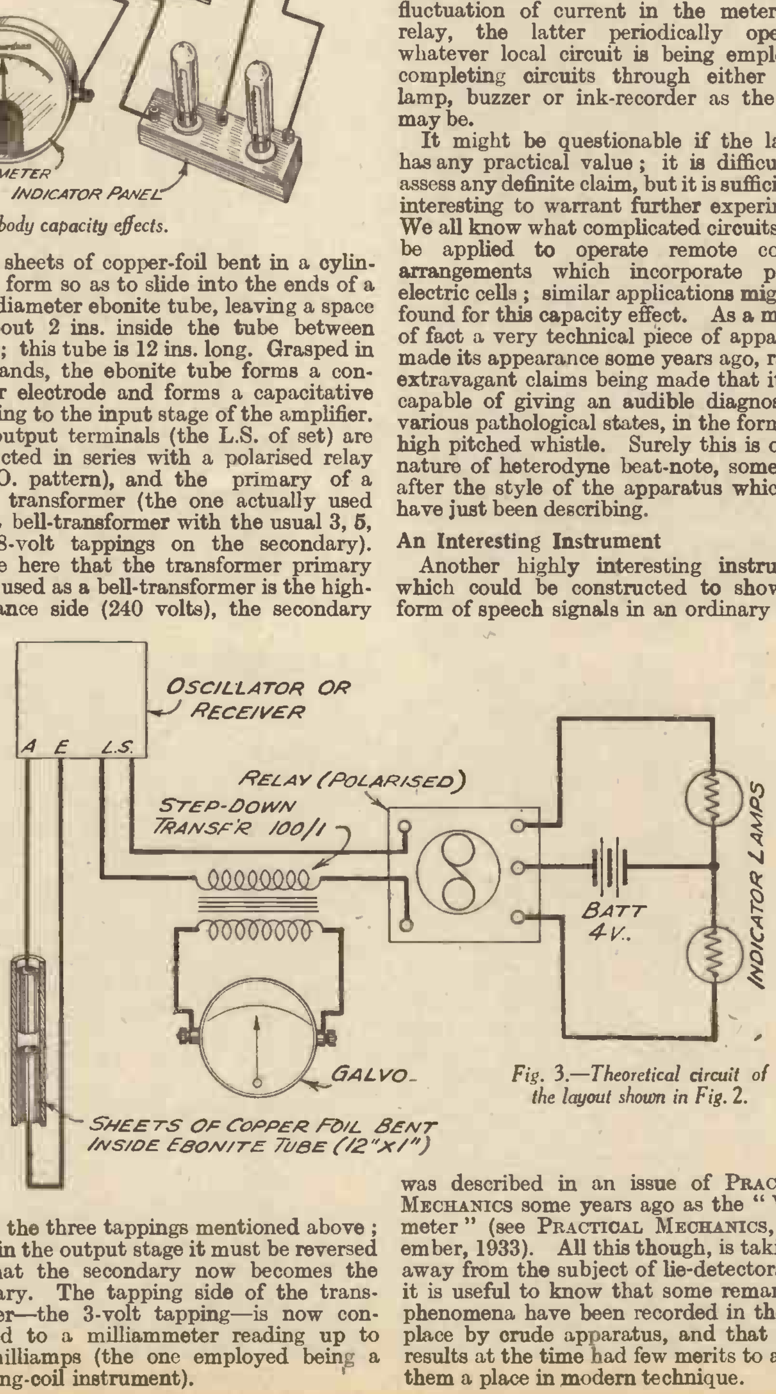


Fig. 3.—Theoretical circuit of the layout shown in Fig. 2.

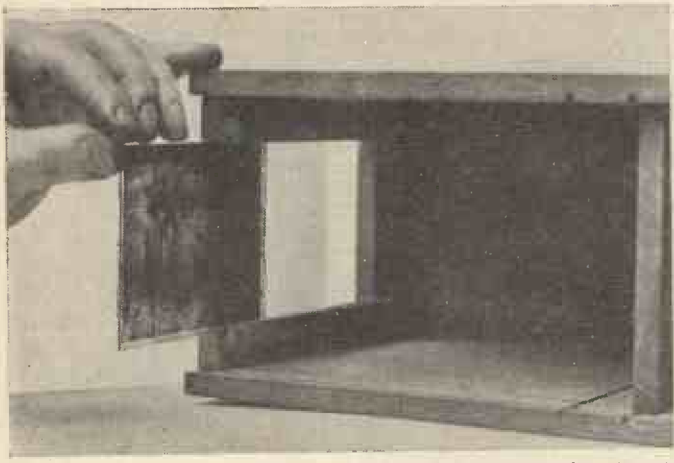
An Impulse Counter

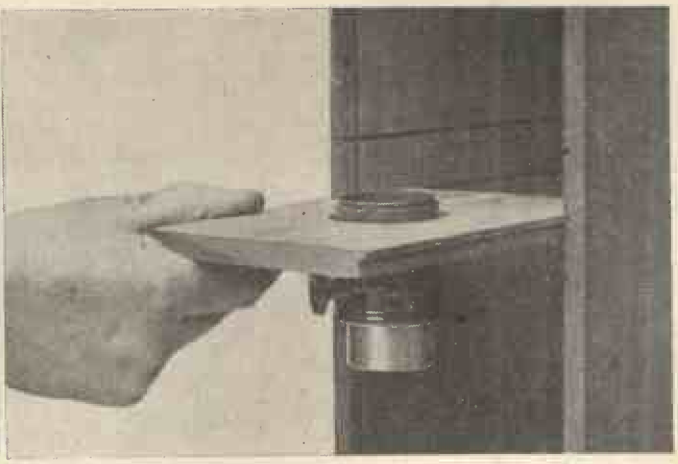
The relay contacts are closed through any piece of apparatus such as a lamp, bell-indicator or buzzer and a battery. If required this circuit may incorporate an impulse counter to record the number of impulses impressed on the grid of the first valve, or to operate a graphical ink recorder. This is at the choice of the experimenter. The conditions of operation are quite simple, for the first thing to do is to tune the amplifier, using reaction to produce a high-frequency whistle which can just be heard from the vibration of the relay armature. When this is quite audible, the set is oscillating and a meter reading is immediately given as shown by a momentary swing of the needle. This needle deflection increases when the ebonite electrode is grasped in the hand, at the same time a change in the pitch of the armature is distinctly discernible. Since there is a continuous fluctuation of current in the meter and relay, the latter periodically operates whatever local circuit is being employed, completing circuits through either pilot lamp, buzzer or ink-recorder as the case may be.

It might be questionable if the layout has any practical value; it is difficult to assess any definite claim, but it is sufficiently interesting to warrant further experiment. We all know what complicated circuits may be applied to operate remote control arrangements which incorporate photo-electric cells; similar applications might be found for this capacity effect. As a matter of fact a very technical piece of apparatus made its appearance some years ago, rather extravagant claims being made that it was capable of giving an audible diagnosis of various pathological states, in the form of a high pitched whistle. Surely this is of the nature of heterodyne beat-note, somewhat after the style of the apparatus which we have just been describing.

An Interesting Instrument

Another highly interesting instrument which could be constructed to show the form of speech signals in an ordinary radio was described in an issue of PRACTICAL MECHANICS some years ago as the "Voxometer" (see PRACTICAL MECHANICS, December, 1933). All this though, is taking us away from the subject of lie-detectors, but it is useful to know that some remarkable phenomena have been recorded in the first place by crude apparatus, and that many results at the time had few merits to accord them a place in modern technique.





(Left) Inserting the negative in its holder. *(Right)* Showing the lens mounted on its removable panel.

A DAYLIGHT ENLARGER

Straightforward Instructions for the Construction of a Simple Type of Semi-Adjustable Photographic Enlarger at a purely Nominal Cost

DAYLIGHT enlargers, despite the admitted conveniences of those of the artificial light variety, have certain advantages of their own.

In the first place, they are cheap to construct and they cost absolutely nothing to operate. Secondly, owing to the absence of a condenser in their construction, they give a perfectly well-illuminated picture, the detail of which is nicely " rounded " without being hardened in an exaggerated manner, as sometimes occurs with artificial light enlargers. A daylight enlarger is essentially a portable device and, in the form described in this article, it can be stored away very conveniently when not actually required for use.

The Lens

Apart from the cost of the lens, the enlarger described in these columns can be built up for a total outlay of about one and sixpence. A suitable lens, however, if one is not already possessed by the reader, need not cost him more than two or three shillings or so, provided that it is obtained second-hand, for an expensive anastigmatic lens is not required. Any type of cheap single or R.R. lens will suffice for the purpose, provided that it is capable of being stopped down to about f/32.

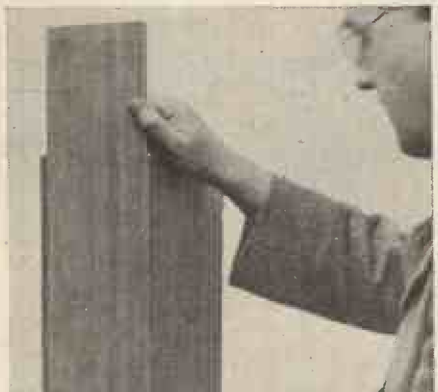
The Woodwork

The enlarger can, of course, be built in a number of sizes. It is, however, proposed to describe the construction of an enlarger taking quarter-plate (4¼ × 3¼ in.) negatives and enlarging them to half-plate size (6½ × 4¾ in.) not only because the half-plate size is a very convenient one for enlargements and can readily be masked to postcard size if desired, but also because a negative of quarter-plate dimensions is a favourite one with the more serious type of amateur photographer. Furthermore, if, at any time, it is desired to enlarge the extremely popular 3½ × 2½ in. size negatives in this enlarger, these can be accommodated in the negative carrier by making a suitable wooden or cardboard sub-carrier or holder for them.

The photographs accompanying this article will serve to show the reader at a glance the appearance of the enlarger and its parts. The enlarger can be made throughout of thin plywood, but, if possible, it is better to employ ordinary " solid " wood which has been well seasoned, since there will then be no fear of warping, shrinkage, or bending.

Let us begin the construction of the enlarger by considering the lens. This, as previously mentioned, need only be a cheap article, but it must be capable of being stopped down. Furthermore, it must have a focal length of 6 in. Lenses of this focal length are very plentiful, however, and the reader will experience no difficulty in picking up one second hand at any photographic stores.

If possible, the lens should be fitted into a rack-and-pinion jacket or mount, since this type of mounting serves to give very fine focusing. The rack-and-pinion mount, however, is not absolutely essential for the successful working of the enlarger, and it can be dispensed with, if desired.



The finished enlarger, showing its sliding side.

With a lens of 6 in. focal length, the fundamental dimensions of the enlarger are as follows :

Distance from lens to holder = 18 in.
Distance from lens to negative = 9 in.
Negative size = 4¼ × 3¼ in. (quarter-plate).
Paper holder size = 6½ × 4¾ in. (half-plate).

It will thus be evident that the external dimensions of the enlarger will be a little more than 6½ × 4¾ × 27 in.

In measuring distances from the lens, the middle point of the lens must always be taken, that is to say, the point midway between its component glasses if the lens is an R.R. one. If, however, the lens is of the " single " variety, the distances are to be taken from its glass surface.

The enlarger, as will be seen from the photographs, consists merely of an elongated box fitted with a sliding side, a negative carrier at the top and a paper holder at the base. The sides of the enlarger can be nailed, screwed, or dovetailed together, but it is essential, of course, to see that all the joints are perfectly light-tight.

The Sliding Side

The " paperholder " at the base is provided merely by cutting two opposite grooves in the sides of the enlarger at its base so that a half-plate (6½ × 4¾ in.) sheet of bromide paper can be slipped into position there. The sliding side of the enlarger is, of course, constructed by suitably grooving the two opposite wooden sides of the apparatus and by thinning down the two edges of the sliding side so that the latter fits snugly into the grooves and slides up and down in them freely. It is advisable, also, to cut a groove in base of the enlarger so that the sliding side may rest in it and thus effectively prevent light from gaining access to the interior of the enlarger at this vulnerable point.

The construction of the negative holder is clearly shown in the photograph. Merely glue and screw two opposite grooved strips of wood to the under side of the upper end of the enlarger. These wooden strips must be exactly 3¼ in. apart so that they will accommodate a quarter-plate negative.

The upper side of the enlarger is, of course, left open so that light can pass freely to the negative held in the carrier.

The lens, with or without a rack-and-pinion jacket, is mounted on a wooden panel which makes a sliding fit in a pair of opposite grooves cut in the sides of the enlarger. By cutting a number of these opposite grooves in the enlarger's inner sides, it is possible to fix the lens at varying distances from the negative carrier and thus to make varying degrees of enlargement possible. By this construction, the enlarger becomes "semi-adjustable," a property which is still further enhanced if the lens itself is provided with a rack-and-pinion jacket.

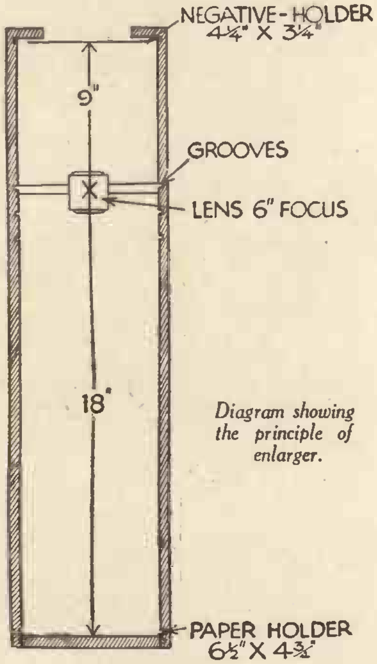


Diagram showing the principle of enlarger.

Enlarging a Quarter-plate

For enlarging a quarter-plate negative to half-plate, however—assuming a 6-in. focus to be employed—the lens, as mentioned previously, must be situated 9 in. from the negative and 18 in. from the paper holder.

By inserting a sheet of ordinary white paper into the paper holder and by sliding the enlarger side three-quarters way down and then holding up the enlarger so that the negative in its carrier faces the sky, the enlarged image of the negative will be seen clearly on the paper. If the image is not sufficiently sharp, readjust the position of the lens, either by means of its rack-and-pinion adjustment or by removing the lens panel from its grooves and inserting it into another pair. The sharpness of the projected image is also increased by stopping down the lens. It is better, however, to "sharpen up" the image by readjusting the position of the lens relative to negative carrier and paper holder rather than by stopping the lens down, for the use of a small lens stop necessitates lengthy exposures.

Having suitably focused the lens, it will, naturally, remain unaltered in focus, provided the size of negative and scale of enlargement remain constant. It is, therefore, well worth taking a maximum amount of trouble over this detail in order that perfectly sharp enlargements may be secured every time.

The enlarger with its sliding side removed showing negative, lens and bromide paper.

Working the Enlarger

The actual working of the enlarger is very simple. It is taken into a dark room (the negative having been inserted into the carrier) and a sheet of bromide paper is placed in the paper holder. The enlarger is then taken out into the open and held so that the negative in its carrier faces the sky. It is held up in this position for the necessary length of exposure, after which the enlarger is again taken to the dark room, the bromide paper removed from it and developed.

If required, a simple type of exposing "shutter" may be contrived for the enlarger by means of a piece of wood sliding in and out of a pair of opposite grooves cut on the outer side of the enlarger above the negative carrier, but this detail is by no means necessary. Indeed, it is apt to be disadvantageous, for in operating such a "shutter" there would be great danger of moving the negative itself during exposure, an act which would render the resulting enlargement woefully unsharp and "fuzzy."

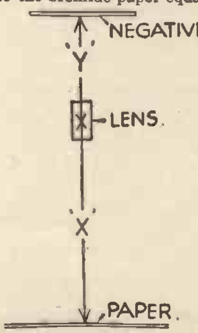
It is a convenience to fit a substantial handle to the side of the enlarger in order that it may be carried from dark room to daylight by means of one hand alone, and it is also very advisable that the whole of the enlarger's interior should be very thoroughly blackened by means of a dead-black paint. An effective paint of this nature can be made by stirring lamp-black into celluloid varnish, care being taken not to make the varnish too thick, in which event the resulting black surface of the woodwork would acquire a considerable shine.

Finally, a word or two about exposure. This is a matter which can only be judged by trial and experience, since it depends upon so many varying factors. With a negative of average density used in the enlarger described above and employing a sheet of contrasty bromide paper, the necessary exposure will be in the neighbourhood of 20 seconds, a lens aperture of f/22 being used under average daylight (not sunlight) conditions. Softer grades of bromide paper require less exposure. Gaslight papers, however, require many times the above exposure, since they are very slow-working.

NOTE.

Readers wishing to apply the constructional principle of the enlarger described in this article to other sizes of enlargers or to other focal lengths of lenses, may work out the necessary fundamental dimensions by means of the following rule:

The distance, X, from the centre of the enlarging lens to the bromide paper equals the focal length of the lens multiplied by the degree of enlargement required, the focal length of the lens being then added to the product.



The distance, Y, from the centre of the lens to the negative equals the distance, X divided by the degree of enlargement required.

Example.—To enlarge a ¼-plate negative to ½-plate size (i.e. to produce a "2-times" enlargement) using a lens of 6 in. focus.

Distance X = (6 × 2) + 6 = 18 (inches).

Distance Y = 18 ÷ 2 = 9 (inches).

Showing the method of inserting the bromide paper between two opposite grooves at the base of the enlarger.

STARGAZING FOR AMATEURS

A NEW SERIES

By N. de Nully

A GUIDE FOR FEBRUARY

THE planets Mercury, Venus and Jupiter are all "morning stars" obliterated by the glare of sunshine. Mars and Saturn remain in the evening western sky for two or three hours after sunset. Mars is seemingly moving towards Saturn and, on the 2nd, will be about four Moon's widths above that planet. Both now set at 9 o 'clock. Saturn's ring system is very slowly re-opening and, in a few months will be more distinctly observable in small telescopes.

Eros Approaching the Earth

The asteroid Eros, as it approaches the Earth, is increasing its rate of movement among the stars. At present this is about one degree in twenty-four hours. Therefore, according to its direction of motion and the last available computed position (R.A. 4 hrs. 5 min., N., Dec., 36 deg. 16 min. for Jan. 18), it should now be somewhat to the right of the star Beta Tauri lying in the track of the Milky Way. Eros is estimated to be less than 20 million miles off and coming nearer. Another of these insignificant cosmic vagrants has recently passed even closer, to disappear into the twilight. It is the tiny body discovered photographically by Herr K. Reinmuth at Heidelberg and known officially as 1932 H.A.

As the dark nights commence early and the Moon will be absent during the first and last weeks of this month, attention is directed to some specially interesting telescopic objects now conveniently placed. They should all be discernable through a refractor of not less than 2½ inches or a reflector of 4½ inches aperture. The situations of the constellations may readily be found from the star chart on this page. It shows the aspect of the heavens at 11 p.m. at the beginning, 10 p.m. in the middle and 9 p.m. at the end of February. The January chart now serves for the earlier periods between 9 and 7 p.m. Objects invisible to the naked eye or through a binocular and not marked on the chart, may be located with the aid of a star atlas.

Famous Great Spiral

If the observer's outlook permits, a survey might commence at the constellation Andromeda, which contains the famous great spiral nebula M. 31 and the beautiful gold and blue double star γ (Gamma) of the group. Cassiopeia is rather higher up, its conspicuous W embedded in the Milky Way. It embraces several scattered clusters, notably M. 50. Near by, also in the Milky Way, is Perseus with its unique double cluster (illustrated last month), and the interesting variable star Algol, "the Demon." The light changes of the latter are believed to be due to regular partial eclipses by a dark companion; the maximum and minimum phases being separated by intervals of about 2 days, 20 hours, 46 minutes. To the left of Perseus, across the Milky Way so to speak, the constellation Auriga flashes its brilliant leader Capella. This group contains a beautiful star cluster M. 37. Below Auriga and Perseus stretches Taurus (the Bull), embracing the Pleiades, a more scattered cluster the Hyades, the ruddy star Aldebaran and the so-called "Crab" nebula, the last named being close above and to the right of ζ (Zeta) Tauri.

The designation "Crab" was given to this misty patch by the late Lord Rosse who, viewing it through his big telescope, fancied that in the projecting wisps of luminosity along the margin, he saw a resemblance to the legs and claws of the familiar crustacean. Some justification for this anology may be discerned in the wonderful photograph taken by Prof. Ritchey at the Lick Observatory and reproduced here. An important connection has recently been traced between this nebula and a 900-year-old Chinese record of an extraordinarily brilliant "new" star that blazed out at the same spot in A.D. 1054. Modern telescopic and spectroscopic scrutiny have revealed that the brightness of the centre of the "Crab" nebula is due to a pair of glowing suns spouting forth vast quantities of nebulous matter at prodigious rates. From calculations of the speed of expansion of the gaseous mass, it is considered established that the stellar outburst of nine centuries ago was actually the preliminary stage of the formation of this nebula. Moreover, owing to the inconceivable remoteness of the scene of that violent explosion, the occurrence must have taken place nearly five thousand years before the light from it reached the Earth. The import of these conclusions adds significance to the behaviour of Nova Pictoris in 1928 and Nova Herculis in 1935. In both these instances the original single star divided into two separate newly-formed suns; and each of them is already surrounded by a distinct haziness. It is therefore probable that, like the Chinese, we in modern times have also witnessed the birth of future nebulæ.

The stars in February. The shaded band indicates the cloudy track of the milky way. To use the chart turn it round until the section of the horizon facing the observer is at the bottom. The centre represents the zenith.

The "Crab" nebula in the constellation Taurus (The Bull).

Orion

Orion, very prominent in the south-west was dealt with in the January number. But, in addition to the Great Nebula, it contains many smaller ones and numerous coloured double stars. In Canis Major, slightly below and to the left, is the incomparable Sirius, the present white lustre

(Continued on page 298)

One of the stages in the casting of phenolin cast resin-catalin.

CATALIN—A NEW MATERIAL

A Prescription for Billiard Balls that Started a Ten Million Industry

IT was less than seventy years ago that an unknown printer was "figuring out" how to make billiard balls of some other material than ivory. He was hoping to win a prize of about £2,000. As well as this he happened upon the formula that led to the establishment of a ten million industry because, as a result of his dogged experiments in his makeshift laboratory, *pyroxylin* made its appearance and since then, as celluloid, it has become familiar to the public in some 25 thousand uses. And yet, celluloid is only one (although the first) of the six major types of plastic material that have, literally, transformed the world not only for the user of plastic materials, but for the manufacturer and—vitally important—the younger generation of designers. For a series of new materials of amazing possibilities was at their disposal.

Used in Liquid Form

To the chemist (always the man behind plastics !) the other five materials are, briefly, cellulose acetate, phenol-formaldehyde, urea-formaldehyde, casein and the vinyl resins. But to the manufacturer and his key-man, the designer, these new materials appeal as substances that can be moulded, cast, laminated or used in liquid form in lacquers, paints and in varnishes; and to impregnate wood and textiles.

But celluloid is at least first cousin to—gun-cotton, a highly inflammable relationship; and so cellulose-*acetate* (which we know best perhaps in safety glass and safety film) which only burns reluctantly, was a great step forward in 1932; if you measure such steps by money, in three years after its introduction it was worth ten million dollars in the States alone.

Obviously there is the inevitable "human story" behind these successions of "discoveries" in the plastics world; simply because chemists—research men or just men with scientific imagination went exploring in chemistry—are arbiters of the whole business. There was the Belgian, Dr. Leo Baekeland who discovered phenolic moulding resins; carbolic acid plus formaldehyde. In powdered form, mixed with "fillers" such as wood flour, asbestos or mica a measured amount is dropped into a steam jacketed steel mould; the press comes together with a 2,000 lb. or 3,000 lb. pressure to the square inch and the material is fused into its final form. From the designers and the manufacturers angle the biggest drawback to start with, and later possibly the biggest asset, is the initial cost and the natural rigidity imposed on the form of the output.

Shortage of Materials

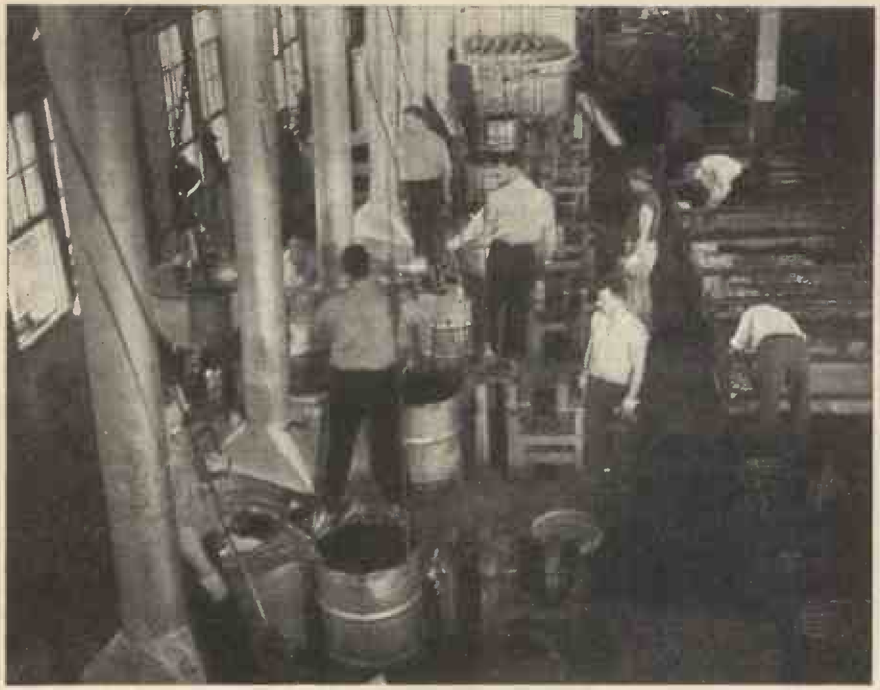
Meanwhile—with the war starving them of raw materials, desperately Germany and Austria attacked the problem of making synthetic rubber. It was a frenzied search that led, among other things, to an Austrian chemist Fritz Pollak, discovering the formula that gives us now the most famous of all *cast* resins, catalin; that has been called the "gem" of plastics. The Austrian opened up an entirely new world to the designer and the manufacturer and the craftsman who does the bidding of both. A world of such tremendous interest to the ordinary enthusiasts among readers of PRACTICAL MECHANICS that some details are of immediate practical interest.

For cast phenolics—made by condensing those two household chemicals phenol (carbolic acid is the name we know best) and formaldehyde and casting the resultant treacle-like mixture in lead moulds to be cured in heat from 3 to 6 days. After curing, these shapes are knocked from the moulds, and in these forms delivered to manufacturers and designers for working. They work like hard wood, easily and with standard tools. Catalin is, in fact, an entirely new material for the designer and comes in every variety of colour, from water clear crystal to opaque, mottled or flecked colours of every type.

Two further stages in the making of catalin.

Vast New Factory

The rapidly expanding industry is still starving for accomplished cast-phenolics' designers: that it is expanding is indicated



A busy scene inside the Catalin factory.

by the vast new factory, perhaps the most modern of its kind in the world, that has just sprung up in Essex. Here it is possible to see the most effective machinery that four countries can produce "making up" this giant prescription, leading—after fabricator and craftsman have handled this raw material to almost every type of house parts, furniture and motor-car "hardware"—aeroplane accessories—innumerable buttons and modern dress jewellery and nearly all the accessories for dressing-table, dining table and kitchen table—in the modern manner. Here there is such scope for the younger technician with a knowledge of the possibilities of plastics materials in general and cast-phenolics in particular, that the vital interest is in the stages between the emerging, from its casting, of the lovely raw material and its final presentation by the manufacturer of the object which his designer and technician have created, for his public.

No material yet presented has the possibilities of the cast resin with its almost unlimited scope for originality and its easily worked technique. No longer are laborious hours spent in planning, sanding and rubbing down coats of finish: for with the new coloured cast resins a few touches with a power sanding disc, and a buffing wheel; and you have a surface of real beauty and, of course the pattern and colour right through (since it is an intrinsic part of) the material. Incidentally, you can buff off your msitakes!

Buttons, Jewellery, etc.

The objects most easily within reach—and in most demand, are buttons, dress jewellery and clips, buckles, bag tops and umbrella tops; utilitarian things about the modern home, from door handles to knife handles, via every sort of household utensil that has a handle and would like a heat insulated one! And the raw material, cast catalin—leaves its place of birth in the form usually of the profile, or shape required. A good example of this is the average drawer handle or the rather amusing dress ornament in the form of a dog, in profile. The material for both these is cast in rods having an exact profile.

The rods are then cut off at the required thickness for the objects. This cutting is done either by a band saw, a circular saw or by means of an abrasive wheel: and (if actual detail be of interest), the saws should have approximately 14 teeth to the inch, a slight set and a surface speed of about 1,400 r.p.m. This is too slight a description to go into details; but I understand that the catalin layout includes a demonstration room for fabricating work.

These small objects—handles or ornaments of this type actually require very little finishing; possibly only sanding, drilling and polishing. For individual objects, singly cast, the top surface (the "flash") is best removed on a finisher on which a fine or medium coarse sanding-belt is used.

Economical Method of Cutting

The most economical method of cutting, from the parent cast rod, the innumerable button blanks—is by hot-slicing or shearing; a process which there is not space to describe, but which is in effect exactly what it is called! But it is important to remember that there is no loss of material in this method; and the method itself is largely responsible for the importance of catalin, and cast resins generally in the tremendous button and ornament industry.

Catalin is worked from standard tubes or sheet stock or, of course, special castings; the machining involves sawing, drilling, turning, carving, engraving, forming; and it may be sawn by hand with a band, a circular or a fret saw. It may also be bent or formed satisfactorily if it be heated to about 180° F., and for cutlery handles it is shrunk on to the metal tang, or stud.

Since—once again—it is necessary to emphasise that the paramount modernist material, *cast* resin, needs no special equipment to fabricate it, it is obviously an adventure for the progressive younger designer (or fabricator) to experiment with.

Within the Scope of Many

It brings itself thus within the scope of the private individual, the craftsman and artist; or the commercial designer with ideas. First must come the appreciation of the material, its capabilities, its few limitations and its unexploited possibilities. Then the lone craftsman must remember that a bracelet can be made in an evening that will open up a vein of rich possibilities. Already, in the States, the experimental kit has come within the scope of amateur hobbies; a vastly simplified arrangement, of course—but having the great advantage that it gives the budding technician an idea of possibilities in an industry that, in the country at least, still cries aloud for designers who are munitioned with this elementary experience.

The tremendous spread of the dress-jewellery trade; and (by the law of compensations!) of the button trade when for a season jewellery is in eclipse—offers perhaps the widest immediate scope to designers. But it is not wise to ignore the vast possibilities of cast resins in actual interior decoration. The door bell handle, the door handle, electric light fitments; the radio; the fire surround and actual translucent lighting accessories . . . all these give the ordinary home a face lift but, better still, enter into the economic designing of the new house. In the bathroom, the use of catalin bath taps—hand rails, shelves, panels and lighting fixtures is obvious; and this without taking into account the possibilities (as yet hardly touched upon in Britain) of the use of the liquid resin for laminating, and for the impregnation of wood. We have already, for instance, catalin-impregnated golf-club heads, racquets and cricket bats with their harder surfaces and greater elasticity and driving power.

WELDING OF ALUMINIUM

SUCH rapid progress has, of late, been made in the applications of aluminium that many users and potential users find it difficult to keep abreast of all the latest practical developments. For this reason, a new booklet, "The Welding and Riveting of Aluminium," just published by the Northern Aluminium Company, is of more than ordinary interest.

It is pointed out in the booklet that the welding of aluminium nowadays presents no difficulties provided the correct technique and good-quality materials are used. Practical instructions are laid down for the various processes.

The welding of aluminium and its alloys may be divided into three main classifications:

(1) Fusion or autogenous welding using oxy-acetylene or oxy-hydrogen flames;

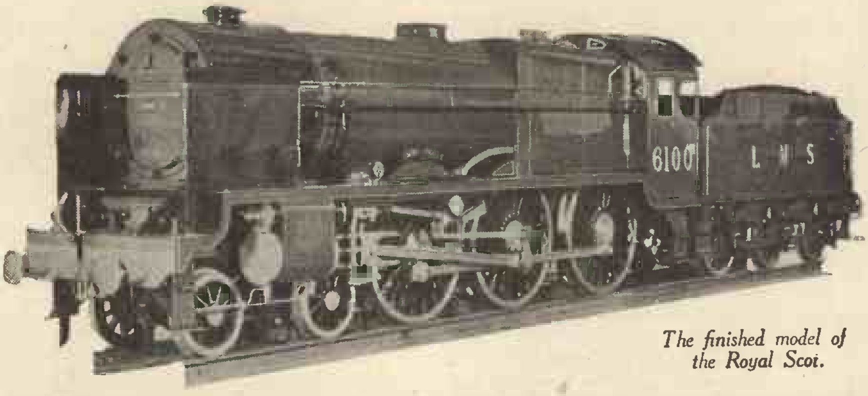
(2) Electric-arc fusion welding, including the metallic arc carbon arc and atomic hydrogen arc welding processes;

(3) Electric resistance welding, including butt, spot, and seam welding.

Practical details of materials and equipment are given, including the important subject of the choice of the correct welding rod or wire, the adjustment of welding flames, preheating, and, indeed, every aspect of practical welding.

The latter part of the booklet is devoted to an exposition of the design of riveted joints, and the practical methods of application. Also included is a useful series of comprehensive tables giving the mechanical properties of aluminium alloys and welded and riveted aluminium alloys under various conditions.

A GARDEN RAILWAY MASTER-PIECE



The finished model of the Royal Scot.

Details of a Remarkable Model of the "Royal Scot"

DURING the summer months I visited many beautiful estates with their garden railways and appreciated the pleasure these gave to visitors both public and private.

But although the driver of a garden railway locomotive can often be quite young, other members of the family who make or buy the locomotive, superintend the laying of the track, and the maintaining of the railway in good working order have a real engineering job, which requires much solid hard work during the winter months.

This is the time of year when much garden railway building work is going through, and there has been completed at Northampton recently the finest working model of the Royal Scot ever built.

Popular L.M.S. Locomotive

The Royal Scot engine itself, despite the advent of The Princess Royal and the streamline Coronation Scot, is still the most popular of all the L.M.S. locomotives. She attained world fame in 1933 by her trip across the continent of America, and at the Chicago Exhibition over 2,000,000 people examined the engine and passed through the train.

The Royal Scot locomotive and others of its class are 4-6-0's designed for express passenger service. The prototype burns soft coal, uses 250 pound steam pressure, has three cylinders 18 in. × 22 in., 81 in. drivers and weighs 190,320 pounds. It is interesting to know that the train with the Royal Scot during the American visit is now actually pulled by the Princess Class Pacifics, which are heavier and more powerful engines.

The finished model, as illustrated, is over 8 ft. long, with a weight well over 800 lb. It burns solid fuel and construction is on generous lines, the tender holding approximately 8 gallons of water. The boiler is fed by two injectors.

Months to Build

In producing the model, a job of months for several craftsmen, every working detail of the original was followed as well as the characteristics of external design. The boiler framing and mechanism are built as in the original.

Sixteen sheets of working drawings, and numerous photographs supplied by the L.M.S., comprise the data used for the model, which is one of the first to be fitted with double-ported inside admission 1-in. piston valves, ball release valves, automatic drain cocks, and long stroke Walschaert valve gear, arranged to provide the most accurate distribution of steam.

One special feature is the water pick-up. This is situated in the tender operated by a lever at the side handy for the driver. When pressed down the scoop is in operation, and when released it automatically brings the scoop up to its normal position. Under test the pick-up works efficiently at a speed of between 8 and 10 miles per hour.

The cylinders measure 2¼ in. diameter by 3½ in. stroke, and lubrication is by a Wakefield mechanical lubricator fitted under the smoke box. The boiler, which is usually in steel, is in this model made of copper with copper tubes, lagged with asbestos and cleated with Russian iron. As will be seen from the photographs, the fire door is a double sliding door.

Specification

Some of the specifications follow :

Main frames $\frac{3}{16}$ in. planished steel plate 57½ in. long with separate gun-metal horns. Cast gun-metal angle plates. Cast-iron subsidiary main stretcher. Cast-iron drag plate. Cast-iron truck-pin stretcher.

Axle-boxes—gun-metal axle boxes with oil container on top. Under hung spiral springs through.

Wheels and axles—cast-iron wheels forced on steel axles. Hardened wheels each with correct balance weight, 10-in. diameter. Truck wheels 4¾ in. diameter. Tender wheels, 6 in.

Bogie. Equalised with built-up beam and tension springs. Cast-iron stretcher guide, brass pad piece, and side control guide. Solid gun-metal axle boxes in angle guides. Spiral spring side controls.

Cylinders. Double ported inside admission 1 in. piston valves with 5 rings per head. Cast-iron pistons. Piston valves ground in lapped out centrifugal cast liners. Also automatic release draw cocks fitted.

Boiler. Copper boiler (and tubes) with Belpaire firebox. Tested to 160 lb. per square inch. Lagged with asbestos and cleated with Russian iron. Grid type superheater.

Valve gear. Walschaert long-stroke with box links on separate girder frames. All pins hardened and rods fluted.

Reversing gear. Screw type.

Cab and footplates. Of planished steel plate, jointed with angles and strips. Cab roof removable by sliding top to give accessibility.

Fittings. Water gauge, with three cocks, steam pressure gauge with syphon, two steam valves for injectors, wheel valve for jet blower, two check valves, steam brake lever and Royal Scot pattern throttle in cab. Also two clearing plugs in boiler. Safety valves of direct loaded type imitating Ross' pattern. Two whistles—one dummy-scale size and a large whistle under the footplate to give the correct deep note.

There are trapped water release valves on each valve chamber.

Garden railway locomotives these days are quite akin to their prototypes in ingenuity and have their individual workmanship and finish, and, with the boom in model railways of every gauge, there will be more, I think, being built this year than for some considerable time.

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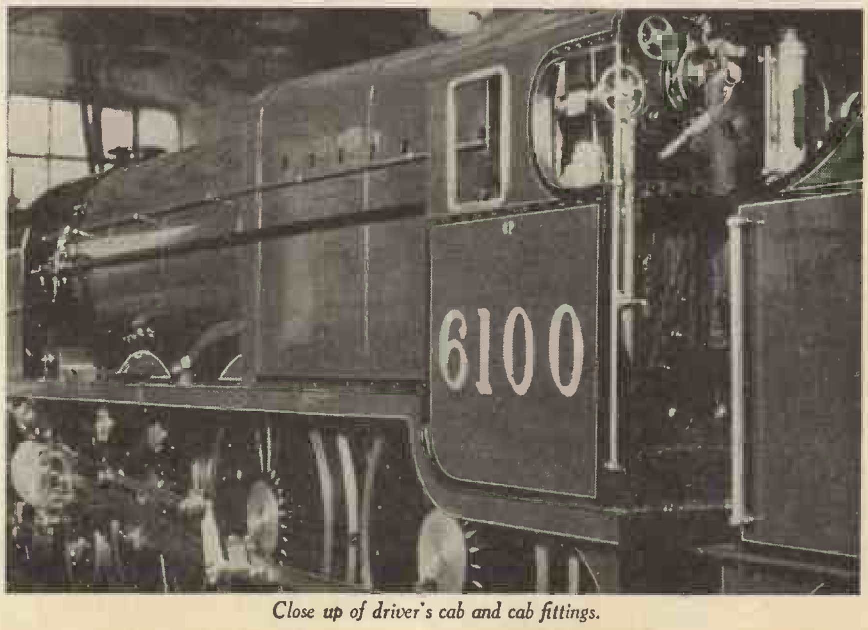
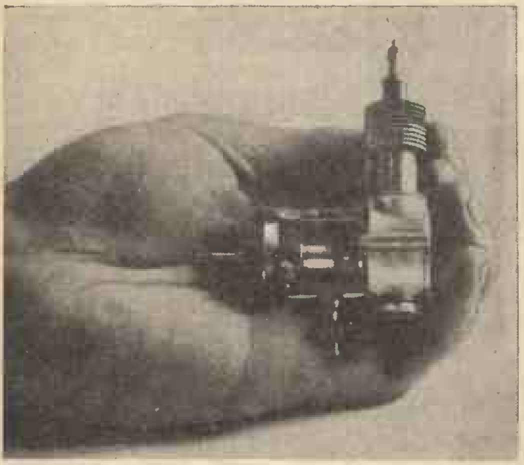


Close up of driver's cab and cab fittings.

BUILDING A 1-C.C. ENGINE



The size of this midget engine can be gauged by comparison with the hand. In spite of its smallness, it will fly a model weighing 20 oz.

By W. H. Deller

Part II

The Crank Case and Main Bearing Bush

(Sets of Blueprints are available at 5s. per Set)

Finishing the Crank-case End Cap

CUT the plug which was used for the previous operation to leave a head $\frac{1}{8}$ in. in thickness. Screw into crank case and hold in the chuck as shown in Fig. 6. Face off flush and bore to $\frac{5}{8}$ in. diameter, flat bottomed, to a depth of $\frac{9}{32}$ in. Recess this hole to $\frac{3}{4}$ in. diameter, leaving $\frac{1}{16}$ in. at the mouth of the hole of the original diameter. Remove from lathe, mark out and drill six equally spaced $\frac{1}{16}$-in. holes and drift out to form the spanner slots. A piece of 16 swg. mild steel $\frac{3}{4}$ in. wide forms the key with which to remove the cap.

Crank Case, Fifth Operation

Mark out and drill two $\frac{1}{8}$-in. gas-thread tapping holes on the centre line of the crank case, $\frac{3}{8}$ in. from the front face, and tap $\frac{1}{8}$ in. gas thread, taking care that the threads are true with the opposite hole.

Sixth Operation

Hold the piece of $\frac{1}{2}$-in. duralumin in the chuck and face the front. Turn back about $\frac{3}{8}$ in. and screw $\frac{1}{8}$ in. gas thread. Screw the crank case on to this peg fairly tightly and face up the side of the case to $\frac{17}{32}$ in. from the centre line. Face away to leave a boss $\frac{1}{2}$ in. diameter down to the $\frac{15}{16}$ in. counter-bore in the front of the case; this forms the boss for the drain plug. Reverse the crank case on the peg, face down to $\frac{9}{16}$ in. from the centre line and bore out the $\frac{1}{8}$ in. diameter gas-thread tapped hole to $\frac{7}{16}$ in. diameter. Counterbore to $\frac{15}{32}$ in. diameter by $\frac{5}{32}$ in. depth and screw 40 threads per inch. Bore out the mouth of the thread to $\frac{1}{2}$ in. diameter by $\frac{1}{32}$ in. deep to permit the cylinder to screw right down.

Drain Plug

The peg upon which the last operations were performed may not be altered to form the drain plug. Face away the thread to leave $\frac{9}{64}$ in. from the face. Saw off on the $\frac{1}{2}$ in. diameter to leave a head $\frac{3}{32}$ in. thickness. Reverse in the chuck, holding lightly on the thread, face the head to $\frac{1}{16}$ in. thick and drill a $\frac{1}{4}$-in. flat-bottomed hole $\frac{5}{32}$ in. deep. Recess the back of the hole to $\frac{19}{64}$ in. diameter leaving $\frac{1}{16}$ in. of $\frac{1}{4}$ in. diameter in the front; this hole is then drifted out to $\frac{1}{4}$ in. across the flats for a hexagonal key.

Crank Case, Seventh Operation

The next job on the crank case is to cut the transfer channel. This is central in the flange of the cylinder boss. After spotting up for drilling, the case is mounted at an angle on the drill and two $\frac{1}{16}$-in. holes are drilled side by side, which are afterwards drifted out to form a rectangular channel $\frac{1}{16}$ in. by $\frac{1}{8}$ in.

Eighth Operation

Mark out the crank case as shown in profile, Fig. 11, and cut away the shaded portion by drilling, sawing and filing. File away also the surplus metal on the back of the crank chamber leaving only the cylinder boss projecting. The corners adajacent to both the cylinder and drain-plug bosses are next dealt with as shown in Fig. 12, the case being held on a steel peg turned to fit the $\frac{13}{16}$ in. diameter bore of the crank case, and secured by means of a bolt passing through the bearing boss and tapped into the peg.

Ninth Operation

Mark out and drill the 40 T.P.I. by $\frac{3}{16}$ in. diameter hole in the back of the crank case. The tapping will have to be accomplished with a plug tap as the hole fouls the bore of the crank chamber slightly.

Tenth Operation

The last operation on the crank case is the drilling and finishing of the holding-down lugs. The holes are marked out and drilled as shown and spot-faced to clear the web. The lugs are formed by filing, the spot-faced surfaces serving as a guide.

Main Bearing Bush

The material for this bush is $\frac{3}{8}$ in. diameter silver steel; actually for the job a piece only $1\frac{1}{4}$ in. in length is required, but the remainder of a 13-in. length will serve to make certain other parts at a later stage.

First Operation

Cut a piece of bar $1\frac{3}{16}$ in. long and face both ends cleanly to bring overall length to $1\frac{7}{64}$ in.

Second Operation

Hold in the self-centreing chuck, centre drill and drill through $\frac{3}{16}$ in. diameter. Slack the chuck jaws off slightly and re-drill with a No. 4 drill, finally reamering to $\frac{7}{32}$ in. diameter in the lathe. The hole at this stage must be clean and free from scores, also the hole requires to be parallel and to size. Should the bore be other than perfect, do not proceed to finish the part, but ascertain the cause of the trouble, and after rectifying start again. When satisfied that the finish leaves nothing to be desired, carry on with the next operation.

Third Operation

Before taking out of the chuck the mouth of the partly finished bush requires to be radiused to match up with the under side of the crank plate. This radius is $\frac{1}{32}$ in., and it is better to " work " it on with a small tool and smooth up by lightly scraping and polishing, as in this way the radius will be true with the bore.

Fourth Operation

It is advisable to finish the bush on a centred mandrel, as the wall of the bush when finished is on the thin side. If a hardened and ground mandrel is not to hand see that the mandrel made or used supports the job along its entire length. Reduce the diameter by means of light cuts, otherwise the pressure of a heavier cut may force the job on to the mandrel making its removal a matter of difficulty. Should this happen it is liable to enlarge the bore of the bush. Finish the head diameter, and if the finish from the tool is sufficiently fine, leave ·003 in. to ·005 in. on the shank for fine finishing. Accomplish this with a smooth " Swiss " file and finally polish with very fine emery cloth. The finishing should be done carefully, the aim being to secure a good finish and at the same time a really parallel surface. The outside diameter of the shank at this stage should measure ·267 in. throughout its length. This leaves ·001 in. to remove after hardening. The slight chamfer on the end of the bush is intended to prevent the sharp edge from cutting the metal in the crank case when the bush is pressed in and requires therefore to be just large enough to make certain that the sharp edge is removed.

Fifth Operation

The bush is now ready for hardening. As it is too frail to handle by means of tongs a light wire hook should be used to handle it when hot. Make certain that the means of heating available will give an even heat. If a blow pipe or lamp is used, take the precaution of shrouding the bush in a piece of steel tube while heating, to prevent the flame from playing directly on to the article. Heat the bush to a dull red and cool out in water. No warping will result providing that the steel is not overheated, and the bush is held perpendicular with the surface of the water when quenching.

Sixth Operation

Test for hardness—a file should not make and impression—and clean out the bore. Lightly push it on the mandrel and finish the outside diameter to ·266 in. with emery cloth.

Seventh Operation

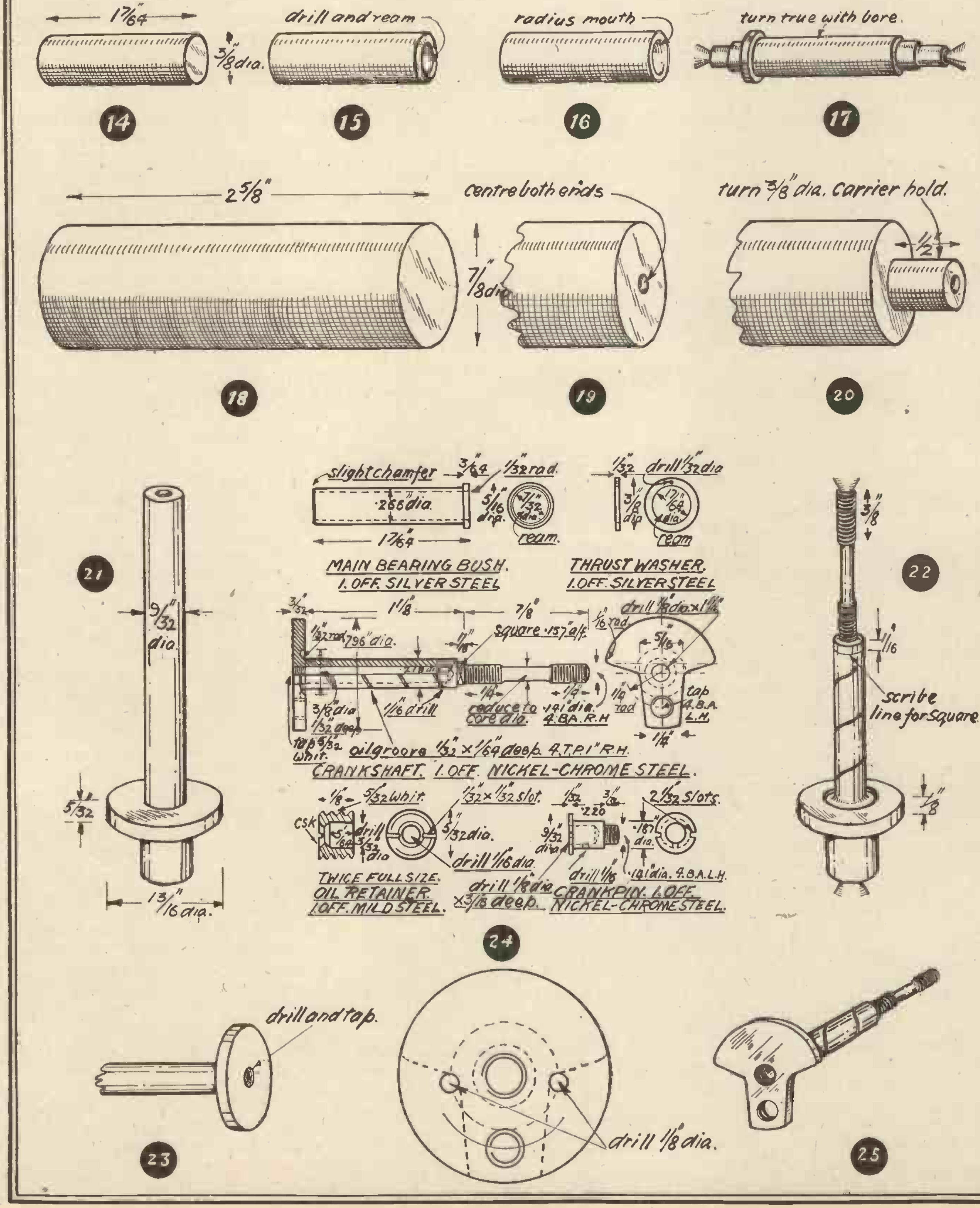
Remove the bush, oil the shank and carefully press into the crank case. The head of the bush, of course, goes inside the case. If the bush has been accurately made no difficulty should be experienced in getting it in, as less than ·0005 in. diameter has been allowed for a press fit. It would, however, be advisable to use a good fitting bolt, and pull the bush in by tightening a nut,

(*Continued on page* 301)

THE 1 c.c. TWO STROKE PETROL ENGINE

Stage-by-Stage Constructional Details

CRANKSHAFT AND BUSH



MODEL AERO TOPICS

CURRENT NEWS FROM THE WORLD OF MODEL AVIATION

BY F. J. C.

S.M.A.E. News

THE F.A.I. meeting took place in Paris on Jan. 24th to Jan. 26th, and Messrs. York, Cosh, and Houlberg were S.M.A.E. representatives. They placed the views of the S.M.A.E. before the F.A.I. A most important decision was reached regarding the use of binoculars for international records. The S.M.A.E. pressed strongly that the use of binoculars should be banned.

* * *

Messrs. Bullock and Houlberg informed the S.M.A.E. that they had each prepared a lecture. These are without slides and may be had by affiliated clubs on application. Permission to fly on Epsom Downs was granted to the Blackheath M.F.C., and the Ealing Club offered the S.M.A.E. space for exhibiting models at an exhibition which will be held early in the New Year. The Harold Wood Club has been renamed the Romford Flying Club. Capt. Plugge proposes to bring up the subject of model aircraft in Parliament, and members of the S.M.A.E. Committee have prepared a summary for Capt. Plugge's guidance. The S.M.A.E. will incorporate in the new 1938 Handbook advice on organising a model aeroplane club. It is hoped that the book will be available for affiliated clubs early in the New Year.

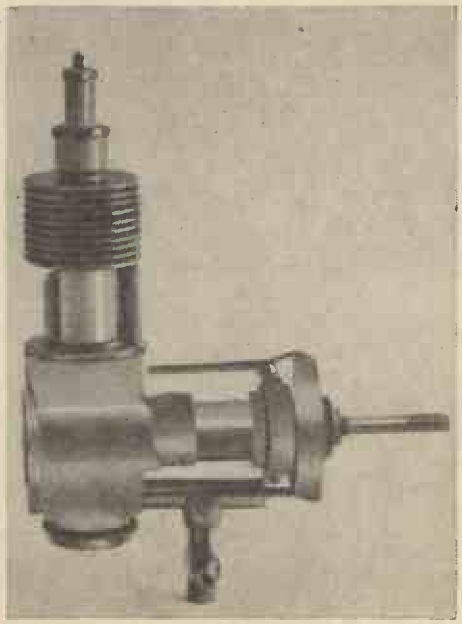
A New Catalogue

I HAVE received from the Model Aircraft Stores, Bournemouth, their very complete catalogue of model aeroplane materials, kits, and engines. This includes dope, bamboo, plastic wood, cements and adhesives, rubber lubricant, wire, tubing, strip brass and steel sheet, gear wheels, landing wheels, airscrews, blueprints, fittings, compressed-air engines and tanks, etc. I notice there is an addition to the Baby range of engines—the Trojan. It weighs in flying order 9 oz. with batteries, and is of ⅞-in. bore by ⅞-in. stroke. The cylinder is of cast iron and the cylinder head of dural, as are the cylinder fins; the piston is of cast iron with solid skirt, tool-steel gudgeon pin, bronze connecting rod, heat-treated crankshaft, roller crankshaft bearings, aluminium crankcase, ⅜-in. sparking plug, dural petrol tank, and complete it costs £4 18*s*. 6*d*. The Spitfire engine has been redesigned and is now marketed under the name of the New Spitfire.

Model Airships

S. SMITH, 44 Legh Street, Warrington, has sent me a set of parts for making a non-flying model of the *Graf Zeppelin*. The model is 5 ft. in length and built to a scale of 1/150th full size. The price of the kit is 5*s*., and when assembled a most realistic replica results.

A petrol-driven high-wing monoplane made by Mr. E. Penhall, Hants. It is fitted with an 18 c.c. engine, and has made over 500 successful flights, during which the machine has covered over 100 miles. The model is also fitted with port and starboard wing-tip lights and a landing light. It has made over 20 night flights without mishap.



A set of blueprints for constructing this 1 c.c. engine can be obtained for 5s. (see pages 264 and 265).

Unusual Models

I SHOULD like to see more unusual models, such as helicopters, ornithopters, Farman-type biplanes, seaplanes, Pterodactyls, and so on. Models, if I may say so, are tending to degenerate into a type, and I should like to see a little more originality. After all, the same old style of fuselage, the same old constructional methods, the same old wing forms, and the same old monoplanes, built on the same old lines and held together by faith, hope, and charity, which seem to be the only adhesives suitable for balsa, get monotonous in time. Neat little fittings, properly designed undercarriages, and stronger construction are necessary. Weight is not such an important factor to-day, when we can rely upon very efficient miniature petrol engines. In fact, some modellers go to an inordinate amount of trouble to reduce weight in some directions where it does not need to be saved, or should not be saved, and pile it on in other directions. Chassis are the chief offenders. You find heavy wheels, heavy chassis limbs; you find chassis which are sprung and allow the airscrew to break. You find wings held on with rubber bands. I do appeal for systems of construction which more nearly conform to engineering practice; butted joints in woodwork held together with cement are not ideal. The surface-tension system, in which the shrinkage of the covering is relied upon to hold the parts together, is also bad. I should be glad to have photographs from my readers of any unusual models, or sketches of any unusual methods of construction, and to pay for them if published.

The 1 c.c. Engine

JUST a reminder that those readers who wish to complete our 1 c.c. engine in advance of publication may obtain a set of blueprints for 5*s*. from our Blueprint Department. This little engine is the first 1 c.c. engine to be described in any journal. It is a fascinating little chap with many novel features. It may be made by anyone having reasonable skill with a lathe and hand-tools, and when finished you have a model which is not only a practical power unit for model aircraft and model boats but one of which you can be justifiably proud.

MASTERS OF MECHANICS

No. 30.—Christian Huygens, the Ingenious Dutchman

MORE, perhaps, than any other single mechanical principle that of the piston and the cylinder has revolutionised the face of the civilised world. From this basic principle has sprung the age of engineering and mechanics in which we live at the present time. Indeed, one might regard the piston and the cylinder as constituting the veritable cornerstone of our engineering era, for if, by some mysterious influence, all the world's innumerable pistons and cylinders could be done away with in the twinkling of an eye, the multifarious and far-flung industries of the nations would come to an end almost as abrupt as that of the sound of an organ pipe suddenly deprived of its wind.

Even the most mechanically-minded individual of the present day is very much inclined to take the piston and the cylinder for granted. Yet, obviously enough, there was a time when this vital combination was unknown, unthought of, and when whatever small amount of mechanical work it was necessary to perform was carried out by wind, water and animal power.

Continental Wine Casks

We shall never know with any exactitude the circumstances of the first creation of the piston and the cylinder. The latter originated, it is certain, in the stoutly-made continental wine casks of the seventeenth century. In these it was the custom, at times, to burn sulphur for the purpose of "souring" the wines. Sometimes, gunpowder was ignited in them and, no doubt, impressed by the energy of burning gunpowder, some unknown individual first conceived the notion of dropping an iron or wooden disc into the cask just before the powder was ignited. The energy of the combusting powder would often fling the wooden disc out of the barrel or cask high into the air.

It was a curious and sometimes spectacular effect, this firing of gunpowder in a barrel, but, with few exceptions, the good folk of the seventeenth century were not mechanically minded, and so experiments made in this direction led to nowhere—except, perhaps, that, in after years, the circular plate which had been dropped into the barrel became the piston of the steam and internal combustion engine.

Christian Huygens—from the title-page of one of his books.

Creator of the Cylinder

One of the first individuals to think out a useful application of the then long-known barrel and gunpowder experiment was a Dutchman, Christian Huygens. In a sense, Huygens may be styled the "Creator of the Cylinder," for it was certainly he who devised for the first time in the world's history a smooth-bore metal cylinder within which a plate or disc could be made to move up and down. This experiment, which Huygens made almost at the end of his life, took the form of erecting in a vertical position a wide-bore tube in which a weight was suspended. The lower end of the tube was closed and the weight within the tube or cylinder had attached to it a cord which, after passing around a pulley placed above it, was attached at its other end to a heavier weight which normally retained the former weight at the upper end of the cylinder.

Into the upper end of the cylinder, just above the piston or weight, Huygens rammed a charge of gunpowder. Upon ignition, the exploding charge forced the weight or piston downwards to the bottom of the cylinder, thus drawing up the external weight and so enabling some semblance of useful external work to be performed. By opening a release valve attached to the upper end of the cylinder, the products of combustion were allowed to escape, whereupon the "piston" rose to the top of the cylinder and the external weight descended. Again a fresh charge of gunpowder was ignited above the piston and the sequence of operations repeated.

Naturally enough, this type of "engine," although it was really the world's first internal combustion engine, was utterly useless. Huygens, in fact, realised it to be so and he was on the point of endeavouring to replace the gunpowder with steam when he died on the 8th of June, 1695, in the sixty-sixth year of his age.

Favoured by Fortune

Christian Huygens, in many respects, was favoured by fortune. His life was a congenial, fairly affluent and tranquil one, and had he wished, Huygens might simply have lived to add to the number of aristocratic nonentities which his age produced so multifariously. Huygens, though, was made of better stuff and, as a result, his lifetime constitutes a record of scientific effort put forward continuously for the betterment of mankind.

Born at the Hague (Holland) on 14th April, 1629, Christian Huygens was the second son of a father who, as well as combining the rôles of poet and mathematician, had been the State Secretary to three successive Dutch princes of the House of Orange.

Christian, despite the comfortable, and, indeed, the affluent surroundings into which he was born, was by no means a lazy lad. There is a record of his having mastered the elements of Greek, Latin, mathematics and music by the time he had reached the tender age of nine years, and before he was twelve years old he had constructed a number of ingenious mechanical models, some of which are still to be seen in the various museums in Holland.

During his teens, the growing youth was strongly attracted by the then rapidly-advancing science of astronomy. Telescopes, in Huygens' days, were very few and far between, and even those which were ordinarily obtainable were of very low power and not well suited for astronomical observations. Consequently, in order to obtain an instrument of really effective power, Huygens quickly realised that he would have to make it himself. This, after

An example of up-to-date clock mechanism. The movement of a "turret" or tower clock, which is weight-driven and pendulum-controlled.

many trials, some only partly successful, he succeeded in doing. Devising methods for the grinding of long-focus telescope glasses, Huygens constructed a number of telescopes of then unprecedented light-collecting power, and with these he advanced the science of astronomy so greatly that he has been rightly named "Galileo's successor."

Astronomy

It is not opportune here to enumerate Huygens' discoveries in astronomy. Nevertheless, one of them is worthy of passing reference. This was his discovery of the ring surrounding the planet Saturn. Galileo, previously, had observed that Saturn was an extraordinary planet, but his telescope was of too low a power for him to discern the true nature of Saturn's make-up.

In the year 1655, Huygens constructed a telescope having the then enormous focal length of twenty-three feet. Training this instrument upon Saturn, he made a discovery which he chose to publish in the following year (1656) in the following apparently senseless jumble of letters: aaaaaaa ccccc d eeeee g h iiiiiii llll mm nnnnnnnnn oooo pp q rr s ttt uuuuu This sort of anagrammatic announcement of a discovery was not uncommon in the time of Huygens, investigators adopting such a method as a means of establishing a priority of discovery. Three years afterwards, seeing that nobody else had called attention to the remarkable make-up of the planet, Saturn, Huygens gave the solution of his anagram in the following Latin sentence: *Annulo cingitur tenui plano nusquam cohaerante ad eclipticum inclinato,* which rendered into English, announced that "The planet is surrounded by a solitary flat ring, inclined to the ecliptic, and nowhere touching the body of the planet."

Huygens' discoveries in astronomy, together with his writings on various scientific and mechanical subjects, brought to him a well-earned measure of fame. He was invited by the French government to settle in that country, an offer which he accepted. Accordingly, in 1666, he became a salaried member of the French Academy of Sciences, a position which he occupied until 1681, in which year he returned to his native Holland owing to the religious persecutions which were then arising in France.

Greatest Practical Discovery

It was during his stay in Paris that Huygens hit upon what may be termed his greatest *practical* discovery. This was the application of the pendulum to clocks, an invention which he described in his book, *Horologium Oscillatorium*, published in 1673.

Previous to Huygen's adaptation of the principle of the pendulum to clock-making, it was impossible to construct a clock which would in any way keep accurate time, since there was no known means of accurately controlling the escapement mechanism of a clock.

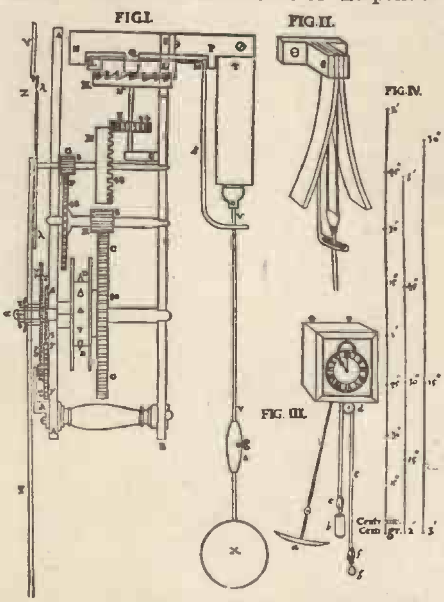
Huygens, however, by his introduction of the pendulum clock mechanism, at a single stroke, annihilated the former imperfections of clock construction and gave to the world a time-keeping mechanism which really lived up to its name and which, particularly in its subsequently improved versions, enabled accurate time-keeping to be carried out anywhere.

Galileo had studied the pendulum and its properties before Huygens, and it was from the laws of the pendulum as laid down by the former scientist that Huygens derived his inspiration to apply it to the mechanism of clocks.

The Pendulum

A pendulum, when oscillating freely, has a fixed "natural" period of vibration. If it were not subject to friction it would continue to oscillate for ever at an absolutely unvariable "period" or "frequency" of oscillations. Huygens realise this fact, and he saw, also, that if a pendulum were incorporated into a clock mechanism the clock itself could be made to give the swinging pendulum the little push which is periodically required to keep it in motion. The clock, under these conditions, would supply the energy for keeping the pendulum in motion, whilst the pendulum itself would register its oscillations upon the dial of the clock. Since the oscillations of the pendulum are absolutely constant, the train of wheels controlled by the pendulum moves at a constant rate and as the clock hands are operated by this wheel-train it follows that they, too, must move at a constant rate.

The world's master clock at Greenwich Observatory. It operates upon the fundamental pendulum principle enunciated by Huygens in 1673.



An actual reproduction of Huygens' original illustration of his clock pendulum principle taken from his book "Horologium Oscillations," published in 1673.

Thus clock-making, to say nothing of the science of accurate timekeeping, came into its own. Following Huygen's discovery of pendulum timekeeping, pendulum clocks sprang up in all parts of the then known world. Indeed, one may say that Huygens founded an industry which has lasted down to our era and the practical benefits upon civilisation of which are utterly illimitable.

"Father of the engine cylinder," "Father of the time-keeping clock," Huygens was also, if one may use the term, "Father of the Ether."

It was Huygens who first used the expression *Ether* to denote the vast, subtle, imponderable non-material, *something* which is supposed to exist not only in inter-planetary and celestial Space, but also within the very interstices of molecules and atoms and through which light waves and other electromagnetic oscillations are transmitted. True it is that in modern times, much doubt has been cast upon the actual existence of this Ether. Nevertheless, whether it exists or not, its conception has been of great assistance to scientists during the past hundred years or more in enabling them to scheme out a working explanation of the Universe.

Sir Isaac Newton, who was a contemporary of Huygens, considered light to be due to steams of "corpuscles" which were shot out from the luminous body much in the same way as electrons are hurled off the heated filament of a radio valve. How far Huygens subscribed to this view is difficult to be certain. But, without actually announcing the present-day wave-theory of light, Huygens drew attention to the similarity between the properties of light and those of vibrations set up in elastic bodies, and there seems little doubt that had he lived longer he would, in due course, have arrived at our modern explanation of light propagation.

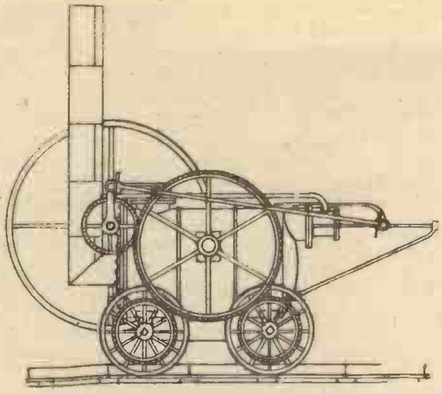
His Later Life

During his later life, Huygens journeyed to England in order to make the personal acquaintance of Newton, who was fourteen years his junior. Newton, at Cambridge, had astonished the scientific world with his investigations into the fundamentals of mechanics, and he would have liked Huygens to remain with him in order to share his work. Nothing, however, appears to have come of the proposal, for shortly afterwards, the renowned Dutch mechanician and philosopher returned to his family estate at Hofwijck, near the Hague, in Holland, there to remain in uninterrupted tranquility until overtaken by death in 1695.

In the closing years of his life, Huygens devoted his energies to two things. First to the experiments described at the commencement of this article, and secondly to the composition of a treatise concerning the possibility of the planets being inhabited by various races.

We have seen that the life of this scientific pioneer was brought to a termination just when he was about to apply the force of steam to the primitive type of engine which he had devised. Huygens, therefore, although he did not actually construct a working steam engine, must be reckoned among the pioneers of steam power, for his was the brain which, so far as we can ascertain, first wrestled with its many problems.

Huygen's last book on the possible planetary worlds was not published until after his death. Yet it had an enormous sale. Under the title of "The Celestial Worlds Discovered," it ran through two editions in this country, and even nowadays it is sometimes quoted by students of Space travel, and by those who believe that the ultimate mystery of the planetary bodies will one day be unravelled.

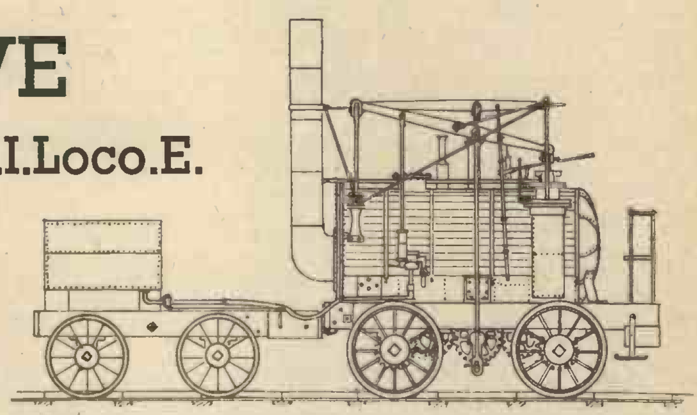


Richard Trevithick's Locomotive. Pen-y-Darren. Tram Road, 1803. The first Steam Locomotive that ever drew and moved a train upon a railway track.

MILESTONES IN THE PROGRESS OF THE BRITISH STEAM LOCOMOTIVE

By W. J. Bassett-Lowke, M.I.Loco.E.

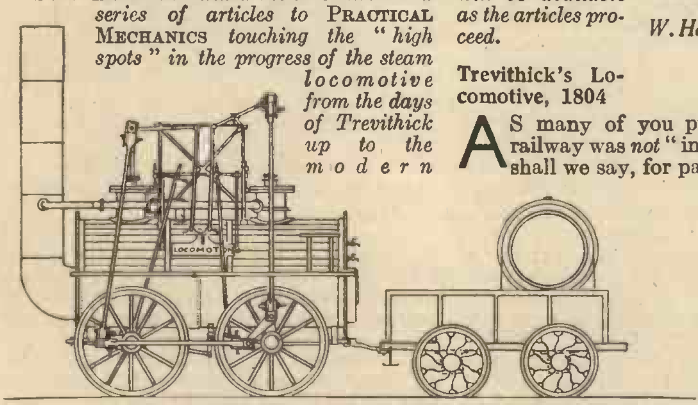
Illustrations by E. W. Twining



W. Hedley's & Blackett's Wylam Colliery locomotive. Puffing Billy, 1812. Stephenson's first inspiration.

Transport of most kinds has a fascination for me—whether by road, sea, air or rail—and this year I have taken a special interest in the history of the British locomotive—so much so that I am having a set of small models made for my collection and to show to friends to whom this subject appeals.

Your Editor has asked me to contribute a series of articles to Practical Mechanics *touching the "high spots" in the progress of the steam locomotive from the days of Trevithick up to the modern stream-liners. As I progress, railway fans may perhaps disagree with me as to whether the models (which in all number about thirty) represent in their opinion the most important locomotives of railway history. This series is my own personal opinion, and the elevations which illustrate the articles are all to the same scale, 3½ mm. to the foot and are suitable for 16-mm. gauge railways. Detailed drawings of each locomotive will be available as the articles proceed.*



Stephenson's Locomotion No. 1, 1825. The first locomotive to be put into use on the opening of the Stockton and Darlington Railway.

Trevithick's Locomotive, 1804

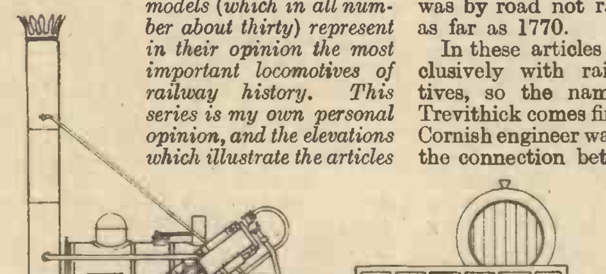
As many of you probably know, the railway was *not* "invented," or devised shall we say, for passenger travel. In fact its first use was to meet the transport requirements of the British coal industry.

Twenty-five years before Stephenson's famous "Rocket" came upon the scene, the first steam engine had travelled on rails under its own power—and for the first steam-power transport, which was by road not rail, we have to go back as far as 1770.

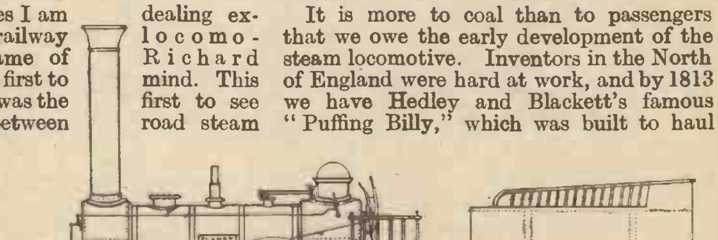
In these articles I am dealing exclusively with railway locomotives, so the name of Richard Trevithick comes first to mind. This Cornish engineer was the first to see the connection between road steam carriages, and the primitive railways on which in the early nineteenth century, horses were pulling wagons of coal. Illustration No. 1 shows you the result of his idea. With the stationary engine in mind, Trevithick thought that a flywheel would be necessary for a steady output of power, and drove his engine with a single horizontal cylinder, similar to the road steam-roller of to-day. From the flywheel he transmitted his power to two driving wheels on one side of the engine by a series of gear wheels. The driving wheels had no flanges, for the track over which they ran consisted of pairs of cast-iron angles, fixed to stone blocks. This engine ran on the Penydarren Tramway near Merthyr Tydfil, in South Wales, and it carried loads of iron up to ten tons in weight in addition to about seventy people.

Hedley's "Puffing Billy," 1812

It is more to coal than to passengers that we owe the early development of the steam locomotive. Inventors in the North of England were hard at work, and by 1813 we have Hedley and Blackett's famous "Puffing Billy," which was built to haul

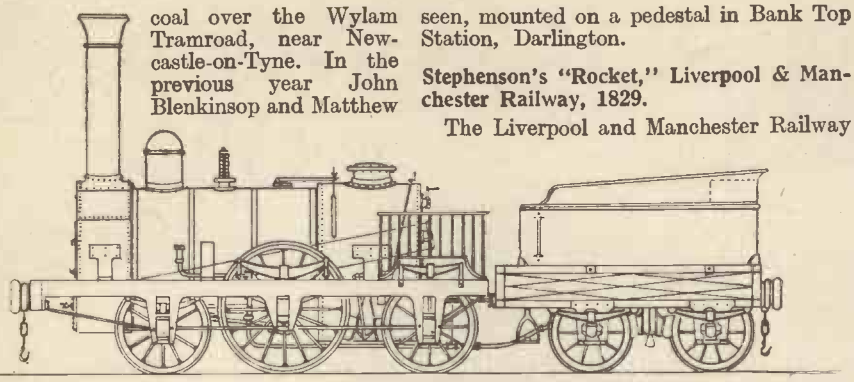


Robert Stephenson's "Rocket," 1829. Liverpool and Manchester Railway. The pioneer of the successful locomotive combining mulitubular boiler, blast pipe and directly driven wheels.



Robert Stephenson's "Planet," 1830. The first locomotive combining modern-type boiler with firebox, cranked axle, outside frames and cylinders enclosed in smoke box.

coal over the Wylam Tramroad, near Newcastle-on-Tyne. In the previous year John Blenkinsop and Matthew



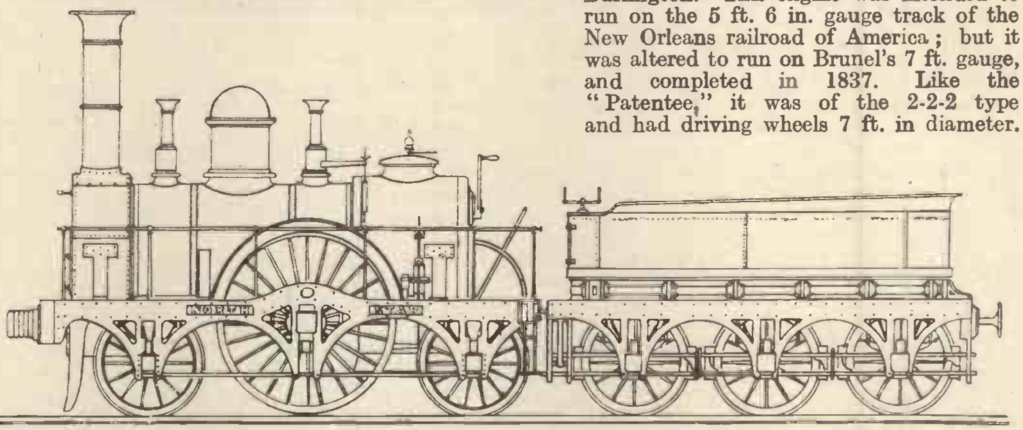
Robert Stephenson's "Patentee," 1834. The precursor of the single driver inside cylinder express locomotive.

Murray had built for the Middleton Colliery, near Leeds, a successful steam locomotive, which was propelled by a toothed wheel engaging with projections at the sides of the rails. This machine, ancestor of present day rack-and-pinion railways in the Alps, had worked a 25-ton train of coal, together with 50 passengers, on its first trip. But Hedley and Blackett determined that adhesion between the locomotive driving wheels and the rails should be sufficient for progress, and "Puffing Billy" triumphantly proved it. This engine is now preserved in the museum at South Kensington. The cylinders were vertical, at the side of the boiler, and the gear wheels, transmitting the thrust from the cylinders to the driving wheels are similar to Watts' Beam Engine.

It was the sight and sound of "Puffing Billy" passing the humble cottage at which the Stephensons lived, that fired the imagination of young George, destined to become the most famous railway pioneer in history. As enginewright at Killingworth Colliery, he built the locomotive, Blucher—this was at the time of the battle of Waterloo—but his big chance came when he was asked by Edward Pease to become Engineer to the Stockton and Darlington Railway. For this George Stephenson designed and built "Locomotion" and drove it himself on the opening day, on September 27th, 1825, amid tremendous public rejoicing. The 90-ton train ran the whole length of the line at ten miles an hour and at times rose to 15. This famous little pioneer is still to be seen, mounted on a pedestal in Bank Top Station, Darlington.

Stephenson's "Rocket," Liverpool & Manchester Railway, 1829.

The Liverpool and Manchester Railway was nearing completion and the directors offered a prize of £500 to the designer whose engine would best fulfil certain conditions. Four engines in all entered, to run to and fro continuously until seventy miles had been covered, stops for water and coal being allowed. The "Rocket" had a worthy competitor in Timothy Hackworth's "Sanspareil," but



Robert Stephenson's "North Star," 1837. The first successful engine to have 7-ft. driving wheels. Drew the first passenger train on the opening of the Great Western Railway.

bad luck overtook this engine and the "Rocket" proved an easy winner. Stephenson used a tubular boiler, as well as water-jacketed firebox, which improved the steam raising. In the present-day method of reckoning the "Rocket" would be an 0-2-2 type engine, and "Locomotion No. 1" with its coupled wheels, was of the 0-4-0 arrangement.

Robert Stephenson's "Planet," 1830

Development in locomotive design now became very rapid. Only a year after the "Rocket" Robert Stephenson brought out the "Planet" a locomotive which showed the most revolutionary improvements that have been introduced in so short a time. The cylinders were mounted inside the smoke box, between the outside frames so that they should not lose heat by radiation; and the increase in power so obtained was remarkable. Inside cylinders involved the use of a cranked axle to drive the engine, and the sandwich frames of the engine, formed of ash or oak planking, and strengthened both outside and inside with iron plates, were another new departure. The boiler too had become in general principles more like the locomotive boiler of to-day; it contained 129 tubes with the firebox an integral part of it. The driving wheels were 5 ft. diameter. Four years later came the "Patentee," a further development of the "Planet," with an additional pair of carrying wheels at the firebox end, forshadowing the coming popularity of the 2-2-2 type single-driver.

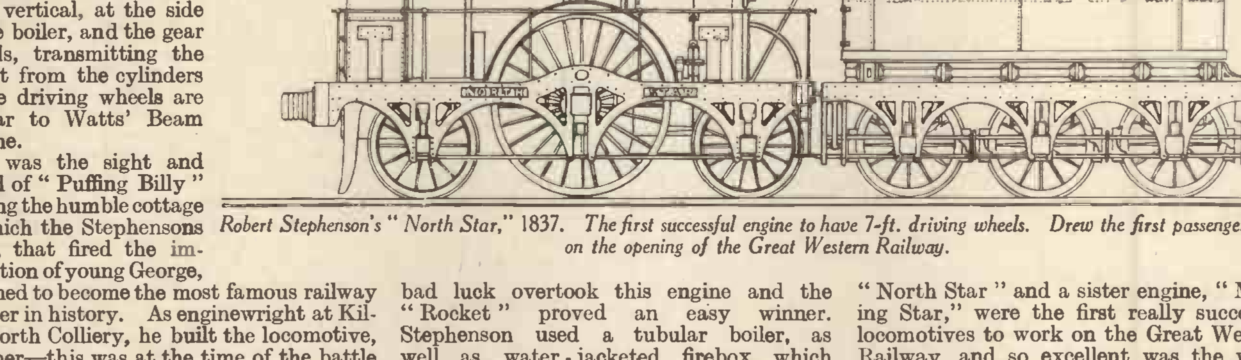
Stephenson's "North Star," Great Western, 1837

The engine which worked the first train out of Paddington, Great Western Railway, on June 4th, 1838, the "North Star," designed and built by Robert Stephenson, who by now had established a thriving locomotive works; the works which continues to-day under the same name in Darlington. This engine was intended to run on the 5 ft. 6 in. gauge track of the New Orleans railroad of America; but it was altered to run on Brunel's 7 ft. gauge, and completed in 1837. Like the "Patentee," it was of the 2-2-2 type and had driving wheels 7 ft. in diameter. "North Star" and a sister engine, "Morning Star," were the first really successful locomotives to work on the Great Western Railway, and so excellent was the workmanship of "North Star," that in 1854 it was reboilered at Swindon Works, and continued in service until 1870. Between 1839 and 1841, Robert Stephenson's firm built ten more engines of the "Star" class with various improvements, including the "haystack" type of fire box, crowned by the safety valve which for many years to follow was a typical feature of locomotive design.

Gooch's "Lord of the Isles," Great Western Railway, 1851

This brings us to one of the most famous locomotive engineers of history—Daniel Gooch of the Great Western Railway. His name is generally linked with that of Brunel, the Engineer of the same company, as the two protagonists of broad gauge.

(*To be continued*)



Daniel Gooch's "Great Western," 1846. The first of Gooch's famous 8-foot single drivers (broad-gauge) locomotive.

TRICKS OF ESCAPING AND MAGIC WITH KNOTS

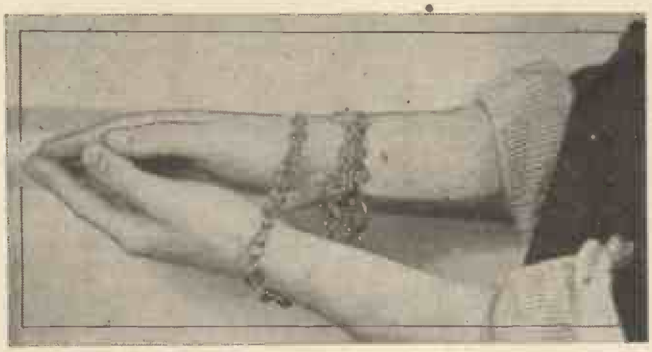


Fig. 1.—A chain escape. The chain round the upper part of the right wrist passes through a ring and so forms a slip knot which, however tight it is pulled, can be loosened by turning the wrist slightly to the left.

By Norman Hunter
(The Well-known Conjurer of "Maskelyne's Mysteries")
Further Articles on the Secrets of Conjuring will appear Regularly and Exclusively in this Journal

Construction of the Chain

THE art of escaping from handcuffs, leg irons, boxes, and cages is a highly specialised branch of the conjuring business, and as a rule an escape artist restricts his activities entirely to feats of this kind. Many of the secrets of escape work depend upon expensive prepared handcuffs and heavy apparatus, built especially for the work. There are, however, a number of simple escape tricks, which the amateur may like to include in a programme of general conjuring.

The escape trick illustrated in Fig. 1, is usually presented as an independent trick, but it can also be used in conjunction with other effects which I propose to explain later.

In effect, a length of chain, furnished with two rings, is handed for examination, together with a padlock. The performer then asks a member of the audience to bind his wrists tightly together with the chain and padlock it. The chain is drawn so tightly that the links can be seen pressing into the flesh, yet in a couple of seconds the conjurer can free himself, and instantly hand out the chain and padlock for inspection.

The secret lies partly in the construction of the chain and partly in the way in which it is used. There is a ring at one end of the chain and a second ring a few inches along the chain, as shown in Fig. 2. We will call these rings A and B. To begin with, the performer passes the plain end of the chain through ring A. He then passes the loop so formed over his right wrist, holding the hand with the thumb uppermost. The ring A must be on top of the wrist, that is, on the thumb side, and the chain must pass up through the ring on the palm side of the hand. Having drawn the chain tight, the conjurer then places his left hand alongside the right, the free end of the chain hanging between his wrists, and asks a member of the audience to take the hanging end of the chain, pass it round his left wrist and on round his right wrist. The end of the chain is then passed through ring B, which will be found just under the right hand, drawn very tight, and padlocked at a convenient point. Fig. 1 will make clear the way in which the chain must be bound. The movements should be carried out with the chain in the hands and no difficulty whatever will be experienced in getting the fastening right.

Figs. 2 and 3.—(Left). Chain for manacle release. (Above) An escape sack.

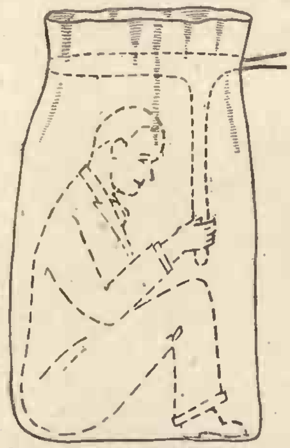


Fig. 4.—How the performer pulls the cord inside the sack while the sack is being fastened.

The performer's hands are now, to all intents and purposes, firmly bound together. He can, however, release himself in a few moments by simply turning his right wrist to the left, when the chain will loosen and can be drawn off, although still remaining padlocked. The reason for this is that the first loop of chain is really a slip-knot, and once this is loosened the whole fastening is automatically released.

Fig. 5.—A bag escape with a small object. Notice how the ribbon with which the bag is tied hides the join between the visible bag containing the object and the secret duplicate bag inside it. The bags are shown different colours to make the explanation clear.

The Mail Bag Escape

Now for a somewhat more ambitious escape, sometimes referred to as the Mail Bag Escape. In this the performer is fastened inside a large sack, a screen is placed round him, and in a few moments he walks out from behind the screen with the

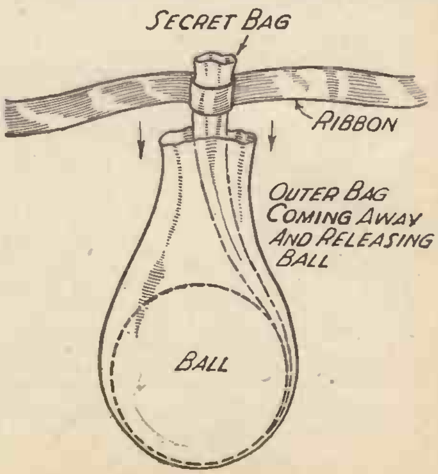


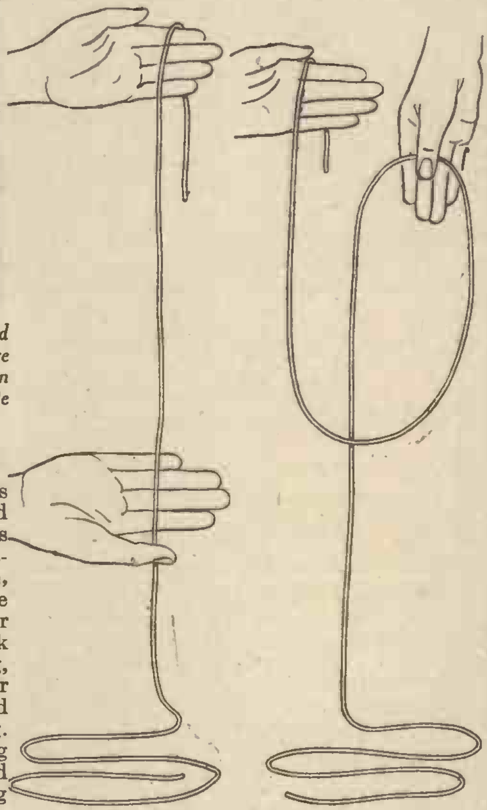
Fig. 6.—A "secret" bag.

Fig. 7.—Forming a secret knot. The cord is picked up in a loop which is turned completely round before being placed in the left hand. Every loop so made in the cord will cause a knot to appear when the opposite end of the cord is passed through the loops.

sack, till securely fastened, over his arm.

The simplest method of performing this effective escape is by means of a prepared sack. The preparation is so slight that it is extremely unlikely that it will be discovered, even by the closest examination, and even if it is discovered, it is improbable that it will mean anything to the spectator who finds it. The construction of the sack is shown in Fig. 3. It is simply a large bag, roomy enough to contain the performer comfortably and fitted with a draw cord run through a hem at the top of the bag. Any kind of strong fabric will do for making the bag. The draw cord must be of good length. The preparation consists of leaving the lower part of the hem unsewn for a few inches at the part opposite to the opening where the draw cords emerge. (See Fig. 3.) The bag can safely be handed for examination without fear of this slight preparation giving any clue to the escape afterwards performed.

The performer steps into the bag and draws it up over his head, instructing his volunteer assistants to draw the cord tight, tie it securely, and seal the knots in any manner they please, so that they may be able to identify the seal later. In helping the assistants to gather the mouth of the sack, the performer secretly pulls down through the unsewn part of the hem about eighteen inches of the draw cord and holds on to it (Fig. 4). The assistants now tie up the sack as firmly as they please; but as soon as the performer is told that the screen is round him (he had better have an assistant of his own to give him this cue, in case a spectator remains behind the screen, or does not conceal him properly, which would give away the secret) all he has to do is release the piece of cord he is holding, when he can open the sack sufficiently to get out.



Figs. 8 and 9.—The method of forming a secret knot.

Having escaped, the conjurer then cuts the cord where he was holding it, draws it tight, ties the ends together and tucks them under the part of the hem from which he took them. This leaves the sack securely fastened and the original seals intact.

An Effective Escape

With these two trick escapes ready to perform, the conjurer can make a very effective escape by first having himself manacled with the chain and padlock and afterwards tied and sealed in the sack. While the sack is being fastened he escapes from the chain, leaving him only the sack escape to make when the screen is placed round him.

Next, let me describe a very puzzling trick, which is in the nature of an escape, but is used with a small object such as a ball or a bottle, instead of with a human being.

The object is placed in a cloth bag, the neck of which is firmly tied with ribbon. The ends of the ribbon, which is a long piece, are held by two members of the audience, and a large cloth is thrown over the bag. The conjurer puts his hands under the cloth, and immediately removes the object that was in the bag. It can be identified as the same object by any kind of mark the audience care to put upon it at the start. Yet the bag is still firmly tied and sealed as at first, and the closest examination of the bag reveals not the smallest hole or secret opening.

The Secret

Fig. 5 gives a general idea of the secret of this effective trick. Two bags are used, both alike. One is folded into small compass and concealed just within the mouth of the other. In showing the visible bag, the conjurer keeps the folded one concealed under the fingers of the hand. The ball or bottle having been marked, is placed inside the bag and the mouth of the bag is gathered round it. In doing this the performer draws out a little of the mouth of the concealed bag and holds the two bags with his hand round the join. He then takes a long piece of ribbon, about two

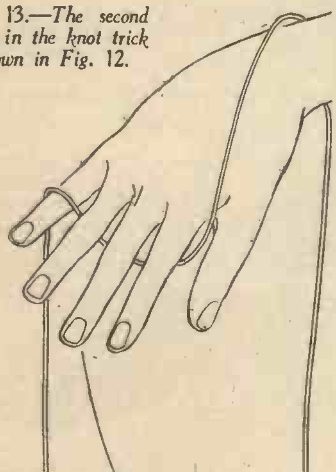
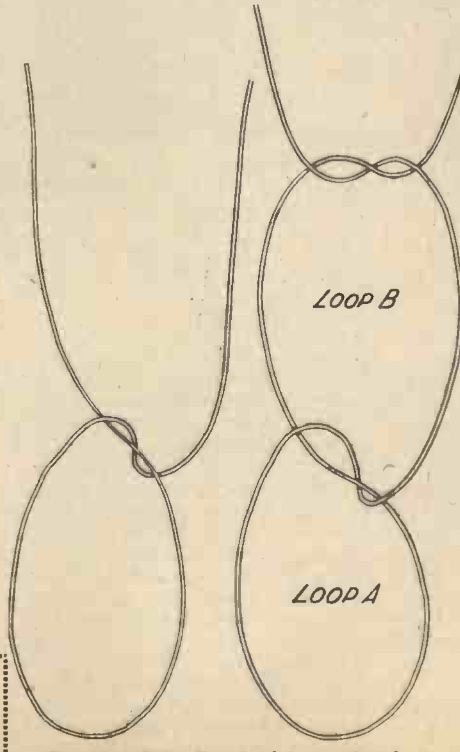


Fig. 13.—The second stage in the knot trick shown in Fig. 12.



Figs. 10 and 11.—Details of the vanishing knots.

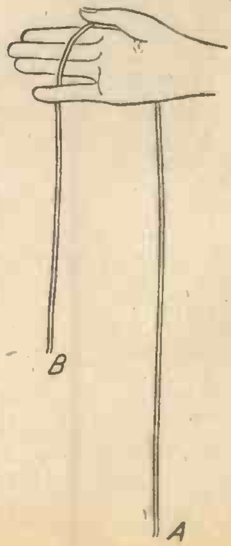


Fig. 12.—How the string is held prior to making a knot appear.

or three inches wide, and ties the mouth of the bag. The ribbon is bound round the place where one bag emerges from the other. Fig. 5 shows this being done. The inner bag is shown black to contrast with the bag which actually holds the object, in order to make the illustration clear. In performance, of course, both bags would be the same colour, and to the audience there would be but one bag in use.

The ends of the ribbon being held by two spectators, a large cloth, such as a tablecloth, is spread over the bag. To effect the release the conjurer has only to pull off the outer bag, which will come away from the ribbon, as shown in Fig. 6, thus releasing the object contained in it. This bag is concealed in the folds of the covering cloth as it is drawn off. The original inner bag is now seen firmly tied on the ribbon, and, of course, being without preparation it may be thoroughly examined.

Tricks with knots are features often introduced into programmes both of escape tricks and of general conjuring. Here is a particularly ingenious one.

The magician takes a long piece—half-a-dozen yards in fact—of cord, which may be examined. He coils it up and lays the coil on the seat of a chair. Taking a shorter piece of cord he ties several knots in it and makes the knots vanish. On picking up the end of the long cord the same number of knots are discovered tied, at intervals along the cord.

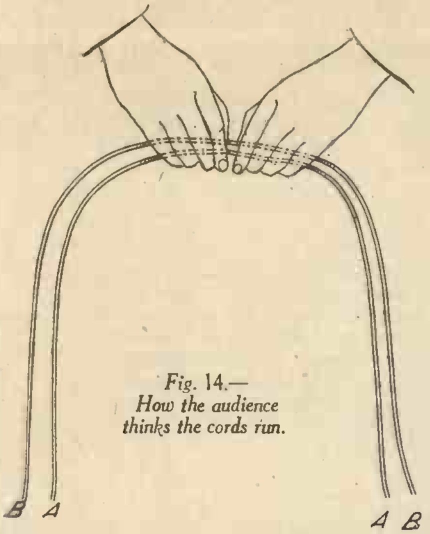


Fig. 14.—How the audience thinks the cords run.

Fig. 16.—Secretly looping the centres of the cords for the "Strangling Trick." The cords are shown different colours to make the explanation clear. In actual practice both cords are exactly alike.

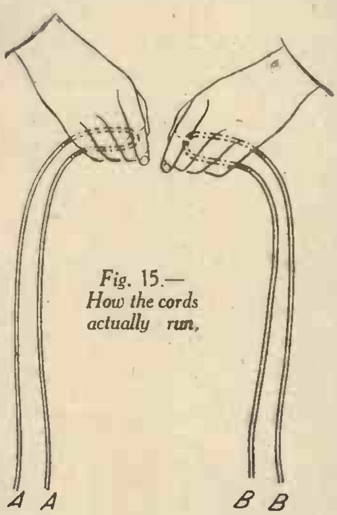


Fig. 15.—How the cords actually run.

The Knots

The appearance of the knots on the long cord is managed by a movement that is very easy to do, but extremely difficult to describe. The following instructions should be followed with a piece of cord in the hands.

Hold the end of the cord in the left hand, allowing the cord to hang straight down. With the right hand take the cord about two feet below the left hand. The cord must be grasped with the fingers at the back, and the thumb in front. This means that the right hand will have its palm turned towards the audience. The right hand is now brought up and round in a semi-circle towards the performer's body, the thumb describing an arc until the knuckles of the hand point directly towards the left hand. Fig. 7 shows the position at this point, and Figs. 8 and 9 will further explain the movement. The loop in the right hand is now placed in the left hand along with the part of the cord already held there.

This movement is repeated until the whole cord has been looped up. It is important to note that each movement will, later, produce one knot, so that it is easy to regulate the number of knots as required by the trick. Finally, take the free end of the cord and place it between the fingers of the left hand. Now drop the coils on to a chair, retaining the end between the fingers so that the coils drop over it, then lay the end down where you can find it again. At the end of the trick it is this end of the cord which you pick up, and there will then be one knot in the cord for each loop you made.

Vanishing Knots

The disappearance of the knots is accomplished by tying three knots in a special way and making them vanish from the cord, after which this part of the trick is repeated if six knots have been provided for on the long cord. Refer to Figs. 10 and 11 while reading the following explanation of the vanishing knots.

Use a piece of thick, soft cord about three feet long. Holding one end of the cord in each hand, tie a simple knot in the cord. Be careful to see that the left-hand end of the cord is passed in front of the other end, that is on your own side of it, in making this knot. Draw the knot down to form a loop, as in Fig. 10. Now tie another knot in the cord, but this time pass the left-hand end behind the right end, that is on the side farthest from you. Draw this down to form a second loop, as in Fig. 11. We will call the loops A and B. Now take the end of the cord that is in your left hand and pass it from front to back, that is from you towards the audience, through loop A and then through loop B. If you have followed these directions correctly, when you pull the ends of the cord the three knots will melt away to nothing.

While we are on the subject of knots, I should like to explain a very clever-looking trick which is quite easy to do and gives the impression of needing great skill. You lay a piece of cord over your hand, give it a shake and a knot appears in the centre of it.

The Trick Explained

Here again the diagrams in Figs. 12 and 13 will explain better than words how the trick is performed. When the cord has been laid over the hand, the front portion is caught up with the little finger, as shown in Fig. 12. To make the knot, you simply dive the hand down quickly and catch the end A of the cord between the first and second fingers, give the cord a shake and the knot will form. Study the diagrams with a piece of cord in your hand.

An effective escape trick with cords is that which is usually referred to by conjurers as the "Strangling Trick." The performer takes two lengths of examined cord, and passes them round his neck. He ties the ends together, crosses the cords in front of his neck, and pulls the ends tight. To the astonishment of the audience the cords appear to pass right through his neck and they come away free, still tied together.

The two cords used must be of the same colour and type. In fact, two lengths cut (*Continued on page 296*)

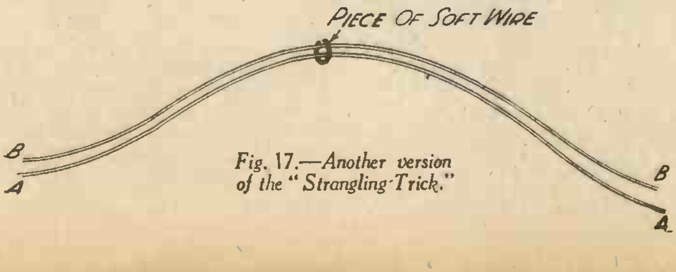


Fig. 17.—Another version of the "Strangling Trick."

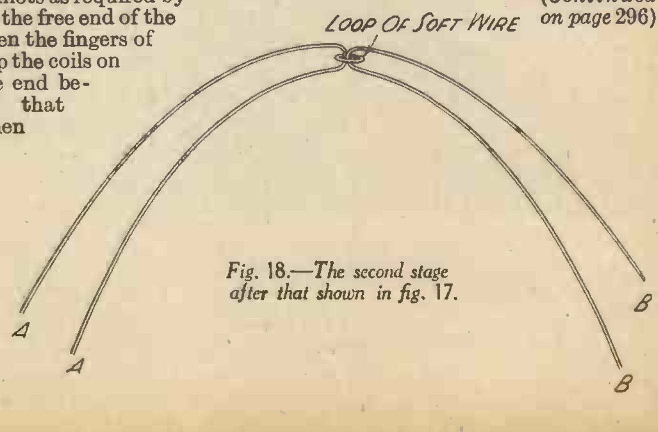


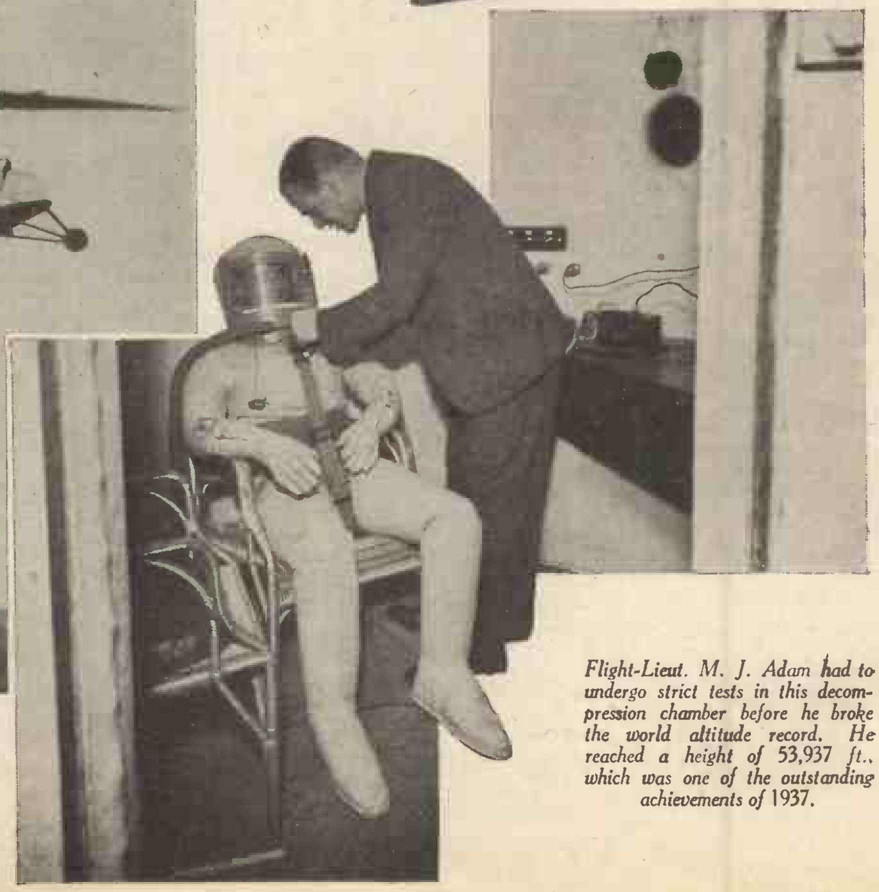
Fig. 18.—The second stage after that shown in fig. 17.

OUTSTANDING IN THE OF SCIENCE DURING

One of the new tube trains which made its appearance during the past year. It incorporated many new features designed to increase comfort and gave increased performance over the old type.

The Italian firm "Gilera" built this special aerodynamic four-cylinder motor cycle, which during trial runs reached a speed of nearly 190 m.p.h.

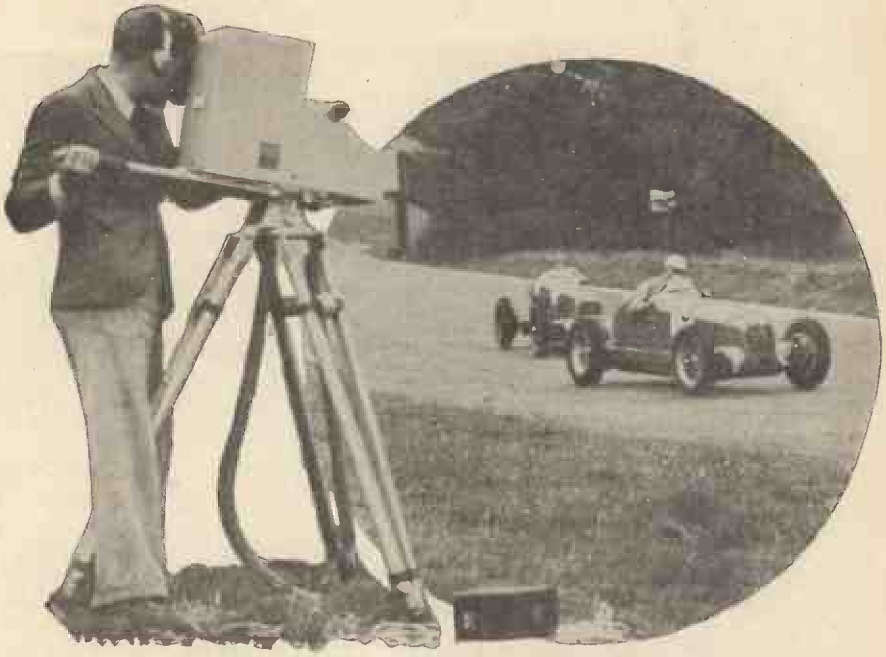
The Breguet gyroplane, fitted with a 300 h.p. Hispano-Suiza engine, which won the French Air Ministry prize for "hovering." It was stationary in the air for more than ten minutes.



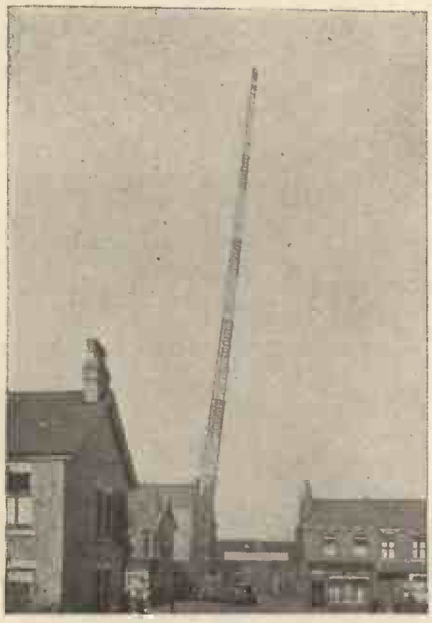
Flight-Lieut. M. J. Adam had to undergo strict tests in this decompression chamber before he broke the world altitude record. He reached a height of 53,937 ft., which was one of the outstanding achievements of 1937.

WORLD 1937

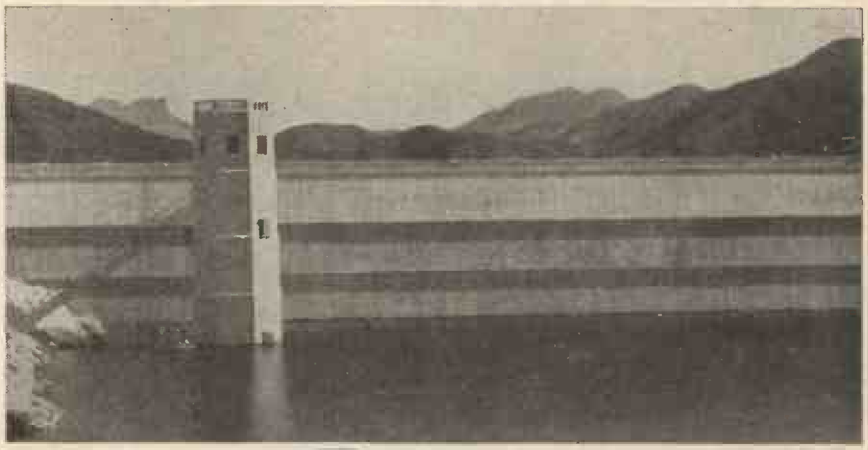
ACHIEVEMENTS OF THE PAST YEAR SHOWN IN PICTURE



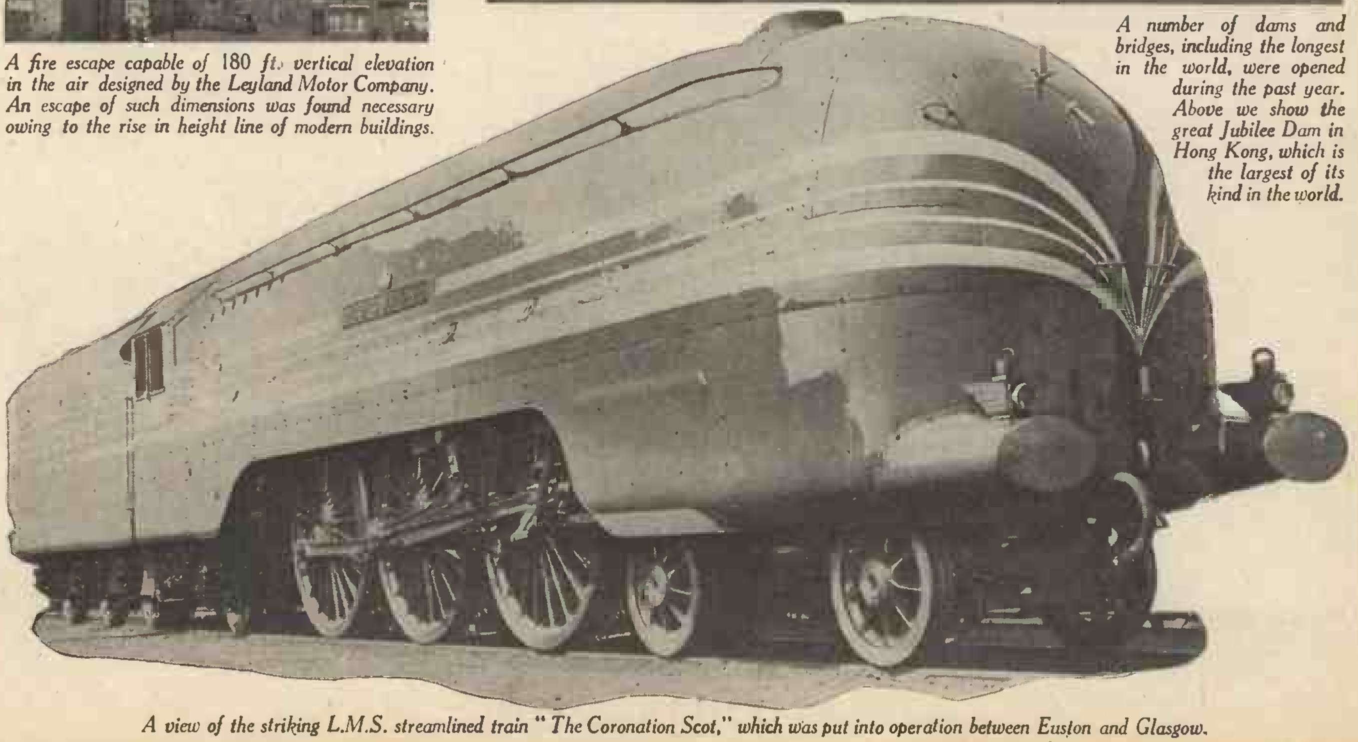
Television figured prominently in the headlines of 1937. Outdoor sporting scenes were televised successfully for the first time, outstanding being the televising of the Coronation of King George VI.



A fire escape capable of 180 ft. vertical elevation in the air designed by the Leyland Motor Company. An escape of such dimensions was found necessary owing to the rise in height line of modern buildings.



A number of dams and bridges, including the longest in the world, were opened during the past year. Above we show the great Jubilee Dam in Hong Kong, which is the largest of its kind in the world.

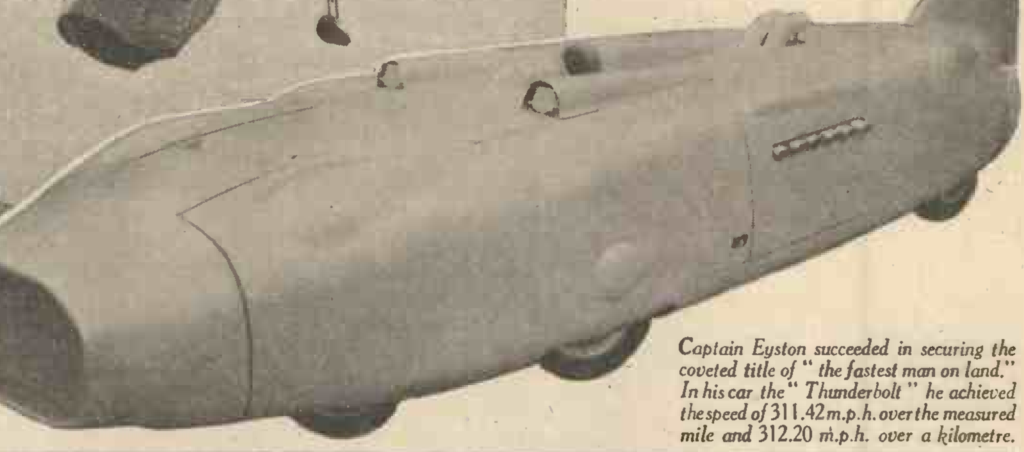


A view of the striking L.M.S. streamlined train "The Coronation Scot," which was put into operation between Euston and Glasgow.

The American flying-boat, Clipper III, takes up her anchorage after landing at Foynes, Ireland.

The Imperial Airways long-range flying boat the Caledonia.

On July 6th, 1937, two flights were completed across the Atlantic by two giant flying boats, the Caledonia (British) and Clipper III (American).



Captain Eyston succeeded in securing the coveted title of "the fastest man on land." In his car the "Thunderbolt" he achieved the speed of 311.42 m.p.h. over the measured mile and 312.20 m.p.h. over a kilometre.

The ingenious pick-a-back aircraft designed by Imperial Airways to facilitate Atlantic flights.

BUILDING THE "LUTON MINOR" LIGHT AEROPLANE

PART V

Assembling the Undercarriage

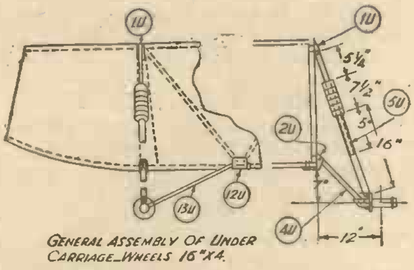


Fig. 1.—The undercarriage is of the split-axle type.

THE "Minor" undercarriage is of the split-axle type with external compression legs for absorbing the landing shocks (see Fig. 1). The following materials are required:

- 1 M.S. tube, 36 in. × 1⅛ in. o/d. × 18 s.w.g. } Compression legs.
- 1 M.S. tube, 38 in. × 1 in. o/d. × 20 s.w.g. }
- 1 axle tube, 14 in. × wheel hub diam. — 1/100 in. × 16 s.w.g.
- 1 M.S. tube, 30 in. × 1 in. × 16 s.w.g. Axle extensions.
- 1 M.S. tube, 48 in. × ¾ in. × 17 s.w.g. Radius rods.
- 1 sq. ft. M.S. plate × 16 s.w.g. } Fittings.
- ½ sq. ft. M.S. plate × 14 or 12 s.w.g. }
- 10 aluminium separator plates, 2½ in. diam. × 18 or 20 s.w.g.
- 36 in. — ¼ in. M.S. rod, plain or screwed.
- 14 aero rubber compression rings, 2¼ in. × 1 in. × 1 in.
- 2 wheels and tyres, 16 in. × 14 in.

Note.—All steel tubing to be 28-ton weldable (D.T.O.41), and steel sheet 28-ton steel (Z.S.3).

First make up four channel fittings, 5U/1 (Fig. 3), and six M.S. discs of 12 or 14 s.w.g. and 2½ in. outside diam. Four of the discs will have ⅞-in. holes bored centrally, and the other two have 1-in. holes. The latter are welded ⅛ in. from the end of the two tubes, 1 in. diam. × 20 s.w.g. × 16½ in. long. Now thread fittings 5UA on the tubes and fix to the discs by means of 2 rivets, countersunk in the disc face (Fig. 2).

At the other ends of these 1-in. tubes cut slots ⅜ in. wide × 1 in. deep, and weld the 16 s.w.g. inserts in position. Drill right through for ¼-in. bolts, ⅜ in. from the end.

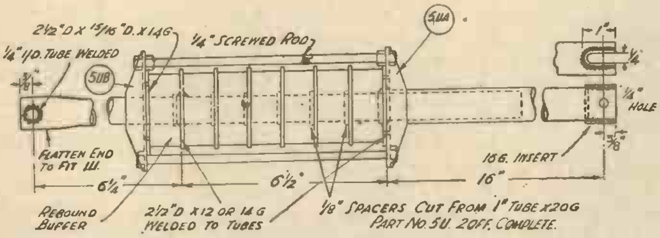


Fig. 2.—Thread fittings 5UA on the tubes and fix to the discs by means of two rivets.

Next weld one disc on each of two ⅞-in. diam. tubes (20 s.w.g. × 18 in. long), the outer face of the disc being 6⅛ in. from the tube end.

Cut 10 (5 for each leg) 18 or 20 s.w.g. aluminium separator plates, 2½-in. outer diam. and ⅞ in. inside, and also 12 ⅛-in. spacers from the 1-in. diam. tube.

We are now ready to assemble the legs. Thread six rubber compression blocks on to the longer length of the ⅞-in. tube, one of the small spacers being inserted in each compression block and one aluminium spacer between each two rubbers. Slide the smaller tube into the larger tube, as shown in Fig. 2. Thread a rubber block and spacer on to the small end of the inner tube and follow with an M.S. disc, riveted to 5UB.

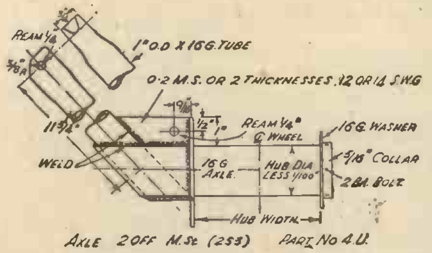


Fig. 5.—Details of the axles.

Connect up by inserting two ¼-in. rods through 5UA and 5UB. These rods may be either screwed rod, or plain rod with the ends threaded for ¼-in. B.S.F. nuts. The two inner nuts should be screwed well on at first and the whole is tightened up by means of the outer nuts. Lock up by holding each outer nut and screwing the inner nut out against the former.

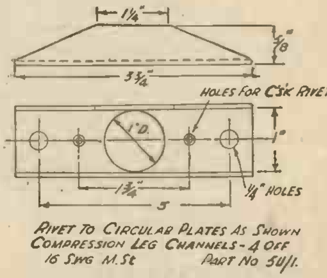


Fig. 3.—The channel fitting, four of which are required.

Now, and not before, the end of the smaller, inner tube may be slightly flattened to ⅝ in. and fitted with a ¼-in. inside diam. tube, welded in position.

A smart finish may be obtained by means of a plywood fairing (Fig. 4). This consists of two spruce formers, the top one of which is recessed to fit over fitting 5UB, and is held in position by means of screws through from the steel disc. The other former is threaded on to the 1-in. tube, on which it is an easy sliding fit, just below 5UA. The plywood covering, 1 mm. thick, may be glued to the lower former, but screwed to the top former for ease of removal.

We now come to the axles, 4U (Fig. 5). The length of each axle, at the centre line, is about 7 in., but will depend to some extent

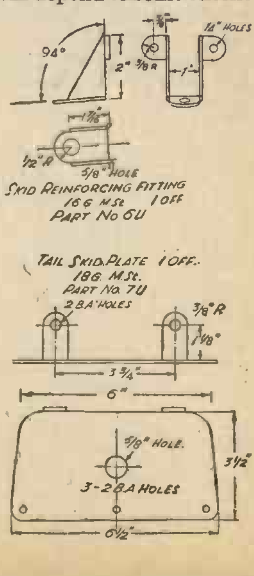


Fig. 7.—The skid plate and reinforcing fitting.

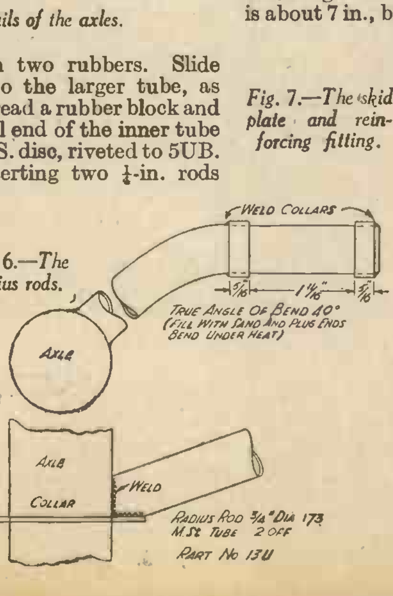


Fig. 6.—The radius rods.

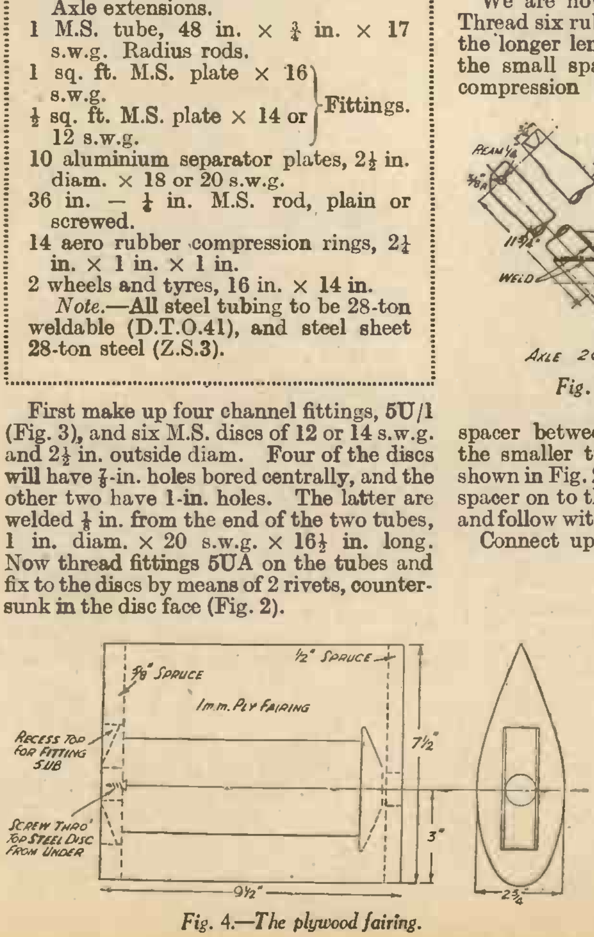


Fig. 4.—The plywood fairing.

on the wheel hub width. One bevel cut is sufficient for both axles. The bevel end of the axle is drilled and filed to receive the 1-in. extension tubes, these being welded in position, top and bottom. Flatten the top ends of the extension arms to $\frac{3}{4}$ in., shape as shown, and drill for $\frac{1}{4}$-in. bolts.

Note that the axle tube should be not less than $\frac{1}{100}$ in. under the wheel hub. diam., and the wheel should be very free to rotate, or a seizure will undoubtedly occur when taking off or landing, with unpleasant results.

Cut a steel disc 2 in. larger than the axle in diam. and weld on the outer face to the axle, taking care to get the disc exactly perpendicular to the latter. Also cut a steel web to insert between the disc and axle extension tube. This may be made from a piece of mild steel, $\frac{1}{4}$ in. thick, or from two pieces of 12 or 14 s.w.g. steel plate. Weld along the three edges and drill a $\frac{1}{4}$-in. hole as shown.

A 16 s.w.g. washer, of diameter $\frac{1}{2}$ in. larger than the wheel hub, is threaded on the axle after the wheel, followed by a $\frac{5}{16}$-in. collar, which is bolted to the axle by a 2 B.A. bolt. When all is complete this bolt should be locked by riveting the head or by some other suitable means.

The axles and compression legs should be pinned temporarily in position, and carefully trued up. The radius rods, 13U (Fig. 6), are bent through 40 degrees, under heat, then cut to length and shaped. $\frac{5}{16}$-in. collars are welded, $1\frac{11}{16}$ in. apart, to match with the attachment fittings, 12U, and the lower end of the radius rod is welded to the axle and collar.

Apart from fitting up, the undercarriage is now complete.

The Tail Skid

Before fitting the tail skid, which is of spring steel and tracking, the skid plate 7U and reinforcing fitting 6U (Fig. 7) should be made. These fittings should be made together to ensure proper matching up. A spruce packing piece, say 3 in. × $\frac{3}{4}$ in., is glued between the bottom fuselage longerons at the stern, and a good job is made by gluing a further piece of $\frac{1}{16}$-in. plywood, 3 in. × 6 in. or so, across the top of the packing block and longerons. Fit 6U and 7U in position and drill the $\frac{5}{8}$-in. holes. A steel tubular sleeve, 1 in. long × $\frac{5}{8}$ in. o/d. × 17 s.w.g. is welded to fitting 7U and passes up through the packing block and into the $\frac{5}{8}$-in. hole in 6U. The sleeve is not fixed to

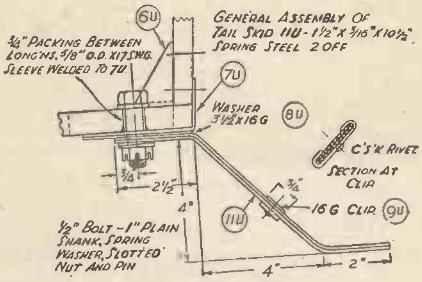


Fig. 8.—The tail skid.

6U, but should be just flush with, or slightly below, the top face. A $\frac{1}{2}$-in. bolt, 2 in. long with 1-in. plain shank, is welded to 6U. Fittings 6U and 7U may now be fixed in position by means of bolts.

The tail skid (Fig. 8) consists of two thicknesses of $\frac{3}{16}$ in. × $1\frac{1}{2}$ in. spring steel, bent to the required shape. This should be done by an experienced blacksmith, who will properly temper the springs after bending. (Luton Aircraft supply skids properly shaped, or will carry out the necessary work on customers' springs.)

The two leaves are held together by means of a small 16 s.w.g. clip, 9U, which is riveted to one leaf only with a countersunk rivet, leaving the other leaf free to slide over the former.

Insert a 16 s.w.g. washer, $3\frac{1}{2}$ in. in diam., between 7U and the skid, the whole being held together by means of a slotted nut and split pin, together with a spring washer. The top horizontal tail decking may now be fixed in position on the fuselage, assuming the tail plane and rudder attachment fittings have all been locked in position. The exposed part of the stern post is also faired off forward by means of two spruce formers, ply covered, so as to form practically a half-cylinder. The tail and elevator should be placed in position to obtain the correct thickness of this fairing. It should nicely clear the similar fairing at the elevator gap. This fairing greatly stiffens the stern post, decreases head-resistance, and improves the appearance.

TAIL SKID MATERIALS

- Spring-steel strip, $\frac{3}{16}$ in. × $1\frac{1}{2}$ in. × 21 in.
- M.S. plate, 18 s.w.g. × 6 in. × $6\frac{1}{2}$ in.
- M.S. plate, 16 s.w.g. × $3\frac{1}{2}$ in. × 10 in.
- M.S. bolt, $\frac{1}{2}$ in. × 2 in. × 1 in. shank, with slotted nut.

CONTROL SYSTEM MATERIALS

- M.S. tube, $\frac{7}{8}$-in. or 1-in. diam. × 18 or 20 s.w.g. × $5\frac{1}{2}$ ft. for control column, cross-tube, and rudder bar.
- M.S. tube, 1 in. or $1\frac{1}{8}$ in. diam. × 17 s.w.g. × 2 in. for 3C.
- M.S. tube, $\frac{1}{4}$ in. i/d. × $1\frac{1}{8}$ in. long for 1C.
- M.S. tube, $\frac{1}{2}$ in. i/d. × $1\frac{1}{8}$ in. long for 6C.
- M.S. plate, 16 s.w.g. × 1 sq. ft.
- M.S. plate, 18 s.w.g. × 6 in. × 6 in.
- M.S. plate, 12 or 14 s.w.g. × 9 in. × 3 in.
- Aluminium pulleys, 2 in. or 3 in., 2 in addition to 6 wing pulleys.
- 10-cwt. flexible steel cable (aircraft).
- 10-cwt. turnbuckles, 9.
- 10-cwt. steel shackles, 18.
- Aluminium tubing for fairleads, $\frac{5}{16}$-in. diam., 6 ft. length.

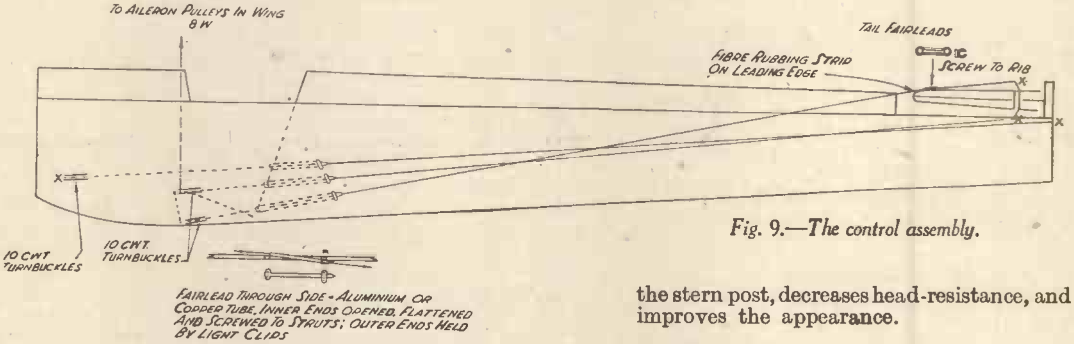


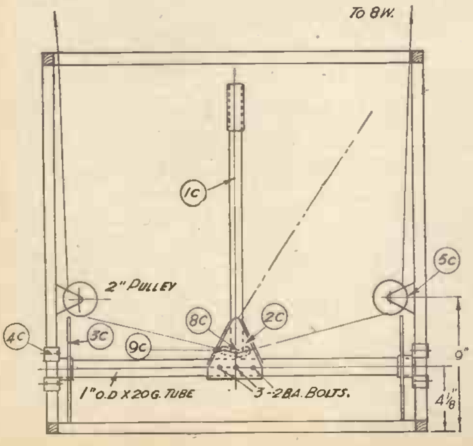
Fig. 9.—The control assembly.

The Control System

The control assembly layout is shown in Fig. 9, the control column and rudder bar being shown in more detail in Figs. 10 and 11 respectively. The various items are shown detailed in Fig. 12.

The bend in the control column is done in order to move the hand-grip farther forward from the pilot's seat. The bending should be done with the tube red hot, it having been previously filled with sand and the ends plugged. Bend very carefully and avoid crinkling of the metal. When bolting the elevator levers to the ends of the cross-tube they should not be vertical, i.e. parallel to the control stick, but should slope forward so that the bottom hole in the lever is approximately 1 in. to the rear of the cross-tube centre line.

The aileron actuating cables run from the control column base, over pulleys at 5C and



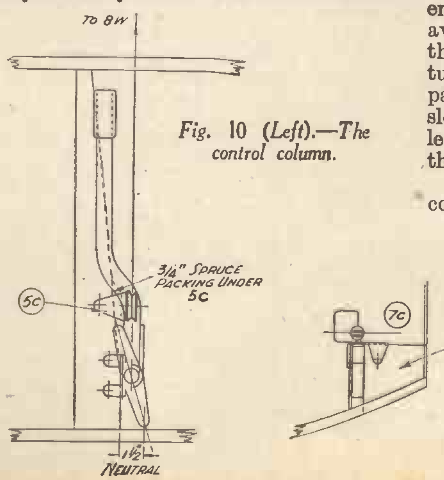


Fig. 10 (Left).—The control column.

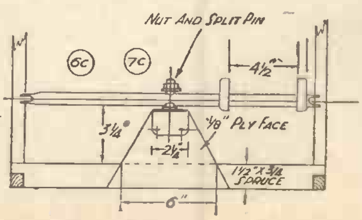


Fig. 11.—The rudder bar.

up to pulleys 8W in the wing and thence to the *top* aileron levers via the outer pulleys. The aileron balance cable (already dealt with) connects directly across the bottom aileron levers via the appropriate pulleys; 10-cwt. turnbuckles are inserted between the cables and both top aileron levers, and one bottom lever.

Turnbuckles attach to both ends of the rudder bar and to both ends of each elevator control lever. The cables pass out from the fuselage just to the rear of the pilot's seat, suitable fairleads being made from $\frac{5}{16}$-in. aluminium tubing and screwed to the two diagonal struts there. Short tubular fairleads may be similarly attached to the top of tail-plane ribs to prevent the elevator cables from rubbing the tail plane, and if necessary small fibre discs may be screwed to the tail leading-edge for the same purpose. The control cables should be threaded through all tubular fairleads before splicing has been done at both ends. Failing this it becomes necessary to cut open the fairleads along their length for insertion of the cable.

The pins holding the aileron cables to the link plates, 9C, should be provided with safety pins for ease of release for dismantling. The same applies at the rudder and elevator cable connections at the rear.

Types of Engine

Almost any type of engine of about 30 B.H.P. is suitable for use in the "Minor," provided the weight is not much greater than 100 lb. If the engine weight, including radiator and water in the case of water-cooled engines, approaches 150 lb. it becomes necessary to instal the wing tank in place of the fuselage fuel tank, and the pilot's seat may have to be moved back through a distance of 3 in. or so.

It is strongly recommended that engines should comply with the following brief specification:

1. Weight not exceeding 125 lb.
2. Maximum power not less than 30 B.H.P.
3. Revolutions at 30 H.P. to be not more than 3,000, unless drive is geared.
4. Dual ignition.
5. Reliability of a high order.
6. Air-cooled for preference.

The selection of the power unit to comply with this simple specification, and available at a reasonable price, is not altogether easy. Messrs. Luton Aircraft have tried out almost every type, and eventually it was decided to take the Anzani V-twin air-cooled engine as a basic power unit, to redesign certain parts that had given trouble, and to equip the improved version with dual ignition and an impulse starter.

The original Anzani engine was fitted to the winning machine in the 1925 International Light Aeroplane Competitions at Lympne, so that it is by no means a new and untried product.

PARTICULARS OF THE LUTON-ANZANI 35-H.P. ENGINE

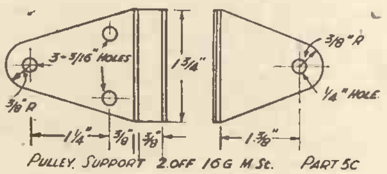
The Luton-Anzani is an air-cooled V-twin, having 4 overhead valves with duplex springs per cylinder. A special shock-absorbing mounting is provided.
Capacity, 1,100 cc. Bore, 83 mm. Stroke 101·5 mm.
Lubrication by gravity to mechanical pump.
Weight—100 lb. single ignition.
105 lb. dual ignition.
Power—35 H.P. maximum at 3,150 r.p.m.
21 H.P. at 2,000 r.p.m. normal cruising.
28 H.P. at 2,600 r.p.m. high-speed cruising.
Price—complete with dual ignition, impulse starter, and airscrew hub . . £65 10 0
single ignition, impulse starter, and airscrew hub £60 0 0
"Minor" Anzani airscrew £6 4 0

Development of the Luton-Anzani 35-H.P. Engine

One of the main obstacles facing the constructor of an ultra-light aeroplane is the lack of suitable and reliable engines. Perhaps the chief cause of the apparent unreliability of small engines is the prevalent tendency of pilots to keep the engines running at speeds very close to their maxima. This is more than is expected from large aero engines, and certainly the small, relatively cheap engine should not be called upon to undergo such severe treatment.

It is true that light single-seaters can be flown successfully with an engine horsepower of 20, or even less, but the difficulty comes when a rapid climb has to be made in order to avoid some obstacle, and this is an important point that is seldom given sufficient consideration. Bearing in mind the low efficiency of airscrews of small diameter revving at high speed, figures of 20 and 30 H.P. should be regarded as the absolute minima for cruising and top speed conditions, and these should correspond to engine speeds of roughly 2,000 and 3,000 r.p.m., or preferably less.

The 34-H.P. Anzani air-cooled V-twin



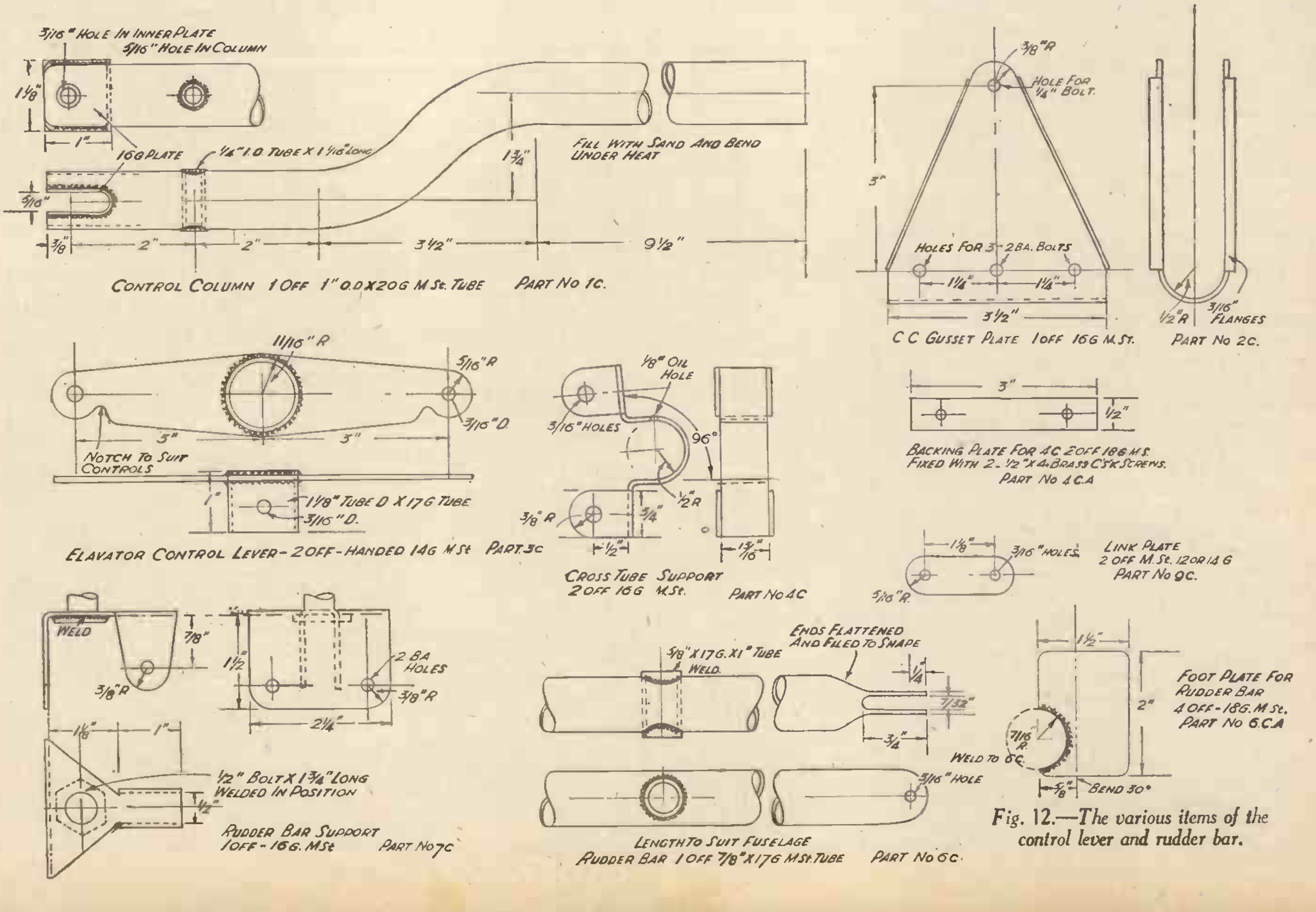


Fig. 12.—The various items of the control lever and rudder bar.

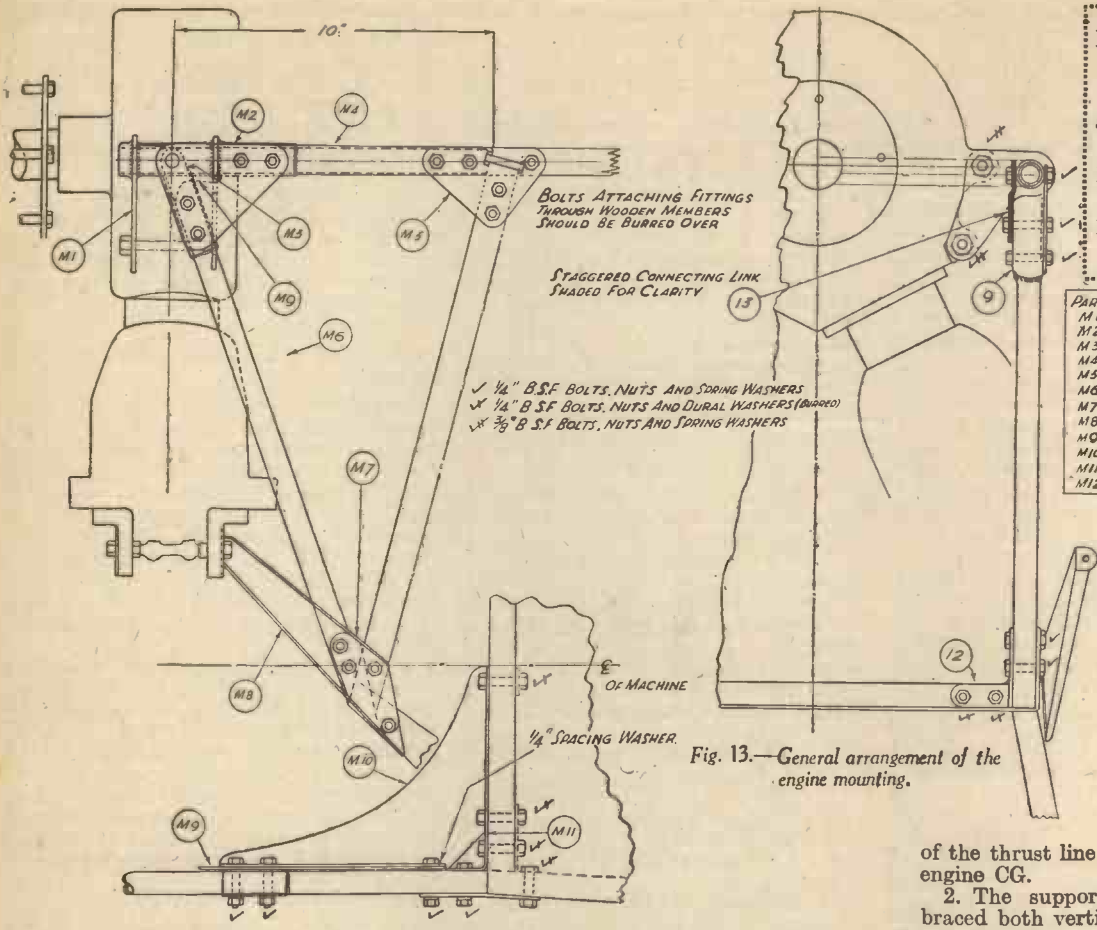


Fig. 13.—General arrangement of the engine mounting.

MATERIALS REQUIRED FOR ENGINE MOUNTING (ANZANI)

5 ft. M.S. tube, ¾ in. o/d. × 17 s.w.g.

1½ ft. M.S. tube, ⅞ in. o/d. × 17 s.w.g.

1 sq. ft. M.S. sheet, each 12, 14, 18, and 20 s.w.g.

Part No	Description
M1	Housing
M2	Housing Plate Outer
M3	Connecting Link
M4	Top Bearer Tube
M5	" " Attacht Plate
M6	Diagonal " "
M7	" " "
M8	Lower Bracing Plate
M9	Housing Plate Inner
M10	Upper Bracing Plate
M11	Top Corner Fitting
M12	Bottom " "

Engine Mounting

Since the Luton-Anzani engine has now been adopted as standard, the mounting for this engine will be described.

The following points should receive careful consideration in the mounting of any other engine :

1. Support the weight close to the intersection of the thrust line and vertical through the engine CG.

2. The supporting structure must be braced both vertically and horizontally to prevent rotation of the engine relative to the fuselage.

3. Attach the support members to nodes, or joints, in the fuselage structure, attach-

appears to meet with the above requirements and has been extensively used by Luton Aircraft, Ltd., in their "Buzzards," "Minors," and other light aeroplanes during the last few years. Unfortunately, although in many ways the Anzani "met the bill," the reliability of this engine has not been all that might be desired, and Luton Aircraft accordingly set out to overcome the weak points that their accumulated experience had brought to light.

It was decided, therefore, to completely redesign all working parts that had given trouble during the many flying hours with this type of engine, and as a result roughly half the working parts have been either completely changed or modified. After assembly the new engine was subjected to a systematic series of tests, lasting over several running hours, which culminated with 30-minute periods of continuous running under load at progressively increasing speeds, viz. 2,000, 2,250, 2,500, and 2,650 r.p.m.

The engine was examined after each test, and whereas previously certain adjustments, notably of the valve tappet clearances, had to be made after almost every flight, no modification has been found necessary throughout the whole of the tests, beyond slight adjustment after the initial settling down.

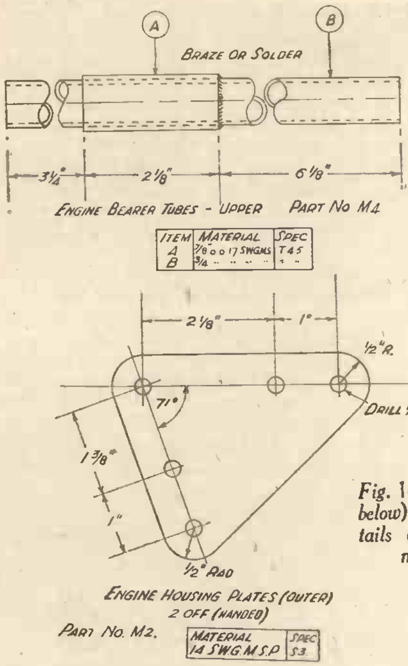
Although reliability was the chief quality sought, the running has been improved in other respects, and the smoothness is very noticeable. There is a slight increase in maximum power, whilst the slow-speed running is now particularly good, the engine ticking over at 100 r.p.m.

The Luton Anzani is now available with either single or dual ignition with impulse starter, and in the latter form a remarkably good unit has been made available at a very moderate price. Existing Anzani engines can be modified to conform with the new specification.

PRICES OF MATERIALS AND PARTS

	£	s.	d.
Undercarriage materials (metallic) as specified . .	1	0	0
Aero rubber compression rings, 14	1	0	0
2 wheels, tyres, and tubes, 4 in. × 16 in. . .	4	0	0
Complete set undercarriage materials, as above .	6	0	0
Pair axles, made up, complete	2	10	0
Pair compression legs, made up, complete with rubbers	3	10	0
Pair radius rods, made up, ready to attach . .	1	0	0
Complete undercarriage, with wheels . . .	11	0	0
Add for fairings . .		10	0
Tail skid spring steel. . .		2	0
All tail skid materials, as detailed . . .		4	6
Tail skid made up, with clip		9	6
Fittings 6U and 7U made up		7	6
Contol System, steel tube and sheet . . .		9	0
Pulleys, 8 at 1*s*. each . .		8	0
170 ft. 10-cwt. cable . .	1	10	0

	£	s.	d.
9 turnbuckles, 10-cwt. at 8*d*. each . . .		6	0
18 steel shackles, 10-cwt. .		3	0
6 ft. aluminium tubing, $\frac{5}{16}$-in. diam.		3	0
Complete set control system materials and pulleys .	2	15	0
Control column, cross-tube, and gusset plate, made up		18	0
Rudder bar and footplates, made up . . .		14	0
2 elevator levers . . .		8	0
Fittings 4C (2), 4CA (2), 7C, 9C (2), and 5C (2) . .		18	0
Control system, complete, comprising last 4 items, 170 ft. cable, 9 turnbuckles, 18 shackles, 8 pulleys, and 6 ft. aluminium tubing . . .	5	5	0
Engine Mounting Materials, comprising M.S. tube, 5 ft. × ¾ in. × 17 g., and 1½ ft. × ⅞ in. × 17 g., together with 1 sq. ft., each of 12, 14, 18, and 20 g. M.S. plate . . .		15	0
Complete set of fittings, tubes, etc. (24), made up .	3	7	6



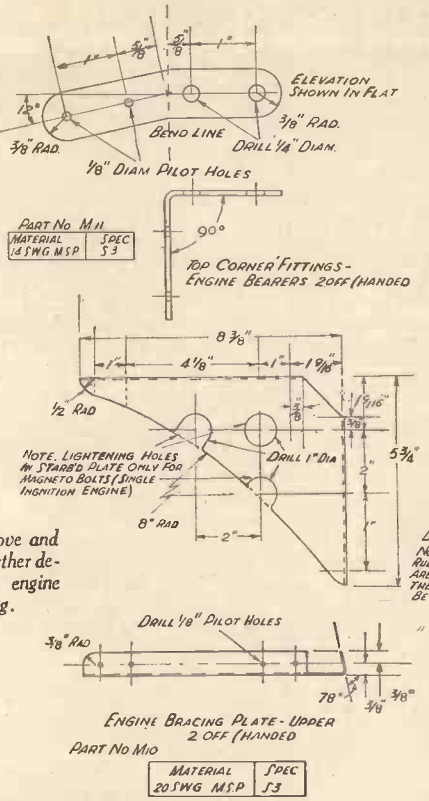
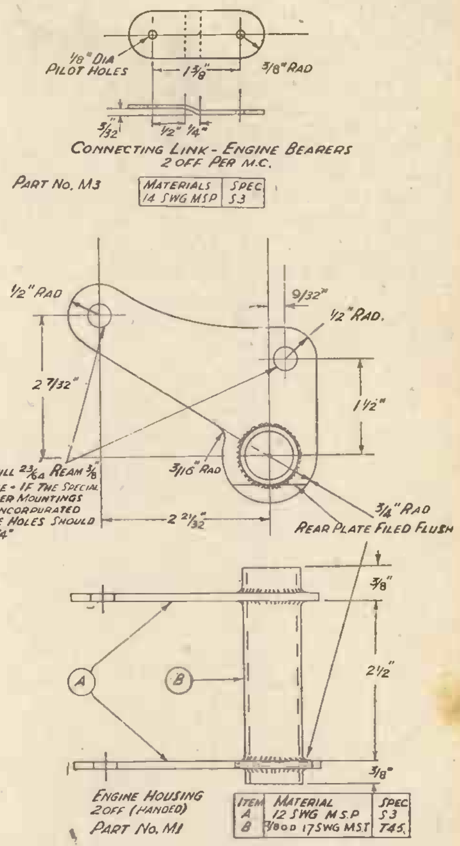


Fig. 14. (*Above and below*).—*Further details of the engine mounting.*

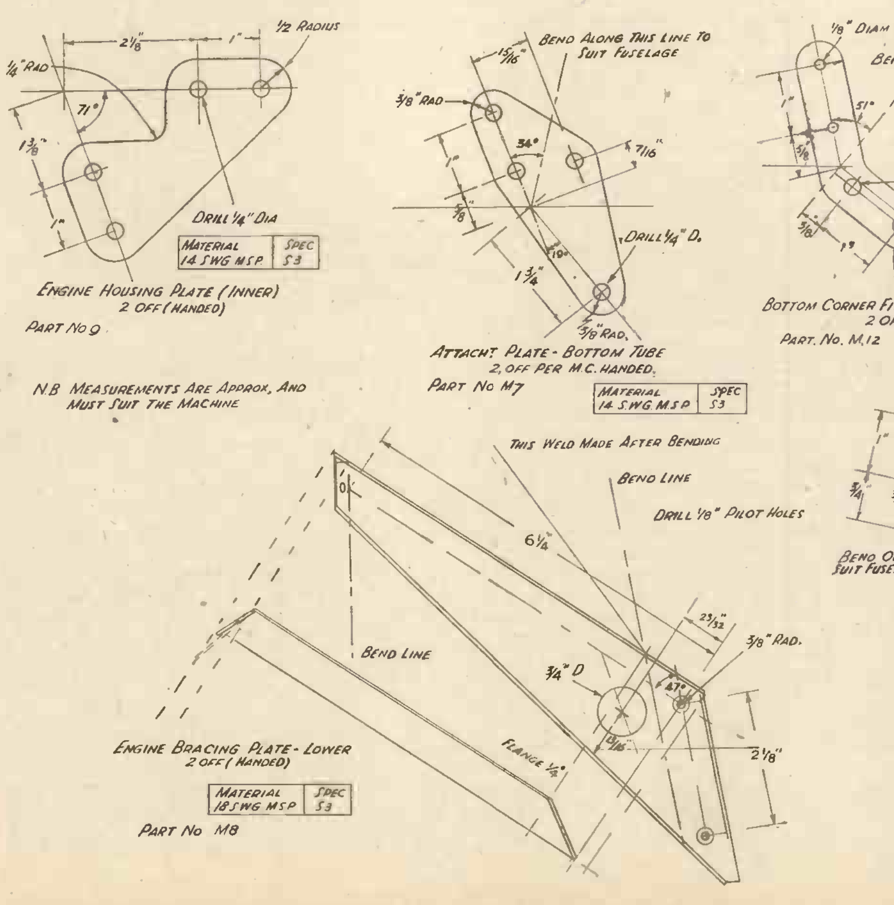


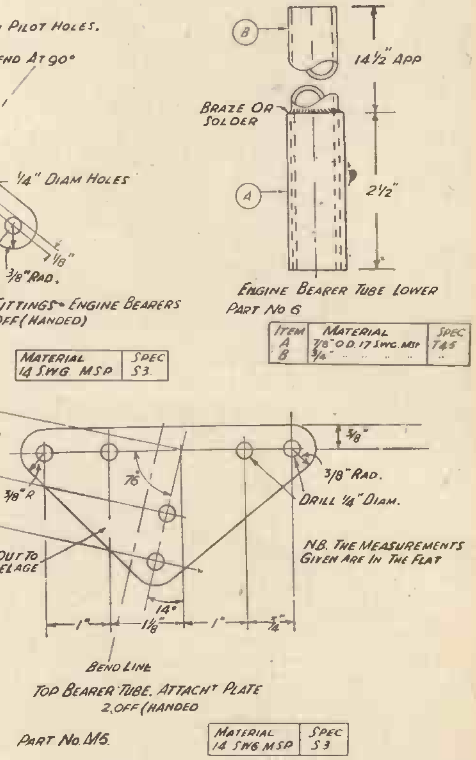
ment being made to the longerons where possible.

4. Provide shock absorbers which will allow slight rotation of the engine in a plane parallel to the airscrew disc.

The general arrangement of the engine mounting is shown in Fig. 13, the details being given in Fig. 14. A horizontal tube, M4, is fixed parallel with the top longeron, on to which sleeves a cradle, M1, which bolts to the two crankcase lugs with ⅜-in. bolts. In the case of the engine being fitted with the special shock absorbers, ¼-in. bolts are used, and care should be taken to see that these bolts are only just tight. Fixing is then done by means of slotted nuts and split pins.

The engine weight is supported by side tubes, M6. The support tubes are held to





the cradle by means of side plates, M2 and M9, together with a small joggled link, M3. By releasing one side bolt the engine may be slipped forward off the horizontal support for dismantling.

(*To be continued*)

PHOTOGRAPHING SOUND

PHOTOGRAPHING sound is the latest departure in the WLW sound department.

For months Don Winget Jr., experimented in an effort to reproduce over the air a "natural" gunshot. Various guns of several types were used but in each case the sensitive microphones failed to give the critical effect desired.

In the old days of radio a slapstick was used. This is accomplished by striking a leather cushion with a rod. That method, however, imitated the impact without retaining the reverberation which is necessary, Mr. Winget explained, if the sound is to be natural to the ear.

Sound Recording Camera

After months of research Mr. Winget and Arthur Young of the Crosley Radio Corporation laboratories announced completion of a sound-recording camera. By using the shadowgraph method the apparatus takes pictures at one-ten millionth of a second, believed to be the fastest device of its kind. Bullets were photographed in various stages. When the collection of films was developed Winget and Young found they had recorded the complete sound of gunshots.

"We shoot an average of 1,000 shots a month in various programmes," said Mr. Winget. It is very difficult to get the effect over the air. The same analysis applies to riveting and similar machines and any high level sound, such as explosions, thunderclaps and so forth.

"Our only idea in reproducing the correct sound was to analyse it. We have analysed, with our electric camera, the various sound components of a gunshot. By removing the initial high impact we still leave unimpaired the reverberation and aftertone which is the characteristic sound of a shot."

Mechanical Filter

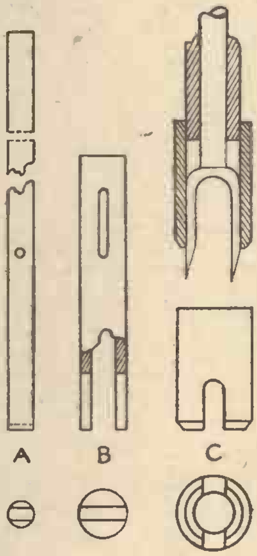
Removing the initial impact and retaining the reverberation of one shot may sound impossible, Mr. Winget explained, but his department has accomplished the feat by constructing a mechanical filter which absorbs the initial impact but leaves the reverberation unimpaired.

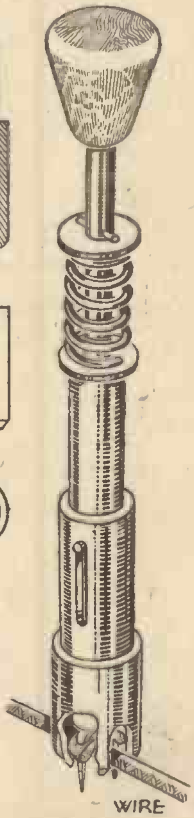
The electric camera has been used in photographing sound waves of various other devices and will mean that radio sound technicians at WLW will be able, by analysis, to reproduce naturally on the air virtually every sound.

A STAPLE-DRIVING TOOL

STAPLES smaller than ½ in. require patience and are extremely awkward to place into position before they are driven home. Here is a design for a tool which will make the work considerably easier, and allows the staples to be quickly inserted even in extremely awkward corners.

The device consists essentially of a holder, made from two pieces of tube, with a solid rod passed down through the centre, which pushes the staple into position, as shown in Fig. 2, details being given in Fig. 1. A piece of steel tube *B* should be selected having an outside diameter a few thousandths larger than the head of the staple. The legs of the staple will not be parallel, and will have sufficient spring to enable them to hold in the tool. A slot is cut across the end of the tube deep enough



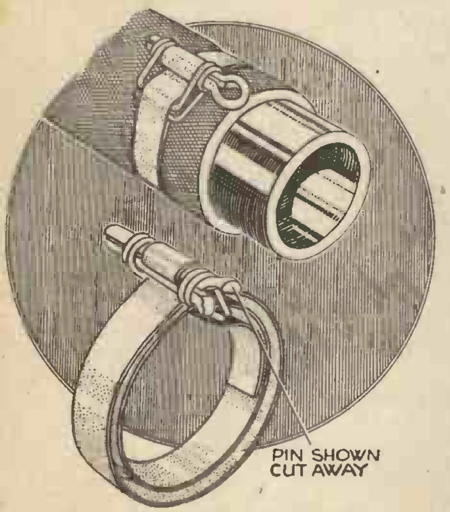


Figs. 1 and 2.—The method of constructing and using the staple-driving tool.

to take the full length of the staple. A second slot is cut up the tube to take a spigot inserted into the driving pin.

The larger tube *C* fits over the end of the tube *B* and is either driven on or soldered into position. The slots which are cut wide enough to clear the wire, are placed at right angles to the slot in the tube *B*. The driving pin *C* is a good sliding fit inside the main tube and has a spigot tapped into it, which passes out through the slot in the main tube and prevents the pin being driven from the tube by the return spring, and also prevents the pin being driven down so far that the wire which is being fixed by the staple, is crushed. The inside end of the driving pin is filed to fit the head of the staple, and a pressure handle fitted to the other. The details of the return spring can be seen in the illustration of the complete tool, which is shown in use.

A NEW HOSE CLIP



Showing the method of fixing the clip.

THE Perfect Clip Co. have produced a new type of hose clip which is simple to fit and extremely efficient to use. Twenty-four clips are supplied with a spool containing sufficient strip for making twenty-four 2-in. clips.

The illustration on the left shows the clip fitted to a hose and also the method of fixing. As well as being supplied in boxes the clips can be obtained in specific sizes ready for fitting.

An illustrated pamphlet giving full instructions for fixing are enclosed with the clip, so that it is quite a simple matter to attach it to the hose.

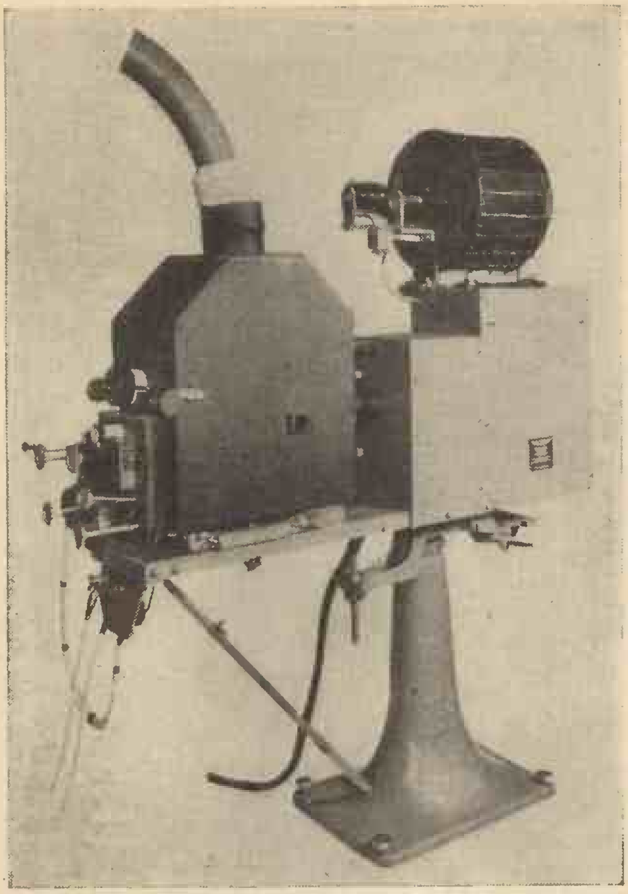
A FINISH FOR WOODWORK

THE following method, recommended by an expert who has for years been handling large quantities of decorated woodwork for the trade, should prove a useful hint to many readers. The work entailed staining and polishing.

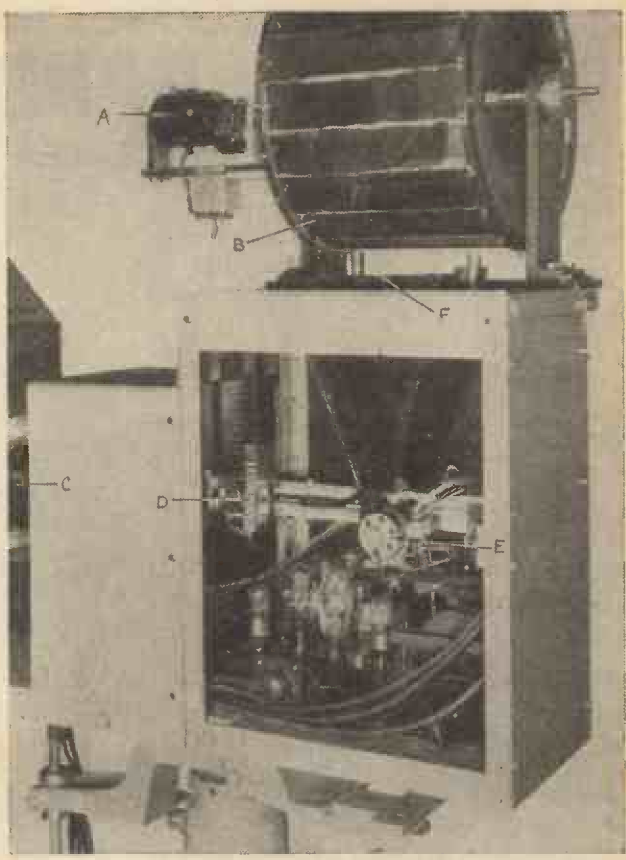
"As a finish to our woodwork it was found that french polishing was too lengthy a process, so a method had to be devised which would give perfect results with the minimum of labour. Much experiment revealed that it was fatal to good results to give too little time to the preparation of the wood before staining. Two grades of sandpaper are therefore used, medium first, followed by the finest quality, which process ensures a satin smoothness. This part of the work is never rushed, and care is taken that no corners are missed.

"Next comes the designing—the outlines of which are burned into the wood. Then the staining process and lastly the polishing. The finish being all-important, many experiments were made, with the result that wax-polishing with Mansion polish proved to give very good results.

"The following method is employed. Two brushes of the shoe-polishing variety are used, one being softer than the other; also a pad of soft, non-fluffy rag. Mansion polish is applied freely with the rag and rubbed well into the grain of the wood. The article is then put aside for ten minutes or so, after which the real work of polishing begins. First the soft brush is used, working with the grain of the wood—never across—with firm strokes and a fair amount of pressure until polish begins to appear. Then with the stiffer brush and with lighter and more rapid strokes a high polish is obtained. A final rub over with a soft rag ensures a really perfect finish."



The Scophony television projector, for use in public halls. This model is for pictures 6 ft. by 5 ft.



Interior view of the Scophony public hall projector, which gives pictures approximating cinema standards of brightness up to 6 ft. in size. The illustration shows the amplifier which drives the light control, and above the amplifier is seen the high-speed synchronous motor.

THE SCOPHONY TELEVISION SYSTEM

Details of the Latest Mechanical Process Which can be used for Home and Theatre Television Picture Reproduction

THE present television apparatus which is available to the public for receiving the television programmes broadcast by the B.B.C. consists of electrical equipment, in which a picture is reproduced upon the end of a cathode-ray tube by fluorescence due to the bombardment of the coating of the tube by an electronic stream. It has previously been stated that only an electrical system could succeed in giving a reproduction of the pictures which are now broadcast, owing to the fact that the system used is known as a "high-definition" system. In the first television system used in this country the picture was divided into 30 lines vertically disposed, and to receive a picture one used a rotating disc having thirty holes, and these travelled across a flat-plate of a neon lamp. The glow of the lamp was controlled by the received picture impulses and the holes in the disc travelling at speed produced lines of light travelling from one side to the other and the flickers of the lamp gave the effect of a picture. In the present system the picture is divided into 405 lines, arranged horizontally, and split into two parts each consisting of 202½ lines, and these are interlaced to form the complete picture. Thus it would appear that no mechanical apparatus could be expected to provide the required speed and light necessary for viewing a picture under normal domestic conditions.

Effect of Light

The size of the holes for the original 30-line system was such that with a convenient size of disc the light was extremely weak. Attempts to overcome this defect were made by using a rotating drum upon which were mounted 30 mirrors at varying angles to reconstitute the picture area and a brilliant lamp was employed in conjunction with it. By passing the light through a form of filter, controlled by the signal, the picture could be built up in a more brilliant manner than the disc apparatus and could be projected on to a small screen, giving a much larger picture than the other system. There were variations of this system, but the principle was the same. A well-known television engineer persisted in his efforts at making a mechanical system to receive the high-definition pictures, and as a result of the researches of the Scophony company, a perfected machine has now been demonstrated in which an optical-mechanical instrument has been used to provide a picture over 6 ft. in height, comparable with a cinema picture, and avoiding many of the difficulties of the electrical or cathode-ray system. In the early days of the high-definition system the size of the picture was limited by the size of the cathode-ray tube employed, and in the majority of domestic receivers this is limited to about 10 in. by 8 in. A larger tube would not only be very expensive—a 12-in. tube giving the 10 in. by 8 in. picture costs £15 15*s*.—but would also be difficult to manufacture owing to the external air pressure. At the date of the recent Radio Exhibition, however, it was announced that two firms, Philips and H.M.V., had succeeded in designing a domestic television receiver in which a picture approximately 2 ft. wide could be obtained. This was accomplished by using a very small cathode-ray tube, upon which a

picture about 1⅝ in. wide was produced. This tube stood vertically at the bottom of a cabinet, and the picture was directed through a lens on to an inclined mirror and so on to the rear of a screen. The number of lines sets a limit to the degree of magnification, and there is also loss of brilliancy. Furthermore, to overcome the latter defect the tube is run at a very high voltage (over 8,000 volts) and its life is thus of short duration.

The Scophony System

In the Scophony system some interesting features are to be found. Firstly, the light-source is a standard electric arrangement—in the domestic receiver a small cinema projection lamp, and in the cinema or large hall model a standard cinema arc system is utilised. The light is directed on to a quartz crystal and this is mounted at the end of a tube filled with a special liquid. The viscosity of this liquid and its other characteristics are so chosen that when a radio-frequency oscillation is applied to the crystal waves are set up in the liquid, and the speed of these waves may be calculated from the specila nature of it. Immediately in front of the crystal is a bar so situated that, if no R.F. impulses are applied to the crystal, it prevents the light from being thrown forward. In front of the bar is a condenser and lens, and when an R.F. is applied to the crystal the waves caused through the liquid result in the light being spread out or leaking over the edge of the bar and being thus directed on to the second lens assembly. In front of this assembly is a polygon scanning element made from stainless steel, rotated by a synchronous motor, the speed being adjusted to keep in step with the oscillations through the liquid, and thus it is possible, by applying the television signal to the crystal, to obtain the necessary picture light and shade variations. This motor is kept in step and controlled by the line frequency broadcast by the B.B.C. and the light which is caught by the rotating scanner is projected in an upward direction, through a further lens on to a rotating mirror drum—similar to the old low-definition apparatus.

Synchronisation

This drum is also turned by a synchronous motor, and it provides the picture-repetition frequency. The relationship between the speed of the two motors, and the number of mirrors on the drum and surfaces on the scanner ensure perfect interlacing and synchronism with the transmission, and as the motors are synchronously controlled it is essential that the transmission should also be similarly controlled. Previously, difficulties were experienced due to the fact that the B.B.C. time-bases varied, and representations were made to the Television Advisory Committee, as a result of which the B.B.C. apparatus was modified and now functions in such a manner that this new mechanical system may be employed. The advantages claimed are, larger picture (the domestic model at present being put into production provides a picture over 2 ft. in width), low voltages compared with the electrical apparatus (the maximum voltage in the Scophony receiver is 350 compared with over 1,000 in the standard cathode-ray apparatus), and ease of control.

Two views showing the attractive appearance of the finished set.

THE P.M. 1938 S.W. THREE

Further Operating Notes and Hints for Obtaining Maximum Results on all Wavebands

THE brief operating details given in last month's issue should enable the majority of those who have built this receiver to obtain a number of stations without any difficulty. Unfortunately, short waves are not so simple to control as the ordinary waves such as are used for the normal broadcasting in this country. It should be remembered that the short waves are at high frequency. The term "wavelength" is, unfortunately, a rather obscure term and leads many listeners into pitfalls which would be avoided if the use of the term "frequency" were more commonly adopted. A wavelength is the distance from the crest of one wave to the crest of the next—it being remembered that the signal which is radiated from a transmitting aerial sets into motion the substance known as the ether, and it travels in all directions from the aerial in a series of waves. Obviously, therefore, if the distance between succeeding waves is short, the rapidity of the oscillations forming the wave will be greater than when the distance between the waves is greater, and thus as we go down the wavelength scale the frequency increases. You will see from the details of broadcast stations that a wavelength of 300 metres, for instance, coincides with a frequency of 1,000 kilocycles per second, whilst 30 metres is 10,000 kilocycles per second. The higher the frequency the more difficult it is to control the oscillations, and the slightest barrier to the path of the currents will result in their trying to find a quicker way to earth. Therefore one of the first things to do in order to get maximum efficiency from a short-wave set is to make certain that all the signals which arrive at your aerial pass through your tuning circuits, and insulation of the aerial is the first and most important thing.

Aerial Sizes

Do not imagine that because you wish to pick up signals from the farthest part of the globe that you need the largest possible aerial. A large aerial will only lead to difficulties, and for general short-wave results a horizontal aerial suspended between the house and a pole in the garden, with a length of about 30 feet, will be found adequate. Use a good chain of insulators at each end, and where the lead-in enters the house leave a substantial space between it and the leading-out wire for the earth. Use insulated wire for the earth lead, preventing the bare earth wire from coming into contact with anything until it enters the earth, and at this point attach it to a large plate of metal buried in ashes or some other medium which will retain moisture. With such an aerial-earth system this little receiver should give you all that you need in DX or distant reception.

Mount the Clix L.S. panel which was specified on the side of your cabinet and connect as per the maker's instructions, but instead of a loudspeaker use a pair of the Ericsson 'phones which are specified. If you then switch over to the 'phones you will be able to make your first search of the ether in a more satisfactory manner. Remember that although a good dial is employed on the condenser, and that band-spreading is employed, you can still miss a station.

Tuning the Set

The process of tuning should be carried out in this way. Turn the reaction control (lower centre) anti-clockwise as far as it will go, set the left-hand (band-setting) dial to 0, and then, reaching round to the back of the set, turn the control mounted there until you can hear a rushing noise in the 'phones. If you carry this adjustment too far a loud whistle will be heard and you will then be unable to hear speech or telephony and will only be able to hear C.W., or continuous-wave code signals. When you hear the rushing, turn the reaction control and note whether there is a gradual build up until the set bursts into oscillation. This should occur when the condenser is nearly in its maximum (clockwise) position. If you cannot obtain oscillation at maximum turn up the rear control slightly, and you should be able to find a position where the rear control may be left entirely alone, and all reaction carried out by means of the front control. If this is not found possible, and all wiring is in order, modify the aerial connection as mentioned last month by connecting a short length of wire to the aerial terminal and twisting this round the aerial lead, not permitting bare wire to come into contact. The capacity so formed should be adjusted until the desired reaction control can be obtained. Having found this, leave the main condenser at 0 and slowly turn the band-spreading condenser (right-hand control) through its entire range. You may not find any signals at this point at the first trial, and therefore the main dial should be turned to the fifth division (the short line between 0 and 10) and the right-hand control again turned through its complete movement. The capacities of these two condensers have been so chosen that the right-hand control spreads out the dial readings of the left-hand control and thus "splits up" the tuning, giving a much better effect than can be obtained with the best type of slow-motion drive. Proceed in this way through the entire scale of the left-hand control and you should be able to get stations at all points, but remember that the amateur transmissions are on certain bands of frequency and between these you will hear only commercial broadcasts such as Press, police, and other special transmissions. As mentioned last week, with the coils which we specify you will be able to hear the 16-metre band on the small coils and the 40-metre band on the larger

One S.W. Condenser, Type 2043	J.B.
One Midget U.S.W. condenser, Type 2141	J.B.
One L.F. Transformer—Niclet	Varley
One 50,000-ohm potentiometer	Bulgin
Two 4-pin Chassis-type Valve-holders (Type VI)	Clix
One 7-pin Chassis-type Valve-holder (Type V6)	Clix
One 6-pin Coil Base	B.T.S.
Two ·002 mfd. Tubular Fixed Condensers	T.C.C.
One ·0001 mfd. Tubular Fixed Condenser	T.C.C.
One ·1 mfd. Tubular Fixed Condenser	T.C.C.
One Reaction Condenser, ·00015 mfd.	B.T.S.
One 1-meghom Grid Leak	Dubilier
One 3-meghom Grid Leak	Dubilier
One 40,000-ohm 1-watt Resistor	Dubilier
One 100,000-ohm 1-watt Resistor	Dubilier
One A.E. Socket Strip	Clix
One L.S. Socket Strip	Clix
One 4-way Battery Cord	Belling-Lee
One 6-pin Low-loss Coil (Type to suit wave-length, or a set may be obtained)	Eddystone
One 7-pin HP215 valve	Hivac
One 4-pin P220 Valve	Hivac
One 4-pin L210 Valve	Hivac
One Metallised Chassis, 10 in. by 8 in. by 3 in.	Peto-Scott
One Metal Panel, 10 in. by 8 in.	Peto-Scott
One pair Ericsson 'phones	
One Clix L.S. Panel	
One 120-volt H.T. Battery	Exide
One 2-volt L.T. Accumulator	Exide
One 9-volt G.B. Battery	Exide

coils, but you must be very careful in choosing your times of listening on the various bands. Thus in the early evening, just before darkness falls, the 16-metre band will be most suitable in ordinary climatic conditions, whilst after dark the 40-metre band should be employed.

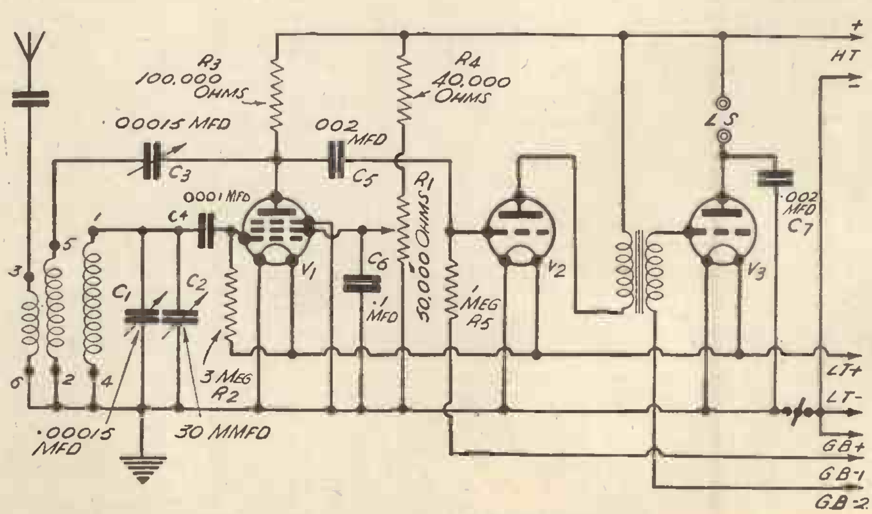
If you find atmospherics are too bad on one waveband you can try one of the others, as the majority of long-distance short-wave broadcast stations usually transmit on two or three bands, and very often employ beam or directional transmission. This means that you will probably be unable to hear, for instance, a German transmission beamed on Africa if you live in the Midland district of England, whilst American transmissions beamed on England will come in almost as loudly as the B.B.C. programmes when conditions are favourable.

Directional Aerials

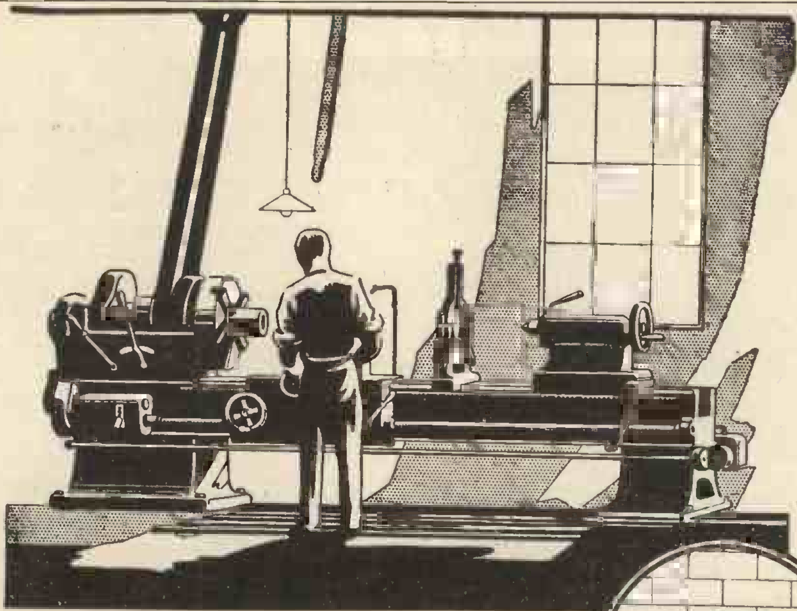
When you have become used to the method of tuning you may find that signals from some continents come in better than others, and when you have used the set for some time and are certain that such results are not due to climatic conditions, you may find it worth while to modify your aerial so that it is directional to the weaker stations, and this will give you an increase in signal strength. In this connection a good atlas and a compass will be of great use, as you will be able to confirm that your present aerial is non-directional to that continent and make the necessary modification. A vertical aerial is non-directional and should pick up stations from all directions equally well, but support it well clear of the walls of the house, use thin copper tubing, and a total length of from 10 to 15 feet will be found best. Solder the lead-in to the lower end of the aerial and let this be as near the set as possible, so that the lead-in does not play any part in picking up the signals.

Interference

If you live near a main road you may find that interference is experienced from car electric equipment when cars pass your house. In such a case the aerial should be placed as far from the roadway as possible, and if this results in an extra-long lead to the receiver, a special type of screened cable should be used—otherwise the lead-in will pick up the interference. To avoid the losses introduced by such a length of screened wire, a special type of transformer should be joined at the receiver end and at the aerial end. These transformers, together with the screened cable, may be obtained from your local dealer or direct from such firms as B.T.S., Belling-Lee, ect. They are known as anti-interference aerial equipment, but should be employed only when interference is experienced from local electrical apparatus. It is possible to use over 100 feet of the screened lead-in without loss, and this often enables the aerial to be so placed that all local interference is completely eliminated and signals obtained with a clear background.

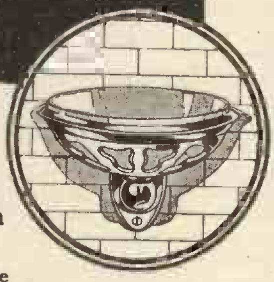


The Circuit which is employed in the P.M. 1938 S.W. Three.



For every fixing job LARGE OR SMALL use RAWLPLUGS

RAWLPLUGS will enable you to fix any article quicker and neater, no matter what kind of material you wish to fix to. For heavy work, such as fixing machinery, large-size Rawlplugs (Nos. 20-30) with coach screws should be used.



If you want to fix a sink or cistern, there are medium-size Rawlplugs (Nos. 10-18), and for small household articles, such as a soap dish, there are the small Rawlplugs (Nos. 3-8). There is a Rawlplug for every size of screw or coach screw. Anyone can use Rawlplugs; no previous experience required. Sold by Ironmongers, Stores, etc., in complete Outfits at 1/6, 3/6 and 5/6.

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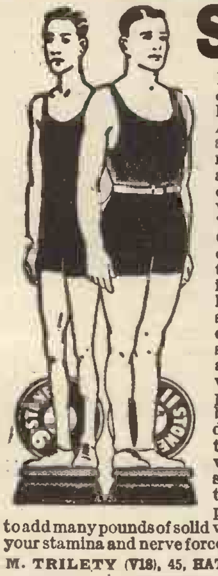

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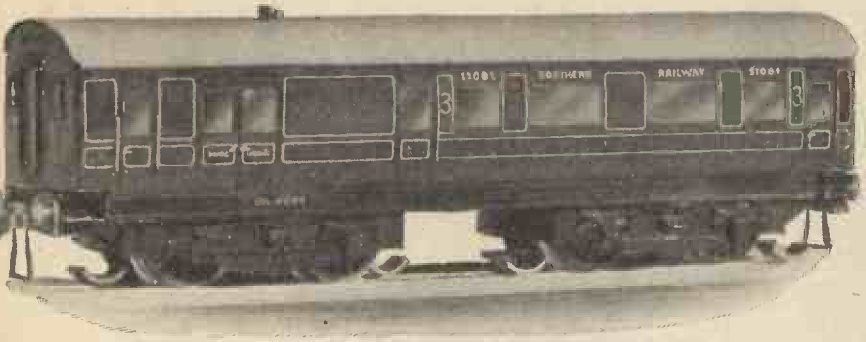
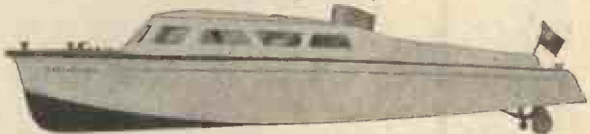
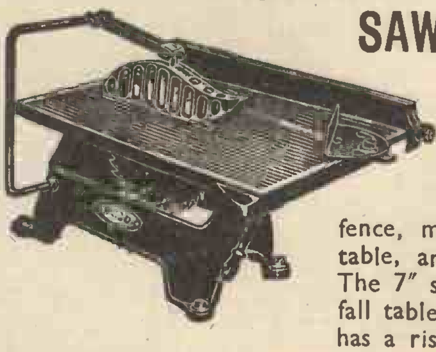






NEW INVENTIONS

Graceful Crooks

IN the walking stick and umbrella trade a very large number of sticks are made of chestnut wood. Almost invariably the design of the handle is a hook, presumably because it is convenient for hanging on the arm. The graceful curve is obtained by steaming. To improve the appearance of the handle by picturesque markings, in the spring, selected saplings on growing trees are indented at the point which is to form the handle. As a result, when the saplings are cut in the autumn, it is found that the indentations, by a natural process, have produced small, hard knots in the wood. This improves both the appearance and the grip of the handle.

However, this system is somewhat costly, as the workmen have to be skilled, and a considerable amount of time is occupied in marking the saplings, not to mention that spent in going to and fro.

An inventor has now patented a process which will materially cheapen the ornamentation of the handles. The new method will imitate the natural markings by punching or indenting them by hand or machine. Although the markings are not absolutely identical with those produced by Dame Nature, the devisor maintains that they sufficiently resemble them to give a pleasing effect.

Incidentally, I venture to express the hope that these sticks will always retain the curved handle intended by their maker. I have possessed an umbrella with a crook with a tendency to return to the straight life. In other words, it has been caught *not* bending.

Life-saving Kite

THE kite is usually regarded merely as a toy. When, like a tethered lark with a long weighted tail, it strains up towards the stratosphere, its customary rôle is to amuse the young. But, following in the wake of Benjamin Franklin, who employed a kite for a scientific purpose, an airways official, in the native land of that celebrated American, has made good use of the kite. He has arranged for it to carry an aerial when a 'plane is forced to land upon the sea, as an inhabitant of the Irish Free State might put it. To protect the passengers, in such an event, this device should be eminently useful. When a 'plane is on the water, a trailing wire aerial would obviously be ineffectual. And the aerial stretched between wing and tail would not be sufficiently elevated to be of much effect. It is also proposed that the kite should be red, so that it could then act as a signal of distress—first cousin to the shirt which shipwrecked mariners hung out on a raft in the romances of our boyhood.

To Make a Direct Hit

AS "The Thousand Years of Peace," of which Tennyson sang, is not likely to be rung in in the immediate future, the nations are arming with feverish haste. And since it is evident that the next war will be largely aerial, the inventor has naturally devoted his attention to the projectile which descends from aircraft. Bombs provided with vanes and dropped from aeroplanes follow a curved trajectory, as its course is termed. Consequently, they strike the ground at a considerable distance from the point of release from the 'plane. And the distance varies with the speed and height of the 'plane.

The following information is specially supplied to "Practical Mechanics," by Messrs. Hughes & Young (Est. 1829), Patent Agents, of 9 Warwick Court, High Holborn, London, W.C.1, who will be pleased to send readers, mentioning this paper, free of charge, a copy of their handbook, "How to Patent an Invention."

In order to enable the bomb to follow a more direct trajectory, some aerial bombs are furnished with parachutes which open as the bomb is released. And, after a predetermined period sufficient for the bomb practically to lose its horizontal speed derived from the velocity of the aircraft, the parachute is automatically disconnected.

An improved projectile of this type enables the aiming angle and the speed of the aircraft to be determined independently of the altitude of the 'plane, and more particularly for a given speed of the 'plane, the aiming angles will be practically the same whatever the altitude. This, it is contended, will conduce to more effective aim. Therefore it should render bombing less inhumane. When the aim is accurate the bomber can honourably comply with the rules of warfare, for, in spite of the adage, all is not fair in love and war. A means of correctly aiming will enable him to avoid hitting women, children, and other non-combatants.

"Perms" Without Burns

VARIOUS methods have been adopted for causing that charming undulation in the hair of the ladies known as "the permanent wave." These usually involve winding on an electric heater or curling pin. But an inventor contends that, in the apparatus hitherto employed, absolute security against burning of the scalp is not ensured. He has contrived an expedient which he maintains will remove this danger. According to his device, the curling of the hair is effected by means of liquid heated by electric current in such a manner that the hair is never in contact with the electric heater. He also declares that, with his method, more suppleness and longer life are imparted to the curls. I am afraid, however, that no system will give to the curly locks of the ladies the permanence of what are known as "everlasting flowers." This is all for the best, thinks the hairdresser. Otherwise his cubicles would be akin to the Deserted Village.

Caps for Cups

THE chief office of a saucer is to catch the spillings which descend when one's cup runs over. In some circles—not the best, of course—the tea is poured therein, when the temperature of the liquid is somewhat high. Occasionally, the saucer, inverted, is used as an improvised lid to prevent the heat from evaporating. When thus "domed" and the cup is carried, its temporary roof has a tendency to wobble, if not to doff itself. This danger may be obviated by the employment of a device lately accepted by the United States Patent Office. The inventor has blended the concave and the convex in a happy manner. The resulting design produces a saucer so loyal that, when placed above the cup, it shows the greatest attachment. There's *not* many a slip 'twixt the cup and the saucer.

Veneered Teeth

THE Golden Age has not yet dawned: but the present may be termed the Age of Rolled Gold. It is now possible to display a tooth which is not solid gold, although it has the appearance of that precious metal. A Spanish inventor has patented in this country a method of making artificial teeth which are gold only practically on the surface. Upon a nucleus of some suitable material the tooth is first moulded in wax in correct anatomical shape. Then the mould is replaced by a replica in gold. It is maintained that this method enables gold-cased teeth to be made by mass production. Of course, the tooth need not be veneered with gold: material of some other colour could be used.

By the way, the fair sex, who already have talon-like nails tinted *à la* a sunset, by adopting ruby teeth, would be "red in tooth and claw."

Bad News for "Bunnies"

RABBITS are in demand for pies, to say nothing of the supply required by conjurers who produce these animals from top hats. In these circumstances, any contrivance that will trap rabbits effectively and humanely is worthy of a welcome. A patentee has recently protected an improved net for catching these prolific creatures. This net is placed between the burrows and the feeding ground. While the rabbits are cropping green pastures, a concealed trapper raises the net by pulling a cord. Frightened by dogs or beaters, the rabbits scamper towards their subterranean residences only to find themselves entangled in the net.

A feature of the invention is that it can be subdivided into sections by means of rods extending from top to bottom of the net. Consequently, the animals caught may be segregated in separate compartments. This way of catching rabbits will appeal to the tender-hearted, who are horrified at the thought of a steel trap which may maim without killing its victim.

A Note for Musicians

THE musician is often "crotchety." His artistic temperament is easily subject to irritation. This is excusable when his instrument, owing to some defect, produces a discord which the listener believes to be the fault of the player. For instance, brass instruments such as cornets, tenor horns and trumpets usually have pistons which, when pressed down by the finger, determine the notes to be sounded. It appears that the stems of the valves are likely to stick owing to dirt or other cause. Moreover, the moisture consequent upon the saliva invariably expended on wind instruments, results in corrosion. The British Patent Office has accepted an application relating to a device which has for its object the efficient and durable working of these pistons. The inventor of this improvement surrounds the valve stem by a skirt depending from the finger piece. This slidably engages a socket fixed to the valve-casing head. Let us hope the sequel will be that "music" which "hath power to soothe the savage breast."

DYNAMO.

HARNESSING THE MAINS

Useful Points on Wiring and Construction of Mains Equipment

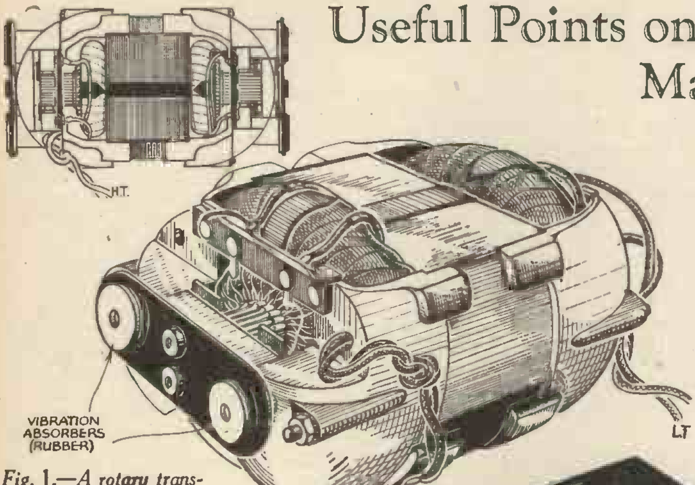


Fig. 1.—A rotary transformer which is a very useful type of unit. Below, the unit enclosed in a case.

WHEN making adjustments or alterations to one's mains equipment, and when installing new apparatus, there are a number of points concerning wiring and construction with which some readers are not fully conversant.

Consider, first of all, the way in which the mains power is distributed; the district served derives its supply in a number of ways. Two of the more usual dealt with here, form the essential circuit features of the other systems. Fig. 3 illustrates what is known as the "three-wire system," and referring to this circuit, it will be seen that the substation power output is divided into two feeders by the introduction of a neutral or earth wire, thus the maximum output which may be 460 to 500 volts is halved, one feeder giving 230 to 250 volts below earth potential, whilst the other feeder is 230 to 250 volts above earth potential: Therefore, one house or street may be wired to the positive side, whilst another will be wired to the negative side, both, however, receiving their positive or negative poles from the earthed neutral respectively.

Short Circuits

Now from this it will be apparent that in a supply where the positive pole is at earth potential, the negative side must be guarded against possible short circuit to earth which could occur through any associated apparatus, and, of course, where the negative pole is at earth potential, this is similarly applicable to the positive pole, although in this instance, there is less likelyhood of this arising, since the majority of experimenters take for granted the negative pole as being at neutral.

In Fig. 4 the A.C. version of the D.C. three-wire system is modified slightly, but at the substation end, in as much as the earthed neutral is shown taken from the centre tap of the power output transformer, this being the more usual method of distribution, and although space will not permit details regarding the benefits of this system, it serves, however, to show the fundamental difference of the A.C. and D.C. supplies.

The point to be noticed here is that each pole (Fig. 2) is alternating between positive and negative, and so far as radio is concerned, it is always advisable to locate the neutral pole, since, in some receivers a hum will be more decided when the chassis is live in respect of earth, so that a reversal of the mains polarity should assist in curing the trouble. In all instances when endeavouring to locate the neutral wiring in a house, it is useful to have a small neon light attached to a length of twin flex, thus permitting an earth return to be made through an inefficient or high resistance medium, such as one's own body.

Earth Connections

The illustration, Fig. 5, clearly shows the effect referred to, but, on no account should this be made in direct contact with the ground or a damp floor, and it is a wise plan to obtain, where possible, a definite earth connection to one side of the lamp, tapping the mains with the other wire until the dead or live side, as the case may be, is ascertained.

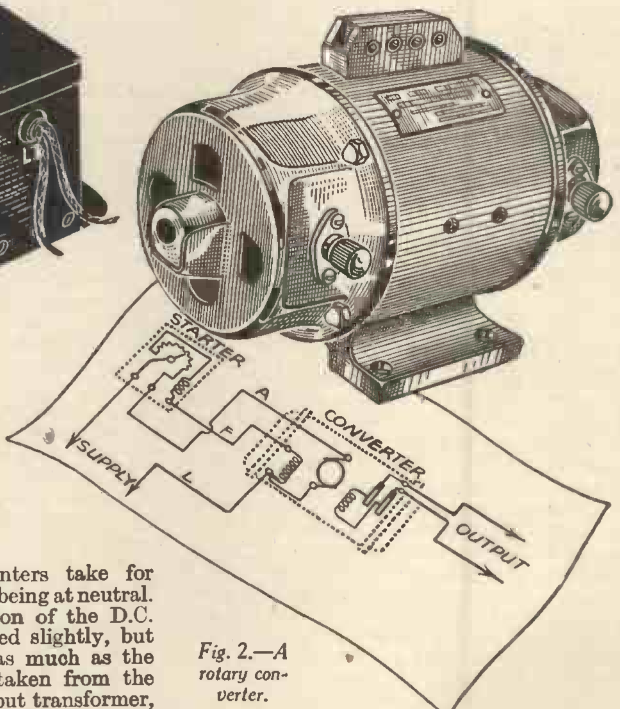
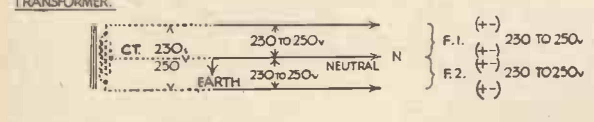


Fig. 2.—A rotary converter.



Figs. 3 and 4.—(Above) The D.C. version of the three-wire system. (Below) The A.C. version of the three-wire system.

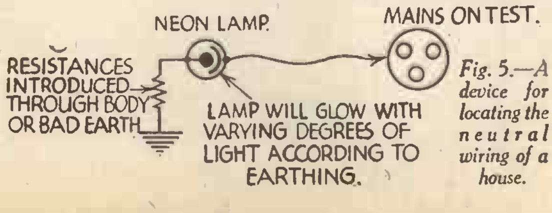


Fig. 5.—A device for locating the neutral wiring of a house.

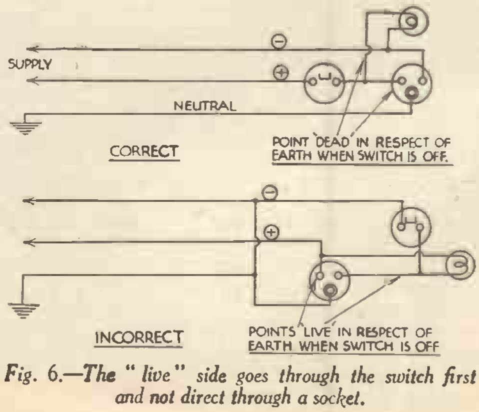


Fig. 6.—The "live" side goes through the switch first and not direct through a socket.

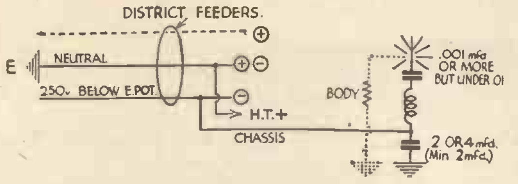


Fig. 7.—A condenser and choke filter pack.

Now in this country, the lowest supply is approximately 100 volts, and in a number of instances, where mercury arc rectification is employed at the power station, consumers experience bad D.C. hum, and sometimes voltage fluctuation, thus necessitating extra smoothing with chokes and condensers. An alternative method of current derivation is in the use of a convertor, and this will be dealt with later.

Many amateurs are reluctant to tamper with the mains, and quite naturally, since the various regulations concerning specific cables and fuse box capacities are apt to be a little confusing, however, the local electrician should be consulted when it is a question of altering the wiring, since he is best suited to explain the correct cable to use for various circumstances.

Incorrect gauge of cable can result in serious trouble by fire, for example, in some cases caused through fusing wires igniting adjacent woodwork, such as skirting boards or slats, and compensation would be difficult to obtain from an insurance company. This, of course, also applies to inferior installation, such as switches and points generally.

Safety Precautions

When fixing a new switch or plug socket the first consideration is the supply, this should be switched off from the house wiring by the main switch, and to prevent confusion it should be remembered that a fuse box is designed to handle a specific number of points only, and in some cases it will be found that there are anything up to three or four or even more independent fuse boxes, some of wood, whilst others are of the "metal clad" type. In the new housing property, the whole house supply is invariably divided into two separate units, one comprehensive fuse box of wood for handling all five amp. points, whilst the other, for fifteen amp. power points, is of the metal clad type.

The fuses in the metal clad boxes are not accessible for replacement until the switch is turned to the "off" position. This unlocks the lid which may be let down by unscrewing one terminal, usually on a hinged shank.

The cabling can be roughly traced from the switching to the points by following the direction of the cables emanating from the fuse boxes, but in cases where the fuses are installed in, say, the garage adjoining the property, the ascertaining of the switches governing the different points, can only be made by experimentally switching on and off the different sets of wiring and noticing the points affected in the house; in fact, this is the better method to adopt, and the safest.

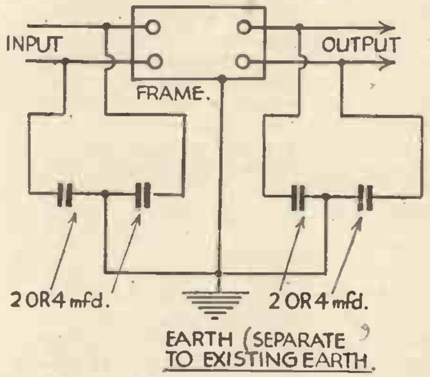


Fig. 8.—Inserting a condenser in the aerial lead to obviate shock.

Removing the Switch Cap

Having switched off the supply, the next thing to do is to remove the switch cap, loosen the wire clamps and remove the switch fixing screws. In the case of a switch mounting block, it may be found that the screws holding the block are those securing the switch, or again, separate screws may have been used for block and switch, but little difficulty should be experienced in this respect.

The switch or plug socket having been removed, the mounting block is usually left screwed to the wall through the centre; the wires should be examined for corrosion and cleaned carefully with a penknife.

The dangers in using the incorrect circuit will be apparent when studying Fig. 6, which shows that the live side goes through the switch first and not direct through a socket or lamp-holder returning to the switch; and this brings us to a simple rule, i.e. all metal work in the vicinity of a point, if within arms length, must be earthed, and in any case the council responsible will invariably require the earthing of the apparatus in question whether this applies or not.

With regard to the suitability of the supply for radio purposes, and recalling the instance of the bad D.C. supply it is sometimes best remedied by independent smoothing by the use of reservoir condensers connected across the mains, with a centre tap made to earth, this being effected prior to supplying the apparatus. To quote a simple example, a battery-operated receiver employing an H.T. battery eliminator could be arranged to be fed from a condenser and choke filter pack, similar to that illustrated in Fig. 7. It may not be necessary to use more than a total capacity of 8 microfarads, but in some instances anything up to 40 mfd. capacity may be found necessary. In the pioneer days of radio this meant rather large condenser packs, but with the advent of the electrolitic condenser, it is now possible to obtain a capacity of as much as 1,000 mfds. for 500 volts working, although, of course, this would be rather large for ordinary use, and the maximum average voltage for this size of condenser is in the neighbourhood of 12 volts.

With the installation in question, the use of a multiple of electrolitics each having a value of about 16 mfd. at 250/500 volts D.C. working would be suitable. The two high frequency chokes L.1 and L.2 assist by impeding the passage of frequencies in

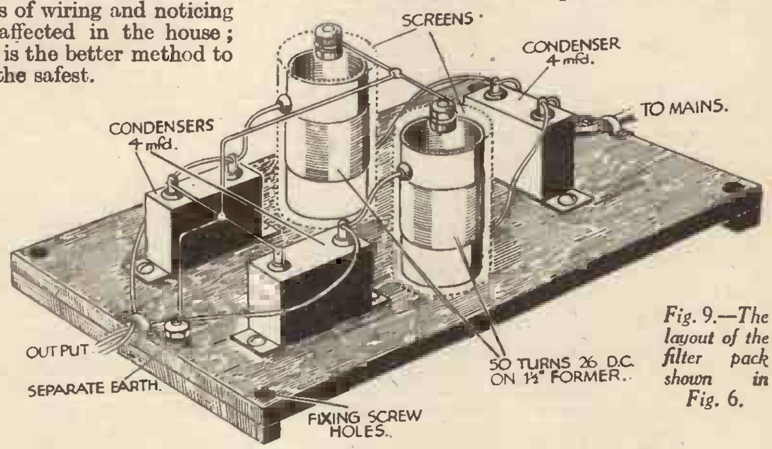
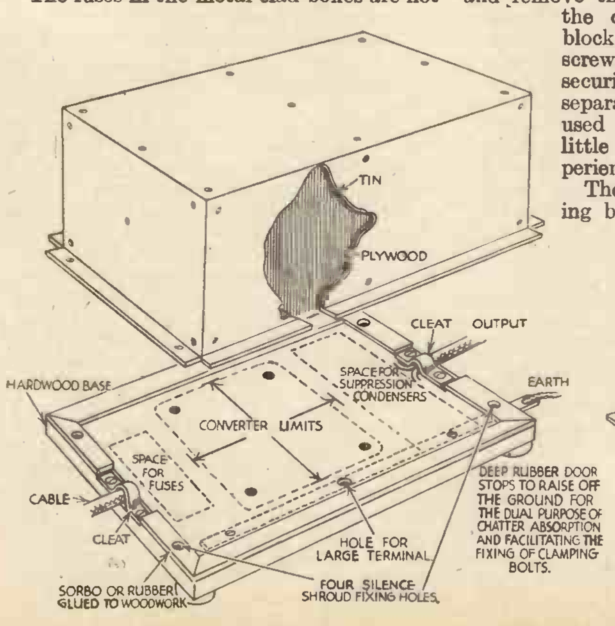


Fig. 9.—The layout of the filter pack shown in Fig. 6.



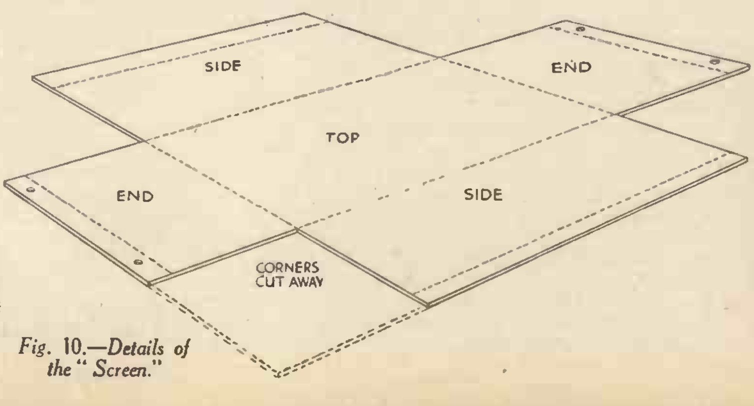


Fig. 10.—Details of the "Screen."

the neighbourhood of 1,000 cycles, thus meeting the range of interference generally attributed to man-made statics, such as vacuum cleaners, refrigerators, small motors, etc., and as much as 40 per cent. suppression has been obtained in this manner.

A.C. Mains

The advantages in the use of alternating current mains are now well understood, but there are other points which may prove troublesome, for example, if a heater is used in the radio "den" and stands on bare boards, any dust or extraneous substances which has accumulated on the elements, during the period of disuse, will, the moment current is switched on, cause a loud humming, which sometimes may resonate through the house, being amplified by the sound-box effects of the rooms underneath. This is due to the effective inter-turn insulation of the elements causing inductive influence on the metal work of the heater. After a while this disturbance will gradually subside as the foreign substance on the leements is burnt away, but during the trouble the heater apparatus should be stood upon a mat or other suitable absorber.

Now with regard to the radio receiver generally, it has often been stressed that it is advisable to insert in the earth lead of the receiver, a suitable condenser, preferably one of at least 2 mfd., the reason being that in the case of a positive neutral, a short circuit to earth through the receiver will be avoided, and it is just as advisable to insert a condenser in the aerial lead to obviate the possibility of shock to anybody touching the aerial lead when the earth is positive in respect of the chassis. The capacity of this condenser in the aerial lead should be in the neighbourhood of ·001 mfd. and reference to Fig. 8 will clarify the reason for this, theoretically.

Radio Reception

As previously stated, there are many instances where the mains is normally unsuitable for quality radio reception, for example, a country house supplied with 110 volts D.C. would best be suited in the use of an A.C. receiver operated from a rotary convertor and to make more clear this method of operation, a word or two on the systems of current conversion in use to-day will be of help.

(1) A combined motor and generator, mechanically coupled by the same shaft—A.C. motor/D.C. generator or D.C. motor/A.C. generator.

(2) Petrol motor driving A.C. or D.C. generator.

(3) Rotary convertor giving A.C. from D.C., D.C. from A.C., or D.C. and A.C., the convertor being driven from another motor and the two supplies being taken from the input and output terminals.

(4) The rotary transformer, where a high voltage is required from a low voltage.

(5) Rectifiers: (*a*) The half and full wave valve rectifiers; (*b*) The half and full wave metal rectifiers; (*c*) The vibrating reed rectifier.

Static

Transformers are used where alteration in pressure (voltage/current) is required and by suitably arranged primaries and secondaries the output power is obtained, governed by a predetermined ratio which gives inversally proportional current and voltage from primary and secondary terminals.

Now it is proposed to deal with the rotary convertor and rotary transformer, since these, from the point of view of installation, have immediate bearing on the subject.

Those wishing to obtain a higher voltage and different polarity supply from the existing mains for experimental or ordinary radio purposes find the use of a convertor the most economical and suitable method of doing so. Thus they have the added advantage of a supply not influenced by outside man-made statics, since the direct ordinary supply feeders are not directly employed. The question of noise suppression, however, does arise, but in a less serious nature, and a few points concerning this aspect of the installation will be useful.

The main classes of disturbance can be listed as under:

(*a*) Electrical radiation from the convertor.

(*b*) Mechanical vibration or resonance of any fitments of adjacent apparatus.

(*c*) Rotor hum.

Dealing with these in order, the electrical radiation may be overcome by connecting across the output and input terminals of the convertor, two 2 or 4 mfd. condensers centre tapped to earth (see Fig. 9).

Mechanical vibration and resonance is usually due to a number of external causes, for example, through fixing the convertor to loose boards or metal work, and the remedy here is self explanatory.

The Screen

With regard to (*c*) it is usual to arrange a "silence shroud" in the form of a metal or wooden cover to completely encase the whole unit including the smoothing condensers, as shown in Fig. 10. The measurements are, of course, not shown owing to the varying degrees of requirements. A number of manufacturers supply the silence cabinet or shroud with the convertor, but occasions do arise when home construction is necessary.

The rotary convertor model illustrated in Fig. 2 is one of the more popular types, delivering 120 watts at 230 volts single or three phase—two phase being almost now extinct—and the output may be regulated as desired, as the input E.M.F. ranges from 24 to 250 volts D.C. Thus it will be apparent that this margin of control permits this type of convertor to be even run from a battery of accumulators, within the voltages quoted.

The rotary transformer is a particularly useful type of unit, being in some cases very small yet capable of delivering power in the neighbourhood of two to three hundred volts, with a very low order of input E.M.F. such as 12 volts, and one model as illustrated in Fig. 1 gives 250 volts output at 80 milliamperes with an input voltage of 12; thus this model finds great favour with designers of transportable equipment where anything up to 10 watts output is required. Police cars in certain areas have this method of H.T. installed due to the faultless and consistent source of power with low consumption on the car accumulator.

The combined motor and dynamo is seldom employed for low power work owing mainly to the expense involved in the employment of two different units, when one—the rotary convertor or transformer—will do the same work.

TRICKS OF ESCAPING AND MAGIC WITH KNOTS

(*Continued from Page 275*)

from the same cord should be used, as it is important that there should be no visible difference between them. A small knot may be tied at the ends to prevent the cord unravelling. Both cords must be the same length; about three feet is a convenient measurement.

Trick with Cords

Commence the trick by having the cords examined, then hold them up side by side to show that they are of equal length. Now take the centres of the cords and allow the ends to hang down. Now comes the crucial movement upon which the whole trick depends. The cords are secretly separated, so that the looped centre of one cord is held in each hand. The cords are separate, but the hands are held close together, so that to the audience it appears that both cords run through the hands. See Figs. 14 and 15, which show the difference between the way in which the audience imagine the cords to be held and the way in which they are actually held.

The two looped ends are now hooked one in the other. Fig. 16 shows this movement. It must, of course, be covered by the hands. Two cords of different colours have been used in the photograph purposely, in order to make the movement quite clear.

The cords may now be held in the closed hand, and as two cords drop out at each side of the hand, the audience have no reason to imagine that the two cords are not simply held in the centre and pass through the hand. The cords are now passed over the head and the looped ends tucked into the collar at the back, which keeps them in place. The ends are knotted, and one cord from each side is crossed to the opposite side. When the cords are pulled, the loops slip out from each other, and the cords come away free in front.

This trick may be made even more sensational if, instead of knotting the cord, long cords are used and, when the cords have been crossed as described, the two ends on one side are given to one spectator and the two ends on the other side to a second spectator. On a given signal, the two spectators pull firmly on their cords. Presumably the result would be to strangle the performer in the loop of the cords, but, of course, owing to the secret looping at the back, the cords slip round his neck and come away free in front.

A Varied Form

This trick is sometimes presented in slightly varied form, and instead of placing the cord round his neck, the conjurer first ties some rings to the centre of the double cords, then passes the ends down the sleeves of a borrowed jacket. He then asks the owner of the jacket to put it on, and again one cord from each side is crossed and two spectators hold the ends. When they are told to pull, the rings drop off on to the floor and the cords come clean away through the jacket sleeves, leaving the victim free.

The method of performing the trick is exactly the same as for the Strangling Trick I have already described, but as there is no means of keeping the looped centres of the cords from coming apart, a different means of connecting the centres of the cords is used. This consists of a short length of soft wire, such as heavy-gauge fuse wire, or even a short length of solder, sold in thin wire-like sticks. When the cords are laid across the hand at the beginning of the trick this piece of soft wire is nipped round the centres, as shown in Fig. 17. The cords can then be separated as shown in Fig. 18, the small wire fake being invisible at short distance. The rest of the trick is then easily managed, and when the final pull is made the wire is simply forced apart and drops unnoticed to the floor.

WHEELS FOR MODELS

By "Handyman"

The Third Article of a Short Series Dealing with the Construction of Wheels Suitable for every Type of Model.

WE now come to a method of making cast metal wheels for small locomotives and rolling stock of No. 0 or No. 1 gauge, which is so simple and requires so few tools that any mechanically-minded boy should be able to turn out these parts for his engines and wagons for himself, especially if he follows these instructions carefully and has available a fair number of damaged lead soldiers and other such toys. By the way, "lead" soldiers is not a correct term. These little infantry and cavalry men with their horses and guns are not made of lead, or at any rate, not wholly. The metal is a mixture of lead, antimony, bismuth, etc., which is much harder than pure lead, and results in cleaner and sharper castings than lead alone would do.

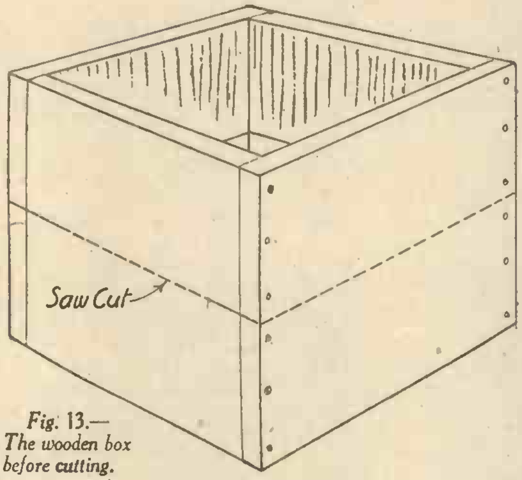


Fig. 13.—The wooden box before cutting.

Tools and Materials

The tools and materials required for making wheels by the process to be described are: a twist drill, of about ⅛-in diameter, a light hammer, a fine saw, such as a piece of a hack-saw blade, a screw driver, a few brads and screws, some ⅛-in. diameter wire, some fine plaster of paris and the before-mentioned broken soldiers. Briefly, the idea is to make a mould in plaster, melt the soldiers down and pour the metal into the mould, the whole of the operations being of a kind which it is calculated will delight the heart of the average boy.

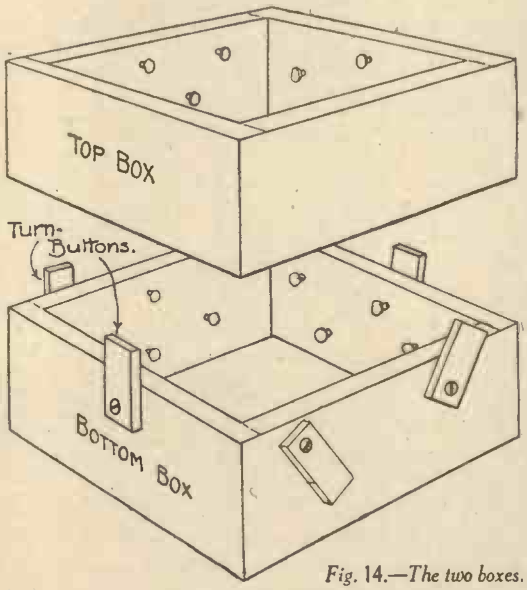


Fig. 14.—The two boxes.

The Mould Boxes

The first thing to do is to make a box of ¼-in. fretwood which, when divided into two, will be converted into moulding boxes. Fig. 13 shows the box made first in one piece and then sawn round the middle as shown. The two faces must be trued up by rubbing them on a sheet of glasspaper, laid upon some flat surface such as a piece of glass. Both boxes will be left open top and bottom. Around the edge of one of the boxes screw about six little turn-buttons, and around the insides of both boxes knock in some small tinned tacks, leaving them projecting a little, all as drawn in Fig. 14.

Filling with Plaster

Both boxes have now to be filled completely with plaster of paris, the best kind to use being that which is known as surgical plaster, which can be bought from a chemist. The only difficulty which is likely to be encountered is the quickness with which this plaster sets, and the best way to mix it is this; half fill a breakfast cup or a small basin with water, quickly add about an equal bulk of plaster and stir it quickly. It will mix readily, but the knack lies in getting the right consistency at once, for, from the time the plaster and water come into contact with each other until it is poured into the mould, not more than ten to fifteen seconds should elapse. It is better to have it too liquid than too stiff, but the consistency should be about like that of fresh running cream. The box which is being filled should be laid upon a piece of glass as shown in Fig. 15, for this will give a beautifully smooth face to the plaster. The finish of the top of the plaster, which will be the outside of the box, will not matter. Both boxes will be dealt with in the same way, a fresh lot of plaster being mixed for each.

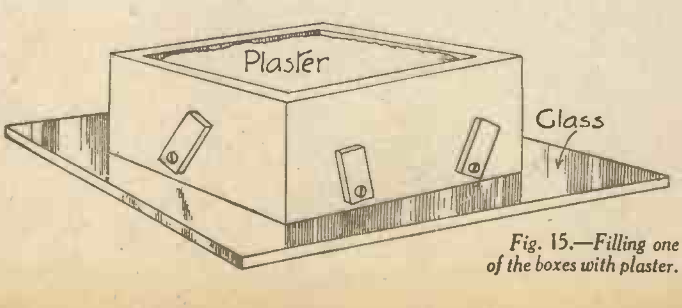


Fig. 15.—Filling one of the boxes with plaster.

It will be seen that the object of the tacks on the insides of the boxes is to provide a key for the plaster, to hold it in place.

Drying the Plaster

The boxes should not be moved from off the glass for at least a quarter of an hour, until it is certain that the plaster is sufficiently hard, and then a very great amount of patience will have to be exercised before anything further can be done, for the plaster must now be left until it is bone dry, and this may take as long as a week.

Artificial, but not too rapid, drying can be resorted to, a good place being well up inside a flue or chimney; anywhere, in fact, where it can get a current of warm dry air passing over it. In the early stages it must not be got too hot, or steam will be generated in the plaster, which will burst it. In summer time, out of doors in the sun and wind will be most effective.

Strickling the Mould

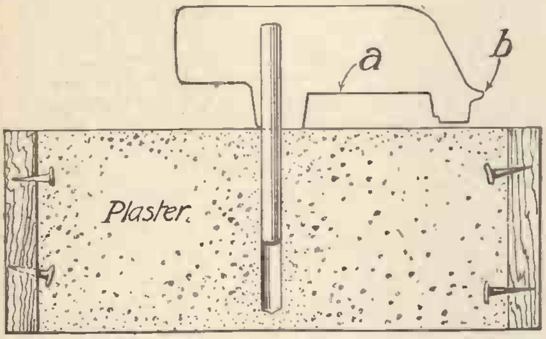
When it is certain all moisture has evaporated, take one of the boxes and drill a hole in the centre of the plaster dead square with the true surface; then make—with a bit of tin, soldered in a saw-cut in the brass wire—a scraping tool having a profile exactly that of the required wheel. Such a tool is called, by foundry moulders, a strickle. It should be carefully filed to shape and have an extension on the opposite side for revolving it with the fingers. The outline of the strickle and a section of the plaster and box is given in Fig. 16.

Now it will be seen that if this little tool is revolved like a compass, allowing the pin to act as a centre where it turns in the drilled hole, the parts projecting below the line (*a*) and the point (*b*) will scrape the plaster away, sinking a hole next to the pin, and an annular groove farther out (below (*b*)). The hole will be the mould for the hub of the wheel and the ring that for the tyre, the point (*b*) forming the flange.

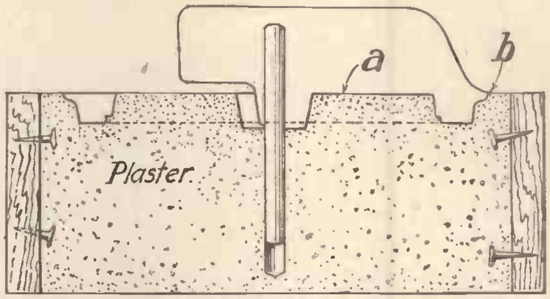
The strickle must be worked until line (*a*) and point (*b*) just touch the surface of the plaster all round the circle, and the state of the mould will then be as drawn in Fig. 17. If we compare this sketch with Fig. 16 we see that what has happened is that the tool has cut only a circular groove around the radius swept out by the strickle and a sunken hole next to the pin, but with nothing in between. What is now required in order to make a wheel (in reverse, or inside-out so to speak), is to connect the central hub with the rim by means of spokes; it is for this purpose that we require a piece of hacksaw blade.

Marking Out the Spokes

On the flat surface of the plaster between the sunken hub and the tyre, divide up carefully the circumference into the required number of spokes and draw the cutting the grooves for spokes, if desired. Such carving will best be done with a small chisel and perhaps a penknife. The final result being as shown on the right-hand side of Fig. 18; this drawing representing the appearance of the mould when ready for casting. The left-hand drawing shows the face of the other box and plaster. Here a deep, half-round groove is cut which is suddenly reduced to a small one. This



Figs. 16 and 17.—(Left) The strickle commencing to cut. (Right) The strickle finishing the cut.



centre line of each with a soft pencil. Then proceed to cut them with the saw to such a depth that they come nearly but not quite out to the face of the tyre. After sawing, widen them a little towards the hub and towards the top surface of the plaster. This latter widening is very important, for it is essential that the whole of the parts of the mould shall be made to taper outwards; otherwise the castings will not draw from the mould.

Before filling the moulding boxes with the liquid plaster, they should be thoroughly well soaked in either hot wax or shellac varnish, for, if this precaution is not taken, the wood will warp badly and the key pins, or tacks, will pull flakes out of the plaster. An alternative way of dealing with the plaster is to omit the tacks and, when the plaster is well set, to remove the boxes altogether; leaving, to serve as moulds, only the plaster. In this case the turn-buttons will not be needed and the two plaster blocks will, when the metal is poured, have to be lined up by eye, which will be quite near enough correct, for they will not need to be placed together with an extreme degree of accuracy.

Counter-balances and Cranks

In the case of driving and coupled wheels, the next best thing to do to the mould, after the strickle has done its work and spokes are cut, will be to carve away the plaster to form the balance weights and the cranks, though this can be done before

groove is known as a runner, and into it the molten metal is poured when the two boxes are placed face to face. In the left-hand sketch, Fig. 18, of the runner, the bare outline of the wheel is shown by dot and dash lines. Correspondingly, on the right-hand, showing the wheel, the runner is indicated in the same way; from this the reader will see that when the two halves of the mould are folded up and put face to face, the main part of the runner must come on the same side as the balance weight, in order that there shall be a big mass of metal which will retain its heat long enough for the rest of the mould to fill up before the runner metal solidifies. The small extension of the runner is provided to supply metal to the comparatively large mass of the boss instead of depending upon this part being supplied through the spokes.

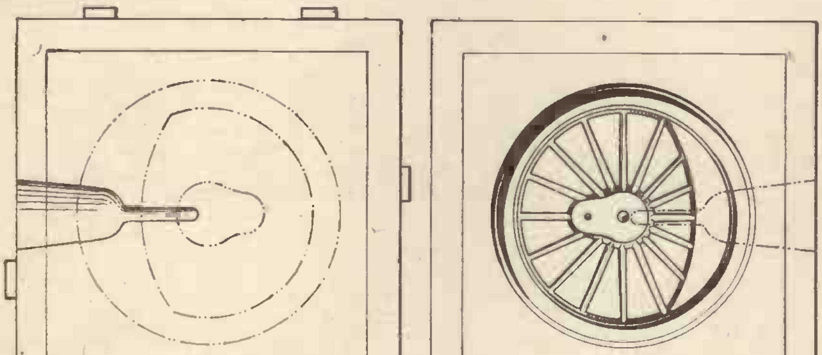


Fig. 18.—The two halves of the mould ready for casting.

Casting Drill Centres

The reader will remember that a drilled hole was provided in one plaster block for the strickle pin to rotate in. Now this hole will have to be filled up, and the best thing to fill it will be with another bit of the same wire as was used for the strickle. This wire should be filed to a point and such point be allowed to project into the mould. When the wheel is cast the point will leave its impress in the metal, and thus a centre is provided, ready marked, for drilling the wheel to fit on its axle. The idea can be carried farther; the cranks will have to be drilled for crank pins; so, in the mould, the throw of the crank can be marked off another hole drilled in the plaster, and a second pointed pin put in. Such a second centre will ensure all the wheels being drilled with the crank throws alike.

(To be continued)

STARGAZING FOR AMATEURS

(Continued from Page 260)

of which in ancient times had a distinctly reddish hue. Just here the stupendous arch of the Milky Way springs from the skyline and spans the heavens in a northerly direction. Its entire glittering track is worthy of close sweeping with even the slightest optical aid. Higher up than Sirius shines Procyon in Canis Minor; and Castor and Pollux in Gemini still nearer the zenith. Gemini abounds in double stars, Castor being the chief of them. There is also ζ (Zeta) and the striking cluster M. 35. In large instruments the latter is a magnificent sight. Hard by may be noticed the inconspicuous little group Cancer (the Crab). It may be identified to the naked eye or through a binocular by the faint collection of tiny stars called the Præsepe, or "Beehive," (M. 44); there is likewise another cluster M. 67. But the most important object in Cancer is the triple star ζ (Zeta) Cancri. This actually a quadruple system consisting of two pairs. Through imperceptible, the existence of the fourth star, has been deduced from the movements of its invisible companion.

Astronomical Notes

There will be no New Moon in February, a circumstance that has been brought about only three times since 1870. On the other hand there will again be two New Moons next month, as in January.

* * *

A search is going on at the Mt. Wilson Observatory, California, for "Dwarf" stars radiating less brightness than our own luminary, and yet sufficiently close to be readily observable. Among those noted within this category so far, is an entirely new more one, the luminosity of which is little than one two-thousandth that of the Sun.

* * *

During the edgewise presentment to the Earth and Sun of Saturn's rings in 1936-7, photo-electric measurements were made of their light intensity. The results indicated a progressive darkening of the surface of the rings: and also a variation in their colour, as if some external nebulosity were enveloping them. The nebulosity was confirmed by visual observations and the nature of the rarified matter is regarded as corpuscular.

QUERIES and ENQUIRIES

A stamped addressed envelope, three penny stamps, and the query coupon from the current issue, which appears on page 301, must be enclosed with every letter containing a query. Every query and drawing which is sent must bear the name and address of the sender. Send your queries to the Editor, PRACTICAL MECHANICS, Geo. Newnes Ltd., Tower House, Southampton Street, Strand, London, W.C.2.

EXPLOSIVES

(1) "I HAVE some samples of beryl from which I wish to obtain beryllium acetate (basic). How can I do this as cheaply as possible. I have in my possession the usual laboratory apparatus.

(2) "How can I extract pure pyridine from bone oil, of which I have considerable supplies. I found I was unable to do this efficiently by distillation, however carefully done.

(3) "Would you please advise me whether an explosive consisting of rubber and a perchlorate (potassium or ammonium) in the calculated quantities is novel, and whether it would be patentable. About four times the volume of gas is produced on combustion of a unit weight of this explosive as by the combustion of an equal weight of gunpowder. The explosive is also plastic and is easily moulded into blocks, etc. It is easily denoted if a small percentage of nitroglycerine is incorporated." (H. T., Notts.)

(1) THE mineral *beryl* is a silicate of beryllium and aluminium, having the approximate composition—$3BeOAl_2O_3 6SiO_2$.

In order to obtain beryllium acetate from it, it will be necessary for you to fuse the powdered mineral with sodium carbonate in a closed crucible and at as high a temperature as possible. The resulting mass, when cool, is powdered and digested with strong hydrochloric acid for about half an hour. The acid solution is filtered and evaporated to dryness, the silica thereby being separated in an insoluble condition. The dry mass is again powdered and this time digested with dilute hydrochloric acid and filtered to remove the insoluble silica. Ammonia is added to the filtrate. This precipitates aluminium and beryllium hydroxides. The precipitate of the mixed hydroxides is filtered off and dissolved in caustic potash (potassium hydroxide) solution. This solution is boiled, whereupon, beryllium hydroxide is precipitated. This precipitate is redissolved in weak hydrochloric acid and re-precipitated from the potash solution several times in order to free it completely from aluminium hydroxide. Finally it is washed with clean cold water and dissolved in dilute acetic acid. On evaporating the latter solution down to a small bulk, beryllium acetate will crystallise out. The entire process is not an expensive one, but it is tedious to carry out.

(2) In order to extract pyridine from bone oil add about one third of the oil's weight of concentrated sulphuric acid, stirring the oil well. This will dissolve out the organic bases such as pyridine, quinoline, isoquinoline, etc. The dark acid layer which forms in the vessel is drawn off and treated with caustic soda solution. This will cause the impure pases to separate out in the form of a dark-brown oil and if this is distilled, you will be able to obtain reasonably pure pyridine from it. Pure pyridine boils at 115° C. It is colourless at first, but quickly turns yellow and eventually dark-brown.

In order to obtain perfectly pure pyridine, you will have to treat the purified pyridine obtained by distillation with con. sulphuric acid, whereby it will become converted into pyridine sulphate. This salt can be purified by repeated crystallisation and finally treated with caustic soda solution which will liberate free pyridine. Finally, the pyridine thus obtained should be dried and re-distilled.

(3) Your proposed invention consisting of an explosive formed by the intermixing of rubber and a chlorate appears to be novel and therefore patentable. It might possibly be of especial value in view of the commencement of the manufacture of synthetic rubber in this country. For use, however, your explosive must be absolutely stable and not liable to spontaneous detonation. It must, also, retain all its properties over considerable periods of time.

THOUGHT TRANSFERENCE

"I WAS interested in an article which appeared in the Dec. issue of PRACTICAL MECHANICS, entitled 'Thought Transference Games for Christmas,' and also an article in a previous issue, 'Is Thought Transference Possible?' I recently tried out the suggestions for thought transference at a social evening. About thirty people were present at the gathering, including a number of children, but the suggestions were not carried out exactly as described in 'P.M.'

"I first explained to my friends what the idea was and asked for a volunteer. They seemed interested and immediately a young girl offered to go out of the room.

"We chose an object which she was merely to touch, when she came into the room, which was an umbrella standing in a corner. She was called in and told we wanted her to touch a certain article, and I also asked the people to imagine her doing so.

"She immediately turned and saw the umbrella, walked to it, and picked it up. (We did not make use of 'transmitters.') She went out of the room again and we next chose a scarf which lay on a girl's knee. When called in the girl stood just for a moment about a couple of yards from the door and then walked unhesitatingly across the room and picked up the scarf.

"After this startling success we asked for another volunteer and another young girl went out. We decided she, if successful, should switch off the lights. She came in and, after wandering round the room, quite suddenly, when standing about three or four yards away from the switches, walked to them and switched out the lights.

"After this, two or three fellows tried unsuccessfully to be guided (I was one), so

we asked the girl to try again. This time we decided she should touch a person, and again she carried out our ' instructions ' with little hesitancy.

" Four of us before we left that night arranged with the girl to think of something at a stated time that night when we should all be at home to test the powers of telepathy at a distance, and again we were rewarded with success.

" On another occasion five friends were together and I suggested that I should think of someone whilst one of them went out of the room.

" My friend laughed but said he would go. After a few minutes he came in to say he could only think of one person, and it proved to be the one I was trying to convey to him.

" I intend to carry out more experiments and shall be pleased to let you know the results." (F. Hughes, Ches.)

THE IGNITION OF LIQUIDS

(1) " AT what temperature, mixed with the necessary amount of air, do the following liquids ignite ?

" (a) Petrol
" (b) Benzole
" (c) Alcohol

(2) " Is this temperature the same when the liquids are in a vapourised state ?

(3) " What are the proportions of the air and fuel (in a liquid state) in a petrol engine cylinder, before being compressed ? " (A. W. Smith, Walton-on-Thames.)

(1, 2) STRICTLY speaking, liquids, as such, are not inflammable. It is the *vapour* of a liquid which, when mixed with air, ignites and burns. All liquids give off vapour, and the higher the temperature of the liquid the more vapour does it evolve. Physicists estimate not the ignition temperature of a liquid but the ignition temperature of its vapour. Thus, in the examples you mention, the Vapour Ignition Temperatures are as follows :

Petrol (High-grade spirit)	600° C.
Benzole (Pure)	710° C.
Alcohol (Pure)	590° C.

The above ignition temperatures are liable to vary according to the conditions governing the ignition of the respective vapours.

(3) Fuel is not taken into the cylinders of an internal-combustion in a liquid state, but in the form of a vapour mixed with air. The proportions of fuel vapour and air may vary between 20 parts of air to 1 part of fuel vapour (which is a very weak mixture) to 8 parts of air to 1 part of fuel vapour, this latter being a very rich mixture. The air-fuel vapour mixture which gives the maximum power output is 12 or 13 parts of air to 1 part of fuel vapour.

A " THREE-WHEELER "

" I AM sending you some photos of my home-built three-wheeler, which may be of interest to some of your readers.

"The chassis is built of L steel and stiffened by steel tubes, the front axle and steering being from an Austin Seven modified to suit requirements. The O.H.V. 350 c.c. Blackburne engine is at the rear, driving through a Rudge four-speed gearbox to a rear wheel of the same make. The speedometer is also driven from the rear wheel sprocket.

" I get from 65 to 80 m.p.g. and have done 72 m.p.h. on a slight downgrade. In 2,200 miles it has given no trouble at all." (Mr. J. J. Thomson, Scotland.)

A view of a " three wheeler " made up by Mr. J. J. Thomson and adapted from designs given in this journal.

REFRIGERATION BY HEAT

" COULD you please explain the principle upon which refrigerators work, in which there is no motor of any kind. I understand those in which a small motor is used to compress or expand a gas such as ammonia or sulphur dioxide, but I fail to understand how the burning of a small gas jet brings about cooling. In the refrigerators I am thinking of a small gas jet or lamp is kept burning constantly. I believe certain chemicals are used in this refrigerator also, but I should be very pleased if you could let me know how such an apparatus works.

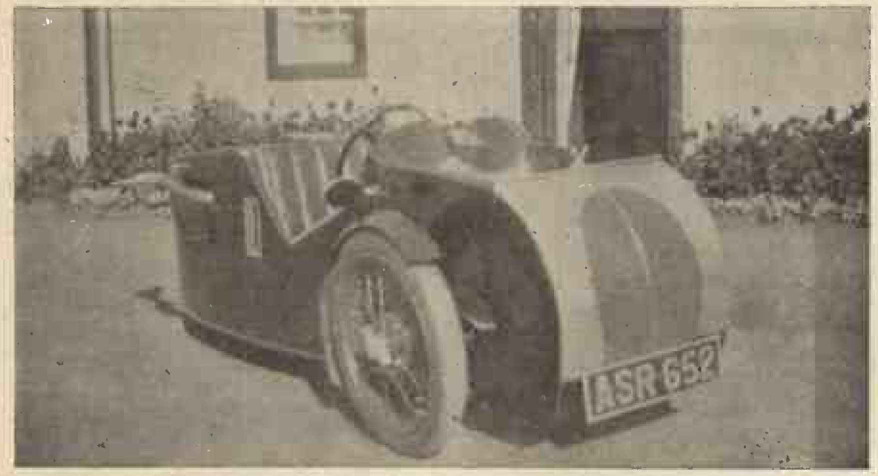
" I have at various times noticed that when answering enquiries you have referred readers to the British Drughouses, Ltd., for supplies of chemicals. On writing for their price lists, however, I was informed that chemicals were only supplied to trade, or professional chemists. As few of your readers are likely to have such qualifications It hink it is rather difficult to obtain chemicals directly from the above mentioned firm." (S. Lewis, Nr. Chepstow).

REFRIGERATORS in which there are no moving parts and which are operated by the application of a small heat-source work upon what is known as the " absorption " principle. This principle, very briefly, is based upon the absorption of ammonia gas by water at relatively low temperatures and the giving up of the ammonia gas when the water solution of it is warmed by an external source of heat.

Within the confines of a single reply, it is impossible to go into details of the working of these "absorption-refrigeration" machines. In general, however, their operation is as follows:

A solution of ammonia gas in water is heated by the externally-applied heat-source. The ammonia gas is given off by the water and it passes through a water-cooled condenser in which it is cooled and liquified. Liquid ammonia gas flows through a "heat-exchanger" compartment into an evaporating compartment where it evaporates. When a liquid evaporates, it absorbs energy in the form of heat. Hence, the evaporating liquid ammonia gas cools the evaporating compartment down to very low temperatures. This latter compartment is arranged around the food store of the refrigerator and, as a result, the cooling action of the apparatus is obtained.

Hydrogen gas is present, also, in the evaporating compartment, and it causes the liquid ammonia gas to evaporate, maintaining, the while, a constant pressure. It is for this reason that the refrigerating system, which is, of course, hermetically sealed, requires no valves of any description. The ammonia-hydrogen mixture sinks downwards into an absorbing chamber. Here it meets weak ammonia water. The hydrogen is practically insoluble in the water, but the ammonia dissolves in it, giving off heat. The absorbing chamber is water-cooled and from it the ammonia solution circulates to the heating compartment in which the cycle of operations is recommenced with the heating of the ammonia solution.



Another view of the car made by Mr. J. J. Thomson.

TECHNICALITIES OF PRINTING

"**I AM employed in the technical department of a newspaper, where, as you know, big quantities of lead, mixed with antimony and tin, are used for our linotypes, etc.**

(1) "I should like to make an analysis of samples of this lead every time after receiving the quantity ordered, so as to be sure that the quality is always the same. How can I separate, in a chemical way, the antimony, lead and tin, so as to find the proportions of lead, antimony and tin there is in the metal we receive.

(2) "I should also like to analyse the ink, which we buy for our rotary presses. How can I find out how they are composed, how much vernise, lamp-black, etc., they contain so that I can ascertain if we always receive the same ink." (B. Langeveld, Holland.)

UNLESS you are a trained chemist and analyst and have at your command an analytical laboratory, it will be quite impossible for you to make an effective analysis of the materials you mention.

Perhaps, however, it may be of assistance to you if we describe very briefly the method by means of which an analyst would conduct the analysis of your materials. First, then, as regards the sample of type-metal. A sample of this metal would be accurately weighed and dissolved completely in strong nitric acid. From this nitric acid solution of the three metals—lead, tin and antimony—the individual metals would be separately extracted in the form of their insoluble compounds. Each compound would be carefully dried and finally weighed.

The analysis of printing inks, if it is carried out thoroughly, is more complicated still, for it is extremely difficult to separate the oily ingredients of a printing ink for the purpose of quantitative analysis. You can make a rough analysis of a printing ink by boiling a weighed amount of the ink in carbon bisulphide or in some other volatile solvent. This will dissolve away the oily, fatty and resinous ingredients of the ink and will leave the pigment or lamp-black unchanged. The latter is weighed and its percentage in the original sample of ink is worked out. From this result, by simple subtraction, the percentage of the oily and other ingredients of the ink can be ascertained.

BUILDING A I-C.C. ENGINE

(*Continued from page 264*)

Eighth Operation

The bore of the bush may contract a shade when pressed in; if so, it will want lapping out to size again. In any case the hole must be burnished to a mirror finish. A simple way of doing this is to wrap a strip of fine emery cloth round a steel rod so that it more or less fits the bore of the bush. Tie the cloth at one end of the rod so that it encases it like a tube. Hold the rod in the vice and pass the bush over the cloth, driving it in alternate directions rapidly for a short while, by pulling a length of string to and fro, which has first been passed completely round the boss on the crank case.

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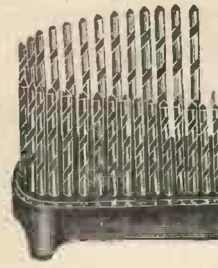

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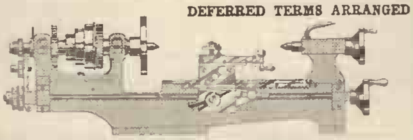

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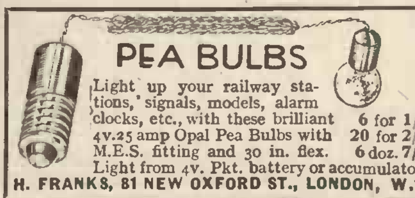

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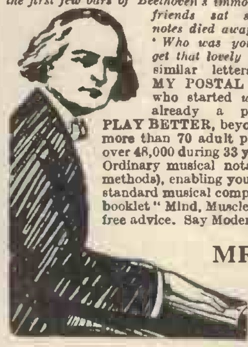
"THEY LAUGHED AT FIRST



but when I began to play—*a hush fell upon the room. I played the first few bars of Beethoven's immortal 'Moonlight Sonata.' My friends sat spellbound. When the last notes died away the excitement on their faces! 'Who was your teacher?' 'How do you get that lovely singing tone?'"* I receive similar letters daily from students of MY POSTAL LESSONS for the PIANO who started *without knowing a note.* If already a player, I'LL MAKE YOU PLAY BETTER, beyond your dreams. I enrolled more than 70 adult pupils last week, have taught over 48,000 during 33 years, and I CAN TEACH YOU. Ordinary musical notation only used (no freakish methods), enabling you to read and play at sight any standard musical composition. Send p.c. for FREE booklet "Mind, Muscle and Keyboard" and form for free advice. Say Moderate, Elementary or Beginner.

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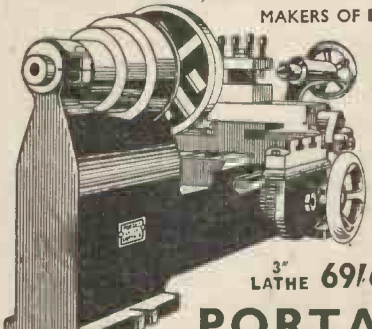

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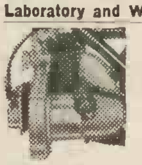

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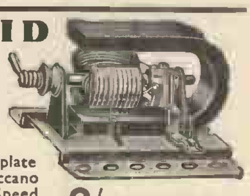

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