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NEWNES

PRACTICAL MECHANICS

9D.

EDITOR : F. J. CAMM

DECEMBER, 1950

PRINCIPAL CONTENTS


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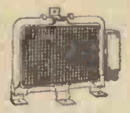

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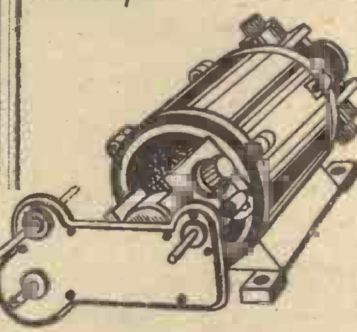

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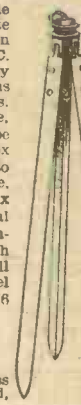

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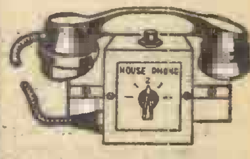

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PRACTICAL MECHANICS

EDITOR F. J. CAMM

DECEMBER, 1950
VOL. XVIII. No. 204

Owing to the paper shortage "The Cyclist," "Practical Motorist," and "Home Movies" are temporarily incorporated.

FAIR COMMENT

By The Editor

The Speed of Light

ANOTHER text-book standard vanishes with the announcement by the National Physical Laboratory of the new figure for the speed of light.

When Dr. L. Essen, of the National Physical Laboratory, announced in 1947 that the speed of light is 186,282 miles per second, or 11 miles more than the previous figure of 186,271, the figure was not generally accepted, but he has since confirmed it using very accurate apparatus. Experiments conducted by Sweden and the U.S.A. have resulted in further confirmation of the figure.

The speed of light is used for many of the fundamental calculations in atomic theory and nuclear physics, and the new measurement is of immediate practical value in radio and radar.

It is, in Einstein's theory of relativity, the highest speed at which anything can travel. It is, therefore, an important physical constant, and its measurement has provided a problem for many scientists for many years. A great deal of time and money has been spent since Romer first obtained a value of 192,000 miles per second from astronomical observations in 1676. The first direct experimental measurement was made by Fizeau in 1849. A beam of light was focused on the rim of a toothed wheel and after passing through a tooth it travelled a distance of four miles and was reflected back to the wheel. If on its return the light fell upon one of the teeth it could no longer be seen from behind the wheel. The wheel was, therefore, speeded up until the light disappeared, and the time of travel was calculated from the rapidity with which the wheel was turning.

In more recent times, in 1935, Michelson in the U.S.A. made a famous experiment in which a beam of light travelled in a metal tube a mile long; the tube could be evacuated in order to remove the small effect of the atmosphere on the speed. The final value he obtained was 186,271 miles per second. This figure was confirmed in other experiments and has been accepted ever since.

Dr. Essen's work concerns the propagation of radio waves, which differ only from light waves in their wavelength. It is generally assumed that they travel at the same speed. The method used by Dr. Essen in re-measuring the speed of light is similar in principle to Michelson's, but whereas he used a tube a mile long Essen's tube was only 7in. long. A radio wave was sent down this metal tube and reflected backwards and forwards between the ends. When the time of travel between the ends equals the time interval between successive waves they build up to produce an electrical resonance which can be detected with very high precision.

In the experiment the time of travel is about one ten thousand millionth of a second; in other words, the waves follow one another at a frequency of ten thousand million per second, and it was necessary to measure this frequency with an accuracy better than one part of a million. Dr. Essen was working on a similar problem during the war, and the equipment then built was ideally suited to this velocity experiment.

The construction of the tube called for skilled workmanship, for dimensions had to be accurate to one hundred thousandth of an inch. This called for the production of new measuring equipment.

"PRACTICAL MECHANICS" AND THE PRINTING DISPUTE

Our readers will have heard on the radio or read in the Press of the printing dispute which has prevented normal publication of this journal since the issue dated September/October. We are happy to record that a settlement has been reached and we shall now be able to publish normally.

We greatly regret the inconvenience which our readers have suffered, but feel sure it will be appreciated that this break in publication has been due to circumstances beyond our control.

The speed of light was comparatively unimportant for any practical purpose until the advent of radar in the last war. In radar, the distance to an object is calculated from the time taken by a pulse of radio waves to travel there and back, the speed of the waves being the same as that of light.

The new figure will, therefore, enable more accurate calculations to be made in connection with radar, and it will be particularly valuable for aerial survey work where the shape of the ground is plotted by means of radar.

The speed of light is also used in calculating a great number of physical constants. The most significant changes will probably be in astronomy, in atomic research, and in radio. The changes are small and not at present of much importance.

Of course, no measurement can be more accurate than the instruments used to make it, and we must remember that as no one has yet made a timepiece which keeps exact time, nor one which, moreover, maintains a constant rate of inaccuracy, it is true to say that no one to-day yet knows the exact speed of light.

GRAMOPHONE DEVELOPMENTS

DURING the past two years important developments have taken place in the gramophone industry in the U.S.A. The first was the introduction of a long-playing record, playing on a suitably adapted turntable running at 33⅓ r.p.m., as distinguished from the turntable speed of 78 r.p.m. used hitherto, and the later introduction of a 7in. record designed to play at 45 r.p.m. Thus, the record trade in the U.S.A. had to deal with the difficult situation of supplying three types of records running at three different speeds. A considerable number of turntables capable of playing at all three speeds has been produced, and it is now possible to buy long-playing records in this country. All of the leading manufacturers of records in America are making records to sell at three speeds.

Electrical and Musical Industries Ltd., who produce records for H.M.V., Columbia, Parlophone, Regal-Zonophone and M.G.M., have announced that they do not propose at the present juncture to make any changes in their equipment. They will continue to study the position to see how it settles down in America; 78 r.p.m., therefore, will be standard in this country for some time to come. If they feel changes to be necessary they will give six months' notice to the trade. Although microgroove records seem inevitable, it is well known that up to the present no one has devised either a pick-up or a needle as satisfactory or reliable as those which exist to-day for 78 r.p.m. records. It seems to be the general opinion in America that none of the combined units for playing at the three speeds is entirely satisfactory.

"BUILDING THE PRACTICAL TELEVISION RECEIVER"

THE highly successful television receiver designed and built in the laboratory of our companion journal, *Practical Television*, and which attracted such favourable comments at the recent Radio Show in Birmingham, has resulted in a great demand for the issues of that journal in which its construction was described. Those issues are entirely out of print, but in order to meet the need they have been specially reprinted on good quality paper under the title of "Building the Practical Television Receiver," and copies may be obtained for 3s. 6d. from newsagents or for 3s. 9d. by post from the book publisher, George Newnes, Ltd., Tower House, Southampton Street, Strand, W.C.2.—F. J. C.

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A Pedal-cycle Side-car

Constructional Details of an Inexpensive Side-car for a Child

By G. W. ASMAN, A.M.I.C.E.

THE side-car here described is of the type which is attached to a pedal cycle or tandem, and is suitable for carrying a small child. No special tools are necessary, and the work can be done by anyone who is at all "handy" and, what is more, at no great expense.

The body is made from 20 gauge aluminium sheet and is supported upon an angle iron frame by hinged brackets in front with two coil springs at the rear. The frame incorporates a flexible coupling for attachment to the cycle and carries the wheel and mudguard. It should be noted that this type of side-car is not rigidly fastened to the frame as in the case of the motor-cycle combination; the cyclist must be able to "lean" his machine in the normal way when turning and consequently a flexible connection is essential.

The first stage is the construction of the chassis frame, which is made from 1¼in. x 1¼in. x 3/32in. angle iron drilled with 3/16in. diam. holes and cold riveted with 3/16in. diam. iron rivets. The frame is composed of two rectangles, a large one incorporating the mounting brackets and coil springs which carry the body, and a smaller one to transmit the load to the wheel spindle. The illustrations show the method of construction and all the members should be marked out and drilled before any riveting is done. Although the frame is rectangular, adequate rigidity is assured by providing two rivets to each corner. For those who may be without experience in riveting, the end of the rivet should project ⅛in. through the other side before hammering over, and spreading is best accomplished by working around the edge of the rivet with fairly rapid blows of a light ball-pane hammer, and finishing off with a few harder blows in the centre to tighten up the rivet. A little practice is all that is required. It was found that ¼in.-long rivets were suitable for the frame connections and ½in. for securing the brackets.

The side-car attached to a cycle (front view).

Wheel Frame

The wheel frame is made from a continuous length of angle iron, the top flange being cut at the corners to facilitate bending, afterwards being joined up with an "L"-shaped plate overlapping each portion of the flange by 1in. and double-riveted at both ends. The end connections to the main frame are formed by cutting along the angle so as to separate the flanges, the vertical one being bent at right angles to fit along the outer member of the main frame and the top flange cranked so as to be across it. Two rivets to each flange connection are required.

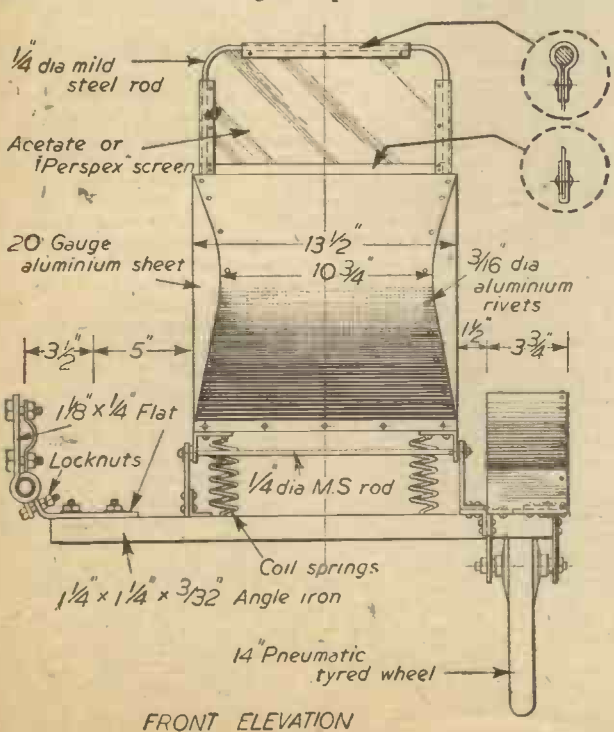
The wheel is carried between two slotted plates 3/16in. thick riveted to the frame. Incidentally, it is advisable to obtain the wheel before the construction is commenced, since different types of wheel may involve slight modification to the dimensions. The wheel actually used for this side-car was a 14in. rim with a 14in. x 1⅜in. pneumatic tyre, of the type used in a child's "Junior" bicycle.

The two front brackets which support the body are made from 1⅛in. x ¼in. flat mild steel, one being bent at right angles and riveted to the top flange of the outer member of the main frame, and the other riveted to the vertical flange of the inner member. They are drilled ¼in. diameter to receive the rod forming the front hinge.

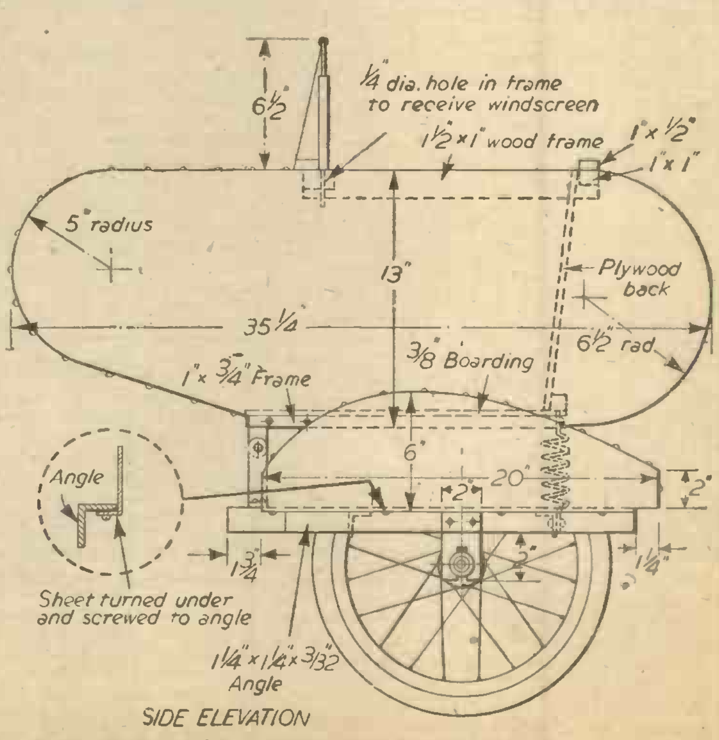
The two coil springs were obtained from a folding perambulator, each end being bent to form an eye. The lower ends were attached to the vertical flange of the rear cross member by means of ¼in. diameter iron rivets and the top eyes screwed to the wooden frame of the body.

Flexible Coupling

The next stage in the construction is the flexible coupling to the cycle itself. This is attached to the lower nearside rear fork, and, since this produces a moment about the centre line of the machine, sufficient friction must be provided to overcome this, at the same time allowing freedom for the cyclist to "lean" his machine. In order to accomplish



FRONT ELEVATION



SIDE ELEVATION

Figs. 1 and 2.—These two views of the side-car show clearly the shape of the body and method of springing.

Three-quarter rear view of the side-car and cycle.

this, a piece of 1in. diameter iron pipe was used, the attachment to the cycle being formed by two vertical brackets 1⅛in. wide by ¼in. thick bent around the pipe as shown. The front bracket is provided with a fixing clip to suit the fork and two ¼in. diameter bolts and nuts, and the rear bracket is drilled to fit the projecting end of the cycle rear wheel spindle. A single rivet secures the rear bracket to the pipe.

The main frame is attached to the pipe by means of a pair of 1⅛in. x ¼in. flat mild steel strips secured to the projecting ends of the cross members by two ¼in. bolts, the other ends being bent around the pipe and provided with a ¼in. bolt and locknuts for producing the correct degree of tightness.

The Body

The body is constructed as follows. First mark out the two sides leaving ⅜in. extra all round for riveting and screwing to the wooden frame. Bend the riveted sections inward at right angles, nicking between rivets around the curved portions, and bend right over where the sides are screwed to the top frame. The extra ⅜in. is kept flat at the bottom for fixing to the bottom frame.

The two sides are next assembled on the top and bottom frames and the front ends are drawn inwards to give a slight taper, being held temporarily with a piece of wire. A piece of stiff packing paper is now fixed to the front of the bottom frame, and drawn round the two sides to the top frame, this enables the correct shape for the front sheet to be determined and marked out. An allowance of ⅜in. must be made at the lower end for screwing to the wood frame, and also at the top edge for doubling under before fixing to the top frame. It is advisable to leave an extra inch or so at the top end as this can always be cut off at the last minute, particularly as the metal does not "give" to the same extent as the paper, and would probably be too short if cut to the exact length. Riveting is done with aluminium wire rivets; in the original, cup-headed rivets were used but flat-headed could be substituted if desired. The rivets should be about 3/16in. in length and are easily cut with a pair of wire cutting pliers. The bottom edge is screwed to the frame and each rivet position is punched, drilled and riveted up in succession. For this operation an assistant is required to hold a piece of iron or a heavy hammer to each rivet head whilst the riveter works from the inside. The back is fitted in a similar manner and on completion the edge of the metal is lightly hammered so as to fit snugly against the corners of the side pieces.

Floor, Windscreen and Mudguard

The floor is composed of ⅜in. boards nailed to the lower frame, and the back is of plywood. The body is attached to the chassis by means of two brackets under the front edge of the wooden frame and a ¼in. diameter steel rod is passed through these and through the vertical brackets, the ends then being riveted over. The coil springs are secured to the rear edge of the wooden frame with substantial wood screws.

The windscreen frame is made with a ¼in. diameter mild steel rod bent to shape, and the acetate or "Perspex" sheet is secured by strips of aluminium bent around the rod and riveted through with small aluminium rivets. The ends of the frame fit into vertical holes drilled through the corners of the upper wooden frame.

The mudguard is made in a similar manner to the body and the bottom edges of the sheets are bent under the top flange of the wheel frame so that the complete mudguard can be slid on from the side. Holes for 3/16in. Whitworth screws are drilled clear in the mudguard and tapped in the frame flange, or alternatively nuts can be used on the inside.

This completes the general description of the side-car, which has functioned extremely well. The dimensions given are those of the original but can, of course, be varied to suit individual tastes and requirements.

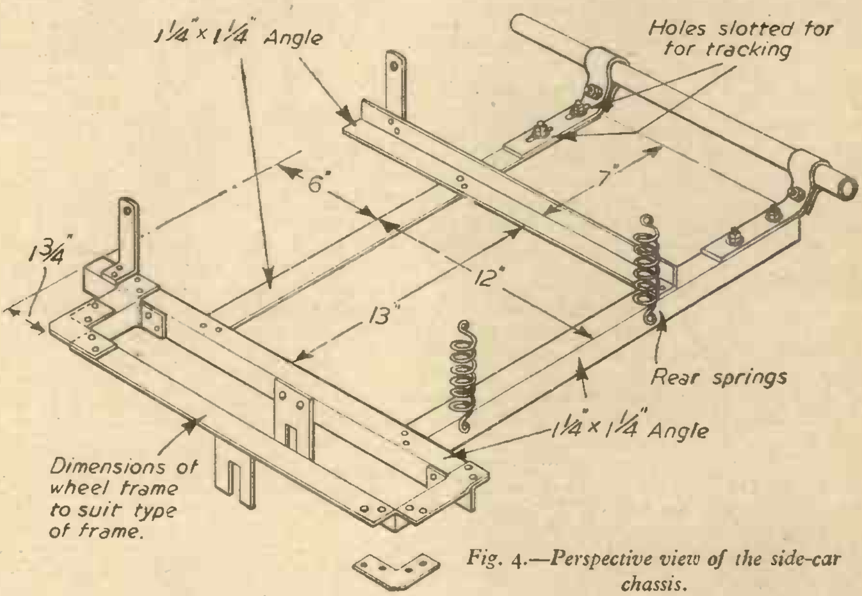


Fig. 4.—Perspective view of the side-car chassis.

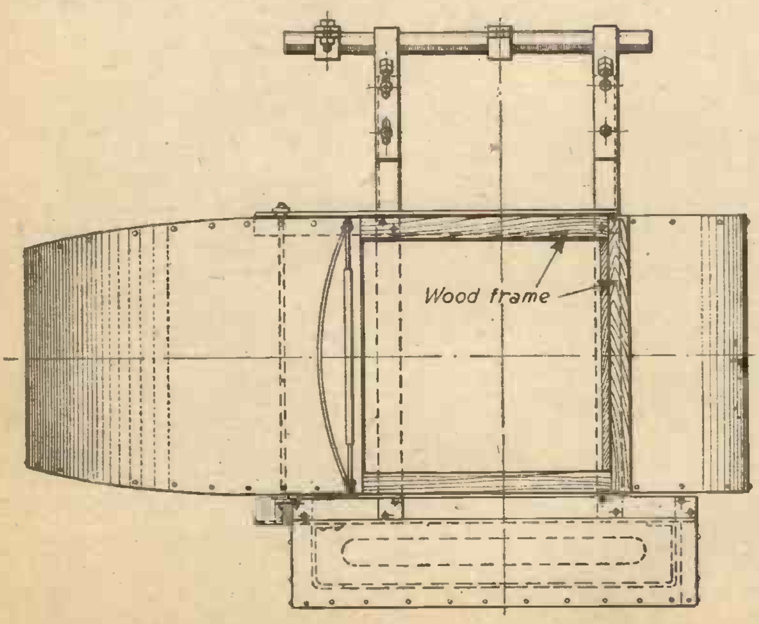


Fig. 3.—Plan of side-car. (Note: This is to the same scale as the front and side elevations.)

Simple Model Die-casting Machine

Constructional Details of an Easily Made Appliance for Home Use

By K. H. NEATE

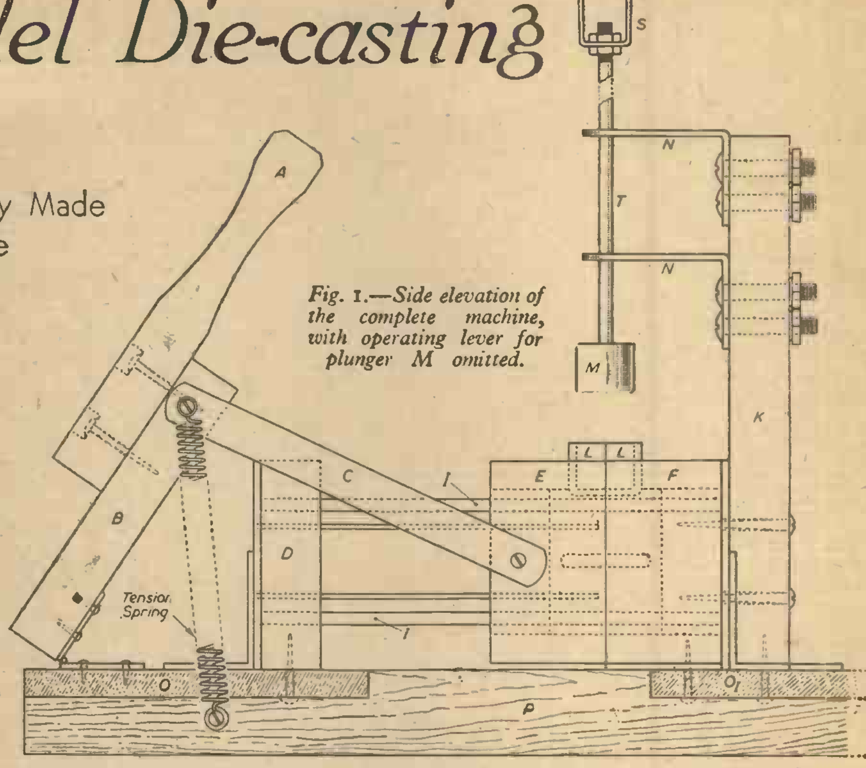


Fig. 1.—Side elevation of the complete machine, with operating lever for plunger M omitted.

THE home modeller and experimenter is always up against it when he requires small, detailed castings. The machine I made, of which details are here given, has helped me out of many difficulties, and saved me a considerable sum of money in my model railway lay-out. It was designed primarily for zinc-alloy castings for bogies, wagon axleguards and wheel castings.

Briefly, the machine consists of easily obtained parts and materials, with machining requirements nil.

The die is moulded of Pyruma or other fireclay material, and this, of course, presupposes that a prototype is available. If not, a pattern will have to be made.

The complete machine is shown in Fig 1. Dimensions require to be modified to produce the sizes of casting required. I decided that a mould of 5½in. x 3½in. would suit my purpose best, and it is on this basis that the machine was made.

Constructional Details

The die consists of two halves made of wood with inside dimensions of 4½in. x 2½in., with a minimum of ¾in. of fireclay from the deepest part of mould for strength. The mould boxes are made with 1in. timber bases for rigidity, as shown in Fig. 4.

The machine consists of two wood bearers P (Figs. 1 and 3) rigidly fastened with screws to cross-platforms O. The fixed die-holder F is secured to cross-platform O1 by steel angles and woodscrews. The slide-ejector block D is similarly fastened to cross-platform O. Handle block B is firmly hinged to cross-platform O. The plunger assembly, S. T. M and L, is simply made from materials found in every workshop. The cylinder L is a piece of tube with a sliding-fit plunger M. Cylinder L should be halved and secured to the two halves of the die. I used a plunger regulator out of an old refrigerator fitting.

The holes for the four guide-slides I in part D and backs of E and F should be drilled in one operation, these three items being clamped together for this purpose. It will be seen that these holes also penetrate the Pyruma. Thus care should be taken to leave clearance for these holes when making the mould. Some constructors may feel that a bearing sleeve could be inserted with advantage in moving portion E. From personal experience, however, I found this arrangement satisfactory even after weeks of use on the same die. No sign of wear or sloppiness developed—probably due to the fair pull exercised by the side pivoting of the withdrawal arms C.

In the plan view, Fig. 2, more detail is shown regarding the ejectors. For those unfamiliar with the practice of die-casting, I would explain that these ejectors are necessary for the rapid and safe removal of the casting from the die.

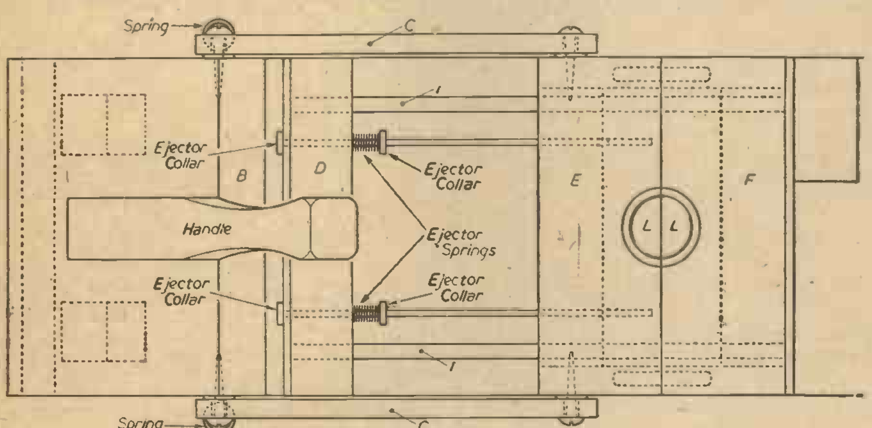


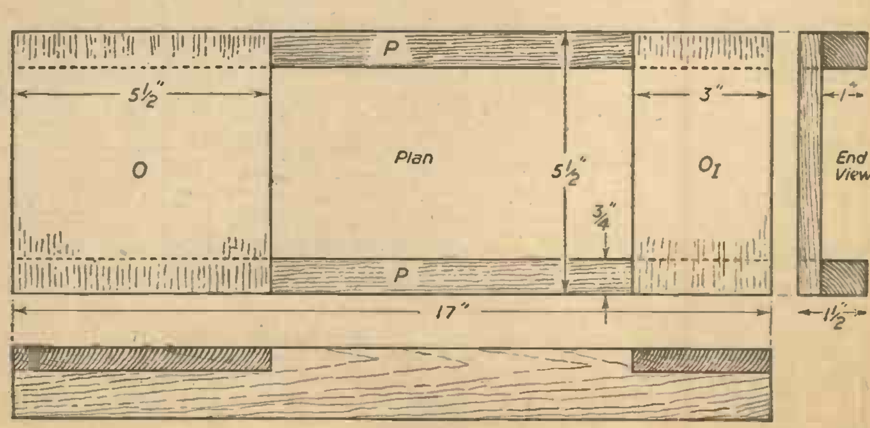
Fig. 2.—Plan view of the machine showing the ejector rods and springs.

Operation

Have a ladle of molten zinc-alloy at right hand:

1. Pour just enough metal in cylinder L (Fig. 1) to fill the mould. (This will come easily after one or two "tries.")
2. Pull down handle of piston M, forcing all metal into corners of mould.
3. Grasp handle A with left hand and pull to the left, when it will be found that casting drops between bearers into receptacle.

The last action explains the whole movement of the ejectors. Moving handle A to the left pulls mould E to the left by means of links C. The mould travels along its



Elevation

Fig. 3.—Plan and side elevation of the wooden base.

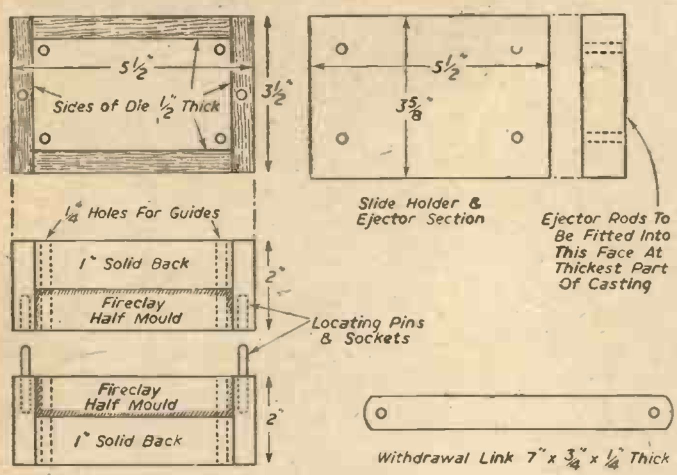


Fig. 4.—Details of die, moulds and withdrawal link.

four slides I. The "working" ends of ejectors (Fig. 2) are in the moving mould (or die), right up against the thickest part of casting. On the first movement of the die the motion is transmitted by collars to springs. This allows a movement of about $\frac{1}{2}$in., when ejectors force the casting out of the mould, the $\frac{1}{2}$in. being all that is necessary to allow the casting to fall between the faces of the moulds.

The prototype (or pattern) is well greased and forced up to its widest part into one box previously packed level with fireclay. The surface is then levelled off with a sharp knife at the top of the box and at its widest part. This is then allowed to set.

The model should then be carefully removed for examination of the mould. If there is a good impression the model should be replaced and the whole of the surface of the mould and back of model painted with a light film of oil. The second half of the box should then be filled with fireclay, on to which is placed the first mould — thus taking the impression of the back half of the model. Squeeze tightly together, ensuring that locating pins are received correctly. Surplus fireclay should be removed from the outside edges of boxes, and the whole left to set.

If the model to be cast is highly detailed or deeply recessed, I found that dipping it in hot paraffin wax, allowing to set, then inserting in fireclay made a better job than coating with oil. The mould, when dry, should be very slightly warmed. When wax melts the model may be withdrawn easily. If this method is not employed it will be found that deep recesses in models cause the fireclay to "wedge" and break off upon removal of the original.

It is very important that the instructions for setting Pyruma or similar material should be carefully followed. This will avoid disappointments when a "run" is in progress, when results of bad setting will show in cracks and flaking of the mould.

Ejectors are made of $\frac{1}{8}$in. round silver steel. Collars are of the constructional kit variety fitted with grub-screws. Only the lightest type of springs are necessary for fitting to the ejectors.

Detail of the piston arrangement has not been shown in Fig. 2, as this item will "decide itself"—and will possibly be anchored to the roof or wall of the workshop, depending on the situation of the machine.

This will, of course, be sprung so as to clear the machine.

Mathematics as a Pastime

The Zero Symbol

By W. J. WESTON

An expression like 2^0 is one of our mathematical curiosities. We know that 2^2 is 2×2, that 4^3 is $4\times4\times4$, and so on. The small figure to the right is different in its nature from the large figure to the left. The large figure denotes a number; the small figure denotes an operation. It directs us to take the number as a factor repeated; it is the index of the number in the particular expression.

But what about 2^0? The 0 by itself signifies a total absence of quantity, and yet we declare that 2^0 is equal to 1. Why? And the only answer we can give is that we seek to be consistent in our mathematics. $2^3\div2^2$ is 2^{3-2}, or 2^1, or 2. That being so $2^3\div2^3$ is 2^{3-3}, or 2^0, or (since the divisor 2^3 is exactly commensurate with the dividend 2^3) 1. Very well: 2^0 is 1; and, by the same reasoning, any number with an index of 0 is 1. That is why the logarithm of 1 to the base 10 is 0: in other words $10^0=1$.

You can, too, attach a meaning to a quantity multiplied by 0: you indicate that the quantity, however great, is eliminated. Nothing remains. The dividing of a quantity by 0 is, however, meaningless. You can "prove" all manner of absurdities once you admit the possibility of dividing by 0. Thus, let us suppose that $a=b$.

Then $a^2=ab$ (multiplying each equal by a)

And $a^2-b^2=ab-b^2$ (subtracting b^2 from each equal).

And $(a+b)(a-b)=b(a-b)$ (getting the factors of both equals).

And $a+b=b$ (dividing both equals by $a-b$).

And if we take it that both a and b equal 1, it would seem as though we had shown that $2=1$. But, of course, you have, quite wrongly, supposed that you are able to divide by 0 (for $a-b$ is 0) and yet get a definite result. There can be no result; or, rather, you can assign any result you please to such division.

Perhaps another example will impress upon you the rule: "Never divide by zero." Here is a "proof" (so called) that two unequal numbers are equal.

Assume that $a=b+c$ (where a and b and c are positive numbers).

Then clearly a must be greater than b. Now, multiply both equals by $(a-b)$. Then $a(a-b)=ab+ac-b^2-bc$.

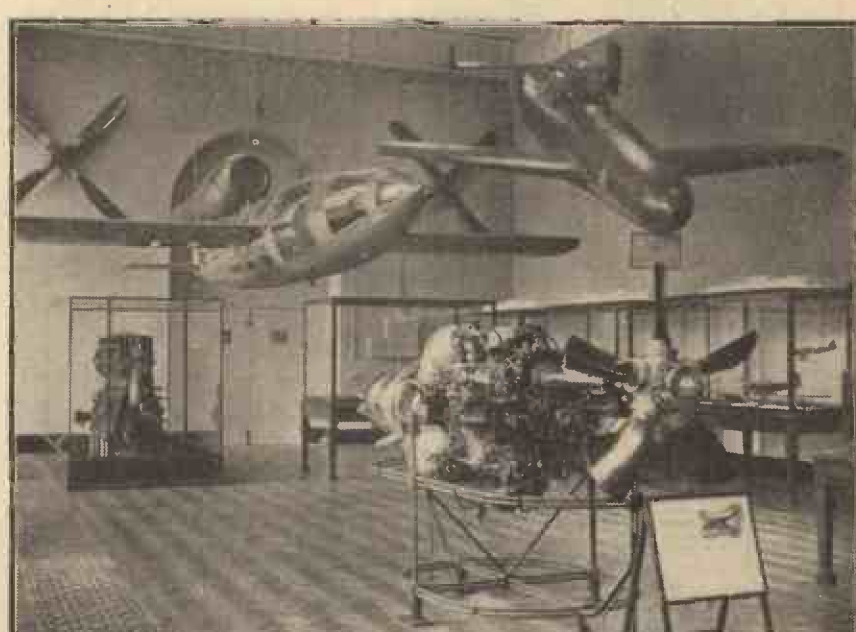
Take ac from both sides.

Then $a^2-ab-ac=ab-b^2-bc$. Or, getting the factors of these equals: $a(a-b-c)=b(a-b-c)$.

[So far there is nothing whatever wrong with our reasoning.]

Divide the equals by $(a-b-c)$ and we get $a=b$ which we know to be erroneous and we have got this erroneous result because we have divided by zero. For $a-b-c$ is 0.

National Aeronautical Collection



Recently opened to the public, this interesting collection is located in the Western Galleries of the Science Museum, South Kensington, London, S.W., and contains many of the world's most famous, and historic aircraft. Progress in aviation is extensively illustrated from the original Lilienthal glider to the world's first successful jet-propelled aircraft; and by the finest collection known of accurate scale-model aircraft. In our illustration is seen the Rolls Royce Trent Engine in the foreground, also the first propeller Turbine engine to fly installed in a Gloster Meteor. Also in the picture can be seen (top left) a German Flying Bomb, and (right) a Japanese Baka suicide dive bomber.

An Electronic Novelty

Constructional Details of an Amusing Unit Using a Single Valve

By F. G. RAYER

THIS interesting novelty makes use of a valve oscillating on a high frequency, and the anode current is fairly large when both anode and grid circuits are tuned to the same frequency. A metal object (about which more later) is connected to the grid coil, indicated as L.1 in Fig. 1, and when a person's hand approaches this object the resonant frequency of the grid circuit is changed; the valve then ceases to oscillate and the change in anode current operates a relay.

When the circuit is correctly adjusted the relay will operate when a hand is brought within a few inches of the metal plate connected to L.1 and this effect can be used to bring about a number of startling and amusing results, all totally unexpected by the individual responsible. The plate connected to L.1 may take many forms—a metal ash-tray can be used, or a piece of metal or foil concealed under a tablecloth, or even under the table itself. The operation of the relay can bring about a number of effects. For example, a radio receiver can be connected so that when anyone approaches a hand to it for tuning, etc., the set switches itself off, only to come on again mysteriously when the hand is withdrawn. For children, a jack-in-the-box arrangement could be tried, Jack withdrawing into the box and allowing the lid to close when a hand is put near. Even a suitably humorous text, placed behind an ash-tray, and illuminated when a person's hand comes near, is quite effective. If the words are cut upon thin card with a razor-blade and placed behind thin coloured paper, no lettering will be visible when the bulb is out and any smoker caught with his hand still some inches from the tray will be astonished.

The completed apparatus.

Other arrangements will readily suggest themselves and only one will be described in detail. In this a small wooden parrot pecks violently when a hand approaches the ash-tray forming his feeding bowl. The action ceases when the hand is withdrawn.

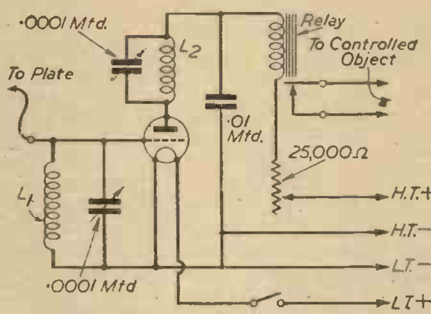


Fig. 1.—Theoretical circuit diagram.

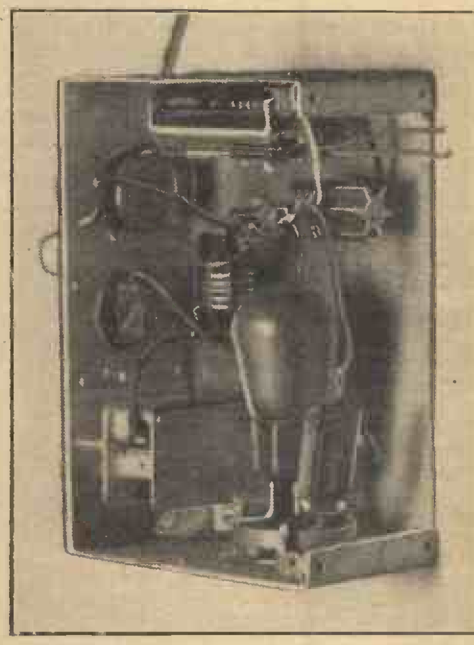
The Oscillator Circuit

This, together with the layout, is shown in Figs. 1 and 2. Coils L.1 and L.2 each consists of five turns of 22 S.W.G. tinned copper wire on a $\frac{3}{4}$in. diameter former, the turns being spaced about $\frac{1}{8}$in. Actually, these coils are not critical provided the frequency tuned is fairly high. L.1 is tuned by means of a .0001 mfd. variable condenser, preferably with small reduction drive. A small preset condenser of about .0001 mfd. maximum capacity is wired in parallel with L.2.

A 2-volt small-power valve was found to give excellent results, anode current being $2\frac{1}{2}$ milliamps when the circuit is not oscillating, rising to 6 milliamps when oscillation occurs. However, other valve types can be used. A 1.4 volt "all dry" receiver-type valve was found to be satisfactory and a mains valve could, of course, be used, provided suitable supplies were available.

The relay is a 250-ohm ex-service one and operates strongly with an anode current of 5 to 6 milliamps, opening sharply when the current falls to half this figure. Such relays are easily obainable. A relay already to hand may prove suitable, even if intended for larger currents, if the return spring is weakened by stretching.

The 25,000-ohm resistor is advisable as this enables the anode current to be adjusted so that the relay operates properly. None of the other parts requires mention, and the whole may easily be built in a toffee-tin or similar container. An insulated lead passes through a hole to the metal plate to which we have referred already. By keeping all batteries well away out of sight and disguising the nature of the apparatus the effect will be greatly enhanced.



Underside view showing layout of components for the oscillator unit.

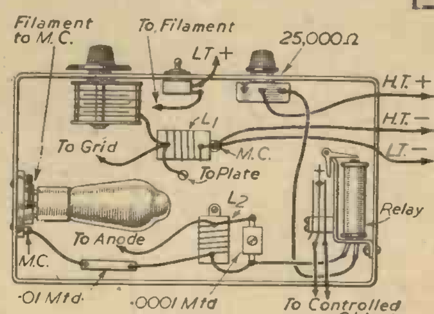


Fig. 2.—Wiring diagram.

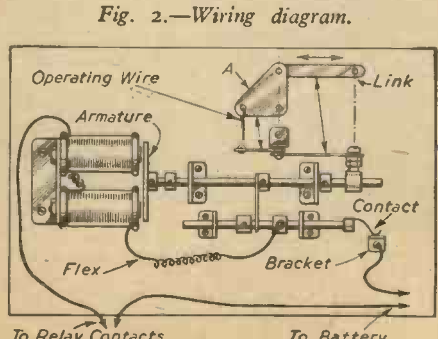


Fig. 3.—The automatic electrically-operated mechanism.

Adjusting the Circuit

It is desirable to connect a meter in series with one H.T. lead as a beginning. The variable condenser should then be adjusted until the anode current peaks sharply. The maximum anode current will depend upon the valve type, setting of the 25,000-ohm variable resistor, and H.T. voltage. With the valve mentioned 60 volts was ample, with the variable resistor set about midway. If the anode current of the valve keeps the relay closed when the circuit is not oscillating, the anode voltage should be reduced by means of the 25,000-ohm resistor.

The tuning condenser in parallel with L.1 will require slight re-setting if the object connected to the valve grid is changed, or the position or length of the intervening flexible lead is modified. The relay should be heard to operate sharply when a hand is brought within a short distance of this plate and the variable condenser can accordingly be set without difficulty. With careful adjustment of anode current and tuning, the relay will operate when the hand is some inches from the plate.

Two leads are taken from the relay contacts which close when the relay is not energised (i.e., when the valve ceases to oscillate). These leads may be taken to a battery and bulb, electric motor, solenoid, or other apparatus as desired.

The "Pecking Parrot" Movement

A small electric motor with reduction drive and crank would be possible, but the arrangement shown in Fig. 3 uses electro-magnets, and gives a sharp backwards and forwards action. The method of operation of the unit is as follows: When the battery and magnet circuit is completed the contact shown is touching the small bracket. The magnets are therefore energised and the armature drawn to the left. As full movement to the left is reached the projection strikes one of the collars on the shorter lateral rod, bringing the contact away from the bracket and breaking the electrical circuit. The weight of the bird's tail then draws the armature away from the magnets and when full movement to the right has arisen, the projecting arm strikes the second (right-hand) collar, thereby bringing the contact spring against the bracket. This motion is therefore continued until the relay contacts open, being similar to that for maintaining oscillations to the pendulum of some electric clocks.

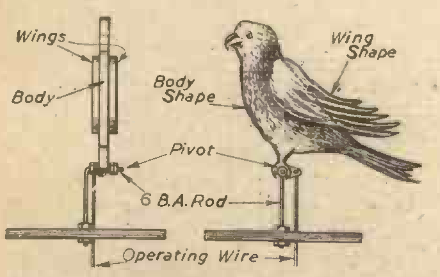


Fig. 4.—Details of the movement for actuating the mechanical "bird."

All the parts should move smoothly. Rods, collars and brackets are found in a well-known constructional set and greatly simplify construction. The backward and forward movement of the armature is transferred to an up-and-down motion by the crank "A," the operating wire passing directly down through the baseboard shown in Fig. 3. The complete movement of the armature will be only about ⅜in. and the operating wire is accordingly pivoted to the parrot's body at a point very near the pivot (perch) about which it moves. This is shown in Fig. 4.

The bird should be quite light and about 3½in. or 4in. long. The body with tail is cut from one piece of 3-ply and the wing shapes from similar material, one being glued on each side of the body piece. Just sufficient weight is added at the tail end of the bird to make this fall, and it is this which withdraws the armature from the magnets.

The magnets themselves should be of good power. Bobbins about 1½in. long and 1in. in diameter wound with 14 S.W.G. wire can be used for a 2-volt supply, the same accumulator being used as for supplying the valve. The armature must be of iron, and is soldered to a collar on the sliding rod. If all the collars are held with set-screws final adjustment will be facilitated. All the parts should move freely, and a little thin oil on bearing surfaces will be helpful.

Final Details

With the units as described, the oscillator in its case can form a base. The operating mechanism can rest on top of this, forming a platform for the bird and ash-tray, which should be a fairly large one if the movement is to come into action when the hand is still some inches away. This is shown in Fig. 5.

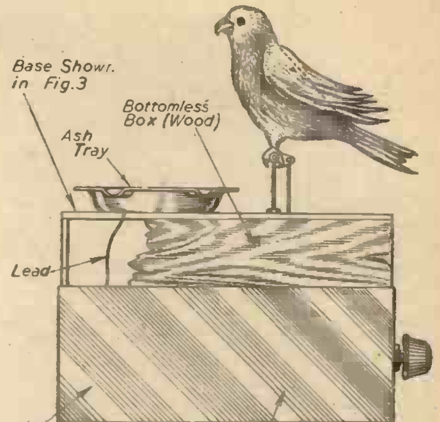


Fig. 5.—Side view of the apparatus, showing the wood and metal casings.

The bird should be finished off in bright red and green and the tuning and other controls are at the back out of sight. Once these are set, no adjustment is required unless some modification is made, as mentioned.

Finally, the circuit oscillates by virtue of the grid-anode capacity. If screen-grid or pentode valves are employed it is necessary to connect screen-grid and anode together, and employ these as anode, or connect a small condenser of about 10 pf. from grid to anode, otherwise oscillation may not be obtained. As mentioned, a small-power triode is the type with which satisfactory results may most readily be obtained and with such a valve, and a suitable relay, no difficulty whatever should be experienced in adjusting the circuit correctly.

The Law About Patents

8.—Opposition to a Grant

By a BARRISTER

EACH Wednesday the Patent Office publishes its *Official Journal (Patents)*. This contains, among other matters relating to the granting or withholding of patents, a list of complete specifications open to public inspection. Among the many items in this issue, for instance, are "Mechanism for balancing single blade aircraft rotor," "Bottle stopper and cap therefor," and "Production of uranium."

Before the list is published the Patent Office itself has made its investigation as to novelty. Has the invention claimed been anticipated in any published specification (other than a provisional specification not followed by a complete specification) filed pursuant to any application made in the United Kingdom within the preceding fifty years, or has been made available to the public in any document within the Comptroller's knowledge published in the United Kingdom?

Public Inspection

The Patent Office is satisfied that the answer is no, and the complete specification is accepted. Now the public is called upon to co-operate and to supplement the official inspection. During three months from the announcement of acceptance anyone can by paying an inspection fee of one shilling, inspect at the Patent Office the application, the specification and the drawings. Copies of the specification are, too, placed on sale at costs ranging from a shilling or two to a guinea or more.

Opposition to the Grant

Perhaps you are surprised by noting a patent application for something you already know, may be already in use. Can you do anything about it? Certainly; the publication was for that purpose, the purpose of receiving and considering objections to the grant. In some countries—the United States among them—no interval elapses between the official examination and the grant. Here, under the Patents Act, 1949, there is a three months' interval. You can oppose the grant on any one of these grounds:—

1. The applicant had the invention from you, or from a person of whom you are the legal representative;

2. The invention has, prior to the date which the patent applied for would bear if granted, been published within fifty years in the United Kingdom;

3. The nature of the invention, or the manner in which it is to be performed, is not sufficiently and fairly described and ascertained in the complete specification;

4. The complete specification describes or claims an invention different from that described in the provisional specification, and you yourself are claiming a patent for that same differing invention;

5. The invention was, during the period from September 3rd, 1939, and December 31, 1945, invented in Germany or in Japan.

Another ground, which will be considered in a later article, concerns the invention for which protection has been claimed in a Convention country. There is a *Patents Form 10*, needing a £1 stamp, for giving notice of opposition.

Opposition to Extended Monopoly

The right of the public to oppose exists also when an inventor, alleging that the normal term of sixteen years for his monopoly has not given him reasonable profit from his invention, asks for an extension of the term. The extension is not a fixed term. At the discretion of the Court, which will take into account—in order to be just and equitable to both inventor and public—all the conditions, the added term may be anything up to ten years. Thus Letters Patent were in 1934 granted to Gillette Industries Limited for the invention of "Improvements Relating to Colouring and Hardening Steel." Now notice is given that the patentee will ask "that the term of the said Letters Patent may be extended for a further period of six years or for such other term as the Court shall think fit." The date when directions will be given about the hearing is given; and "any person desirous of being heard in opposition must, at least seven days before that date, lodge notice of opposition."

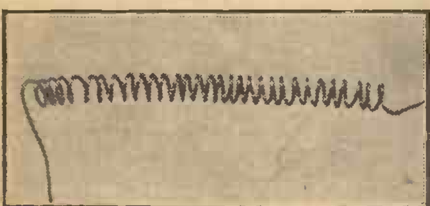
MEMOIRS OF THE METALS

The Marvels of Ruthenium

Its Properties and Characteristics

By J. F. STIRLING

IF the Soviet Union should ever feel a need for a distinctive national metal, that metal should surely be the element ruthenium, which, although it was not actually discovered by a Russian, was eventually named by way of association with the former kingdom of Russia.



A tiny coil of ruthenium-rich platinum used for thermocouple work.

Yet, at the present time, ruthenium is a metal with very little renown. To be sure, it is a "noble" metal, one of the half-dozen members of the platinum group, and it has the peculiarity of being the lightest of them all, but, in point of fact, it is easily the least known; and it is, perhaps, the only platinum metal which does not possess any well-defined industrial or technical applications. Such a fact, however, is very little to go by because a metal which is scarce one day may become relatively common soon after. At present, ruthenium's metallurgy is still pretty well a closed book to us, and the metal still remains something of a chemical curio; indeed, there are really very few technical people who have ever set eyes on it.

Nevertheless, such circumstances are by no means permanent ones. Ruthenium may rise to importance at any time. Even now it is being used as an alloying ingredient of platinum, a platinum alloy containing about 5 per cent. of ruthenium being considerably harder than platinum alone. It is chronicled, also, that a pink china clay which is found abundantly in the Tanokami district of Japan contains ruthenium as a minor constituent. Here, therefore, given a little metallurgical ingenuity, seems to be the eventual end of ruthenium's rarity, so that it is not at all improbable that this Russia-named element may one day attain to a considerable technical status.

There is only one particularly distinctive ore of ruthenium. That is *laurite*, which is a sulphide of the metal RuS_2. But laurite is an excessively rare mineral, and it would be hopelessly impossible to think of extracting it from such a natural source.

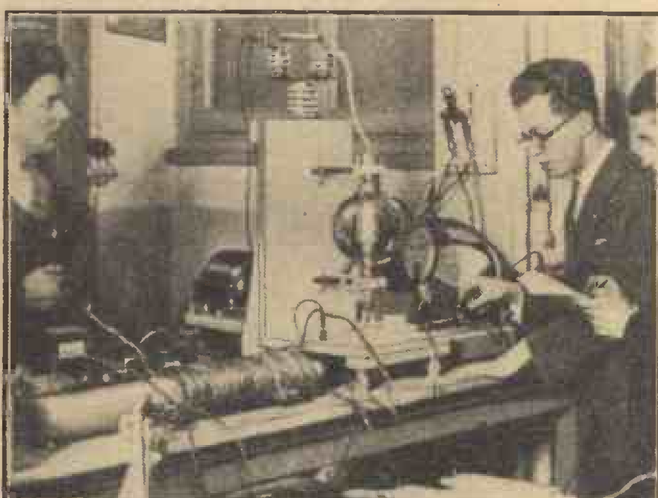
The small amount of ruthenium metal which enters into present-day scientific commerce is obtained from osmiridium, that natural alloy of osmium and iridium which contains, additionally, about 6 per cent. of ruthenium. The metal has also been extracted from the platinum sludges which occur as a valuable bye-product of nickel refining processes around the Sudbury district of Canada.

It is not so difficult to get the ruthenium out of the acid concentrates of the platinum metals, because both ruthenium and osmium form volatile oxides which may be distilled away and thereafter separated by other chemical means. From the pure oxide thus obtained, it is a comparatively straightforward job to obtain the metal.

Botanist Discoverer

The discovery of ruthenium was made just a little more than a hundred years ago by a man whose chief interest in life was botany rather than chemistry or metallurgy. Karl Karlovich Klaus was his name. He was born at Dorpat, in Estonia, in 1796, the son of a local artist of some fame, and, when a boy, was sent off to become a pharmacist's apprentice in St. Petersburg, now, of course, Leningrad.

Although the work of a retail pharmacist became his business, the study of botany formed his main interest, and he spent most of his free time studying the plants and flowers of his district. Then he was offered a lectureship in the University of Dorpat, his home town, a post which he at once accepted, despite the fact that it meant selling his pharmacy business at a loss.



A laboratory electric furnace used for melting small quantities of ruthenium and other platinous metals.

Arrived again at Dorpat, Klaus, for some reason or other, delved into the intensive study of the platinum metals. Possibly he was attracted to this subject by observing the large accumulations of platinum residues which for years had lain unused at the Mint in St. Petersburg. The authorities of that Institution seemed to have been glad to get rid of the "rubbish," for they gave Klaus some twenty pounds of it, and it was from this "dross" that he first prepared metallic ruthenium in 1844.

This, "the last of the platinum metals," as it has been called, was the subject of a 180-page Report which Klaus published, and this was followed in the succeeding year (1845) by a paper "On the New Metal Ruthenium," which appeared in our own *Philosophical Magazine*.

As far back as 1828, a chemist named Osann, who was also a professor at Dorpat, thought that he had discovered three new metals in crude platinum residues from the Ural mountains in Russia. He called his hypothetical metals *pluranium, polinium* and *ruthenium*, the last named being derived from the word "Ruthenia," a classical name for Russia.

But Osann's trio of new metals was proved to exist only in his imagination. Not until Klaus, in 1844, had verified his discovery of a new element and member of the platinum family did he take the third of Osann's metal names—ruthenium—and apply it to his own newly-discovered metal.

In this manner the "last of the platinum metals," became the metal of Ruthenia, or, in short, ruthenium, a name which is now likely to remain with it for all time, unless by any chance all metal names should be abolished at some future date, and mere numbers or code references substituted for them.

First Platinum Metal

Although the "last of the platinum metals" in order of discovery and identification, ruthenium is really the first of these metals. For, as we have already seen, it is the lightest of them all, and it has the lowest atomic weight and atomic number. Constitutionally, it is, therefore, the simplest member of the platinum group. Its melting-point, which is above 2,400 deg. C., is greater than that of platinum at 1,755 deg. C.; but despite this, it is the most oxidisable of all the platinum metals, for, when heated at a low red heat, it becomes covered with a superficial blue oxide film, but when heated to a high temperature in, say, an oxy-hydrogen flame, the metal actually burns, evolving dense black fumes of its pungent-smelling tetroxide. Such a fact, of course, at once renders ruthenium useless for high-temperature work in the presence of air

Ruthenium's liquid oxide, the so-called orange "ruthenic acid," RuO_4.

Osmiridium grains. This native alloy forms a source of ruthenium, the grains containing about 6 per cent. of the metal.

or oxygen, despite its otherwise very useful high melting-point.

The oxides of ruthenium are all very interesting. There are five of them all told, viz.—Ru_2O_3, RuO_2, Ru_4O_9, Ru_2O_5 and RuO_4. They are all black (bluish-black in thin films) except the last-named, RuO_4, which is a yellow crystalline substance whose melting-point (25.5 deg. C.) is so low that it can be liquified by the heat of the hand.

This oxide, ruthenium tetroxide, represents the highest state of oxidation of any metal. It is sometimes called *ruthenic acid*, although it is not actually an acid. When it is allowed to come into contact with any organic material—even paper—it is "reduced," metallic ruthenium in the finely-divided state being formed.

Metallic ruthenium, as it is usually obtained at the present day, takes the form of a grey powder. The metal, however, can be obtained in a coherent state by fusion of the powder in the electric furnace, and, in this state, it has an appearance something between that of platinum and iron. The metal is quite brittle when cold (this is probably due to ineffective methods of producing it), but when heated to redness it becomes malleable. At 220 degrees Brinell, ruthenium is as hard as its superior family member, iridium, but it is not as tough as the latter.

Heated to white heat, ruthenium suffers the great disadvantage in actually losing weight, so that if you start with, say, 1oz. of the metal and heat it for a few days, you have appreciably less ruthenium than when you commenced.

Even although we are aware that the metal oxidises appreciably at high temperatures, this, at first, may seem to be a strange happening, particularly if we take a flash-back to our old chemistry lessons at school in which we learned that metals, on oxidising, combine with oxygen and thereby gain in weight.

However, there is no real paradox here, because although ruthenium, on oxidising, does actually gain in weight like all other metals in similar circumstances, the ruthenium oxide is volatile at high temperatures.

The Metal Explodes!

A very curious property of ruthenium is the fact that, under certain conditions, it can explode! There is no clear explanation as to why it should behave in this manner, but the fact is not to be doubted, although it may never be turned to useful account.

Ruthenium happens to alloy very readily with pure zinc, and if we make an alloy of the two metals and afterwards remove the zinc by dissolving it out with hydrochloric acid, the ruthenium is left at the bottom of the vessel in the form of a grey-black powder. This is "explosive ruthenium." Sometimes it will go off at a touch. At other times it requires to be heated suddenly for the explosion to occur. However, when the detonation does take place, a great deal of heat is evolved and the results are often shattering.

All sorts of theories have been concocted to explain this happening. The most likely theory, however, assumes that there are two varieties—"allotropic modifications" is the correct term—of ruthenium, one of which is intensely stable, the other being highly unstable. Call the first one "Ruthenium-A" and the second one "Ruthenium-B." Ruthenium-B is in a strained condition, something like a contracted spring. Touch it, heat it or by some other means disturb the adjustment of its molecules, and it will fly back to Ruthenium-A with the energy-release of a powerful clock-spring suddenly jerked out of its barrel.

Ruthenium resists all acid attack except that of *aqua regia*, which is a mixture of strong nitric and hydrochloric acids. And even here it only yields slowly and reluctantly to the acid, showing itself to be superior to platinum in this respect, since the latter metal dissolves fairly readily in this intensely corrosive liquid.

Some metals have the property of combining with carbon monoxide when that deadly-poisonous gas is passed over them at elevated temperatures or at raised pressures. Ruthenium is one of these metals which form "carbonyls" or carbon monoxide compounds, and, when ruthenium carbonyl is passed through a heated tube, it deposits the metal in a very pure state in the form of a "ruthenium film" of intense blackness. Possibly, no purer form of the metal is known than this material.

Colloidal Ruthenium

It is also possible to obtain metallic ruthenium in the colloidal state. This is done by dissolving a ruthenium salt in water and by adding to it a few drops of a strong gum arabic solution. Then a solution of hydrazine hydrate is added and the mixture very gently warmed. The hydrazine reduces the ruthenium salt to metallic ruthenium, the particles of which are so small that they are, as it were, semi-soluble in the liquid, which latter preserves its transparency but changes colour to a dark brown. The function of the gum arabic is to "protect" the colloid, that is to say to prevent or, rather, to discourage, the individual particles of ruthenium from agglomerating together and thus precipitating themselves as a visible black metallic powder.

There is, also, spongy ruthenium and crystalline ruthenium. The spongy ruthenium is the commercial form of the metal at the present day. It is made by strongly heating ammonium chlorruthenate. Crystalline ruthenium, on the other hand, is brought into being by fusing ruthenium with excess of tin in a carbon crucible. The excess of tin is dissolved out with hydrochloric acid. This leaves an insoluble residue which consists of an actual metallic compound of ruthenium with tin,—$RuSn_3$. Tin may be attacked by gaseous hydrogen chloride, with the formation of a volatile tin chloride (the material used for smoke-screen production). If, therefore, the above gas is passed over the heated ruthenium-tin compound, the tin is removed from the scene of operations as tin chloride, and crystalline ruthenium, which is unattacked by the acid gas remains.

A Ruthenium Dye

Occasionally, one hears of *ruthenium red*. This is a very surprising material because it dissolves in water to give a red solution which can actually be used for dyeing wool, silk and other fabrics. It is made by the interaction of ammonia and ruthenium chloride, and is of complex composition. Nevertheless, it is a commercial article and has been used for staining microscope sections.

The metal can be alloyed successfully with lithium, and the lithium has apparently a considerable hardening effect on it. Ruthenium actually dissolves in molten lead much as common salt dissolves in water, but there is no combination between the ruthenium and the lead as there is between tin and ruthenium because, on cooling the lead solution, the ruthenium is at once thrown out of solution on the solidification of the lead.

Cobalt, nickel, tungsten, gold, silver, copper and even iron all form alloys with ruthenium.

Because natural *osmiridium* still retains so high a market value, an alloy of 75 per cent. ruthenium, 17.5 per cent. tungsten and 7.5 per cent. nickel has been put forward as a substitute for it. Ruthenium has also been used experimentally as an alloy for lamp filaments, the aim being to render the usual tungsten filament less fragile after prolonged heating and, thereby, to increase its burning life.

A quantity of ruthenium "grains" prior to chemical purification.

For the measurement of high temperatures a ruthenium-iridium thermocouple has been devised, such a couple being able to deal with temperatures far higher than those manageable by thermocouples of lower melting-point metals.

Potassium Perruthenate

Of the several other interesting chemical compounds of ruthenium, space remains only to allow a brief mention of potassium perruthenate, $KRuO_4$, which is the exact analogue of potassium permanganate, $KMnO_4$. Potassium perruthenate forms black crystals which dissolve in water to a blackish-green solution having high oxidising powers.

Although traces of ruthenium are supposed to have been found in meteorites, the metal comprises one of the few elements which have not been detected in the sun.

Magnetic Steel Tester

Constructional Details of a Simple but Efficient Instrument

By ERIC LOWDON

THE method of determining the physical and chemical properties of steel by comparing its magnetic characteristics with a standard is by no means new, and is used, in fact, by many manufacturers of steels and steel components.

Instruments designed for this purpose are quite simple in principle. Basically, they consist of nothing more than a bridge circuit with an air-cored inductor included in each of two arms of the bridge, as shown in Fig. 1, and an indicator to show whether or not the bridge is balanced.

In operation, the bridge is initially balanced, and the standard material is introduced into one coil, whilst the sample to be checked is introduced into the other. If the two are identical with regard to chemical composition, hardness, tempering, grain size, etc., then the bridge will remain balanced. But if the sample differs from the standard in any respect, then an out-of-balance indication will be obtained from the bridge.

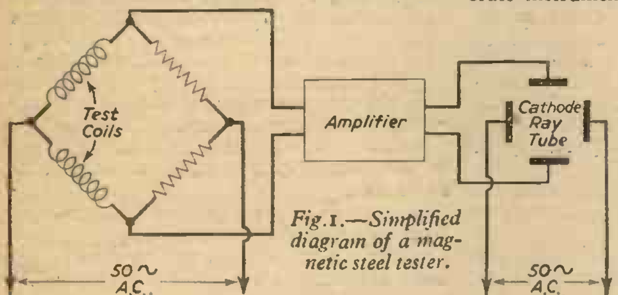


Fig. 1.—Simplified diagram of a magnetic steel tester.

In practice, however, the indicator is generally quite elaborate, and usually consists of a carefully designed amplifier feeding into a cathode-ray tube. The material to be tested is automatically swept through the hysteresis cycle by feeding the bridge from an A.C. source. The output from the bridge is fed via the amplifier to the Y-plates of the tube, and the X-plates are fed from the same source as the bridge to form the time base.

Hysterisis Loop

If the bridge is unbalanced by two dissimilar metals, a hysteresis loop is projected on to the screen of the tube. The shape of the loop will not only indicate that the metals are dissimilar but by correct interpretation will also tell in what respect they differ.

Such an instrument therefore measures both quantitively and qualitively. For instance, a difference in carbon content as small as the second decimal point will be clearly shown, and the detection of 20 points difference on the Brinnel Scale presents not the slightest difficulty. Similarly, the effects of grain size, strain, and internal flaws, can be seen.

Advantages of this method of steel testing over the analytical laboratory methods used hitherto are:

(1) It is non-destructive, and therefore a 100 per cent. check can be carried out if necessary on, say, components on an assembly line.

(2) The results of the tests are displayed instantaneously.

(3) For purely comparative checks, the instrument can be set up for use by an unskilled operator.

On the other hand, for analytical purposes the correct interpretation of the hysterisis loop calls for skill and experience.

Simplified Version

In many cases, however, all that is required is a yes or no answer. That is to say, is the sample the same as the standard or not? If they are not the same is the difference great or small?

The instrument to be described will supply these answers. In fact, it possesses all the advantages outlined above for the more elaborate instrument, except that it will not give a detailed analysis of the sample.

For most everyday purposes such as the rapid inspection of batches of components, the latter condition is not necessary because each sample is being checked against a standard, and we only wish to know whether or not it measures up to the same specification.

This particular instrument was used successfully in a raw material store to sort out different types and grades of rod and bar steel. On a small assembly line it more than paid its way by detecting low quality steel pins which, if they had been used, would almost certainly have caused extensive damage.

The tests were by no means exhaustive, and there is considerable scope for the experimenter who is interested in this sort of thing to try out his own ideas. For instance, since the instrument is very sensitive to small differences in heat treatment it could be of use in the tempering of tools. Another possibility is the detection of steel and iron in non-magnetic materials—nails embedded in wood, etc.

After some experience has been gained with this simplified instrument it could be elaborated on the lines described at the beginning of this article, to allow experiments of an analytical nature.

Circuit Details

The theoretical circuit is shown in Fig. 2. Resistors R1, R2, R4, R5, together with inductors L1 and L2, form the test bridge which is fed with raw A.C. from tapped transformer T1 via switch S1. The switch enables the bridge volts, and therefore the bridge sensitivity, to be varied. R1 and R2 are the bridge balance controls, and R3 is the bridge output control.

In the unbalanced condition, a voltage is developed across R3 which is fed to the grid of 6B6G where it is amplified and passed on to the cathode-ray indicator. Here the signal is amplified still further and causes the indicator shadow to become narrower by an amount dependent on the control settings and the degree of unbalance in the bridge.

Under balanced conditions there is no output from the bridge and the indicator shadow is maximum.

The D.C. volts for the valves are obtained from a conventional half-wave rectifier which is fed from the transformer T1. This transformer also supplies the heater volts.

Component values are not critical and need not be exactly as specified. The 6B6G, for example, is actually a double-diode triode with the diodes left unconnected, and was used here because it happened to be to hand. Any triode with roughly similar characteristics will do instead.

For initial experiments the tapped winding supplying the bridge can be dispensed with and the bridge fed with the full 230 volt mains supply; but if the instrument is to be made up into a permanent job the taps will be necessary.

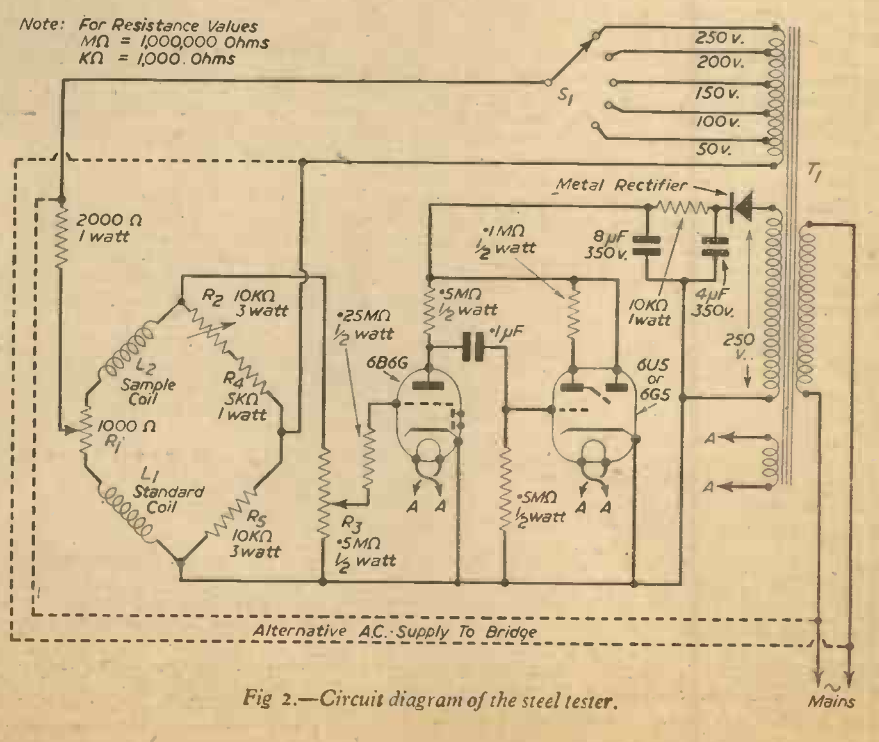


Fig 2.—Circuit diagram of the steel tester.

Two identical bobbins are required for the coils, and may be constructed as shown in Fig. 3. The writer used cardboard postal tube with paxolin end cheeks glued to it. The coils are each wound with 8,000 turns of 32 s.w.g. enamelled wire. There is no need to wind in layers; random winding is good enough.

In order to avoid interaction between the coils and for convenience in testing, each coil should be connected to a length of flex so that they can be moved about independent of the main instrument.

Operation

Before any sample can be tested it is necessary to provide a standard which is known to possess the required characteristics.

For example, if we have in a raw material store various types of rod and bar steel which have become mixed up and the markings obliterated, and we wish to identify a particular grade of carbon steel from the jumble, then we must have as a standard a short piece of this grade of carbon steel, about 8in. long. Further, the standard should be of the same diameter as the steel to be checked. The fact that the standard is only 8in. long, and the steel to be checked is in long lengths of perhaps 14 feet will not matter. The length is only important when we get down to below about 6in.

If the instrument is to be used constantly for this purpose, it will be well worth while to provide known standards for every type of steel that is likely to be accommodated in the store. The type and grade of steel should, of course, be stamped on the standard.

In the case of rapid component testing on an assembly line, one component which is known to be of the correct specification is used as the standard. The others can then be checked against it.

The bridge is balanced initially by putting R3 to maximum and adjusting R1 and R2 for maximum shadow on the indicator. The position of the voltage tapping switch, which governs the sensitivity of the bridge, will depend on the job in hand; a little practice will enable a good voltage to be selected.

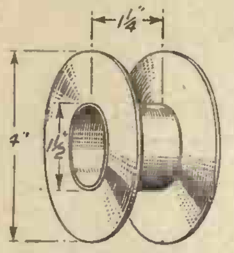


Fig. 3.—One of the coil bobbins.

The standard is now inserted into one of the coils; this will unbalance the bridge and the shadow will become narrower or disappear altogether. The sample is now inserted into the other coil and if it is the same as the standard the shadow will again become maximum, indicating that the bridge is balanced. If it is not the same, the shadow will not return to the maximum position.

It will be obvious, of course, that the sample will very seldom be exactly the same as the standard, and there will always be some degree of unbalance.

Mass Component Testing

In the case of mass component testing, it will be necessary to decide on just how great a degree of unbalance can be tolerated before a component is to be considered as a reject.

One way of deciding this is to select a component which has been tested by other means and found to be just inside the limits of the required specification. Check this in the sample coil against the standard component, and adjust R3 so that the indicator shadow is only a thin line. Thus, any other component that causes the shadow to disappear entirely will be a reject and easily detected by an unskilled operator.

Another method which is useful for experimental purposes, is to provide R1 with a dial marked off in divisions. When the sample has been inserted in the test coil, R1 is adjusted until the bridge is once more balanced. The amount by which R1 is moved will indicate the degree of unbalance and therefore how closely the sample measures up to the standard.

In conclusion, the values of bridge resistors shown in the diagram may not be suitable for every application. If any difficulty is experienced in balancing the bridge, a little experimenting with the values of R2 and R4 should put matters right.

An Electric Gas-lighter

With Details of a Mercury-operated Switch

By F. O. ATKINSON

THE accomyanying sketches give details of a mercury-operated electric gas-lighter, which I have recently installed. It is highly satisfactory and does away with the usual manual switching.

The switch is made from a piece of aerial lead-in tube about 1¾in. long and is threaded internally for about ½in., as in Fig. 1. Next make two brass plugs to fit the tube ends and drill a hole in one and solder a thin brass rod into this plug, as indicated, this rod being long enough to leave a gap of ¼in. when the plugs are screwed in. To assemble the switch, first polish the brass rod and base of top plug so that the mercury will coat them over with a thin film and so make perfect contact.

Then shellac the threads on the bottom plug and screw in tight, pour in some mercury to the level of the end of brass rod, and screw in the top plug after shellacing.

Handle

Take a suitable handle and bore a hole to suit the diameter of the switch, then at the ferrule end bore another hole to take a length of ½in. brass tube and connect the two holes with a central ¼in. diam. hole as shown in Fig. 2 to accommodate the connecting flex. Next, solder a wire to each end of the switch and another to the brass tube, as shown, insert the switch and wires and then make an ebonite or wooden plug to fit tightly in the handle with a hole to allow flex leads to pass to battery or, preferably, a bell transformer.

Plugging the Tube

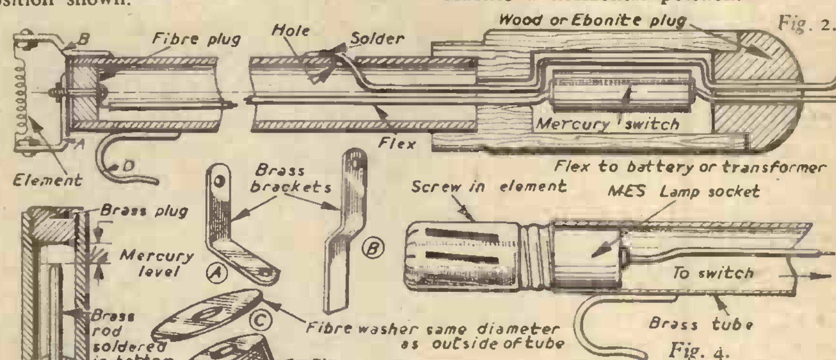
The next step is to make a plug from a piece of thick hard fibre, or from several fibre washers, to fit tightly into the open end of the brass tube. Make two brackets A and B (Fig. 3) from strip brass, solder piece B to the side of tube as in Fig. 2, then pass a bolt with wire attached from mercury switch through fibre plug and washer C, through bracket A, and tighten with a nut. Push the plug tightly into the end of the tube. Solder hook D to the tube in the position shown.

Fitting the Element

The element is a piece of resistance wire suspended between brackets A and B with small bolts and nuts. Instead of this type of igniter a M.E.S. lamp-holder such as is used for radio pilot lamps could be soldered in the tube in place of the fibre plug, thus allowing the screw-in type of igniter, which are on sale, to be inserted, as in Fig. 4.

Breaking Contact

When the lighter is hanging handle downwards, contact is broken, but the mercury will make contact again before the handle reaches a horizontal position.



Sectional view of the completed gas-lighter, and details of parts.

Modern Plastics

Their Properties and Uses in the Home and Industry

By THE MARQUIS OF DONEGALL

THE Plastics Exhibition, held in London recently, was organised by Bakelite, Ltd., to show what is new in Bakelite, Vybak and the Warerite plastics.

Each set of exhibits was shown on a stand which readily became a packing-case ready for the road at the termination of the exhibition.

To my mind the most novel section was that devoted to the use of decorative laminated plastics in transforming the interior appearance of hotels, shops, hospitals, restaurants and, perhaps, especially, ships.

The range of applications for Warerite plastics was illustrated by photographic panels on the building stands. Quite apart from their decorative value their patterns and colours are an integral part of the plastics. Repainting charges are eliminated wherever they are installed. It is claimed that they do not chip, crack or stain—are unbreakable and impervious to steam or moisture, oils, grease and alcohol.

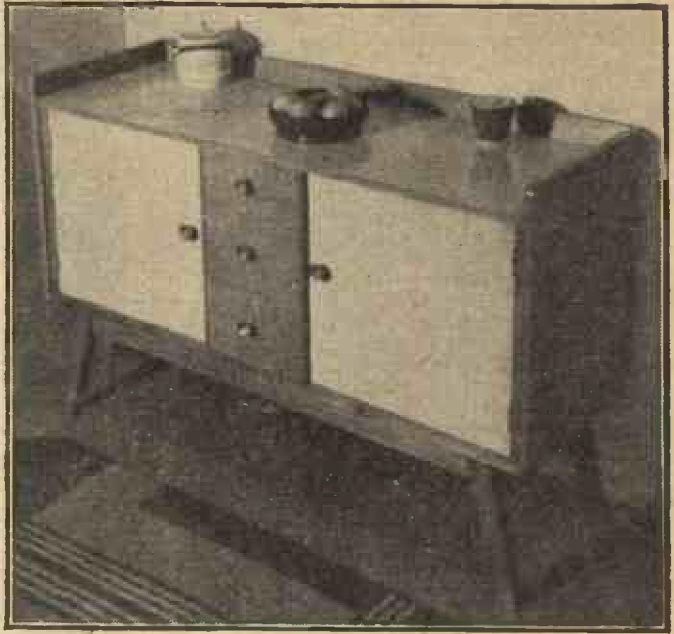
Other exhibits included door furniture, electric light switches, plugs and meter cases.

Plastics are not cheap materials, and they are not substitutes. Any analysis of comparative costs, judged on a material basis, would result in the figure for plastics being as high as that for any other raw material. Adoption of plastics does, however, result in considerable economies because the production methods made possible are far more efficient. A component produced as a moulding, for example, is with very minor treatment, a finished product. It does not require painting or other finishing, and will retain an attractive appearance, provide good electrical insulating qualities, and will not corrode. A similar component produced in metal on a normal machine-shop basis would probably start its life in the form of castings. These may be machined on capstan lathes, may subsequently be drilled and tapped, later to be finished by buffing, and finally, provided with a protective coating of paint or lacquer. With the plastics component, the initial tool cost would almost certainly be higher than the cost of producing patterns and castings, but, with a long-production run, elimination of subsequent machining operations enables the mouldings to show important economies. This ability of mouldings to eliminate machining becomes increasingly important as the complexity of a component increases.

Decorative Wall Panels

From the point of view of a householder I was particularly envious of the table tops and wall panels in attractive designs.

What can be done with wall panels can be seen in the s.s. *Orcades* and the s.s. *Coronia*. Artist's designs, maps or pictures are incorporated in the indestructible plastics.



Warerite Weave, with its extra hard scratch-resistant surface, is here seen incorporated in a sideboard design of Goodearl Bros., Ltd., High Wycombe.

In the *Orcades*, the architect, Brian O'Rorke, A.R.A., F.R.I.B.A., wanted a mural illustrating the original *Orient*. Mr. O'Rorke had obtained a contemporary lithographed print of the ship, and wanted his mural to be a water-colour some nine times the size of the print but having the same "feeling" as the 1881 plate. The artist's impression has the softness of colouring and the general feeling of the old print. The finished water-colour was then permanently incorporated in a panel during manufacture. The old *Orient* now lives again in the smoking-room of the *Orcades*. The picture is unaffected by dust, dirt, sea air or water, and can be washed down.

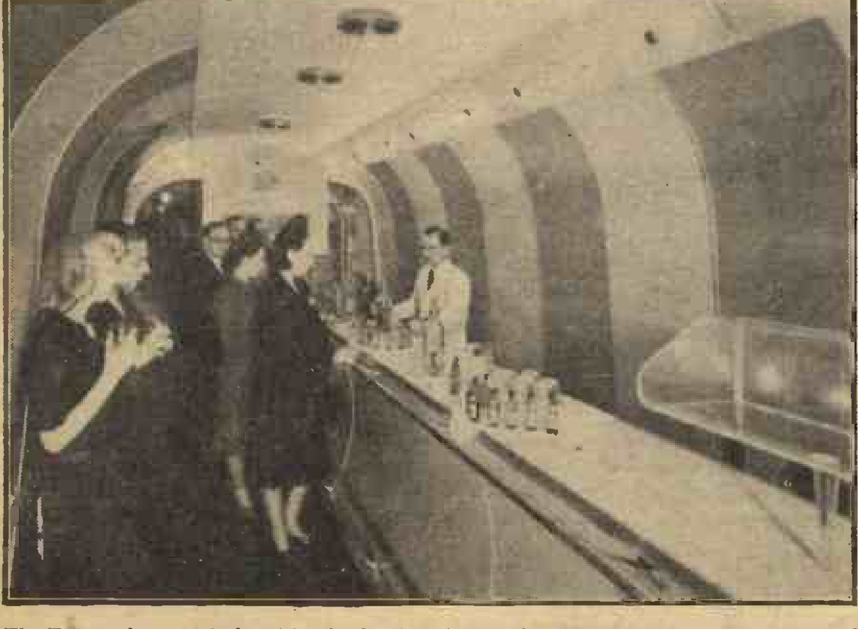
Nicholas Bentley is the artist for the mural facing the customer of the cocktail bar in the cabin-class smoking-room of the *Caronia*. The Bentley figures, drawn in characteristic vein, are life-size.

On a visit to the *Caronia* I thought that, from the plastics viewpoint, the murals in the first-class and cabin-class smoking-rooms are quite outstanding. Technically—as examples of incorporated design—they are probably the most advanced work that has yet been achieved in laminated plastics. In the first-class smoking-room there is a series of panels incorporating a striking design by J. De Uzelai, illustrating the history of shipping over a thousand years. Which brings me from the gigantic to my own table mats.

A couple of years ago a sudden idea led me to take colour photographs of beauty spots in Scotland and Northern Ireland.

These I had made into table mats, and the idea of "personal" table mats has been praised by my guests as being something unusual.

How I wish I had known at the time that I could have had my pictures incorporated into plastic table mats—no heavy and breakable glass covering them in. One lives and learns.



The Trianon bar now included in the Southern Railway's "Golden Arrow" train is treated throughout with Warerite laminated plastics in a colour scheme of grey and pink. The surface of the bar is blisterproof and offers other practical advantages in its resistance to heat, moisture and alcohol.

Variety of Uses

Going round the Plastics Exhibition one was struck by the variety of uses to which plastics can be put—everything from Mosquito aircraft to door-handles, as everybody knows.

One of the more unusual uses of plastics is for gear-wheels. These are shaped or formed from plastic-sheet, rod or tube, by the use of conventional wood or metal-working tools. There was also a display of electrically-operated tools including the body of a D.C.

An interesting example of the use of Bakelite plastics is in the production of electrically-operated tools. The body of this D.C. stud welding gun is moulded in a high-strength grade of Bakelite material and incorporates metal inserts, including the heavy copper solenoid shown.

stud welding gun moulded in high-strength grade of Bakelite material incorporating metal inserts, including a heavy copper solenoid.

Drilling jigs of laminated Bakelite were shown. They are light and strong. The example displayed is used for drilling the cast-metal door of the bridge control unit in the Sperry gyropilot.

So we see that plastics are not always mass-produced. Plastic materials, as opposed to finished articles, are made by most complex processes in elaborate chemical plant. But plastic articles may be mass-produced by moulding plastic powder under heat and pressure in steel moulds. Post office telephones, for instance, are thus produced.

There are two distinct groups of plastics, I learned. Firstly, the thermo-plastic group which includes celluloid. These can be softened by heat and reformed by pressure time and again.

Thermosetting Plastics

The other group is called thermosetting. These plastics undergo a chemical action when heated and pressed. This causes them to change their nature once and for all so that they cannot be reformed by heat or pressure.

Perhaps at this point a general definition of the generic word is helpful. "Plastics" may be defined as an organic material which, at some stage in its manufacture, can be formed by the application of heat and pressure, and which, on cooling, retains the shape imparted to it by the forming process.

Thermosetting plastics include "Bakelite" and "Beetle" products based on phenol or cresol and urea formaldehyde synthetic resins respectively. Others are the melamine formaldehyde resin based products and the alkyd resins which are produced from polyhydric alcohols such as glycerol, and polybasic acids such as phthalic acid, and are used very widely in the paint industry, where they show a great improvement over natural resins.

Thermoplastics include a number of materials based on natural plastics such as shellac and bitumen; these include sealing-wax and bitumen moulding compositions, etc. Also there is a wide range of semi-synthetic products such as celluloid (cellulose nitrate plasticised with camphor) discovered by Sir Alexander Parkes about the middle of the last century, as well as cellulose acetate, cellulose-butyrate, ethyl cellulose, etc. In addition, there are the fully synthetic thermoplastics, such as polyvinyl chloride, polyvinyl acetate and copolymers of these, polystyrene, polythene, nylon and acrylic resins.

The fundamental difference between thermosetting materials and thermoplastics is caused by a marked difference in the molecular structures of the two types.

The First Plastic

It is probable that the first plastic was celluloid, and its discovery has been variously ascribed to Sir Alexander Parkes; a Frenchman, Henri Bracconot; C. F. Schonbein, a German; and John Wesley Hyatt, a young American printer; all of whom worked towards the development of a cellulose nitrate material. Anyhow, in 1863 a prize of 10,000 dollars was offered for a substitute for the ivory billiard ball. Although Hyatt made some billiard balls, he did not win the award, but subsequently he and his brother took out some 75 patents, and in 1871 the Celluloid Manufacturing Company was formed.

But the first thermosetting plastics had to wait until 1907 for Dr. Baekeland to discover them. It was in this year that he perfected the first phenolic resins—a discovery which made possible that branch of the plastic family which once moulded cannot be deformed by heat and pressure and is extremely tough.

For a while people thought that plastics would oust wood completely. But it is now seen that what is virtually a new range of hard-woods has come into existence by the bonding, under heat and pressure, of laminations of wood impregnated with plastic resins: thus creating new outlets for wood, such as the famous Mosquito aircraft.

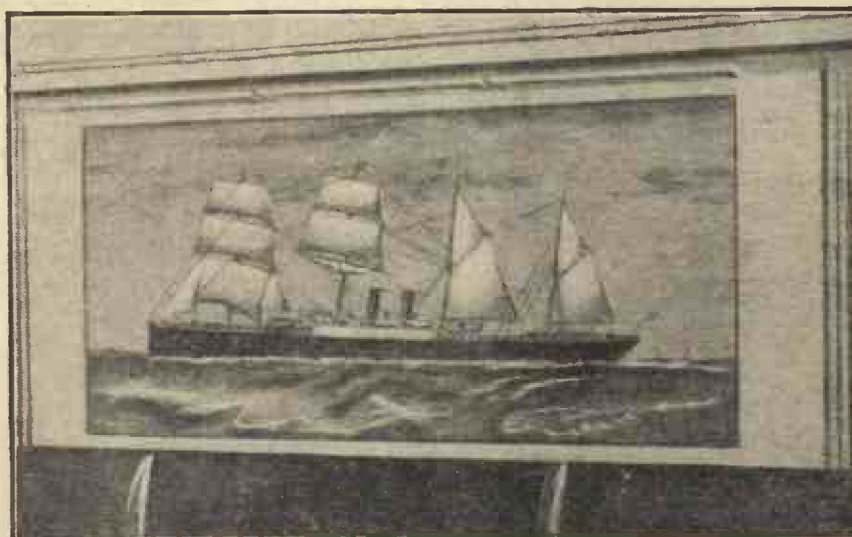
Plastic Furniture

There is no doubt that plastics will have a great part to play in furniture. The advantages of an attractive and virtually indestructible table-top are obvious. But wood and fabrics have their own charm in the home and will never, I feel, be completely replaced, especially as, for certain types of heavy furniture, laminations of wood impregnated with resins and bonded under heat and pressure do the job better than either wood or plastic by themselves.

Leather cloth and furnishing fabrics made in part of plastics also have a future as they are more resistant to cracking, staining, and the effects of moisture, than leather or fabrics by themselves.

Finally, with the enormous jump into our daily lives that plastics have made, greatly due to the impetus of the last war, it is interesting to observe that the word "Plastics" was not in any English dictionary prior to 1939. It just managed to get into the appendix of the Oxford Dictionary in that year as a word that had come into existence since publication.

For those who are interested there is, however, an informative article on the subject in the latest edition of the *Encyclopædia Britannica*.



A decorative wall panel, in coloured plastics, in the smoking room of the liner "Orcades."

The Spring Balance

Elasticity Varies with Temperature : Helical Spring Type : Tension and Coiled Spring Balances

By R. H. WARRING

THERE are several types of spring balances, and metering devices working on the same principle. Some are of the type similar to kitchen scales with a rotary dial, or the simple pull-out type with a hook on the lower end, the design

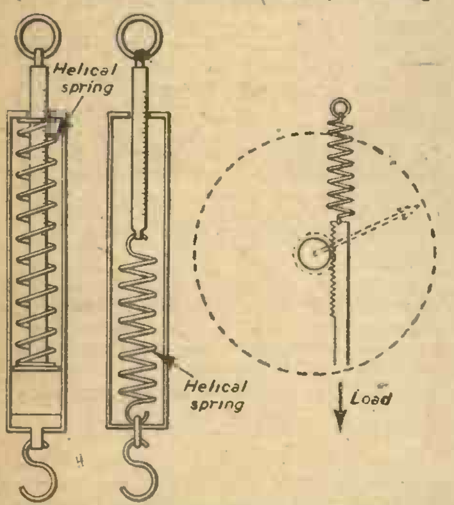


Fig. 1.—(Left) Compression spring balance. Fig. 2.—(Centre) Tension spring balance. Fig. 6.—(Right) Magnifying the deformation of a helical spring with a circular scale.

of which, incidentally, has remained basically unchanged for nearly two hundred years.

The beauty of a spring as the working part of a weighing machine is that it is so simple and so effective. Extension is proportional to load. If a load of one pound will stretch a certain spring one inch, a two pound load will stretch it two inches, and so on, up to the limit of the spring efficiency, i.e., until it is overloaded when the extension formula becomes complex. In point of fact, provided a spring balance is not overloaded, equality of sub-divisioning is obtained far more readily than with any other type of variable resistant.

Elasticity Varies with Temperature

Amongst its main defects are the fact that the elasticity of a spring will vary with temperature. Under rising temperatures springs expand and become slightly weaker. Under falling temperatures the reverse holds true. But if specific accuracy is required, a temperature compensating device can be incorporated in the design of a spring balance. For all normal purposes, however, this variation can be ignored.

Another defect, which is not likely to affect the average user, is variation in accuracy through hysteresis effects. If a spring balance is adjusted for zero reading with no load and a heavy load then applied and left in position for a considerable time, on eventually removing the load the pointer will not return exactly to zero. Such loading conditions are rare, in the normal usage of balances. The instrument would, in any case, tend to "creep" slowly back to the original zero setting. The obvious moral is that spring balances should never be left in a loaded condition if they are to be expected to work accurately.

Helical Spring Type

The earliest spring balances were of the helical spring type. That is, a simple coil spring so arranged that it could be extended or compressed by the application of a load and the degree of extension or compression would then be a measure of the weight of the load. The two alternative methods—extension or compression—represent two distinct classes of spring balances.

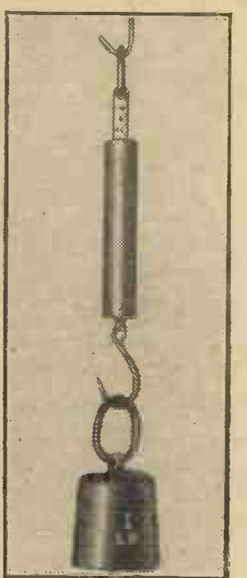
The earliest recorded example was of the compression type—Fig. 1. The steel spring was housed in a copper pipe about 6in. long, with a square rod of copper running through the centre, this rod being graduated to read weights direct, sliding through a square hole in the top end cap of the barrel. It was designed—and presumably manufactured—towards the end of the seventeenth century. Its inventor was a Frenchman.

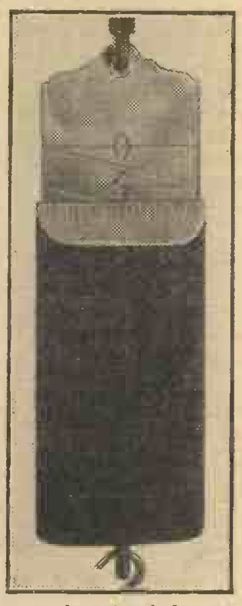
The helical compression spring balance appears to have been widely used throughout the eighteenth century, and for a very considerable variety of purposes. It was undoubtedly used by butchers and probably also by many other shopkeepers.

Tension Spring Balance

The tension spring balance, Fig. 2, does not appear to have been manufactured until the middle of the eighteenth century. It has certain advantages over the other type, being very much easier to read for one thing, and became the most popular of the two.

The earliest type to be made, in this country at least, was manufactured by Richard Salter about 1790 (some authorities give the date as about 20 years earlier). No specimens of this exist, but an exact copy was made in 1825 by William Salter and is illustrated in Fig. 3. The Salters were the first British spring balance makers, and out of their early efforts has grown the present firm of Geo. Salter and Co., of West Bromwich, known all over the world for the reliability and variety of their spring balance weighing machines.





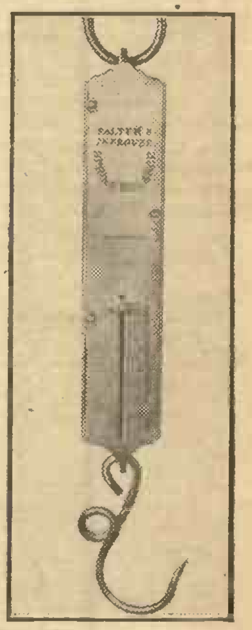


Fig. 3.—(Left) The earliest type of spring balance made first by Richard Salter about 1790. This exact copy was made in 1825 by William Salter. Fig. 4.—(Centre) This balance is described and illustrated in the Patent of George Salter No. 7724, dated 1838. Note the method of indicating weights by means of parallel and diagonal lines marked on the slide and divisions on the external tube. Fig. 5.—(Right) Type of balance used in the middle of the last century.

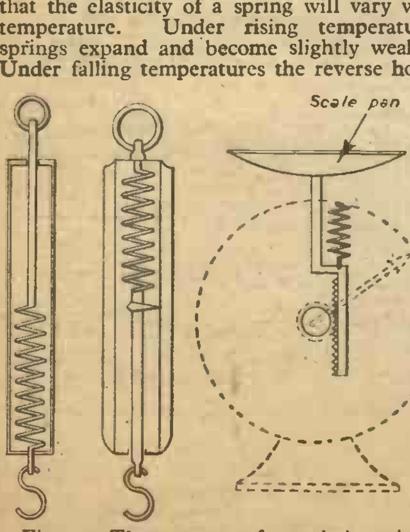


Fig. 7.—Three types of tension spring balances.

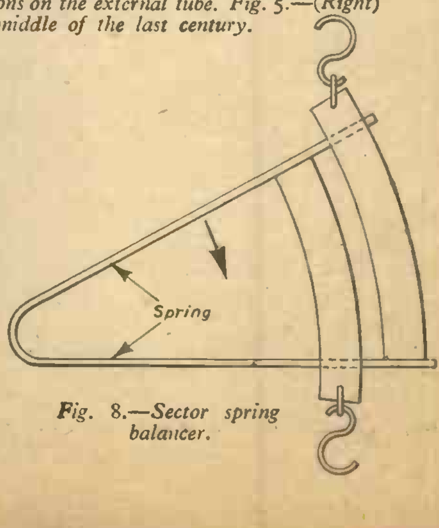


Fig. 8.—Sector spring balancer.

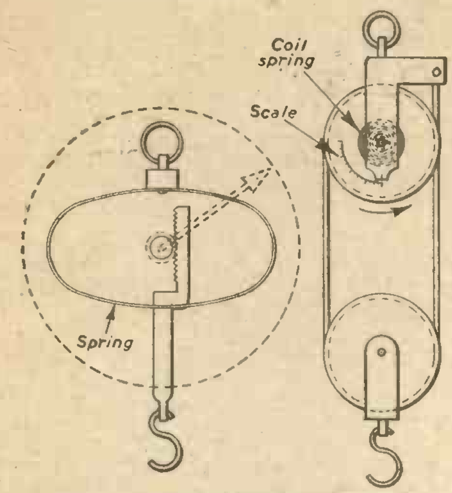


Fig. 9.—(*Left*) *Oval spring balance.*
Fig. 10.—(*Right*) *Coiled spring balance.*

In outward appearance, at least, the simple spring balance has changed very little since those early days. Types are still made with the central projecting scale. A more attractive layout with the scale on the outside of the case—the front of which has now become flat—was adopted by the middle of the last century (see Fig. 5).

The same principle—that of measuring the deformation of a helical spring under load—was also soon adopted to give pointer readings over a circular scale. A simple rack and pinion gives a direct coupling between the movement of the spring and the movement of a pointer over a suitable scale, enabling finer divisions to be read with ease. This method magnifies the deformation of the original spring, which is still the basic mechanism (Fig. 6). Alternatively, the pointer can be replaced with a graduated disc which then rotates relative to a fixed mark on the body of the scale—a principle widely adopted by the modern household scales, except that it is now the practice to elongate the rack and attach to its upper end a scale pan for supporting the object to be weighed. (Fig. 7).

C-spring Balance

Another early type of weighing machine was the sector spring or C-spring balance —Fig. 8. This was probably invented in the late 1770's. Unlike the helical spring types this does not give equal graduations. Nor is it as accurate. But on somewhat similar principles followed the oval-spring balance, Fig. 9, which, properly made, gave very good reliability. Its chief difficulty as regards manufacture of this latter type was in preparing and adjusting the elliptic springs to get uniformity of markings between one machine and another. Balances of this type were at one time widely used for platform weighing, to which they were well suited. Being compact, the oval spring fitted neatly under the platform—something like the present day weighing machine, for example —whence the rack connected to the platform rotated the pinion, in turn connected by suitable linkage to a dial reading.

Just one other type of machine may be mentioned which, although relatively useless in its original invented form, offers a principle which some of the most modern forms of torsion balances, used for the most delicate weighing operations, employ.

Coiled Spring Balance

This is the coiled spring balance. The example illustrated again belongs to the late eighteenth century, invented by Sieur Chapotot, Engineer to the King and Maker of Mathematical Instruments, at Paris.

This has the appearance of a simple pulley block system, as shown in Fig. 10. The upper pulley contains a clock spring, so adjusted that at no load the divided dial is at zero indication. Any load applied to the lower pulley assembly then causes the upper pulley to rotate, winding up the spring. The dial was graduated accordingly to give direct reading of weight applied.

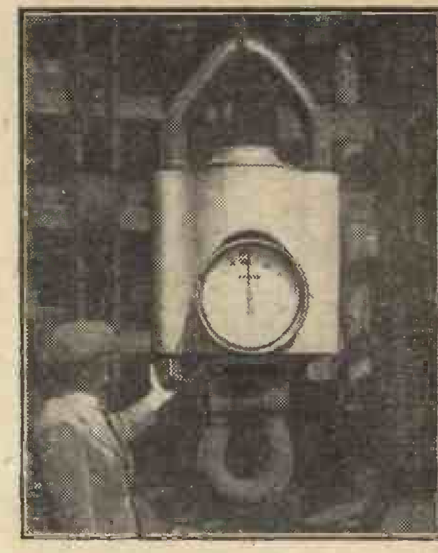


Fig. 11.—*The largest form of portable suspended weighing balance in the world.*

Of all this miscellany of spring balance types the simple tension spring type emerges as the master—a reliable, and certainly one of the simplest forms of mechanical instrument devised by man for his own convenience —and a willing servant in home, garden, or factory, in industry or in domestic life.

A Micro-projection Adaptor

Constructional Details of a Useful Accessory for the Microscope

By G. A. HENWOOD

MICROSCOPY is undoubtedly one of the most interesting and useful techniques employed in research and education to-day, and can be a fascinating pastime even for a person without any specialised training. There must be few people who cannot find cause for wonder and interest in the astonishing and unfamiliar aspect of our world which is revealed by even a comparatively simple and low-powered instrument of the type which can be obtained for a few pounds. The variety of teeming life in a droplet of pond water rivals that of any zoo, and the symmetry and colour of some stained preparations (particularly sections of plant tissues) often have the satisfying beauty and balance of a good stained-glass window of a church. The microscopic study of crystals is yet another wide and interesting field, and the visible growth of crystals in an evaporating drop of solution on a slide is a most intriguing effect, especially so if a polarising arrangement is fitted to the microscope. Many common household substances will well repay investigation in this manner.

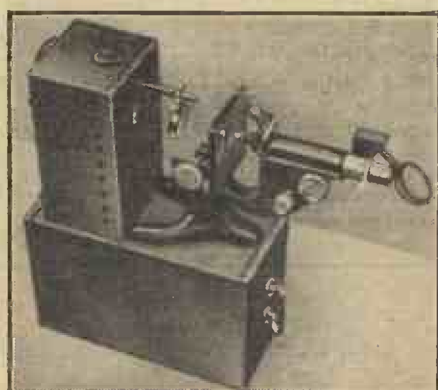
To the student and teacher of zoology and botany, and to a varying degree the other branches of science, a microscope is an essential piece of apparatus, but in its usual form it has certain faults and limitations which can be rather troublesome. The worst of these are undoubtedly the strain on the eyes and, quite often, the spine, which results from prolonged observation and, from a teaching point of view, the difficulty of knowing whether a class group are all looking at and appreciating a given object or portion of an object. It is not unknown for a novice diligently to scrutinise an air bubble in search of a nucleus !

Advantages

To a large extent these difficulties can be overcome by using a micro-projector, which permits direct observation of the image on a screen. A further advantage is that it can easily be arranged for the image to fall upon a work-bench or desk, and by adjusting the size of the image it can be directly traced on a sheet of paper or into a notebook. This method is often quicker and more accurate than the usual process of alternately peering into the microscope and then sketching from memory. For individual or small group work a blacked-out room is unnecessary and a limited amount of screening will suffice.

The degree of magnification obtainable with a micro-projector is considerably greater than that given by a microscope, depending upon the throw to the screen, but the advantage is more apparent than real as there is no increase in relative definition, and in some cases where it is required to resolve fine detail at powers of $\frac{1}{8}$in and higher, the microscope scores. But for most purposes a projector will do all that is required. Generally speaking, it is not possible to project the surface features of opaque objects.

Unfortunately, the specially designed instrument is an expensive piece of apparatus, but anyone possessing a microscope can quite easily adapt it for projection without drastically altering the instrument, and can thus obtain the best of both worlds. All that is required to achieve this object is: a fairly intense light source, a suitable optical system to concentrate the light upon the object, a housing arrangement for these



The microscope arranged for downward projection, as in Fig. 3.

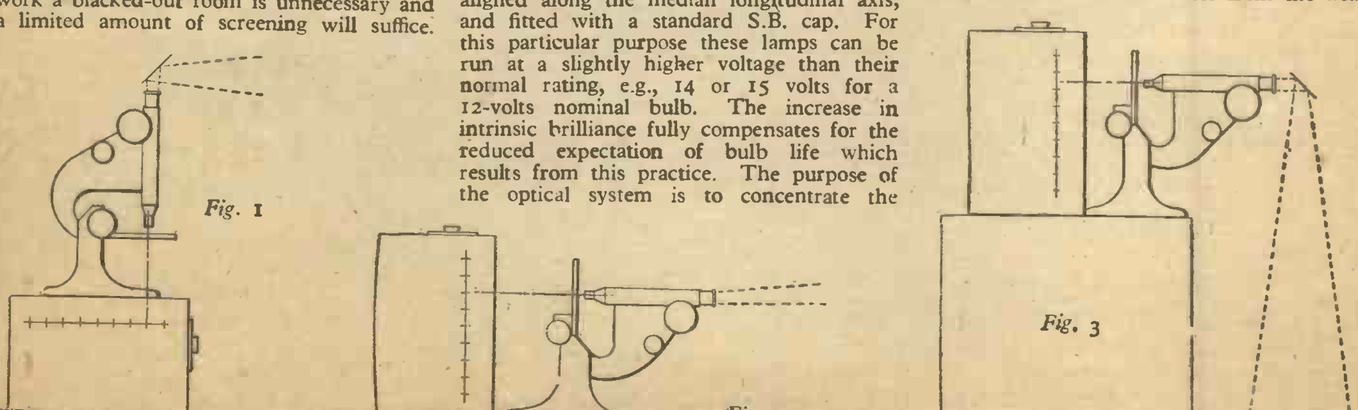
two items, and a cooling trough if living or delicate material is to be projected.

Light Source

Let us briefly consider these requirements in the given order. Special projection lamps are available, but a perfectly suitable and readily obtainable light source is a car headlamp bulb of 48 or 60 watts rating of the type with a short, straight filament aligned along the median longitudinal axis, and fitted with a standard S.B. cap. For this particular purpose these lamps can be run at a slightly higher voltage than their normal rating, e.g., 14 or 15 volts for a 12-volts nominal bulb. The increase in intrinsic brilliance fully compensates for the reduced expectation of bulb life which results from this practice. The purpose of the optical system is to concentrate the

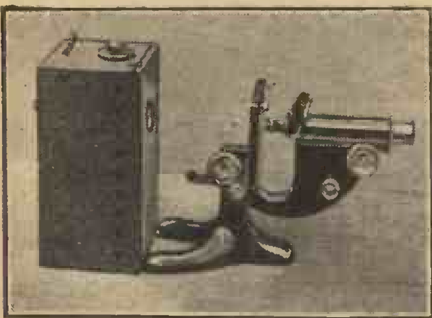
The lamp and microscope arranged for horizontal projection, as in Fig. 1.

transmitted light upon the object on the microscope stage. The necessary degree of concentration depends upon the aperture of the objective employed, which in turn governs the amount of light passed by the microscope. Thus for low and medium powers a single bi-convex lens of such focal length that the filament and object can be arranged at positions of conjugate foci within the limits of the apparatus is all that is required. For high-power work an additional sub-stage condenser is necessary in order to concentrate further the light upon the very small aperture of the objective. This can be the normal microscope sub-stage condenser, if one is fitted, or another bi-convex lens suitably disposed in relation to the first lens. In the latter case slightly better results would be obtained by using a pair of plano-convex lenses as normally employed in an optical condenser. Some means of focusing the light is necessary and may be achieved by a movable lens, but possibly a simpler device is to make the lamp mounting adjustable in two axes. This permits a compact layout and obviates difficulties with the lens mounting. The housing need be nothing more than a robust box with means for ventilation and designed to suffer no undue ill effects from the heat



Diagrams showing different projection schemes.

of the bulb. Concomitant with the concentration of light upon the object is a concentration of heat radiation. In general this is not harmful to mounted, dead or inorganic material, but it can be lethal where living things are concerned, and at best they tend to react to the combination of comparatively intense heat and light by contracting and becoming immobile. The



The microscope arranged for horizontal projection, as in Fig. 2.

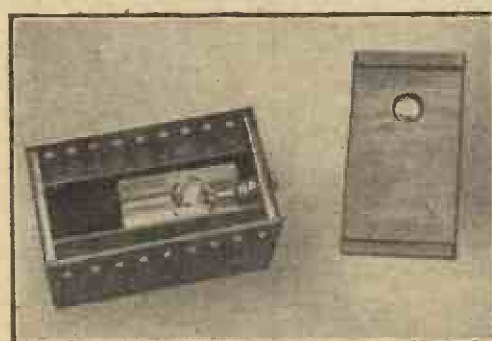
simplest method of reducing the radiation to a harmless level is to interpose a piece of heat-absorbing glass such as Chance's O.N.19 between the lamp and the stage. Unhappily, glass of this type is rather costly, so the more usual method is to use a liquid cell containing distilled or boiled water. For occasional use with the microscope arranged vertically a crystallising dish filled with water will serve very well. The bottoms of these dishes are often slightly irregular, but the resulting distortion of the light beam is not sufficient seriously to affect the amount of light falling upon the object. When the miscroscope is used horizontally a small, flat-sided bottle will serve. A specially designed cooling trough will have some means for allowing for the expansion of the water on heating without allowing air bubbles to enter the liquid. This is commonly either a short length of soft rubber tubing or a tube open to the atmosphere.

The micro-projection adaptor depicted in the accompanying illustrations is simple to construct and use, and efficient enough to show the Brownian movement of fine particles in suspension, with a ⅛in. objective, and an Abbe sub-stage condenser. It can be made quite cheaply, even if none of the materials is to hand and it should prove necessary to purchase everything required. Dimensions and method of construction are dependent upon the miscroscope and materials employed. A most useful general guide will be to describe the prototype in detail and explain the considerations involved.

General Arrangement

The microscope is a Beck, Model 29, with a triple nosepiece, extending draw tube, and an Abbe condenser with an iris diaphragm, i.e., quite a normal instrument of the type usually found in school and other laboratories. No interference with or modification of the instrument was required, and to change from normal use to projection the procedure is simply to slip out the mirror and, if required, clip it to the draw tube and then place the adaptor and microscope together. It is then ready for use.

The arrangement shown in Fig. 1 is the most satisfactory for general purposes, the stage is horizontal and the microscope is at a convenient height above a bench for operation, and the beam thrown from the mirror at the top is high enough to clear most obstructions found at bench level and the heads of an audience looking at the image on a screen. Incidentally, for this work a translucent screen with rear projection is often advantageous, particularly with a fairly large audience. If it is intended to use the arrangement shown in Fig. 2, it is essential to so construct the lamp housing that when the housing is resting on end, the lamp and condenser lens are in the same horizontal plane as the optical system of the microscope. This obviates the annoyance and waste of time involved in packing up either the microscope or the adaptor, probably with books, which is not a very nice way to treat them and is very unsatisfactory, as the whole thing will almost certainly shift at a crucial moment! There is little to be gained by adopting this arrangement. Theoretically it is better to project directly in this manner, but in practice the difference between this and Fig. 1, where the beam is reflected horizontally by a mirror, is not appreciable in spite of everything the purists may say about absorption losses, double image and first surface reflection. Fig. 3 shows a method of projecting down upon a bench. Again, this can be achieved by the vertical arrangement shown in Fig. 1, with the addition of a second mirror to reflect the beam downwards. It is important that it should be plate glass to avoid distortion.



Details of the lamp ι nit.

Constructional Details

Construction of the housing is quite straightforward. Plywood ⅜in. or ½in. thick is very suitable for the body, as it should not warp to any extent when subjected to the heat of the lamp. The prototype has two sides of ¼in. fibreboard. There is no particular advantage in this, but the material happened to be at hand when the body was being made. The joints are simply butted, liberally glued and screwed, and have given no trouble to date. The lid is located laterally by the sides and lengthwise by two cross battens on the inside which fit between the ends. Ventilation is effected by means of rows of holes in the sides and bottom (the adaptor is raised from the surface upon which it is resting by three feet or blocks which eliminate wobble and allow air to circulate through the holes). The holes should be screened from the direct light of the filament by means of baffles in order to prevent distracting beams of light emerging from them. These baffles can be made of aluminium or tinplate and left bright on the surfaces towards the lamp, but in the form shown in Fig. 4 they are primarily baffles and not reflectors.

The lamp mounting consists of two fibreboard discs on a screw which passes through a fairly large hole in one end of the box. By means of a knurled or wing nut the discs may be instantly and firmly clamped in any position within the limits imposed by the hole. A batten type S.B.C. lampholder is fixed to the internal disc with a sufficient length of flexible wire for the connections to allow free movement. It may prove necessary in some cases to make a radial slot in the internal disc and fix a screw through this to prevent rotation when clamping. This will still allow free movement in the lateral and vertical axes, which is all that is required, as a lamp with the type of filament previously specified gives a longitudinally elongated area of light on the object.

Condenser

The condenser lens should have a diameter of 4 to 5 cms. and a focal length of about 3.5 to 4.5 cms. It is fitted into a recessed hole in the lid and is held in place by a steel or stiff brass wire circlip. If required, a further lens can be mounted by means of a short length of dowel plugged into the lid, with two "Terry" spring clips (obtainable from most tool and hardware merchants) bolted together, of suitable size to grip the dowel and the second lens respectively. This provides a simple means of adjustment. The microscope sub-stage mirror is likewise secured to the draw tube by a "Terry" clip and a wooden block with a hole to take the stem of the mirror fork.

The dimensions obtainable from the drawings are intended for general guidance and may have to be varied to suit other microscopes.

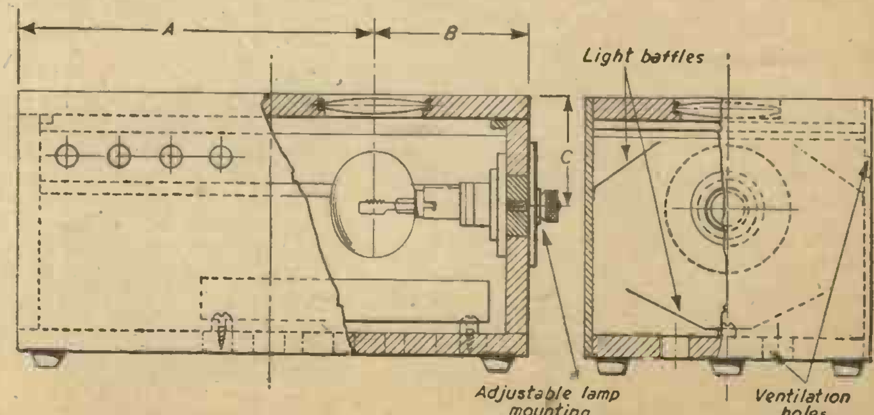
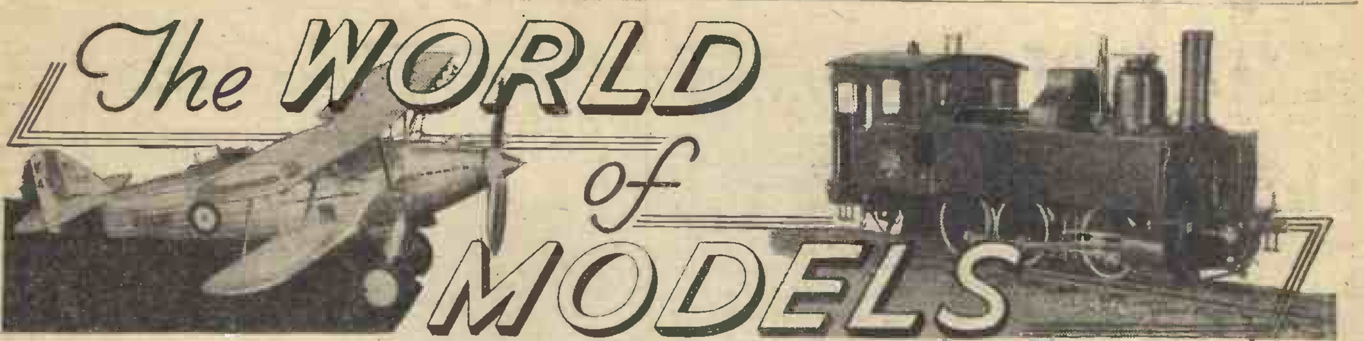


Fig. 4.—General arrangement of lamp housing. Factors governing dimensions: A. Height of draw tube of microscope above base if used as shown in Fig. 2. B. Distance between centre of filament and flange of lampholder plus thickness of inner disc and end of housing. C. Focal length of condensing lens.



The World of Models

Model S.S. "Colombie" : Scale Model K.L.M. "Skymaster" : Modelmakers in Germany

By "MOTILUS"

MANY travellers to the West Indies remember the very attractive ship, S.S. *Colombie*, owned by the French Line. She ran on a regular service between Le

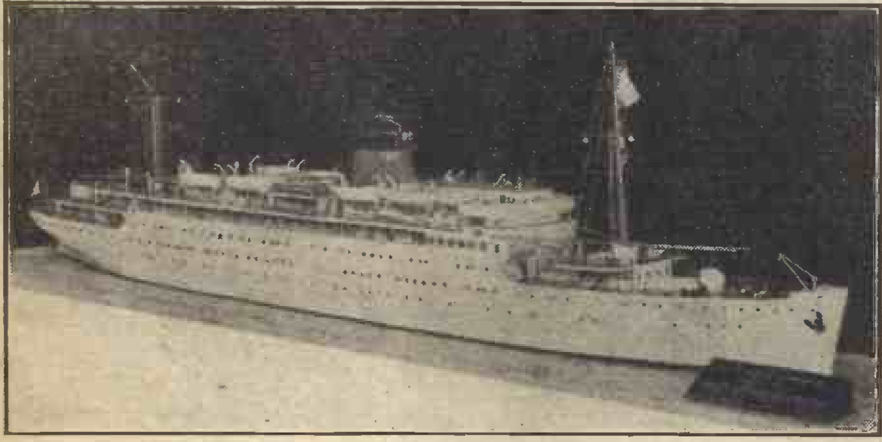


Fig. 1.—Model of the French Line ship, S.S. Colombie, *after reconditioning and alterations,* 1950. *Scale, ⅛in. to 1ft.*

Havre, Southampton, the West Indies and Central America.

At the outbreak of hostilities in 1939 until June, 1940, the *Colombie*, with many other ships, served well in operations in the North Sea and off the coast of Norway. Following the Franco-German armistice in 1940 she became part of the Allied Services Forces and was converted into a troopship, using her original French crew: it was thus that she transported some 40,000 American soldiers to England and the Mediterranean. Later still she was reconditioned as a hospital ship and also renamed *Aleda E. Lutz*, in which service she continued until her return to the French Government when hostilities ceased.

Since then the *Colombie*, now restored to her former name, has been modernised and reconditioned throughout, with the addition of many improvements. She is now engaged once again on the West Indies run, with an increased speed of 17 knots. (Her previous speed had been 15½ knots.)

A model of S.S. *Colombie*, to a scale of 1 : 100, which was built some years ago by Bassett-Lowke, Ltd., has also been rebuilt to incorporate the new features of the vessel. As the illustration, Fig. 1, shows, she is certainly a most attractive, smart passenger ship for the West Indies.

Model "Skymaster"

The use of aircraft is not only increasing for passenger services all over the world, but of recent years air travel is becoming so popular with commercial firms that in some cases they charter air liners for business journeys.

Our illustration, Fig. 2, shows a model of a K.L.M. "Skymaster" 'plane, to a scale of ¾in. to 1ft. The prototype is a standard "Skymaster" that has been converted for the personal use of Mr. Bernard Van Leer, of Van Leer Equipment, Ltd., specialists in metal drums for oil, etc., and well known all over the world.

The 'plane has been fitted so as to provide sleeping accommodation, a study, private sitting-room, kitchen and other amenities. Principally it was used by Mr. Van Leer for travelling to different parts of the world to visit the many factories in the organisation he controls.

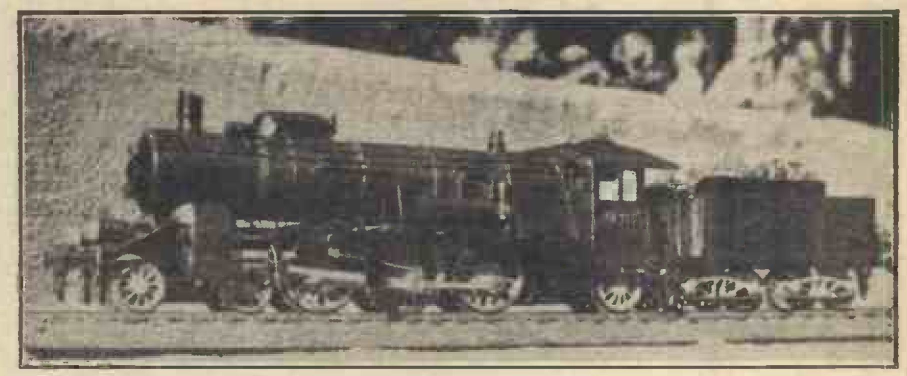


Fig. 3.—A detailed model of a locomotive of the former Wurttemberg State Railway, gauge 0. This model was built by a member of the Model Railway Club, at Esslingen-Obertal, Germany.

Fig. 2.—A K.L.M. "Skymaster" 'plane model, to a scale of ¾in. to 1ft., as chartered by Mr. Bernard Van Leer for business use. One side of the model is cut away to show the 'plane interior.

Modelmakers in Germany

I have further news from the active modelmakers in Germany this month. I have received from Mr. F. Spielhoff some interesting photographs of recent models made by members of the Model Railway Club at Esslingen-Obertal.

First is a model of one of the older locomotives of the former Wurttemberg State Railway. This gauge 0 model is steam driven and represents the series 18 117 2-C-1 (4-6-2 type), with bogie tender (Fig. 3). This was a well-known type of locomotive in the early days of this railway.

Next is an exhibition model, in gauge 0 again, of a tank locomotive of the German National Railways: a typical example of

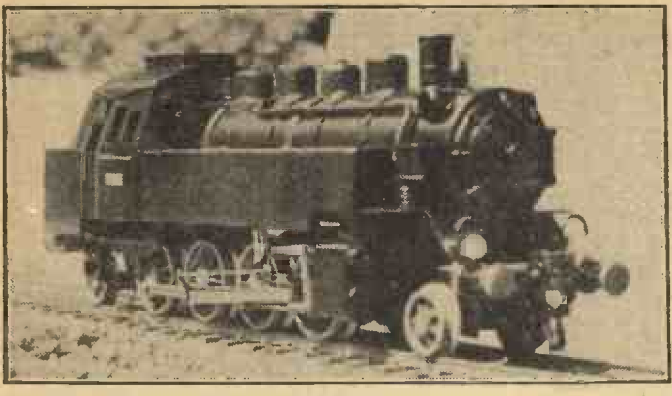


Fig. 4.—(Left) A gauge o model of a tank locomotive of the German National Railways: another example of the work of Esslingen-Obertal Model Railway Club.

series Gt. 86 1ft.-D-1ft. (Fig. 4). Another model is of a new type electrically-driven locomotive for the German National Railways, in contrast to the tank steam locomotive. Electrical contact is by the pantograph system, so widely used already in Switzerland. The model (Fig. 5) is for gauge oo, 1/90th full size (approximately ⅛in. to 1ft. scale in English measurement). It is interesting to note that this model is in advance of the prototype, which, at the time of writing, has not yet been completed for service.

Exhibition Model Railway

Reference has been made in previous articles in this series to the exhibition model railway of Mr. Harold Elliott. Those who enjoy seeing model railway displays and watching model locomotives operated by steam or electricity will be interested to know that Mr. Elliott's attractive layout has been installed throughout this summer as a permanent exhibition at Olympia, Blackpool, and remained there until the end of the illuminations.

This model railway (Fig. 6) now has 500ft. of track, 20 working model locomotives, and a large variety of coaches and goods vehicles. The locomotives include L.M.S. and G.W.R. types, and there is also a complete train in the new British Railway colours.

This elaborate and interesting gauge o railway has now celebrated its second birthday, and I feel it will long be a great attraction, wherever it is displayed.

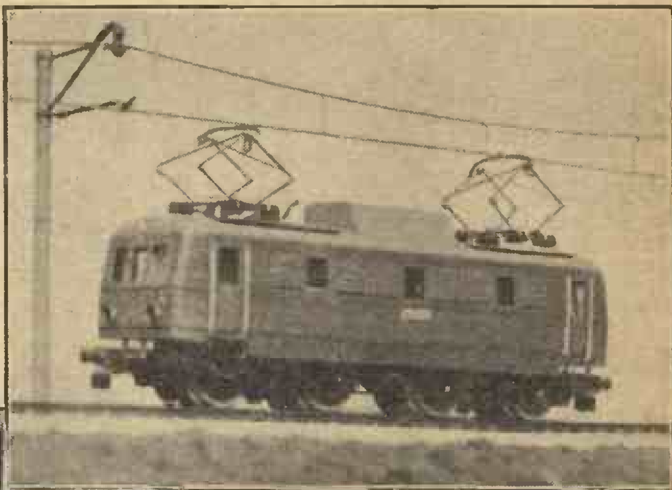
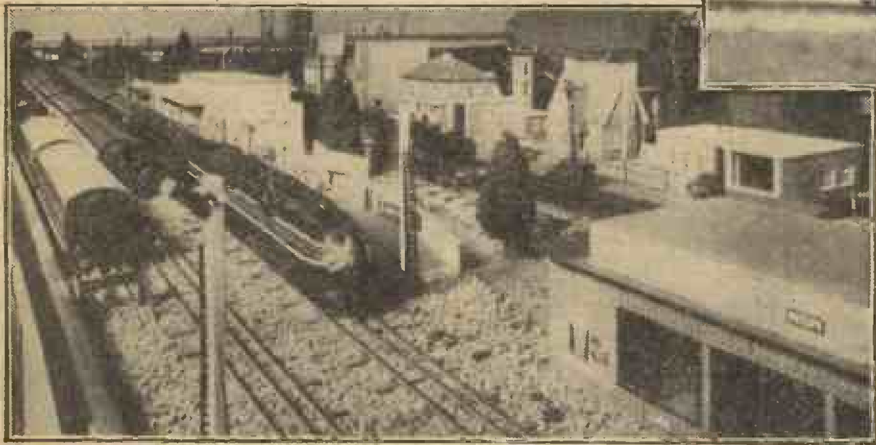


Fig. 5.—A model that has been built before the prototype. A new design for an electrically-driven locomotive for the German National Railways is demonstrated in this gauge oo model, but the actual locomotive has not yet been built for service.

Fig. 6.—(Below) A section of the Elliott Model Railway Exhibition at Olympia, Blackpool, showing a streamlined locomotive hauling a fast passenger train.



Making an Extension Bracket

Constructional Details of a Handy Fitment for the Workbench

By "HANDYMAN"

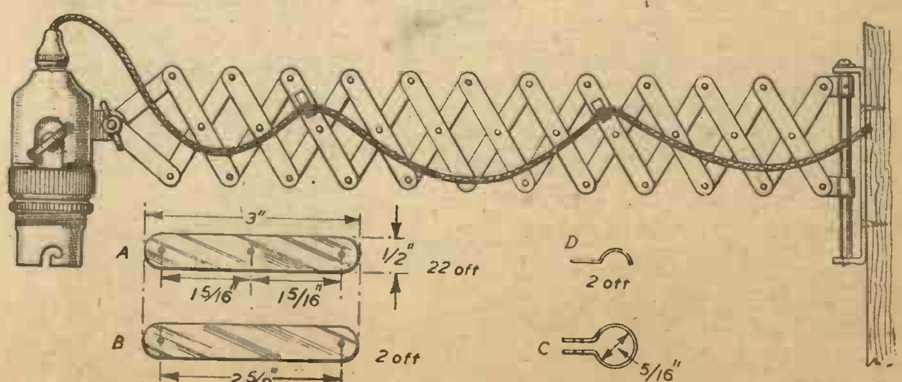
OFTEN when servicing or building a radio set on the bench, the light is not in the desired position. To remedy this I have evolved a suitable bracket which has proved itself a handy addition to the workbench. The parts were requisitioned from the scrap box. The accompanying sketch gives details of the bracket which consists of 22 pieces of mild steel (A) 3in. by ½in. by 1/16in. thick, with three holes drilled as shown to take ⅛in. rivets. Two additional pieces (B), with two holes in each, are required to hold the lamp-holder and switch.

Lattice Strips

A piece of brass strip is soldered on to the lampholder and a hole drilled through for fixing to the bracket with a 4BA screw, thumb nut, and spring washer. The lattice work is clearly shown, and it should be noted that the 22 identical pieces must have the end holes the same distance from the middle one and also in line, otherwise the bracket will not close easily. Further, it is suggested that washers should be inserted between each pair of plates before riveting.

The end fittings consist of two pieces bent as shown at C, the top one being a tight fit around the 5/16in. rod and the bottom one a sliding fit. A rivet or pin should be inserted to hold the top piece rigid. The 5/16in. rod should now be turned down to a ¼in. diam. each end to fit into holes in the bent piece which is screwed to the wall. The 5/16in. rod must be a loose fit in this bracket and a 4BA tapped hole made in its end to take a screw with a spring washer. This is to prevent the bracket from moving too freely sideways.

With the 24-piece bracket an extension of 2ft. can be obtained. To carry the flex two small pieces of brass bent as shown at D are soldered to the lattice pieces, as indicated.



The completed extension bracket, and details of lattice strips and end fittings.

LETTERS FROM READERS

"Hammered Silver" Effect

SIR,—With reference to the query of L. K. Meeres (Middlesbrough) concerning "antique silver" finish on wall brackets. I presume he wishes to obtain a "hammered silver" effect. Anyway, this may be obtained by the use of a suitable paint-sprayer, one that can have its air supply reduced from the normal pressure to zero. The article is first sprayed in the normal manner with any colour and baked on. (I have synthetic baking enamels in mind.) Next, a slightly thinner medium is made up (a contrasting colour) and the air pressure reduced to a mere trickle. By careful adjustment this second medium will "splat" out of the spray-gun producing little "islands" which constitute the hammered effect. The "body" of this second medium must be just right as regards thinning and the low air pressure adjusted accordingly to give the required finish. The spots must be flat (not pimples) and about 1/64in. above the surface of the undercoat. By experimenting on odd pieces of sheet-metal the idea should soon show itself, and a suitable balance of low and high surfaces obtained. The spots are now baked on, and after drying out, an ordinary spraying of silver is applied over the whole job. When this is dried off, a coat of clear lacquer is sprayed over the surface. This protects the silver from a later operation. Thinners with just a touch of clear lacquer mixed in (for knitting purposes) and a drop of black, will produce a "dirty" washy appearance, and this is sprayed *lightly* all over the silver till a dullish finish is obtained. This represents the dark portions in between the silver spots when finally finished. This is again baked on. When ready, a piece of very smooth emery paper is used and lightly rubbed over the whole surface. This rubbing will remove the dark tint from the top of the spots and have no effect on the lower surfaces. By careful rubbing the hammered finish will show itself, and a final coat of clear lacquer completes the job. Care must be shown in not penetrating the protecting lacquer over the silver, otherwise the colour used for making the spots will show up. Hoping this process will not prove too complicated for the desired effect.

Hammered copper or brass may be obtained by the same methods, and each operation must be baked before proceeding with the next.—F. H. SWINGLER (Gedling).

Velocity of Escape: Space Flight

SIR,—Some time ago I came across a book on spacial flight, by Philp, which seems to put a new construction on the V.E. (velocity of escape) required to get away from the planets. Most scientific writers line up the V.E. as directly proportional to the "g" of the planet. Even as high an authority as the late Sir James Jeans does this; but in Philp's book, putting 7 for the earth and omitting atmospheric resistance, he gives a V.E. of 6.6. against a "g" of 30 for Venus. This is consistent. But against a "g" of 5.3 and 13 for Moon and Mars respectively he gives the same V.E. for both bodies, viz., 1.5. Again, he quotes "g" for Jupiter 87, V.E. 37; "g" for Saturn 36, V.E. 22.

Can any of your readers explain this new approach in the face of so much well-founded authority?—"PLANETAS" (Northampton).

Mathematical Problems

SIR,—I have been a reader for many years and much enjoy your monthly.

Apropos your mathematical problems, possibly your readers may be interested in the following:

First bear in mind that

$$(a-b)(a-b)=a^2-2ab+b^2$$

It will be agreed that $4-10=9-15$

To both sides add $\frac{25}{4}$

$$4-10+\frac{25}{4}=9-15+\frac{25}{4}$$

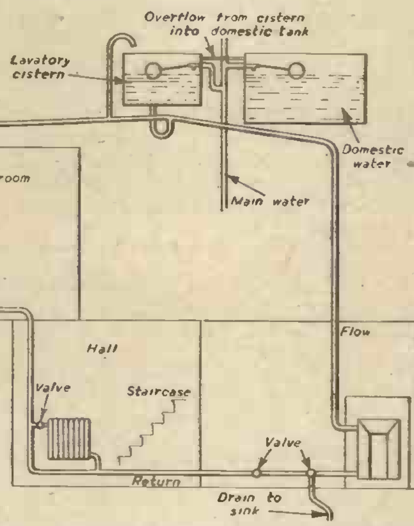


Fig. 1.—Piping layout for a small central-heating system.

Rewritten:

$$(2)^2-\left(2\times2\times\frac{5}{2}\right)+\left(\frac{5}{2}\right)^2=(3)^2-\left(3\times2\times\frac{5}{2}\right)+\left(\frac{5}{2}\right)^2$$

Each side will now be seen to be of the form above, so that it can be rewritten

$$\left(2-\frac{5}{2}\right)^2=\left(3-\frac{5}{2}\right)^2$$

Root both sides

$$2-\frac{5}{2}=3-\frac{5}{2}$$

Add to both sides $\frac{5}{2}$

$$2=3$$

From which any number may be made to equal any other number.—A. BOWEN (Worcester).

[*This is a variant of the old algebraic "proof" that* $1=2$

Let $x=y$

Then $x^2=y^2$

and $x^2-y^2=xy-y^2$

Factorising: $(x+y)\ (x-y)=y(x-y)$

From which $x+y=y$

$2y=y$

$2=1$

Our readers will easily see the fallacy.—EDITOR.]

Central-heating System

SIR,—I was interested in a reader's recent query regarding central heating of a bungalow, and as I have installed central heating in my house, I thought it would interest other readers, should they desire to do likewise.

The arrangement was just a simple circuit, as shown in the diagram, Fig. 1, with three radiators, one in each of two bedrooms, and one behind the front door in the hall downstairs, which incidently provides adequate heat which rises up the staircase to make the house comfortable during the cold weather.

The boiler, which is my own design, is fitted into an ordinary bedroom tiled fireplace fixed in the kitchenette, where the lady of the house spends much of her time; we also have our meals there. As you will see from Fig. 2, the boiler has side pieces, and also a flue through the back, so that the boiler has a large heating surface.

The installation was run throughout with ¾in. × 19 s.w.g. copper tubing, and Instantor fittings were used where necessary. Where possible I endeavoured to use the normal bends of the tubing (which must be made with a suitable bending machine) to cut down to a

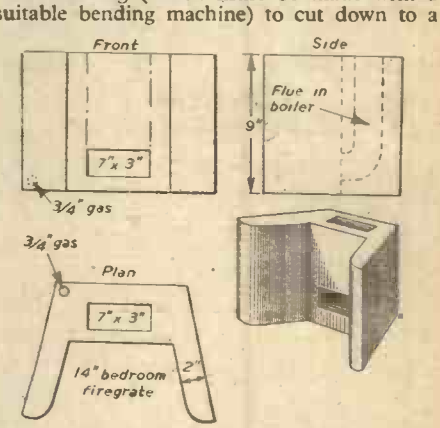


Fig. 2.—Details of the boiler.

minimum elbows and tees which have a tendency to restrict the natural gravity flow of the water in the circulation of the system.

In two instances where tees were used for a junction up to a radiator I soldered a small piece of brass inside the tee to deflect the water round more easily.

As regards the size of the radiators, I obtained the volume in sq. ft. of the room concerned, and the firm where I bought them supplied the correct size.

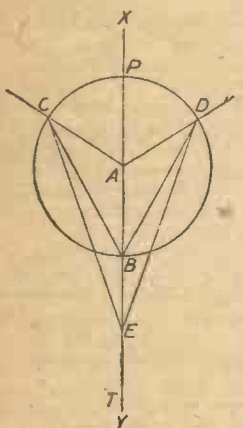
As to the run of the tubing, the aim is to get the flow pipe to the highest point of the building—in my case the false roof—where I fitted a lavatory cistern as shown in Fig. 1, taking note of the fact that the water supply to the system is brought in on the underside of the flow pipe, as in Fig. 1. The cold water main is tapped off the domestic water supply tank.

When the system is filled up with water, all the radiators must be purged (there should be a small tap for this purpose at the top of each radiator) to ensure that all air is excluded.—F. SPITTLE (Middlesbrough).

Trisecting an Angle

SIR,—The construction for trisecting an angle, contributed by Mr. W. Duncan Needham in your August, 1950, issue, is quite accurate, but *not* rigorously correct. As the accompanying calculations show, the error is proportional to the cosine of a small angle, which is very nearly equal to 1.

The most serious error would occur when "trisecting" an angle of 180 deg. Trigonometrical calculation of the three angles produced by this construction shows that they would be 59 deg. 39 min., 60 deg. 42 min., and 59 deg. 39 min. respectively. For many purposes these are equivalent to 60 deg. angles, but not perhaps for the surveyor.



Trisecting an angle. Diagram by E. Bishop.

The error rapidly diminishes. The "trisections" of 90 deg., for example, are 29 deg. 58 min., 30 deg. 4 min., and 29 deg. 58 min. respectively.

The method is thus most interesting, but it does require emphasising that it is very slightly incorrect, and that it has not solved the age-old trisection problem.

The construction can be shown to be false, as follows:

Assume that $\hat{CED} = \frac{1}{3}\hat{CAD}$

Now the line XY bisects angles $\hat{CAD}$, $\hat{CBD}$ and $\hat{CED}$.

$$\therefore \hat{CEP} = \tfrac{1}{3}\hat{CAP}$$

By the well-known theorem,

$$\hat{CBP} = \tfrac{1}{2}\hat{CAP}$$

But in triangle CBE

$$\hat{CBP} = \hat{BCE} + \hat{BEC}$$

$$\hat{CBP} = \tfrac{1}{2}\hat{CAP}$$

and $\hat{BEC}$ is the same angle as $\hat{CEP}$

$$\text{so } \hat{BEC} = \tfrac{1}{3}\hat{CAP}$$

$$\therefore \tfrac{1}{2}\hat{CAP} = \hat{BCE} + \tfrac{1}{3}\hat{CAP}$$

$$\therefore \hat{BCE} = \tfrac{1}{6}\hat{CAP}$$

$$\text{but } \hat{BEC} = \tfrac{1}{3}\hat{CAP}$$

$$\therefore \hat{BEC} = 2\hat{BCE}$$

Taking sines, we have, therefore,

$$\sin\hat{BEC} = \sin(2\hat{BCE})$$

$$= 2\sin\hat{BCE}\cos\hat{BCE}$$

But by the construction

$$BC = 2BE$$

By the sine law,

$$\frac{BC}{\sin\hat{BEC}} = \frac{BE}{\sin\hat{BCE}}$$

$\therefore \sin\hat{BEC} = 2\sin\hat{BCE}$

$\therefore \sin\hat{BEC}$ is *not* equal to $2\sin\hat{BCE}\cos\hat{BCE}$ (unless $\cos\hat{BCE} = 1$, or $\hat{BCE} = 0$ deg.)

$\therefore \hat{BEC}$ is *not* equal to $2\hat{BCE}$

$\therefore \hat{CEP}$ is *not* equal to $\frac{1}{3}\hat{CAP}$.

Note.—The error is quite small, however. The maximum size of $\hat{CAP}$ is 90 deg., therefore the maximum size of $\hat{BCE}$ is $\frac{1}{6} \times 90$ deg. or 15 deg. As $\hat{BCE}$ increases from 0 deg. to 15 deg., $\cos\hat{BCE}$ falls from 1 to 0.9659.—E. BISHOP (Sheffield).

SIR,—The method passed on by Mr. Needham for trisecting an angle is very interesting and good enough for practical purposes but is not, however, strictly accurate. It is based on the fact that, in dealing with the smaller angles, the sines of any two angles are almost in direct proportion to the magnitudes of those angles. The inaccuracy of the method can be seen if addition is made to Mr. Needham's construction by completing the circle CDT (with centre B) and by drawing the radius BD.

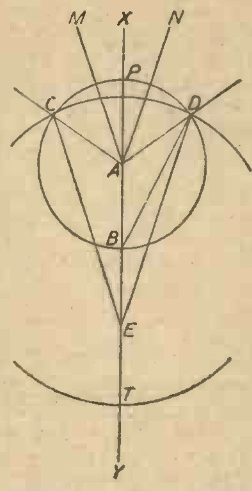


Diagram by W. G. Hills.

By construction, $\angle PAN = \angle BED$ and $BD = 2 \times BE$ and a little Euclid shows that $\angle PAD = 2 \times \angle PBD$ (angles at centre and circumference) and $\angle PBD = \angle BED + \angle BDE$.

Now, if AN is the trisector of $\angle PAD$ ($x°$), then $\angle PAN$ is $\frac{x°}{3}$, $\angle PBD$ is $\frac{x°}{2}$, $\angle BED$ is $\frac{x°}{3}$ and $\angle BDE$ is $\frac{x°}{6}$, i.e., $\angle BED = 2\angle BDE$.

But, in $\triangle EBD$, $BD = 2 \times BE \therefore \sin\angle BED = 2\sin\angle BDE$.

Reference to trigonometrical tables will show that in such cases one angle is *not* exactly twice the other and $\therefore$ AN is *not* the *exact* trisector of $\angle PAD$.

However, in the extreme case of $CAD = 180°$, $BED = 30.3°$ approx., and $BDE = 14.7°$ approx., CAD being divided by construction into two angles of 59.7° and one of 60.6° which constitutes an error for each trisector in the region of 0.5 per cent. only. For smaller angles the error is correspondingly reduced and for practical purposes can be ignored.

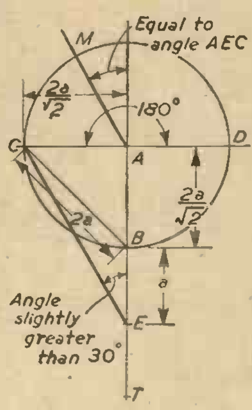


Diagram by H. G. Jollyman.

I cannot help imagining that, far from a French railwayman being the first to stumble on this construction, its fallacy was found by the School of Plato before they abandoned the problem as insoluble.—W. GOODING HILLS (Lewisham).

SIR,—The method of trisecting an angle, described by Mr. Duncan Needham, gives a fairly good approximation but is not exact.

As the construction is supposed to be accurate for all angles, it is only necessary to show that it is untrue for one selected angle to disprove the construction as generally true.

We may therefore consider the case in which angle CAD is 180 deg. Then the construction appears as in the accompanying sketch.

Let BE = a.

By construction, BC = 2a.

$AB = AC = \frac{2a}{\sqrt{2}}$ because angle ABC is clearly 45 deg. Consider right-angled triangle AEC.

$$EC = \sqrt{AE^2 + AC^2}$$

$$= \sqrt{\left(a + \frac{2a}{\sqrt{2}}\right)^2 + \left(\frac{2a}{\sqrt{2}}\right)^2}$$

$$= \frac{a}{\sqrt{2}}\sqrt{10 + 4\sqrt{2}}$$

$$\text{Now } \sin\hat{AEC} = \frac{\frac{2a}{\sqrt{2}}}{\frac{a}{\sqrt{2}}\sqrt{10 \times 4\sqrt{2}}}$$

$$= \frac{2}{\sqrt{10 \times 4\sqrt{2}}}$$

If the construction is correct, angle AEC must be 30 deg. and thus $\sin\hat{AEC}$ must be 0.5.

It is obvious that $\frac{2}{\sqrt{10 + 4\sqrt{2}}}$ cannot be 0.5.

It is, in fact, about 0.501, so the angle is about 5 minutes greater than 30 deg.—H. G. JOLLYMAN (Box, Wilts).

Water "Divining"?

SIR,—I have read with interest the editorial in your June, 1950, issue on "Water Divining."

You do not mention the name or qualifications of the so-called "dowser" whom you consulted, but you are quite correct if you deduce from the feeble "experiments" that it is quite impossible to obtain indications over a glass of water.

Unfortunately for dowsing there are many who are prepared to give such "demonstrations" for editors or for the B.B.C., and it is one of the curses of dowsing that so many who are not sensitive, or who are inexperienced sensitives, are prepared to show off not only powers they do not, but powers they could not, possess. As with many things which are not fully explicable by the five senses, there may be an aura of mumbo-jumbo built round them and auto-suggestion and wishful thinking turn reasonable propositions into incredible stupidities. It is improbable that more than 10 per cent. are natural sensitives, i.e., would produce initially those neuro-muscular reflexes which a London hospital investigated many years ago, and which cannot be denied as "registering" whatever the primary cause may be.

I suggest that if you are sufficiently interested to investigate further, you should contact the British Society of Dowsers, at York House, Portugal Street, who would probably be prepared to arrange a demonstration of normal dowsing, or supply further information.

Whalebone is not an essential but is a convenient type of "twig" which does not lose its springiness with climate or time.

Your opinion of well-borers is evidently low, but I fear you will be disappointed to find that many of them will continue to employ dowsers simply because the results are worth while.—K. W. MERRYLEES (London, S.W.).

[*Much of this is mere expression of opinion, the rest insupportable. Up to the present, our opinion is that expressed in our recent article.*—EDITOR.]

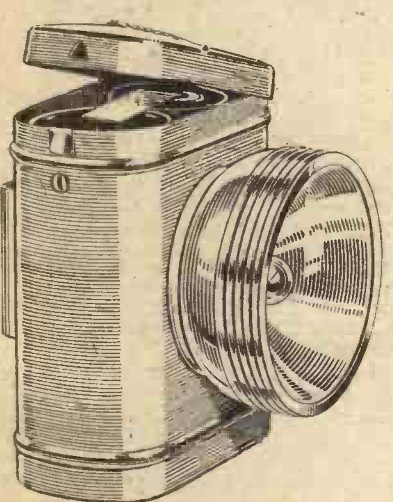
Trade Notes

A Review of the Latest Appliances, Tools and Accessories

New Lucas Battery Lamp

AN entirely waterproof new cycle battery lamp, featuring the exclusive Lucas rotating-reflector-housing-switch, is already leaving the production lines of the Joseph Lucas Cycle Accessories Factory, Aston, Birmingham.

Designed purely for the discerning cyclist, this smart modern cycle front lamp, produced on precision lines, is finished in silver lustre or ebony black. It has a trim, neat appearance, and is known as the "No. 40." There is no visible switch and electrical contact is made by turning the reflector housing. This novel way of switching a cycle front lamp on and off is exclusively a Lucas feature.



The new Lucas cycle battery lamp.

The design and construction have been formulated so that the length of the lamp body suits the battery to a fraction, and there is not the slightest danger of movement on rough, bumpy roads.

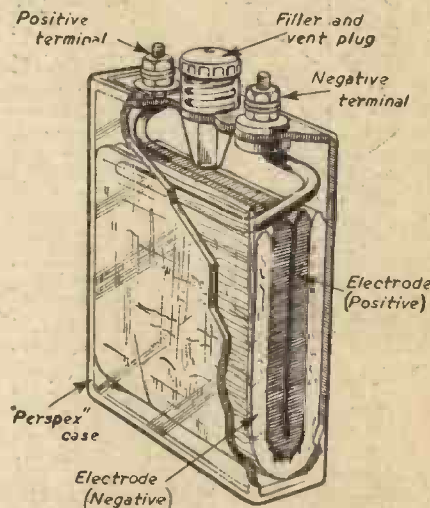
For battery renewal there is an easy release spring catch which effectively clips and holds the lamp top in position after removal.

The juncture of the reflector housing with the lamp body has been waterproofed by the fitting of a sturdy rubber washer which sits snugly in position, its diameter exactly fitting the base of the lamp cone.

The lamp, which is exempt from purchase tax, is sold complete with the No. 69R, twin-cell battery, and costs 5s. retail.

Venner Lightweight Alkaline Accumulators

THE new range of lightweight alkaline accumulators now being marketed by Venner Accumulators, Ltd., Kingston By-Pass Road, New Malden, Surrey, are the result of several years of research work. As shown in the illustration, the electrodes are encased in a semi-permeable membrane which acts as both dielectric and separator, the complete assemblies being fitted into an injection moulded case under slight pressure. The electrodes cannot buckle, neither can the active material escape from the membraneous wrapping and fall to the bottom of the cell and cause short-circuiting. In addition, as the electro-chemical reaction is completely reversible and stable, the shelf-life of the Venner accumulator is remarkably long. At the same time, the ultimate life of the accumulator is not impaired by its being left in any state of charge or discharge. The construction of the accumulator is such that the greater part of the electrolyte is absorbed in the electrode assemblies, and although the normal level for this is within ½in. of the top of the electrodes, accumulators can also be supplied and used with practically no free electrolyte. In this state they are quite unspillable. Among the outstanding features of these accumulators are much longer life than the lead-acid accumulators, half the size and one-third to one-fifth the weight of other accumulators of similar capacity. The amp./hour efficiency is claimed to be over 90 per cent. Folders giving further particulars and prices are obtainable from Venner Accumulators, Ltd.



The Venner lightweight alkaline accumulator.

Club Reports

Hastings and District Society of Model and Experimental Engineers

THE third Model Engineering Exhibition held by this club at the New Pavilion, Falaise Road, Hastings, was a great success; there were approximately 200 exhibits and over 4,000 people paid for admission. The passenger railway was in steam the whole of the week and was run by Mr. J. Penzer, of the Eastbourne Club, assisted by Mr. E. Cooke, of the Hitchen Club, who was visiting Hastings on holiday. On Friday evening Mr. Penzer's 3½in. gauge Atlantic 4-4-0 surprised everybody by getting away and pulling ten adults weighing approximately 15 cwt., while on Saturday two tracks and three locomotives were running, the second track being in the capable hands of the Wightwick Brothers, of Rye.

There were good entries in all sections and the prizes were presented on Saturday evening by the Chief Constable, Lieut-Col. A. G. Cargill. Amongst the most outstanding exhibits was Mr. C. B. Reeves' one-year weight-driven perpetual calendar clock, which was awarded the championship cup at the M.E. Exhibition. Mr. C. M. Keiller, of Bexhill, showed three locomotives of 2½in. gauge, and Mr. E. Cooke three 0 gauge steam locomotives.

In the marine section a model tug by Mr. T. Briderland driven by a twin-cylinder steam engine and fitted with siren and a bilge water ejector caused much interest. A cardboard and match-stick model, which was unfinished, of the French battleship *Richelieu* was an outstanding piece of work, as it was over 5ft. in length and powered by four electric motors. In the non-working section a glass-cased model of the *Royal Albert*, *circa* 1700 AD, and a model of H.M.S. *Victory* were outstanding.

The accompanying illustration shows the "television and radio" stand which was erected by the Hastings Television Club in co-operation with Messrs. Abraham's, a local radio firm, at the exhibition. Television was demonstrated each evening, and a demonstration set was working daily connected to various forms of interference to impress on the public the need for suppressors.—MR. P. KELLER, Hon. Secretary, 3, Portland Terrace, Hastings.

Television and radio stand at the Hastings Model Engineering Exhibition.

Harrow and Wembley Society of Model Engineers

THE following fixture list of meetings up to December, 1950, has been arranged: Wednesday, November 22nd, jumble sale; Wednesday, December 6th, committee meeting; Wednesday, December 13th, Mr. H. H. Anderson, M.I.Fire.E., talk with films, "The Fire Service, Past and Present"; Wednesday, December 27th, "Get Together" night. All of the above meetings will be held at Heathfield School, College Road, Harrow, commencing at 7.30 p.m.—J. H. SUMMERS, Hon. Secretary, 34, Hillside Gardens, Northwood, Middlesex.

(continued on page 66)

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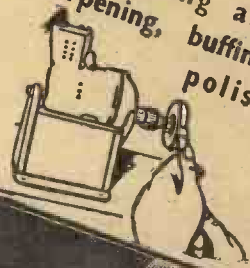
14/-

HORIZONTAL STAND
for grinding and tool sharpening, buffing and polishing



A fully powered 1/4 inch Electric Drill for only **£5-10**

45/-

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Here's the way to convert your 'HANDY UTILITY' Drill into a sturdy drill-press. You'll find plenty of jobs that demand a Bench Stand.

NOT just a drill but almost an electric work-shop on its own—that's 'HANDY UTILITY,' the versatile power tool for faster, smoother, deeper drilling in steel, cast iron, brass . . . for easier drilling in wood, perspex, ceramics . . . for grinding, buffing and polishing metal parts . . . for cleaning off rust and old paint! Drilling capacity in steel 1/4 in.—in hardwood at least 1/2 in.

The mate of all work

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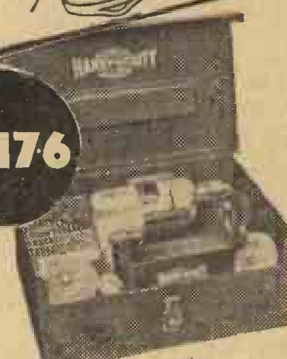
1/4 INCH DRILL KIT
Drill, 13 h/s Bits, Horiz. Stand, Grinding Wheel, Wire Wheel Brush, Buff, Arbor, Metal Carrying Case.



ACCESSORY KIT
Grinding Wheel, Wire Wheel Brush, Buff, Arbor, etc.

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ELECTRIC HANDY-UTILITY TOOLS

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Ilford and West Essex Model Railway Club

MR. G. R. DOW, Public Relations Officer, British Railways (London Midland Region), recently addressed the Ilford and West Essex Model Railway Club on the history and development of the Midland Railway. The talk, which was fully illustrated with photographs, proved very interesting and instructive, and the best thanks of the meeting were extended to the speaker.

Further particulars of the club may be obtained from the hon. secretary (E. W. CORNELL, 42, Lincoln Road, Forest Gate, E.7).

Acton Model Engineering Society

ON Sunday, October 29th, members visited the Camden motive power depot of the L.M. Region, B.Rs., the party being conducted by Mr. Laurie Earl, famous driver of the "Royal Scot" and other express trains.

Many locomotives were inspected, together with the various maintenance shops. Members were also afforded an opportunity to obtain some interesting photographs. Mr. Earl explained many interesting features during the tour, which resulted in a very pleasant and instructive morning.

Arrangements are being made for further visits of this nature, which will form part of the society's regular activities.

The society's workshop is open every Tuesday and Thursday evening from 6.30. A cordial welcome is assured to prospective new members and visitors from other societies at any time. Full particulars will be gladly given on application to the Hon. secretary, S. HICKMORE, 106, Milton Road, Hanwell, W.7.

Aylesbury and District Society of Model Engineers

OUR monthly meeting for October, held as usual at Hampden Buildings, Temple Square, was billed as a general discussion night. However, members were in for a surprise when our chairman, Mr. E. D. Hasberry, rose to announce that Mr. N. F. Southerton, who has been hon. secretary for the past five years, was forced to resign from the club, due to the pressure of business commitments. Mr. E. Smith, our present scribe, was elected to fill the post until the next annual general meeting in January. Unfortunately, Mr. Southerton was unable to be present to receive the thanks of the club for his past services. We offer him every success with his business in the future. —Hon. Secretary, E. SMITH, Mulberry Tree Cottage, Devonshire Avenue, Amersham, Bucks.

Shrewsbury and District Society of Model and Experimental Engineers

THE annual exhibition of the above society was held at the Walker Hall Technical College on Friday, November 10th, 7-9 p.m., and Saturday, November 11th, 2.30-9 p.m., and proved a great success. As in previous years the Oswestry Society collaborated with us. In addition, many models were sent from the Chester and Wallasey areas.

A party of children from Dr. Barnardo's Homes were the guests of the society on the Saturday before the public were admitted. They were conducted around the exhibition and given a ride on the locomotive track! —Hon. secretary, W. T. HOWARD, Technical College, Shrewsbury.

Items of Interest

Photographic Demonstration at Schoolboys' Exhibition

IN January, 1950, an interesting and successful feature of the Schoolboys' Own Exhibition at the Horticultural Halls was the photographic demonstration put on by Johnsons of Hendon Ltd. to stimulate interest in home photography among the younger generation. Nearly 13,000 juvenile enthusiasts were passed through the demonstration rooms and given a brief but effective practical lecture on film developing, contact print-making and enlarging.

The 1951 Schoolboys' Exhibition, opening on January 1st, will have an even larger exhibit, in which Johnsons of Hendon Ltd. have the welcome co-operation of Messrs. Kodak Ltd., who will concentrate on the "taking" side of photography.

The stand will be subdivided into sections and convenient groups of boys (and girls!) will be shown how best to take their photographs and then how a film is developed. Contact print-making, in which the young people can co-operate, will be explained and prints will be developed and shown to them.

Enlarging, the most fascinating side of photography, will be specially featured, and here again everything will be made crystal-clear for the visitors. How-to-do-it books and trial kits for an immediate start when they get home will be available as the boys leave the stand.

Expert demonstrators with unlimited patience, trained to expect the most unexpected questions, will do their utmost to prove how fascinating photography can be.

Speed of Light

LIGHT travels at 11 miles a second faster than the figure generally accepted by scientists for the past 15 years. This discovery was made from experiments at the National Physical Laboratory, which show that the figure should be 186,282 miles per second and not 186,271. (See leading article.)

A Correction

IN our September/October issue we published a photograph of the English Electric "Canberra" jet bomber, the caption stating that the aircraft was the "world's first jet bomber." This should have read "Great Britain's first jet bomber."

Book Received

The Home Handyman. By F. Lockwood. Published by C. Arthur Pearson, Ltd. 150 pages. Price 5s. net.

THE handyman who likes doing repairing and renovating jobs at home will find much to interest him in this useful book. It explains how to clean and repair a variety of articles and appliances used in the home at a fraction of the cost of having the work done by outside help. The subjects dealt with range from Cleaning Clothing, Household Metalwork and Pictures, to repairing Clocks and Watches, Lawn Mowers, Boots and Shoes, Sewing Machines and Household Utensils. The book is well illustrated with numerous explanatory photographs and diagrams.

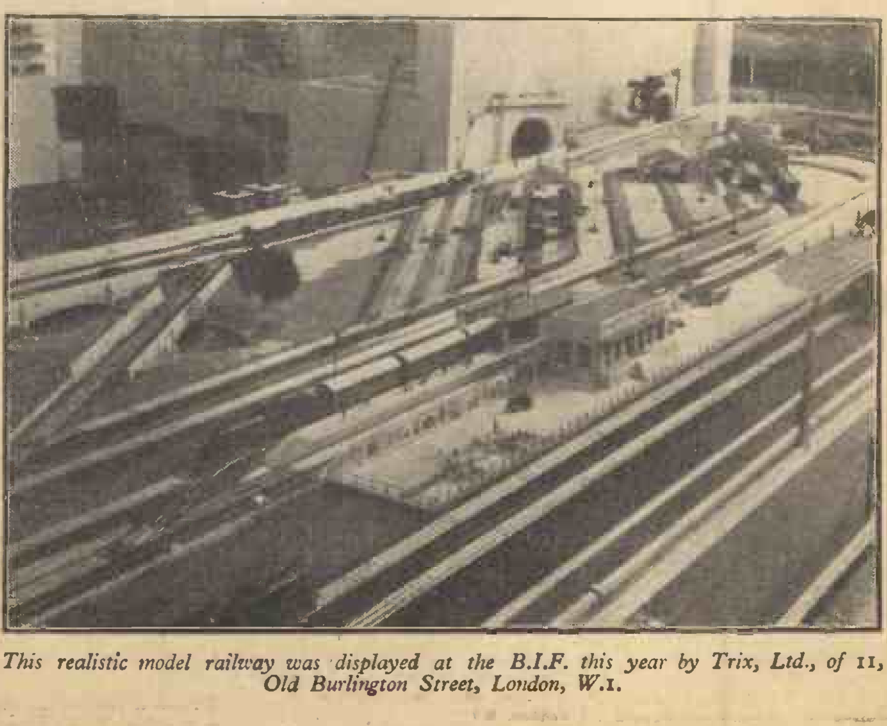
A Problem Solved

THE approach of Christmas brings once again the problem of choosing gifts for one's friends, both at home and overseas.

The solution need not be difficult. Send them subscriptions to PRACTICAL MECHANICS and you ensure a gift that is not only original and immediately acceptable, but also has a cumulative value in that every issue throughout the year serves as a reminder of your good wishes.

We shall be pleased to arrange as many gift subscriptions as you may wish to send at the normal rate of 11s. (Canada 10s.). In addition, an attractive special Greetings Card will be sent in your name with the first copy of each subscription.

Just write to the Subscription Manager, PRACTICAL MECHANICS, Dept. G.5, Tower House, Southampton Street, Strand, London, W.C.2, enclosing the addresses of your friends, with remittance to cover, and we will do the rest.



This realistic model railway was displayed at the B.I.F. this year by Trix, Ltd., of 11, Old Burlington Street, London, W.1.

QUERIES and ENQUIRIES

A stamped, addressed envelope, three penny stamps, and the query coupon from the current issue, which appears on page 16 (THE CYCLIST), must be enclosed with every letter containing a query. Every query and drawing which is sent must bear the name and address of the reader. Send your queries to the Editor, PRACTICAL MECHANICS, Geo. Newnes, Ltd., Tower House, Southampton Street, Strand, London, W.C.2.

Green Dye for a Tent

I WANT to dye my old white tent green, and I understand that I can use copper sulphate solution, which will rot-proof it as well.

Could you give me a formula for a dye which will not need boiling, as I can only immerse in my bath-tub in hot or cold solution?—H. Zamanian, (London, W.C.).

ALTHOUGH copper sulphate will protect your tent fabric from rot, it is useless for colouring it. If you wish to dye the tent fabric, you would have to immerse the material completely in a dye solution and then heat the solution to near boiling-point. The job would be a difficult one and the material would not be rot-proofed.

The best treatment for your tent fabric is as follows:

Dissolve 30 parts of copper naphthenate in 70 parts of a mixture of equal volumes of white spirit and paraffin. You will have to heat the liquid to effect solution of the copper naphthenate, and, as a result, you will get a strong green solution. Paint this solution (preferably hot) on to the outer side of the tent fabric, using a brush for the purpose. One application is sufficient. The tent will be stained green, and it will be completely waterproofed and rot-proofed at the same time.

Copper naphthenate may be obtained from Messrs. Thomas Tyrer and Co., Ltd., Stratford, E.15, price about 5s. lb. It should also be obtainable from any firm of laboratory chemical suppliers, such as Messrs. Vicsons, Ltd., 148, Pinner Road, Harrow, Middx.

Testing Spirit Levels

I AM about to construct a bricklayer's level, and shall be glad if you would describe a method for testing same; I have no level of known accuracy. I intend to fit both perpendicular and horizontal bubbles.—W. A. Hindly (Reading).

THE simplest way of testing out the accuracy of your level, without any special devices or any standard levels to refer to, is as follows:

Obtain a smooth, substantial piece of wood, which must be wider and longer than the level itself. Float this wood on a stretch of still water. An ordinary household bath can be used for this purpose. Then gently place the level on the floating wood. Any deviation of the level from the true horizontal will at once be evident. It may even be possible to dispense with the floating wooden support and to float the level itself.

For testing the accuracy of the perpendicular or vertical level, drive two 6in. nails into a wall at a distance apart equal to the length of the level. From these nails suspend two plumb-lines. Between the plumb-lines arrange a perfectly level table or other support on which to lay the level under test. Get the level perfectly horizontal. Then compare its "vertical" indication with the plumb-lines, which latter, of course, will be perfectly vertical.

Removing Paint and Varnish-stain from Woodwork

WILL you please inform me how to remove paint and varnish-stain from any woodwork? I do not want to use a blowlamp, as I have reason to believe the flame saps the nature out of the wood. Previously I have been using much-diluted caustic soda, which makes the paint rub off like mud, but I find this is rather rough on the hands. What I really want is a chemical mixture to have the same removing effect as caustic soda, but with less damaging effect to clothing, etc. Thank you.—C. Clarke (Birmingham).

VARNISH stain can often be removed from woodwork by means of methylated spirit, but if the actual stain has deeply penetrated into the wood, only a bleaching agent will destroy the colour.

We are inclined to agree with your remarks about the injurious effect of paint-burning on woodwork. A skilled operator, however, can burn paint off with very little injury to the wood, so much so, indeed, that any slight injury is immediately made good again when the woodwork is repainted. The same, however, would naturally not apply to paint burned off a high-class furniture wood.

Caustic soda treatment is very convenient and cheap, but (as you point out) it not only injures the skin, but the wood surface also, and probably this injury is far worse than any slight destruction of the "nature" of the wood occasioned by a blowlamp properly applied.

The modern, organic liquid paint-removers are excellent, and there are many proprietary preparations of this nature now available at all paint shops. They do not injure the wood or the hands. Their chief snag is their cost, since they are made from raw materials which are relatively expensive. Essentially, they consist of a solution of wax or cellulose in blended solvents. When brushed out on to the paintwork, the solvents act rapidly by softening the paint. The dissolved wax or cellulose forms a surface skin on the applied film of liquid and this prevents the speedy evaporation of the solvents. After a few minutes' application, the paint film (even the most hardened) is sufficiently soft to be scraped away with a blunt edge.

A suitable solution of this type is made up as follows:

Benzol	5 parts (by vol.)
Ethyl acetate	3 parts
Carbon tetrachloride	1 part
Acetone	1 part
Paraffin or ceresine wax	3 oz. approx.

This solution must be kept in a well-stoppered bottle. It is highly evaporative and highly inflammable.

Readers are asked to note that we have discontinued our electrical query service. Replies that appear in these pages from time to time are old ones, and are published as being of general interest. Will readers requiring information on other subjects please be as brief as possible with their enquires.

The following paste is said to be a good paint-stripper, but we have not had any direct experience of it:

Soft soap	40 parts.
Carbon tetrachloride	40 parts.
Acetone	20 parts.

The very simplest organic paint-stripper has the following composition:

Benzole	50 parts.
Acetone	20 parts.

Add to the above about 10 parts of paraffin containing about 3 parts of dissolved paraffin wax.

Marbling Cement Products

IS there any way of treating cement products to give any article made with cement an imitation marble effect? If so, could you please give me the formula? I would also be glad to have any information concerning colours required.—M. Scales (Aberdeen).

ATTEMPTS to marble cement products are not very successful, since the cement body is wholly different from that of marble.

Usually, the cement is brushed over with a marble-like material. You can make this latter material by mixing together 12 parts of Portland cement, 6 parts of chalk, 4 parts finest sand, 2 parts china clay or infusorial earth (Fuller's earth will do). These quantities are all by volume. The materials should then be made into a paste with waterglass, and then afterwards thinned down with water to paint consistency.

This cement or "stone paint" is lightly brushed on to the cement or concrete surface. Whilst it is still wet, ordinary watercolours are made up. These are impregnated into cotton or linen fibres, and the strands of coloured fibre are slowly drawn across the painted surface. This will impart to the surface coloured, marble-like veins.

Larger areas of colour may, of course, be brushed on to the surface, the whole then being allowed to dry slowly, a process which takes weeks.

The imitation of marble thus produced is never very good, and it is only very occasionally that similar processes are worked on a small scale.

As for the colours required—these are merely the finely powdered "dry" colours which are available at any paint shop. They are made up with a little dilute waterglass (sodium silicate) solution so that they are the more easily able to attach themselves to the cement material or stonework on which they are laid.

Filtering Rainwater

I HAVE a shed, some distance from the house, which is to be used as a photographic dark-room. As there is no water supply there, it is my intention to collect rainwater from the roof of the shed, by spouts and pipes. Could you please inform me of any method for cleaning this water after collection, so that it will be suitable for mixing chemicals, and washing the films and prints?—J. G. Radcliffe (Wigan).

FILTERED rainwater will be very suitable indeed for photographic use. It must, however, be quite free from particles of rust, otherwise it may set up bad stains on plates and paper, and even blue markings on sulphide-toned prints.

The rainwater, as it comes from the roof tank, should be filtered through several folds of cloth. After this it should be allowed to percolate through a 3ft. cylinder packed with a mixture of coarse grit, sharp sand and charcoal. Emerging from this filter, the water should again be strained through a fine cloth. It will then be quite pure and clear for photographic use and even for drinking purposes.

The filtering materials should all be carefully washed before putting into the cylinder. Charcoal may readily be made by calcining old bones in a hot fire and by breaking up the blackened remains into small pieces. Do not heat the bones too strongly, otherwise the black carbon will burn away, and you will be left only with the white calcium phosphate component of the bones.

If possible, use a non-metallic cylinder for the filtering column. A length of drainpipe serves excellently for this purpose, although it is rather heavy. It will have to be closed with a strong wooden bung at the lower end, through which must pass a suitable pipe provided with a tap.

Running a Three-phase Motor on Single-phase Mains

I HAVE a small three-phase induction-repulsion motor which I wish to run from 230-volt A.C. single-phase mains. Can you tell me if this can be done by using condensers, etc.? I am prepared for very low efficiency and power, but this is quite in order for the job I have to do. —G. M. Marston (Hornchurch).

WE presume that the three-phase motor is actually a squirrel-cage motor. The repulsion-induction motor, which has a commutator and brushes, is a single-phase machine. If the three-phase motor is a 400-volt machine, it will be realised that the safe full load horsepower and the starting torque would be considerably reduced on lower voltage, even if three-phase. The full load horsepower is almost proportional to the voltage, whilst the starting torque is practically proportional to (voltage)^2. On single-phase the full load horsepower and starting torque will be reduced still further.

You could probably use the motor if started by hand before switching two of its three stator terminals on to the single-phase mains. You may be able to make the motor self-starting on light load by connecting one of its stator terminals to one pole of the single-phase supply, the second stator terminal to the other pole of the supply, and the third stator terminal through a condenser to one or other of the poles of the supply; the direction of rotation would then depend on the pole to which the condenser was connected. When the motor has started up, the third terminal and condenser should be disconnected and the motor left running with only two of its terminals connected to the supply.

As we do not know the size and voltage of the motor, we are unable to advise you of the size of condenser.

As a guide we would suggest about 5 microfarads for each 1 amp. of motor rating, but it is possible that a larger condenser will be needed.

Iron Powder : Self-hardening Paste

CAN you tell me where to obtain cast-iron powder, and how to bond it into a very heavy smooth paste with air-hardening or rapid-hardening qualities ?

I believe a method of rapid rusting is achieved by the addition of water and chemicals.

Also, is it possible to react magnesium-oxide, or chloride or hydroxide, to give a self-hardening paste yielding a dense white solid considerably stronger than plaster of Paris ?—"Filler" (Worksop).

WE do not think that a cast-iron powder is commercially obtainable in this country, although you might make inquiries of Spelthorne Metals, Ltd., 34, Berkeley Square, London, W.1. "Puron" is a powder form of very pure metallic iron (not cast-iron, which contains carbon). So, also, is "Carbonyl iron." These may be obtained usually from chemical supply establishments, such as Messrs. Griffen & Tatlock, Ltd., Kemble Street, Kingsway, London, W.C.2, or from Messrs. A. Gallenkamp & Co., Ltd., 17-29, Sun Street, Finsbury Square, London, E.C.2.

If, however, you merely want an iron powder to make a hardening paste, ordinary fine-grade iron filings will suit your purpose, and at a much lower cost. Such material is obtainable from chemical supply merchants, such as the above. This material is made up according to the following formula :

Iron filings (fine)	95 parts
Ammonium chloride (Sal ammoniac)	3 „
Sulphur	2 „

Intimately mix the above. Make into a thick paste with water. Then add *1 drop* only of strong sulphuric acid to start the reaction. The paste will harden in two days. This sulphuric acid addition is not essential but it much facilitates the reaction. One or two drops of vinegar might possibly suffice.

If you merely want to rust the iron filings or powder, scatter it on a shallow non-metallic tray. Then spray the material with water acidified by the addition of vinegar.

The self-hardening magnesium-containing paste to which you refer is made by slaking calcined magnesite (magnesium-carbonate) with a 40 per cent. solution of magnesium chloride (i.e., a solution of 40 parts magnesium chloride in 60 parts of water). The magnesite should be slaked to mortar consistency. It hardens within 36 hours, and the product is much harder and stronger than plaster of Paris. The material very slightly expands during its hardening, a feature which gives it the facility of producing very sharp casts. In general, this material is excellent for casting purposes. It cannot, however, compete with ordinary plaster of Paris and other gypsum plasters in respect of cost.

Matt-black Leather Stain

CAN you advise me how I can make up a good matt-black quick-drying leather stain ?—J. Litchford (Camberley).

THE following spirit-based leather stain will suit your needs :

Methylated spirit ..	10 parts (by vol.)
Acetone	2-3 „
Castor oil	¼ „

In the above mixture is dissolved sufficient spirit-soluble black dye to make up a strong black solution, which is then brushed on to the grease-free leather surface.

The necessary materials can be obtained from any dealers in chemicals, as, for example, Messrs. Vicsons, Ltd., 148, Pinner Road, Harrow, Middx.

Induction Motor : Working Factors

I HAVE a squirrel-cage induction motor rated as follows : 3 PH. 415 volts, 1,500 r.p.m., 2 amps., 1.5 h.p., .85 PF.

If the voltage drops from 415 to 410, does the r.p.m. reduce, amperage increase, horsepower decrease, and the power factor increase ?

If the voltage increases from 415 to 425, does the reverse happen ?—A. D. Letheran (Bristol).

UNDER all stable conditions a motor will draw from the supply sufficient current to maintain the motor torque at the required value, i.e., equal to the torque resistance of the load to which the motor is coupled. If the supply voltage falls the value of the revolving magnetic flux produced by the current in the stator windings will also fall, roughly in the same proportion. The motor torque (proportional to magnetic flux × rotor current × rotor power factor) will also fall. This will cause slight fall of speed, consequently the rotor will cut the revolving flux at a greater rate with increase of rotor voltage and current and slip. The increase of rotor circuit slip will increase the rotor circuit frequency and reduce the rotor circuit power factor. The increased rotor current will increase the motor torque as the speed falls ; the motor torque will probably have risen to the same value as the load torque resistance with less than 1 per cent. fall of speed. Hence, reducing the voltage from 415 to 410 volts will cause slight fall of speed, with increased rotor and stator current. The power factor of the input to the motor will probably increase slightly due to the reduced magnetising current.

The horsepower of a motor is really the power which the motor will develop for the required period without overheating. Actually, since a motor takes an increased current to develop its normal horsepower on reduced voltage, the rate of heating will be increased on reduced voltage and normal horsepower. Theoretically, for the same rate of heating, the horsepower loading should be reduced on reduced voltage, but any normal motor would stand its rated horsepower on a 5-volt drop.

Increased voltage from 415 to 425 volts will have opposite effects. The increase of voltage will increase the magnetic flux and the magnetising current, but will reduce the current required to produce a given torque and horsepower. Normally, the increase of magnetising current will be very small, but if the iron cores are designed for a high magnetic flux density so that they are more or less saturated on normal voltage, a very great increase of magnetising current might be required on increased voltage, especially if the increase was appreciable. In this event the motor might take a high current and overheat even on light load.

Acid and Alkali Resistant Surface

I HAVE constructed a laboratory bench and wish to coat the surface with an acid and alkali resistant paint, or plastic.

Please advise me on a suitable paint, and the source of supply.—G. H. Willis (Hackney).

THERE is no paint or enamel material which will stand up to the hard usage of the average laboratory bench. Indeed, paint or varnish on a laboratory bench is, more often than not, an intolerable nuisance, since it softens under heat influence, and is often badly attacked by alkalies.

We assume, of course, that yours is a wooden bench, in which case the best treatment is a simple one. Having prepared the wood surface by planing and sandpapering, stain the wood black by several applications of a spirit stain to which, if you wish, you may add a little lampblack. Then, using an ordinary floor polish, wax polish the bench top. Repeat the process every few days until you have built up an enduring film of hard wax.

This is the best of all treatments for wooden benches in laboratories. A good surface is readily obtained. The surface is resistant to acids and fairly resistant to alkalies and, although it softens under heat, the surface re-forms as it cools. What is more, the smooth, lustrous surface is at once renewable by the application of a little more of the wax polish.

If you must have an actual paint for your bench top, one of the modern black enamels based on bakelite and obtainable from any paint stores will be the most satisfactory, particularly if this is wax-polished after it has become quite dry and hard.

Photographic Enlarger Details

I AM desirous of constructing a photographic enlarger capable of giving good quality results from negatives of various sizes. I have in mind the possibility of also using the instrument for three other purposes :

(1) Using the body as a quarter-plate stand camera.

(2) As an epidiascope.

(3) As a projector for slides.

Can you inform me as to suitable lenses, disposition and arrangement of the various units, etc. ?—L. W. Parker (Hendon).

NO photographic enlarger can act as an epidiascope, but, within limits, it can function as a projector. Again, there is no enlarger which can function with an unlimited number of plate sizes. The maximum size of plate is determined by the dimensions of the plate-carrier, and this, in its turn, is governed in dimensions by the focal length of the projecting lens and by the diameter of the condenser. Hence, an enlarger which is constructed to enlarge, say, quarter-plate negatives, will not accommodate half-plate negatives, although, by suitable masking, it will take any size of negative *smaller* than quarter-plate size.

Plenty of detail about enlarger construction can be found in any good photographic dictionary or reference book, to which we must refer you. In a reply such as this, we can only give you the "theoretical diagram" underlying all enlarger construction. It is as shown in the accompanying diagram.

Note that the diameter of the condenser must be at least equal to the diagonal of the negative, otherwise the negative will not be evenly illuminated. For ordinary work a 60-watt lamp is quite sufficient. Any type of camera lens will suffice. It need not be of anastigmat quality, provided that it can be stopped down to about f/22. The focal-length of the lens must at least be equal to the diagonal of the negative, otherwise the lens will not "cover" the negative adequately.

The approximate distance between negative and lens, and between lens and bromide paper may be worked out from the following formulas :

Distance between negative and lens :

$$d = f + \frac{f}{n}$$

Distance between lens and paper :

$$D = (n+1)f$$

Where :
- d = Distance between negative and lens.
- D = Distance between lens and paper.
- n = Number of times of enlargement.
- f = Focal-length of lens.

It is not usually practical to utilise a camera body for making an artificial light enlarger. In the first place it is difficult to accommodate the condenser and the illuminant and, secondly, the heat of the lamp is detrimental to the camera woodwork. A metal body is much to be preferred.

The negative must be placed immediately in front of the condenser, and the illuminant should be capable of to-and-fro and, also, of vertical movement in respect of the condenser so that good, even illumination of the negative can be obtained. The sheet of ground glass behind the negative is not necessary, but it greatly aids the evenness of the illumination. It decreases the amount of light transmitted and, therefore, necessitates longer exposures.

As a small-scale projector for positives, this enlarger will function quite well, readily giving a picture of present-day television size, but for large-scale projection it would not be suitable unless a longer-focus lens were used, together with a much more intense source of light.

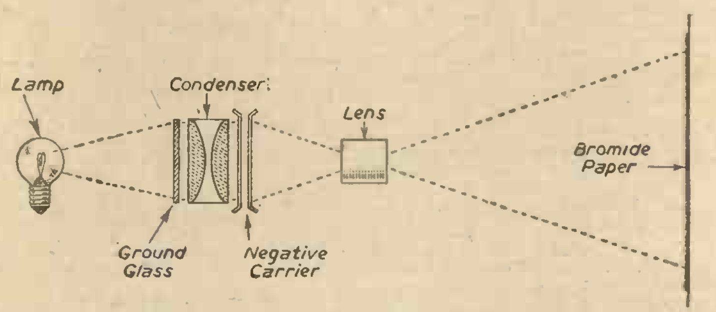


Diagram showing the optical layout for an enlarger.

Glass Embossing

CAN you please explain the rudiments of glass embossing or engraving with hydrofluoric acid ? I understand there is a substance called vegetable black, used for the coating of grease firstly and then laminated lead.

Can this acid be mixed, or diluted, to show different expressions of work ?—C. E. Cleves (Cardiff).

HYDROFLUORIC acid has the power of dissolving glass. It is an intensely corrosive acid, and it is contained in gutta-percha, lead or ceresine bottles. It can be obtained from most chemical supply firms, as, for example, Messrs. Griffin and Tatlock, Ltd., Kemble Street, Kingsway, London, or Messrs. W. and J. George and Becker, Ltd., 17-29, Hatton Wall, London, E.C.1. Maybe you will be able to obtain it from some chemical wholesaler in your city.

The glass sheet is covered with a film of some suitable resisting material, as, for example, hard wax, shellac, varnish, etc. The design is inscribed on the "resist" film, and the acid is dabbed over the film. The acid attacks the glass where it has been laid bare and thereby engraves the required design on the glass. The glass is finally rinsed and the resist film is dissolved away in some suitable solvent.

Hydrofluoric acid is a dangerous material to handle. In contact with the skin it produces serious "burns" and wounds, which take a long time to heal. The acid may, of course, be diluted to any strength with water. We are not clear as to your references to vegetable black and to laminated lead. The latter is merely a thin lead sheet or foil. Vegetable black is a voluminous black pigment of fine texture which is produced by the burning of refuse oil, fat, grease, etc., in a limited supply of air. The black pigment is amorphous carbon. It can be made up with grease in order to form resistant surfaces.

Copal Varnish

WHAT is the formula for an inexpensive copal varnish ?—P. Lloyd (Bramcote).

COPAL varnish is always difficult to make. Its formula varies greatly according to the use to which the varnish is being put, to the nature of the copal and to other factors.

Here, however, is the formula of a simple type of copal varnish :

Copal	110 grams.
Linseed oil (raw)	250 ccs.
Turpentine	375 ccs. (approx.).

Powder the copal and heat it in the linseed oil for about two hours, until the mass becomes homogeneous and can be drawn into threads. The temperature should be around 160 deg. C. Then, after cooling to 100 deg. C., add the turpentine with continual stirring and in small amounts at a time, thus gradually thinning-out the varnish. The quantity given above is approximate only. You may require more or less turpentine, according to the nature of the copal and the amount of heating.

Copal varnish dries slowly. You can, however, speed up its drying by adding a small proportion of a liquid paint drier to it—say 5 parts of drier to every 100 parts of varnish. The more drier you add to the varnish, the quicker it dries, but the more brittle the varnish becomes.

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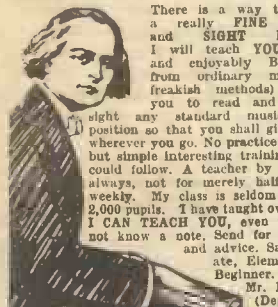

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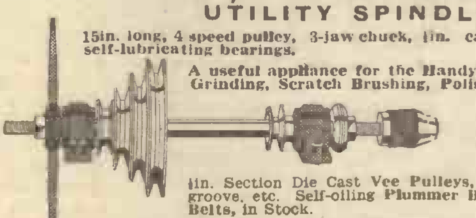

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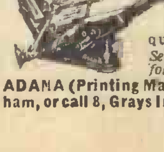

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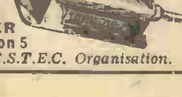

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