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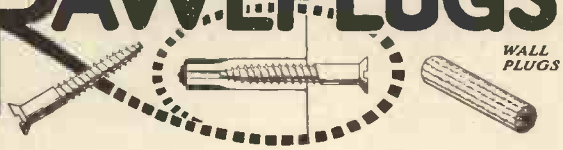
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EDITED BY F. J. CAMM

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PRACTICAL MECHANICS

VOL. IV. MAY, 1937 No. 44.

# Fair Comment

*By The Editor*

## On Finding a Job

IT is one of the weaknesses of old age to reflect that things are never so good as they were, and to regard every improvement, every change in national habit, and each mutation of public taste as a retrograde step which will eventually bring the nation to disaster. According to the lean and slippered pantaloons the country has been going to perdition in this way for centuries, and we are still on our way to that Ultima Thule; the process is evidently a slow one or we should have arrived a long time ago.

It will always be so, but we cannot deny that even within the short space of our own lives the world is a better place in which to live. We have more leisure, we earn more money, there are more amusements, the national health is improved, almost everyone owns a vehicle, the standard of education is higher, and our world is not bounded by the line which circumscribes the parish of our domicile. Travel has broadened our minds and mellowed our outlook, and there is a higher degree of consanguinity among the peoples of the world than was the case in the "good old days," which we moderns regard as the "bad old days."

## The Swing of the Pendulum

But there cannot be action without a corresponding reaction, and there cannot be progression in one direction without a corresponding retrogression in the opposite!

Nothing is ever obtained free of charge, and if we admit that we do enjoy the advantages of living in the twentieth century we must consider the price we pay for them. To every advantage there must be a snag. In the first place we must admit that we live *faster* and it is debatable whether with the urge of modern life we really have the time to enjoy what we think we are enjoying. Before the War, however, we had less time in which to enjoy ourselves because we worked for longer hours. As we are earning more money for less work it is obvious that the cost of living has correspondingly increased. Whilst we are at work, therefore, we must work more intensely for the money we receive, so that work itself becomes less enjoyable, and the leisure we have after work hours must be correspondingly less enjoyable, because we are not in the frame of mind after work to extract the maximum amount of pleasure from the available time.

In fact, it is true to say that the *tendency* is, when work interferes with pleasure to sacrifice work! The desire to work nowadays is less inherent than it was, and the world-wide desire is to extract the greatest amount of money for the smallest amount of work. In spite of the pleasures which the world has to offer life becomes more strained in order to find the money to pay for it. It was considered a monstrous thing when some pre-War Chancellor of the Exchequer imposed a tax on earned income of 6*d*. in the £. To-day it approaches 5*s*. in the £, and taxation direct and indirect has been correspondingly increased. We have Income Tax worries, and the desire to afford what our neighbour affords.

On the positive side of the picture you have the greater advantages and the increased opportunities which life offers to those who wish to earn their living. There were not so many opportunities before the War. Now, there are the new industries which science has created—wireless, aeronautics, road transport, the telephone, the steam ship, the locomotive, journalism, and television, and as there are more opportunities there is a greater demand for qualified man-power to fill the jobs which exist. It is strange and almost a reflection upon civilisation, therefore, that there is a greater shortage of skilled labour to-day than ever before in the industry of the world, notwithstanding the fact that there are nearly two millions of unemployed in this country. What is the reason for this state of affairs? The nation deplores the fact that where there should be work for all, this vast number are unable to find it. Inventions inevitably make employment and create unemployment; because the machine can do so much more than the man, it is probable that it creates more unemployment than employment. The use of electricity for heating and motive power, for example, has reduced the demand for coal, so that we find unemployment rife in the mining districts. That accounts for some of the unemployment, but a large proportion of it is accounted for by the fact that they cannot do the work which is available; they are not unemployed, but unemployable!

## An Early Start Essential

I am regularly approached by youths of 17 years and their parents, asking whether I can introduce them to some suitable employer; they want to start work, however, for a salary exceeding that which skilled men would have been paid before the War. They want to start half-way up the ladder, and avoid the drudgery of clambering up the initial rungs. They forget that it is in that clambering that experience is obtained, and it is experience which is paid for. There is no royal road to success, no short cut to that coveted position. If the best positions did not go to the best men there would be no such thing as a high-salaried post. My advice to all youths is to start work as early as you can, certainly not later than the age of 17 if you wish to make headway. Start at the bottom; you will not regret it in later years. Once you have gained experience and made yourself qualified to hold a good job (and it requires ability to do *that*, as well as to obtain it) you will find the job waiting for you. Plenty of them!

*Showing the boat travelling at speed.*

# BUILDING A FOLDING OUTBOARD MOTOR BOAT

**An Easy-to-Build Portable Speedboat which can be Built at a very Low Cost. Further Constructional Details will be Given Next Month.**

THE folding speedboat which is here described is probably about the simplest of its kind, and the term folding is employed to distinguish it from the collapsible variety usually constructed of canvas which gets torn, and numerous struts which either break or are lost.

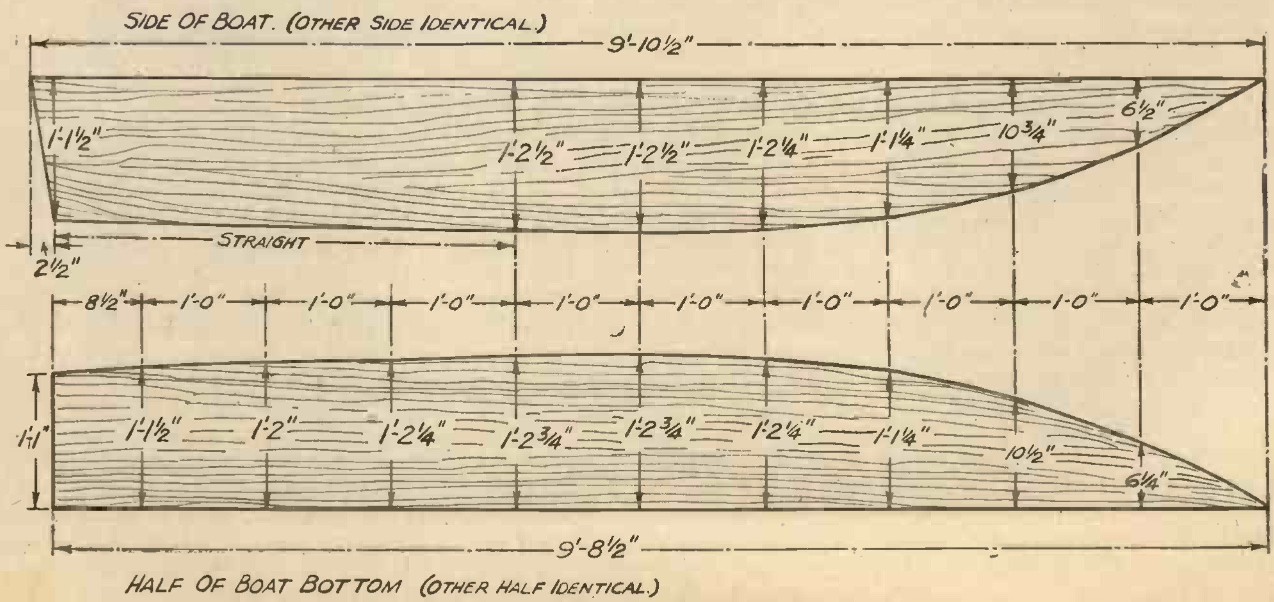
The boat has five principal parts, two sides, two halves to the bottom and a transom, and a sixth component is a frame which keeps the boat spread open when it is erected.

### The Construction

The bottom is made in two halves, the seam between the two runs centrally fore and aft and is rendered watertight by covering with canvas, which also allows it to hinge so that one half can be folded over the other.

The sides are each hinged on either side of the bottom pieces in a similar manner, so that the boat, when in a folded position, resembles a folded screen. The bow of the boat is covered with a small canvas capping, which serves to unite the extremities of the sides and bottom pieces, whilst the ends at the stern are united by a canvas back, which folds up when in the packed condition and spreads out to form a canvas transom when the boat is erected.

The hinging of the sides is further



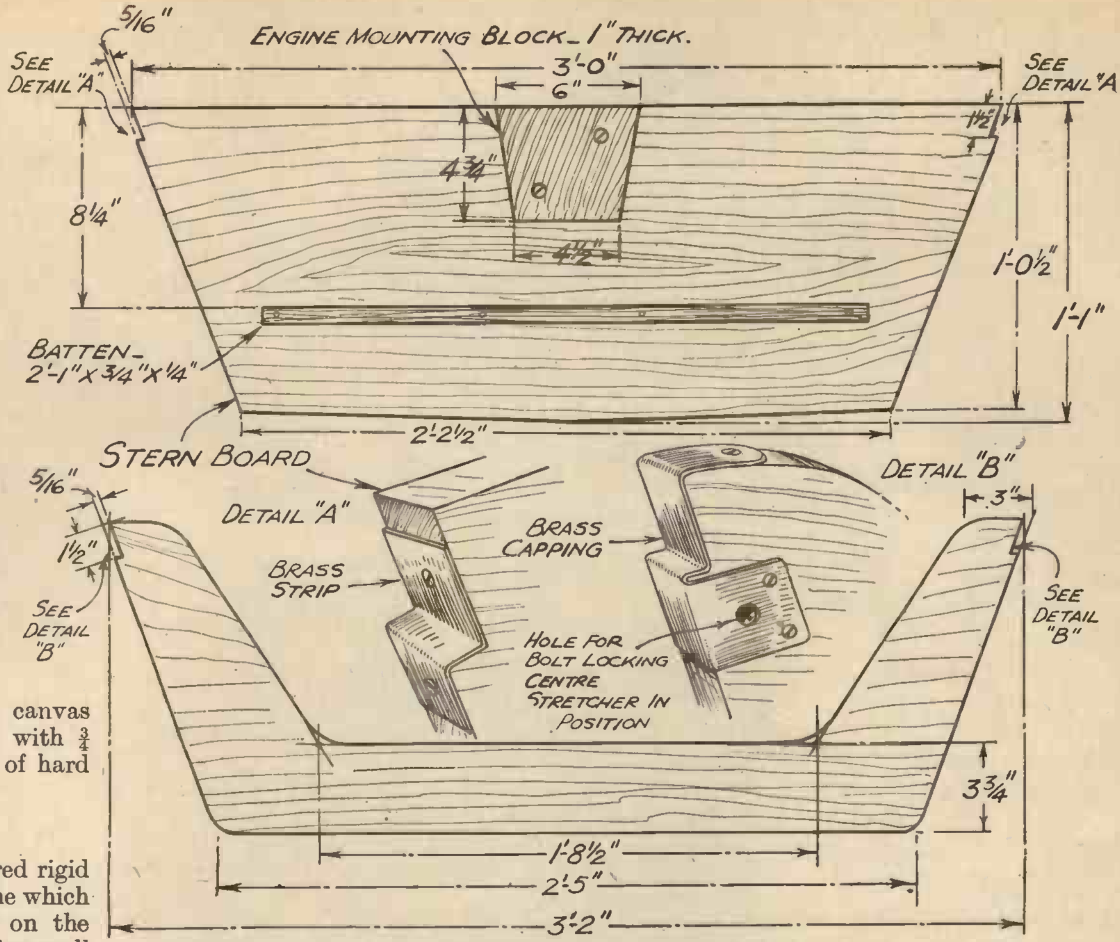

*easurements or constructing the sides and bottom of the boat.*

assisted by three metal hinges on each side.

A wooden transom is provided and slides into grooves on the sides and situated just inside the canvas transom, its purpose being to give the necessary rigidity to the stern and to accommodate the motor. The transom is, of course, rendered watertight by the canvas.

The sides and two bottom pieces are cut from ⅜ in. pine plywood and the transom from ¾ in. ply of similar material.

The edges of the canvas seams are battened with ¾ in. by ¼ in. battens of hard wood.



*The stern board and centre stretcher.*

### Obtaining Rigidity

The boat is rendered rigid amidships by a frame which slides into grooves on the sides and held there by small door bolts which engage with holes in the frame. Simple folding seats are employed, one at the transom and one amidships which are dropped into position after erection.

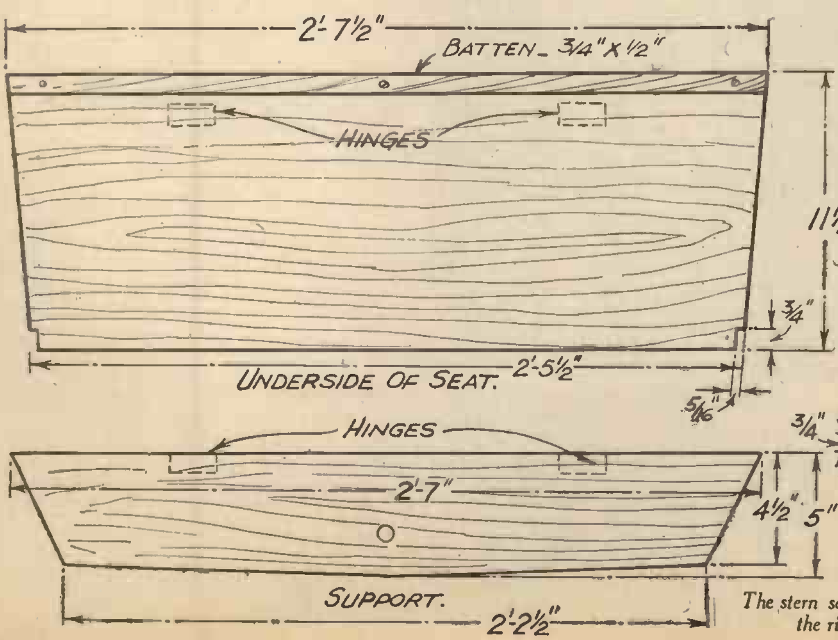
The fastenings used to secure the varous parts may be either rivets or screws; to those with experience of rivets this is the cheaper way out but it is a tricky job for the inexperienced who are advised to use screws (½ in. No. 6 is the most suitable size), brass for preference, but iron may be used for economy if dipped in boiled oil before insertion. Since these may be purchased from any ironmonger as required they are not included in the materials list.

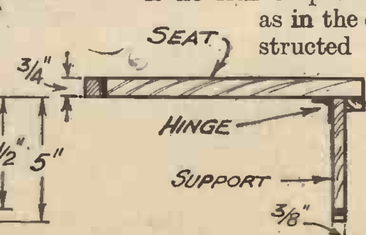
### Rowing

For rowing, ordinary rowlocks are not used, but a simple piece of iron rod ⅜ in. diameter is secured to the side of the boat and projects a few inches above it. The top of this rod is bent over in the form of a hook, and the oars are provided with metal eyes which slide over the rods. Thin brass strip is used along the edges of the sides to prevent chafe, and the top edge of the side pieces is strengthened along its entire length by being battened on each side with ¼ in. × ¾ in. hardwood. The midship frame is made from ¾ in. ply and sawn from the solid piece.

From the foregoing remarks it will be seen that the craft is entirely constructed from wood, and rendered watertight with canvas, but since the canvas only covers the seams, there is no risk of perforation or splitting as in the case of a boat constructed wholly of canvas on a wooden frame. Thus when assembled, the boat more nearly resembles one of the rigid variety than a collapsible.

(*To be continued*)

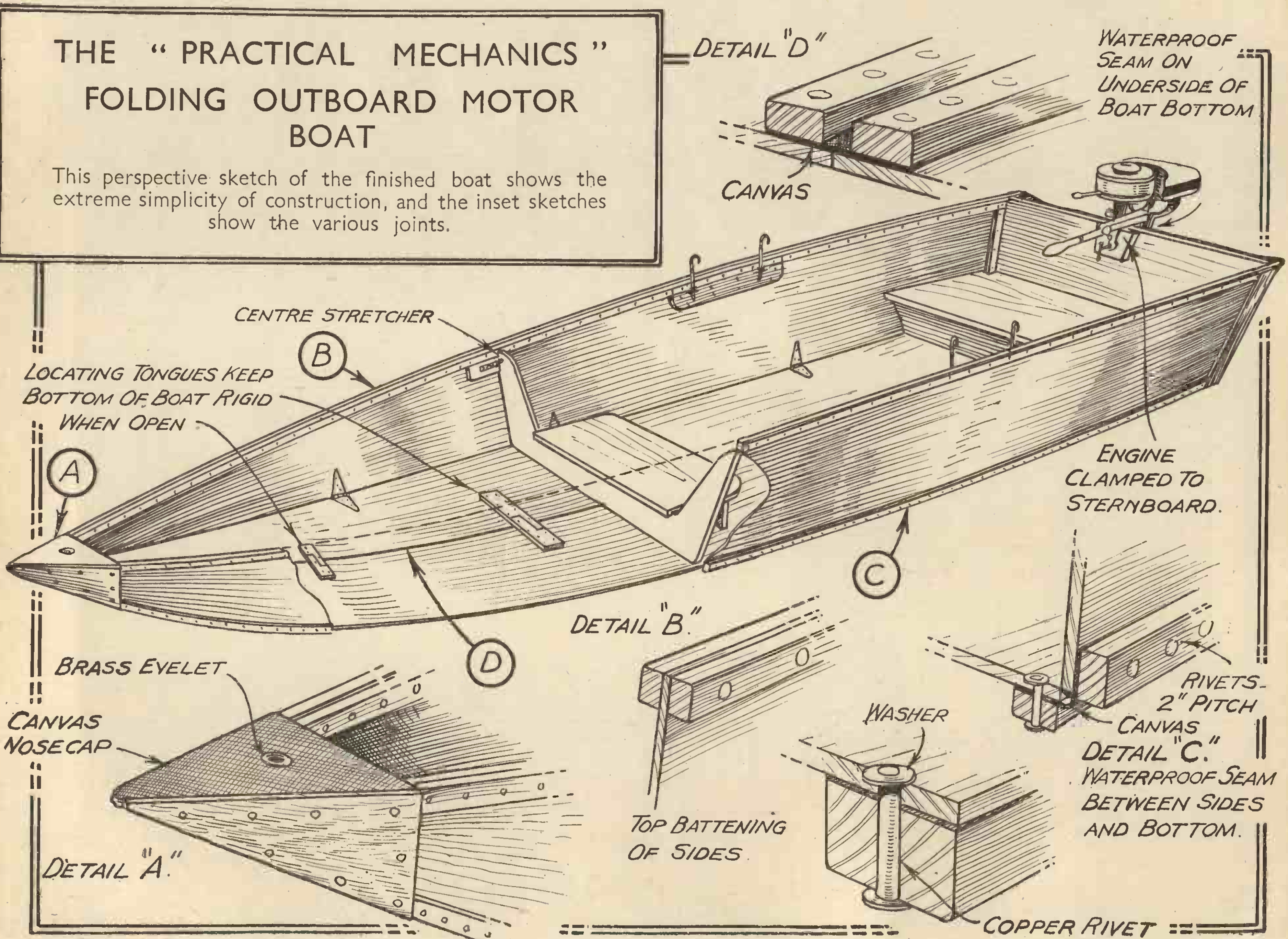


*The stern seat which is supported by the rib on the stern board.*

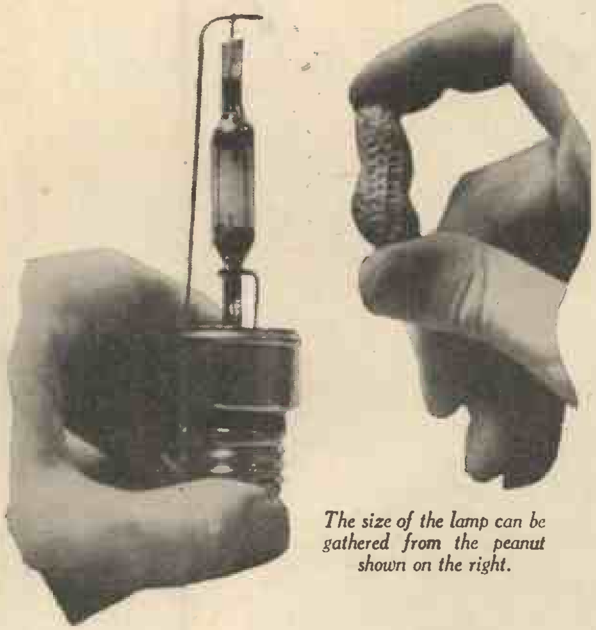
# THE "PRACTICAL MECHANICS" FOLDING OUTBOARD MOTOR BOAT

This perspective sketch of the finished boat shows the extreme simplicity of construction, and the inset sketches show the various joints.



# A "MIDGET SUN"

## A Mercury Arc Which Produces a Temperature Twice That of the Sun. It is Nearest Approach to Artificial Sunlight



*The size of the lamp can be gathered from the peanut shown on the right.*

SENDING increasing amounts of electrical energy through a vapour of metallic mercury sets up a brilliant glow of light and has enabled lighting scientists of to-day to approach within "arm's reach" of a practical artificial sun, according to Dr. John W. Marden, a research scientist.

He demonstrated such a light source for the first time recently before a joint meeting of American Institutes of Electrical Engineers and the New York Electrical Society in the Engineering Societies' Building in New York City. One of these mercury arcs, mounted in the dome of the auditorium, lighted the entire theatre.

"The greater amount of electrical energy sent through such a device, which is still a laboratory oddity and not yet ready for actual application, the nearer does the colour composition of its light resemble that of sunlight," Dr. Marden said.

### Triples Light Output

"Producing light by this method assures scientists of to-day that they are heading along one of the right avenues of to-morrow's artificial illuminant. It operates at unusually high efficiency, converting so much of its electrical input into light that in time it will mean we can obtain three times the amount of light for the same electrical consumption now utilised for lighting purposes."

Its 65 lumens-per-watt efficiency is a far cry from the 3 lumens-per-watt efficiency of early carbon filament lamps and may be regarded as a typical measure of the progress in artificial illumination during the past fifty years. In the recent demonstrations, such a mercury arc, arranged to consume 2,000 watts of electricity, produced light equivalent to 150 filament lamps of the familiar 50-watt size or a total of 7,500 watts.

Achieving higher levels of illumination is the goal lighting specialists say we must seek, if the safety of the human race is to survive an ever-increasing demand upon the eyes during the dark hours of the day.

### Resembles Sunlight

The light of this brilliant mercury arc is almost identical to the spectrum of sunlight, the rainbow which Nature frequently displays following a thunder shower, and perhaps more so than the light of any other single light source to-day, that is with any degree of efficiency, in the opinion of Dr. Marden.

"The mercury light is stronger in green and yellow colours," he said, "but this is an advantage because the human eye is more sensitive to light in the yellow region of the spectrum. If in time we can further improve the quality of light from this mercury arc, we will be able to duplicate sunshine in every way, even to ultra-violet radiations. In fact, the ultra-violet content of this mercury light is proportionately greater than in sunlight."

In his laboratory, Dr. Marden has been able to produce in these mercury arcs demonstrated recently, the highest temperatures known to man. These temperatures are so high that no instruments now available can measure them. They must be calculated.

### Hotter than Sun

The temperature of the sun's surface is about 6,500 degrees Centigrade (11,732 degrees Fahrenheit). That of the axis of the arc stream, a banana-like area of electrically-excited gas which produces the light of the mercury arc, reaches 14,000 degrees Centigrade (25,323 degrees Fahrenheit).

Among Dr. Marden's demonstrations recently was a replica of the first arc light known to man, a carbon arc with charcoal points, invented by Sir Humphrey Davy in 1813 in his laboratories in England. He also displayed and operated a replica of the first mercury arc which Michael Faraday, who was a disciple of Davy, developed. Both of these arcs are ancestors of the present-day high intensity mercury-arc light demonstrated recently.

The possible future uses for such a new type mercury arc include the floodlighting of golf courses, bathing beaches, and industrial yards. Inside large industrial plants, such as steel mills, a few of them can be mounted high above the overhead cranes to provide ample illumination without prohibitive cost of using great quantities of electricity.

### Shows "Peanut" Light

Dr. Marden also demonstrated a new "peanut" mercury-arc light which duplicated the colour quality and ultra-violet content of sunlight, for years the elusive goal of lighting scientists.

A small globule of metallic mercury, in a tiny quartz tube about the size of a roasted peanut, vaporises when submitted to an electrical discharge and sets up a brilliant glow of light. As the wattage introduced into the tube is increased, the colour composition of its light becomes more like that of sunlight, while its ultra-violet content is proportionately greater.

Its narrow arc stream of a brilliancy never before obtained by man in so small a device may eventually make it valuable as a source of light for projection purposes, as in searchlights, spot-lights, and even moving-picture machines," says Dr. Marden, who is experimenting with this light source in his research laboratory.



# THE MECHANICS OF VANISHING TRICKS

*By Norman Hunter*

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

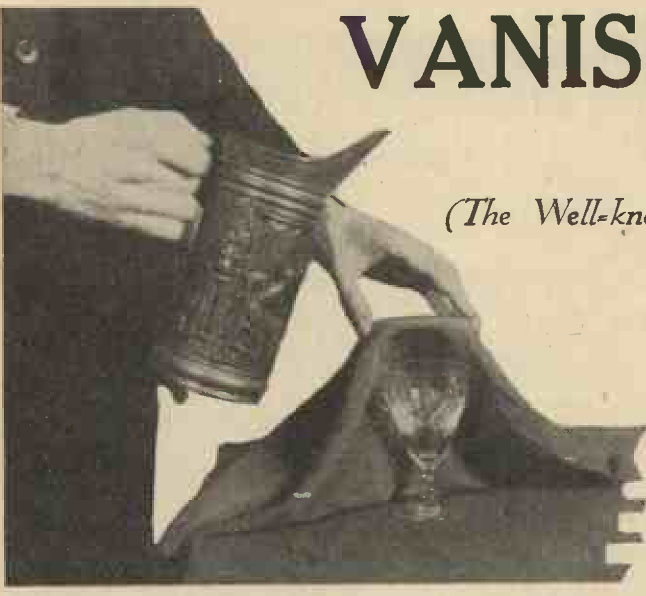


*Fig. 1.—(Left) A view from behind. The cloth containing the disc has been moved forward and the bottomless jug is about to be put down over the goblet to hide it.*

*Fig. 2.—(Right) This is a side view showing the jug going over the goblet, while the disc in the double cloth makes it appear that the goblet is held in the other hand.*

WHEN a conjurer causes an article seemingly to disappear, he uses one of various methods which may roughly be classed under the following headings:

(1) Simulation of the presence of the article after it has actually been hidden or disposed of.

(2) Concealment of the article by some other article at the moment of the vanish.

(3) Disposal of the article while apparently placing it in a place of safety.

(4) Rapid disposal of the article covered by misdirection which causes the audience to look elsewhere at the critical moment.

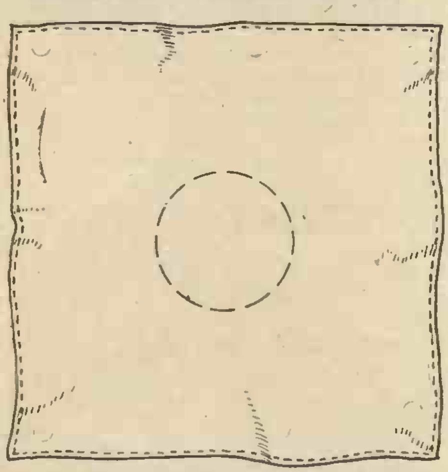


*Fig. 3.—The double cloth with disc the size of the goblet sewn between the thicknesses.*

Let us take an example from class (1). A glass goblet is filled with water, covered with a cloth and carried into the midst of the audience. The cloth is flicked into the air. Goblet and water have vanished.

### The "Goblet"

In this case the goblet and its contents are hidden from sight early in the trick and the cloth when carried into the audience does not contain the goblet at all, but only a disc of card or a wire ring which represents the shape of the top of the goblet. Such a cloth is actually two cloths sewn together round the edges, with the ring or disc sewn near the centre, between the two thicknesses of material. (Fig. 3). The goblet is disposed of by being hidden under the jug used for pouring out the water. The jug, a metal one, has the bottom neatly cut out and a false bottom soldered within an inch or so of the top. The upper portion of the jug is painted dead black inside while the lower portion is lined with cloth. (See Fig. 4.)

Reference to Figs. 1 and 2 will make clear the method of using the cloth and the jug. Fig. 1 shows a view taken from the back showing the cloth, apparently containing the goblet, being moved forward with one hand while the other hand holds the jug ready to cover the goblet. Fig. 2 shows the jug covering the goblet. In actual practice there is no perceptible pause in any of the movements although they should not be hurried. The water is poured from the jug into the goblet with the right hand, the table being on the performer's right. The jug so held will not permit the audience to see either that there is no bottom nor that there is a partition near the top. As soon as the goblet is partly full, the cloth, which lies crumpled in front of the goblet, is lifted over the goblet with the left hand. The same hand grasps the disc in the cloth and moves it forward while the right hand brings the jug down over the goblet.

### Small Table Essential

There are two important points to be noted. One is that the table used should

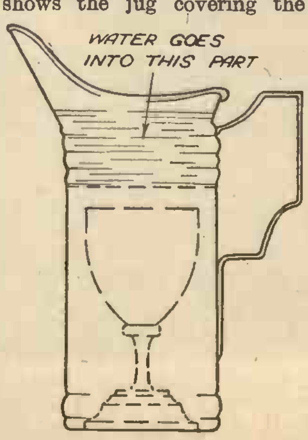



*Fig. 4.—The bottomless jug with partition near the top for water.*

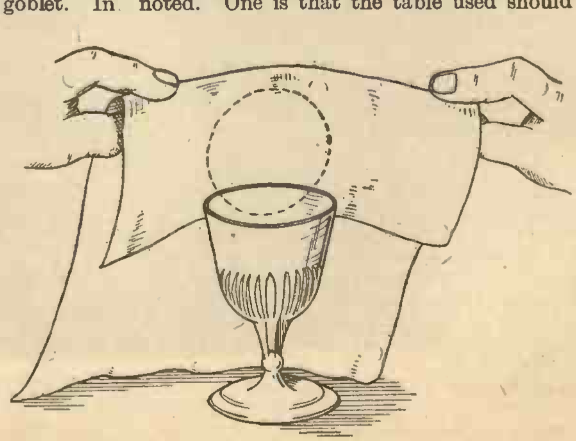


*Fig. 5.—How the cloth is folded before being laid over the glass.*

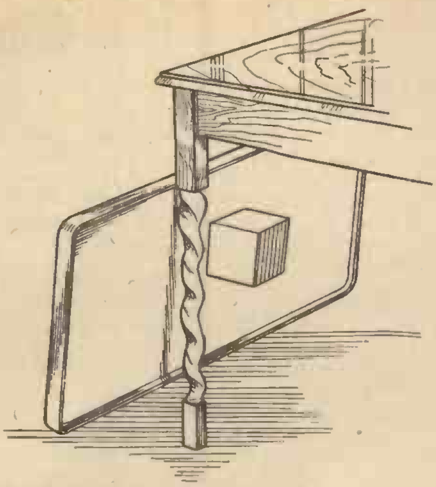


*Fig. 6.—A double-sided tray leaned against the table leg, with the cube attached to the tray out of sight at the back.*

be small, to give the conjurer an excuse for holding the jug in his hand until he has apparently picked up the covered goblet. The other is that the cloth should be folded back as shown in Fig. 5 before being laid on the table. When it is thrown over the goblet with the disc in position, all the cloth is draped in front of the glass, leaving the back free. Refer again to Fig. 3. This enables the jug to be put over the glass before the cloth has been moved forward more than an inch or so. If the cloth were draped right over the goblet it would have to be lifted so far away to clear the cloth that the goblet would become visible before the jug could be brought over it.

### Realism

A further refinement in a "vanish" of this sort is to have a scrap of wet sponge hung on a pin behind the table. This is secretly picked up and brought under the cloth. By squeezing the sponge and jolting the cloth the impression is given that some of the water has been spilt from the goblet and when a moment later the vanish takes place it is doubly mysterious.

The same principle, of representing the presence of an article after it has been made away with is applied in other ways. The shape in the cloth may be square and the cube or box which it is to represent may either be dropped into a bag behind the table, or be fixed to a tray. In the second instance the tray is double-sided. That is to say it has moulding round both faces and appears the same from either side. The cloth having been thrown over the cube and lifted by the square fake, the tray is lowered, with the cube away from the audience, and stood against the leg of a chair or table while the cloth, apparently still containing the cube, is carried forward. (See Fig. 6.)

Sometimes the article to be vanished is covered with a paper "shell." A black wooden rod for instance has a loosely fitting tube of black paper, open at both ends, covering it. The rod is banged on the table to prove its solidity after which the solid rod is allowed to slip out into a bag behind the table and the paper shell alone is wrapped in paper. The vanish is then effected by simply crumpling the paper into a ball and tossing it aside.

*Fig. 9.—Section of the hollow ruler showing the rod which pushes the handkerchief inside.*

### Shells

Mention of a shell to represent an article brings us to class (2). Fig. 7 shows how the centre cube of a pile of three is caused to vanish under cover of a cloth by being hidden inside the topmost cube. This top cube is a shell of stiff cardboard or tin, having its lower side open. The blocks have each a hole bored from top to bottom and fit over a rod on a stand. They are arranged cornerwise. When the cloth has been thrown over the pile, a touch of the finger on the top cube causes it to turn on the rod and slip down over the centre cube. The cloth is then removed and the centre block has seemingly vanished.

In this trick the upper and lower blocks should be quite different from the centre one. Plain or almost plain colours for the top and bottom cubes and a patterned centre cube accentuate the presence of the centre cube. The vanish is almost a visible one for the audience, detecting the downward movement of the shell, naturally take it to be a solid cube falling on to the bottom cube at the moment that the centre cube dissolves into thin air.

It is advisable, whatever the colour of the cubes, to have the top and bottom surfaces of each painted dead black.

Figs. 8 and 10 illustrate two totally different examples of the application of vanishing methods coming in class 3.

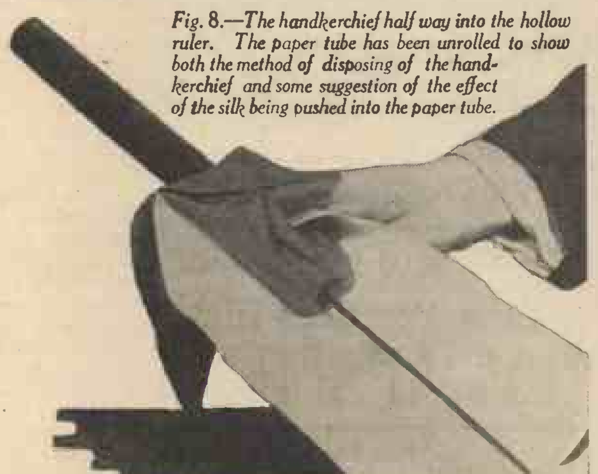


*Fig. 8.—The handkerchief half way into the hollow ruler. The paper tube has been unrolled to show both the method of disposing of the handkerchief and some suggestion of the effect of the silk being pushed into the paper tube.*

### Silk Handkerchiefs

In Fig. 10 the method is simple and direct. A silk handkerchief has to be vanished. It is tucked into the closed left hand which, in due course, is slowly opened with a kneading movement of the fingers to reveal the fact that the handkerchief has vanished, having apparently been gently rubbed out of existence.

Reference to the illustration will reveal the fact that the handkerchief has been tucked into a small hollow ball. This ball, which has a hole large enough to admit the top joint of the thumb, is secretly introduced into the left hand under cover of the handkerchief. The silk is then tucked bit by bit into the left hand, actually into the ball. Just as the handkerchief is well into the ball, the thumb of the left hand is moved upwards. The thumb of the right hand now gives a final poke to the handkerchief. In doing so, the thumb is inserted into the hole in the ball and bent over as shown in the illustration. The thumb of the left hand having

*Fig. 7.—(Left) An exposed view. The top cube is a hollow shell and is seen slipping down over the middle cube.*

*Fig. 10.—(Right) How the thumb lifts the handkerchief ball out of one hand into the other.*

already been moved out of the way, it is easy to bring the ball down into the right hand, where the fingers slightly round it and draw it away. The left hand remains closed, apparently containing the handkerchief. Actually the silk has been got away with in the very act of seeming to place it somewhere secure.

### The Ruler and Paper

The method partly exposed in Fig. 8 consists of making a tube of paper by rolling it round a ruler. One end of the paper is twisted up and the ruler taken out. The handkerchief is then spread over the ruler and apparently thrust well down into the paper tube, which is then closed at the other end and given to a spectator to hold. When he opens the paper he finds it empty.

The ruler in this case is a tube, painted black. One end is permanently plugged, the other has a fairly loose fitting plug into which is fixed a rod, a knitting needle will do admirably, having a small knob on the end. Fig. 9 shows the details of the fake ruler.

The paper is rolled into a tube round the ruler and one end twisted up. When the ruler is withdrawn the loose end and the rod attached to it are left behind. The silk is spread over the now open end of the ruler and thrust into the tube. What then happens is that instead of the handkerchief being pushed into the tube, it is pushed, by the rod, up inside the hollow ruler. The illusion of the handkerchief being packed into the paper tube is perfect and all the conjurer has to do is to withdraw the ruler, which will bring with it the handkerchief and the inner rod, after which he can twist up the open end of the paper, safe in the knowledge that he has also neatly twisted his audience in quite a different way.

Fig. 8 shows the paper tube partly unrolled to show the rod pushing the handkerchief into the hollow ruler.

### Rapid Vanishes

Rapid vanishes, covered by class 4 are usually accomplished by some kind of "pull" on the conjurer's person. A simple example is this: A length of black cord elastic has a safety pin at one end and a spring clip at the other. The safety pin is fixed to the back of the waistcoat, high up, near the neck or, if preferred, to the braces. The elastic is just long enough to permit the clip to hang about waist level. The elastic is then stretched and the clip fastened to the edge of the waistcoat over one hip, or to the edge of the waistcoat pocket. In the act of picking up the article to be vanished, such as a packet of cards or a handkerchief, the clip is unfastened and held in the hand. The article is fixed to the clip and a throwing movement made. As the hands reach their lowest point the elastic is released and the article is rapidly carried away under the coat. The conjurer, however, continues with the upward movement of the throw and follows the imaginary flight of the article with his eyes. This causes the audience involuntarily to do likewise and, if the trick is neatly performed, it produces the illusion of the object having actually vanished in mid air.

A more complicated example is the famous vanishing bird cage trick. In this case the pull is of cord and the cage is collapsible.

### The Cord and Ring

The cord is fastened to the right elbow, carried across the back, under the coat, of course, and through a ring. This ring is attached with a few inches of cord to the left elbow. The cord first mentioned on passing through the ring is returned across the back and down the right sleeve where it terminates in a small swivel hook. This swivel is fastened until needed to the cuff. The cage is of wire and oblong in shape. Every joint is a loose joint so that if the cage is held at diagonally opposite corners and pulled, it will collapse and lengthen into a long drawn out diamond small enough to pass up the sleeve.

In operation the cage is usually fetched from behind a screen, the swivel hook being attached to an eye on one corner of the cage before the latter is brought before the audience. As long as the conjurer holds the cage firmly with his hands and keeps his elbows pressed to his sides nothing happens. When he wishes to vanish the cage he pulls with his left hand on the corner of the cage diagonally opposite to that to which the swivel hook is attached, at the same time quickly and vigorously lifting both elbows. The cage collapses and is whisked up his sleeve out of sight.

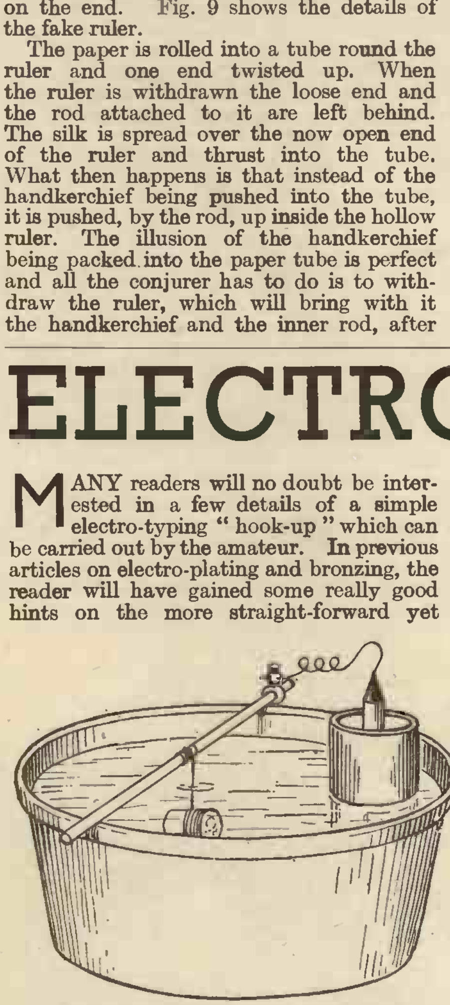
Needless to say, the sleeves must not be too narrow and the flight of the cage, rapid as it is, must be covered by a throwing movement, followed by the eyes as previously described, to convey the impression that the cage has disappeared in mid air.

# ELECTROTYPING

## By "Home Mechanic"

## Some Practical Hints on a Fascinating and Useful Hobby

Many readers will no doubt be interested in a few details of a simple electro-typing "hook-up" which can be carried out by the amateur. In previous articles on electro-plating and bronzing, the reader will have gained some really good hints on the more straight-forward yet



*A vat of copper sulphate solution and porous pot containing dilute sulphuric and zinc.*

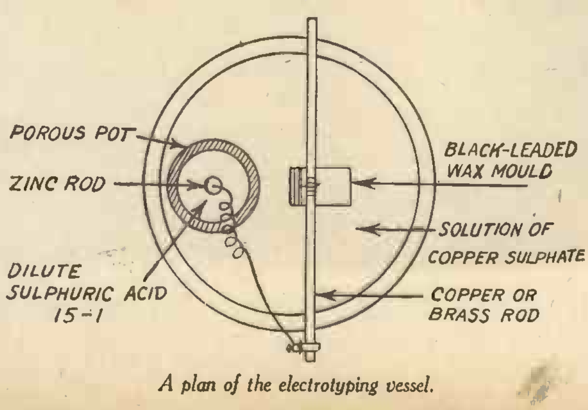
simple processes involved in what has now developed into a most important industry. At the outset of the present article it might be as well to state that the use of an external source of current is unnecessary—that the battery is incorporated in the plating vat itself. This system is an old one where copper-plating is concerned, although it is not general to use it on a commercial scale, for here the problem of rapid production is of the first importance.

The accompanying diagram will explain itself while the rough sketches showing the method of wiring will serve to make the process easy to grasp. A basin or earthenware bowl is the best vessel for holding the electrolyte or "bath" as it is called, and the first thing to be borne in mind is cleanliness, both of solution and metal connections and the latter should be as tight as possible.

### Preparing the Solution

The basis of the solution is copper and the commonest salt to use is copper sulphate; the bath must be an acid one, containing 2 oz. of sulphuric acid to the gallon of copper sulphate solution. A convenient quantity to make up is ½ gallon, so that an earthenware bowl of about a gallon capacity will be required. A deep vessel is the sort to choose, on account of the necessity for the articles to be quite covered with the solution. The next consideration is to prepare the bath, and for this purpose 1 lb. of copper sulphate (in crystals) is placed in the bowl and covered with ½ gallon of hot water, best poured in from a large saucepan which has been used for boiling the water and set aside to cool slightly. Only small quantities of water should be poured on at a time, stirring the solution with a glass rod, finally covering the bowl with a sheet of cardboard and placing it on a shelf to cool. When cold, 1 oz. of strong sulphuric acid is very carefully stirred into the solution, the bath being now ready to use.

An empty porous pot of the size used in Leclanche cells is now required; this is three-quarters filled with water and ½ oz. of strong sulphur acid added, carefully stirring.

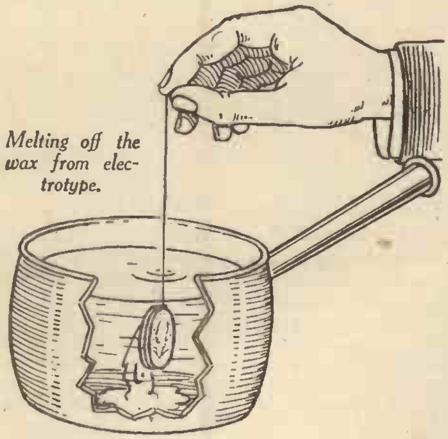



*A plan of the electrotyping vessel.*

This solution should be in the proportion of 1 part of acid to 15 of water, so that the above quantities are only approximate, depending on the size of the porous pot. It might be advisable to make up the solution in a separate vessel, pouring it into the pot until it is three-quarters filled. Into the porous pot is then placed a zinc rod, such as is also used for Leclanche batteries—this rod should be amalgamated (or it may be purchased already amalgamated). The pot and contents are arranged at one end of the bowl, and are now ready to be connected to the wax mould (of the object) to be plated.

### Making a Suitable Mould

Having decided on the article to be copied, it will be necessary to consider the means of taking an impression of it, and also the material in which this impression is to be set. The most convenient and serviceable material for our purpose is paraffin wax, and



*Melting off the wax from electrotype.*

several ways will suggest themselves to the reader whereby this may be used as a mould. If the article to be copied is round, some sort of carton, made from thin cardboard must be placed closely round the edge and tied tightly in position with thread so that the object forms the bottom of a short cylinder. Into this the molten wax is now poured and allowed to set quite hard before it is removed. Be quite sure that the wax is cold and hard and unloosen the cardboard very carefully so as not to damage the impressed image of the article—this will naturally be in reverse. The wax mould should next be placed with the moulded surface uppermost on a firm table preparatory to the operation of treating for the vat, since wax, being a non-conductor needs coating with some suitable material to enable the current to pass over its surface.

### Treating the Mould

If difficulty is experienced in purchasing finely ground graphite or blacklead powder, it will be necessary to powder very finely some of the common block blacklead as used for polishing ironwork, grates, etc. This powder is now placed in a saucer and a fine camel hair brush used to brush it over the face of the mould. A very suitable form of brush to use is that commonly called a borax "pencil" in the trade (being a bunch of hairs bound into a short quill it is used for smearing borax as a flux over work for soldering and brazing). But it is essential to ensure that every little crevice and corner is perfectly covered with blacklead and that this is continued for a distance of about 1 in. up the side of the mould, in order to obtain a good conducting surface.

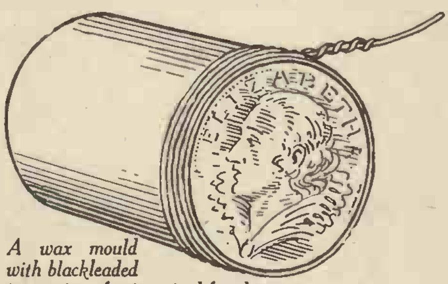
When you are sure that the face of the mould is covered, then wind very carefully but firmly, several turns of bare copper wire, round the mould allowing a certain length to remain free for connecting to the zinc rod. Sometimes it is a little difficult to get the blacklead to adhere closely to the wax; this is obviated either by holding it in steam or else by breathing lightly on it—the great thing being to avoid any high temperature. This simple preparation renders the wax impression a fairly good conductor, having a coat or skin of carbon.

Another method of imparting a conductive surface to a non-conductor is to treat it with a solution of phosphorus in carbon disulphide. But this is a rather dangerous procedure on account of the volatility of the carbon disulphide and the inflammability of the phosphorus—the former liquid evaporates at 46·2° C. Such a solution is convenient to use when the object to be plated is of unusual and awkward design or shape, but with wax impressions it is quite unnecessary, since blacklead answers the purpose admirably.

### The Plating Operation

In order to hang the mould freely in the vat the best arrangement is to provide a stout copper rod placed across the farther end of the bowl, away from the porous pot, but not so near the side as to cause any work suspended therefrom to touch the bowl. This rod should have a terminal or binding screw; or better, a rod-connector—such as used in the plating shop—this ensures a good contact. A wire passes from the zinc rod to this terminal and all the work is hung on the vat rod by bright copper wires; twisting them tightly round it several times and allowing sufficient to enable the wax mould to lie well immersed in the solution.

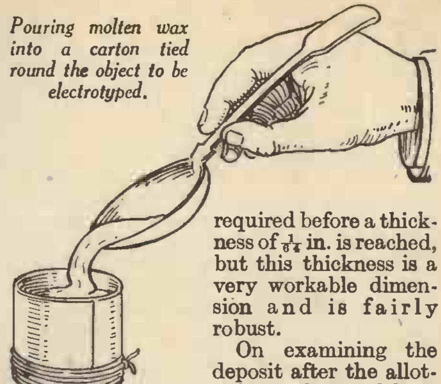
It is evident that both the plating-current and the voltage are very little, and that a fair time is required before sufficient thick-



*A wax mould with blackleaded impression of coin, wired for the vat.*

ness is attained in the deposit of copper.

But this is as well, since a too rapid deposit is liable to peel and may be too brittle to handle comfortably. At the current-strength and density with which we are dealing, twenty-four hours will be



*Pouring molten wax into a carton tied round the object to be electrotyped.*

required before a thickness of $\frac{1}{16}$ in. is reached, but this thickness is a very workable dimension and is fairly robust.

On examining the deposit after the allotted time, be careful not to handle it except by the wire as it is very brittle—the deposit itself looks matt, reddish-brown and unattractive. The entire mould and deposit should be removed from the vat by means of the wire attaching them to the rod, in fact they may be "fished" out of the vat with the rod after unscrewing the terminal.

### Examination and Finishing

To remove the electro-type from the mould it will be best to immerse them in boiling water—a saucepan being ideal for the purpose. The deposit is still very brittle, and the next operation is to soften it and make it more workable. It will be found that quite an additional surface of deposit will have formed beyond the boundaries of the actual copy, so that it may be handled with the aid of a pair of pliers. A bunsen flame or even a spirit-lamp will be sufficient to soften the copper. The mere process of removing the wax from the "electro" tends slightly to soften the latter, but it is insufficient to rely on this alone.

Having removed the electro-type, all that remains is to finish it or give it a presentable appearance. Brushing it gently with metal polish applied on a tooth-brush, and polishing it up with a piece of rabbit-fur applied very gently with a minimum of pressure, will bring up quite a handsome lustre to the deposit which should then be suitably mounted.

# How Many Dimensions has a Cube?

IT is well known that one dimension cannot possibly be a finite object. If a dimension was, say, one foot, this distance would merely represent the relative position of two points. It is obviously impossible for it to have any substance, because without height and width it could not exist as a finite object. Taking one step further, while two dimensions may enclose a space, still they are insufficient to be tangible in the solid sense of the word. A piece of tissue paper a foot square is unquestionably very thin, but it possesses thickness, because without thickness, there would be nothing there. If a third dimension be added, a variety of possible objects immediately become available; in fact with three dimensions any object known to the mind of man can exist. Or can't it? It is a fallacy to think that three dimensions are sufficient to form an object any more than one dimension. In order that this apparently ridiculous statement can be more readily understood, let us visualise a cube, one foot in each direction, made, for example, from stone. Obviously the reader may suggest that if it is one foot high, one foot wide, and one foot long, it is indeed a very real object but a moment's thought will show that it must also possess a 'time' dimension, because if a cube did not exist for any time at all, it obviously is not there. In other words before an object can exist, it must have height, width and length, and it must exist for a fraction of time, however small. It would, therefore, be apparent that an object is incapable of existence if it lacks any one of these four dimensions. Why, then, should there exist such an inborn conception of space that time should be considered as being in any way different from the other three dimensions, when we live in a four-dimensioned world, which would not exist at all if any one of the four dimensions were absent. If the reader has not fully grasped this argument, he will readily do so on a second reading. When the fact that a solid cube must endure in time before it can exist at all is fully understood, the reader cannot unfortunately claim to be thoroughly conversant with the four dimensional theory, but will be nearer to understanding it than by reading a whole volume on the subject.

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# AUTOMATIC TEMPERATURE CONTROL

By S. Boocock

## Thermostats and their Uses Explained

THE idea of maintaining a steady temperature by means of an automatic device, while not a new one, has become very commonly applied during recent years. The name thermostat is given to any such device, and the instrument, in various forms, has come into our life from the laboratory in such articles as refrigerators, incubators, ovens, and water-heaters, to mention but a few of its many applications.

Many a householder is puzzled by the accommodating domestic refrigerator which switches off the motor automatically when the temperature drops too low, and switches it on again when the temperature rises. Yet this almost human behaviour of the machine is not in the least uncanny, being controlled by a simple thermostatic device.

A very common type of thermostat is a straightforward application of the fact that some metals expand unequally for the same rise in temperature. The manner in which this fact is utilised for switching electric current on or off, or in other ways adjusting temperature, is made perfectly clear by an experiment.

### The Differential Expansion Experiment

A compound bar, as its name implies, is compounded of two different metals. Such a bar may readily be constructed for experimental purposes. Cut a strip of tinplate or sheet iron about 9 in. × 1 in. and rivet it to a strip of the same size cut from sheet copper or brass. The rivets should be about 1 in. apart to prevent the strips buckling, and they must hold the two metals tightly against each other.

If such a bar is heated over a Bunsen burner or a gas ring it will take up a curved shape with the copper or brass on the outside. This is due to the copper or brass expanding more than the other metal. The outer edge of a curve is, of course, longer than the inner edge, a fact well known to athletes, who fully realise the advantage of securing the inside place on the track. (Fig. 1.)

For use as a thermostat the compound bar is made from a metal which expands a great deal, such as copper or brass, together with an alloy such as Invar, so named because for all practical purposes it is invariable.

In electrical apparatus, a refrigerator for instance, the movement of the bar as it expands into a curve is used to make or break a circuit, thus controlling the supply of current according to the temperature. By adjusting the position of the contact the current may be switched on or off at any desired temperature within reasonable limits.

Sometimes the bi-metal bar is made in the form of a coil which becomes larger, like a clock-spring unwinding, as the temperature rises.

### Other Applications

The movement of a bi-metal is used to actuate a valve which controls the flow of water in the thermo-siphon system of cooling motor engines. When the working temperature of the engine is reached, the valve is opened to allow more of the cooling water to flow. By this means engines are able to warm up more quickly, the flow of water being restricted when cool.

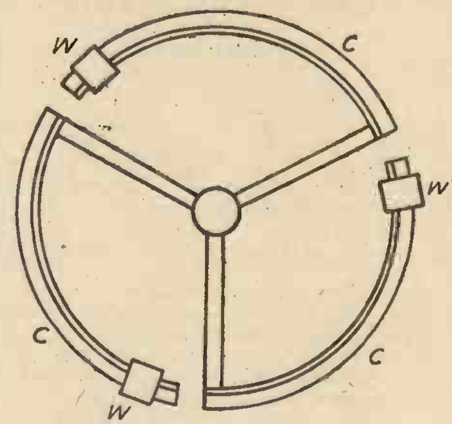



*Fig. 2.—A compensated balance wheel. W = weights. C = compound strips.*

It is interesting to note that the compensated balance wheel of a watch is probably one of the first applications of differential expansion to an everyday purpose. The movement of a watch is controlled by a balance wheel of which the speed of oscillation depends on the mean distance of the rim from the centre. This would naturally change with the temperature in an ordinary wheel so some device is needed to counteract expansion and contraction of the metal.

This is done by having a wheel composed of two metals which expand by different amounts, the more expansible being on the outside. Reference to Fig. 2 will show that as the spokes increase in length the rim will curve, bringing the weights nearer to the centre and thus counteracting the expansion of the spokes.

One type of electric flasher used for giving intermittent lighting in shop windows is also a direct application of this same principle of unequal expansion. The bar is heated by a coil, and its movement makes and breaks the circuit.

### The Gas Cooker

The modern gas cooker has made cooking a more reliable business by giving a constant temperature. This, of course, is done by means of a thermostat which, although depending on the differential expansion of two metals for its action, is of different construction from the compound bar type.

A long tube of brass may be seen inside the oven at the top front opposite the knob by which a setting is made for a desired temperature. Inside this tube is a rod of Invar which is fixed to the tube at the end remote from the gas supply. (Fig. 3.)

As the tube expands outwards from the knob, due to the temperature rising unduly, the rod is pulled away from a valve which is then forced towards its seating by a spring. This reduces the gas supply until the temperature of the oven drops to the required value, when the contraction of the tube causes the rod to open the valve again.

### The Liquid Thermostat

Some thermostats function simply by the expansion of a liquid. For example, one type of thermostat which is used on motor engines opens the valve as a fluid expands, thus allowing a greater flow of water to take place in the cooling system. The fluid is enclosed in a concertina-like capsule. When heated, the expanding fluid pushes the bellows open.

A similar device is used on some types of water-heater for controlling the supply of gas when the water is heated to a required temperature.

It will be seem from the several uses of thermostats that not only do they cause various kinds of apparatus to function with greater efficiency, for example an oven and a motor engine, they also result in an economy of power or fuel. A refrigerator when sufficiently cold no longer consumes electrical energy or gas, a gas heater has the supply of fuel reduced when the water is sufficiently hot. It is obvious, therefore, that such a valuable method of temperature control will become more commonly used in the future and its use will be extended in various ways.

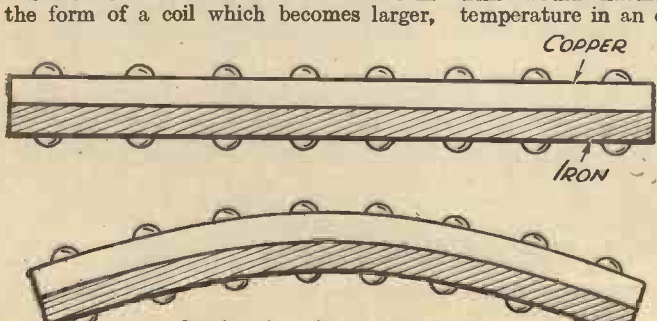



*Fig. 1.—A simple experiment showing how copper bends more readily than iron when heat is applied*

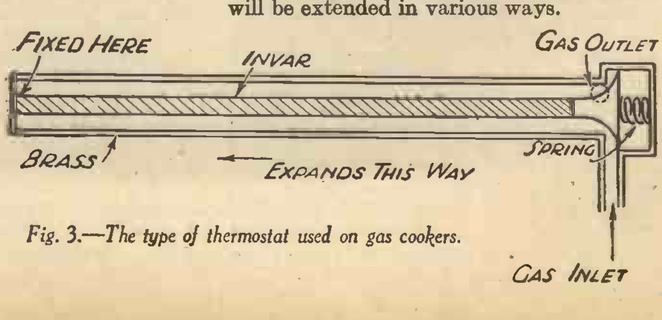



*Fig. 3.—The type of thermostat used on gas cookers.*


*The Luton "Minor," which brings flying within the reach of all.*

# FLYING FOR ALL

## By Captain Needham, B.Sc., etc.

*The Development of one of the Newest and most Successful Light Aeroplanes, the Luton "Minor"*

WHEN the "Flying Flea" first made its appearance in this country, with its revolutionary methods of construction and control, there were many who doubted whether it could ever be a success and who were not sure of the wisdom of adopting such an unorthodox design. However, the "Flea" movement spread with great rapidity and hundreds of these diminutive little machines were built in all parts of the country.

Then came disillusion: accident followed accident, some were fatal, many merely resulted in a few cuts and bruises, though in most cases the machines suffered considerable damage. Practically all flying "Fleas" were first suspended and later abandoned.

### An Experimental Machine

In order to determine whether the tandem-wing arrangement, as employed with the "Flying Flea," possessed the many advantages claimed and largely borne out by theory, Luton Aircraft Ltd., built an experimental machine having two wings in tandem but with an orthodox tail unit and normal controls, and this was subjected to flight trials lasting over a period of some two months. None of the vices which characterise the "Flying Flea" showed itself, but a certain amount of mutual interference took place between the wings at certain flight attitudes, noticeably in the climb, which reduced the aerodynamic efficiency to an undesirable extent.

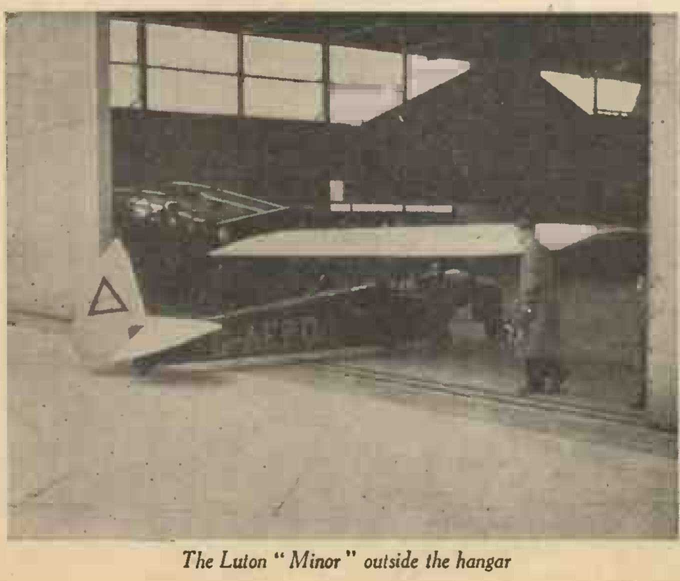
The experiment had proved that if a light aeroplane was to be produced for the novice pilot and at a price that could be afforded by the many interested amateurs, it must be designed along orthodox lines, provided with effective but gentle-acting and well synchronised controls, essentially stable in flight and on the glide, and with simple take-off and landing qualities so that the aeroplane practically performs these manœuvres of its own accord. Manufacturing costs must be reduced, not by eliminating one or more of the essential surfaces, but by simplicity of construction throughout and by the generous employment of building jigs.

### The "Minor" Produced

To meet this specification the "Minor" was then produced and the illustrations show the long fuselage for giving flight stability, whilst the ample size of all control surfaces, with carefully selected gearing, is also noticeable. The first flight proved the correctness of the theories on which the design had been based and not a single modification, from an aerodynamic standpoint, has been found necessary for incorporation in the production model.

The "Minor" is a parasol monoplane, the wing being supported on steel pylons at the fuselage and one pair of steel tubular lift struts run from the fuselage base to the mid semi-span point on each plane.

The wing is of simple but sturdy construction, immensely strong, and is ply covered at the leading-edge and tips. The wing section was carefully selected for its high aerodynamic characteristics and docile behaviour at the lower speeds of flight. The plywood covering maintains the correct shape over the whole span and gives the wing great robustness that is so desirable for handling, storage and transport. No rigging adjustments of any kind are necessary with this machine, as once the MINOR is built there is nothing to get out of place.



*The Luton "Minor" outside the hangar*

*A close-up of the Engine.*

**The Fuselage**

The fuselage is of spruce construction, ply covered, with curved top decking and is of pleasing appearance. The pilot's cockpit is roomy and includes a locker for tools and luggage. Shock-absorbers are included in the under-carriage.

The wing is not made to fold, but is easily detached for housing, 5 minutes being required for this operation and about 15 minutes for assembly.

The "Minor" will cruise comfortably at 75 m.p.h., at which speed the flight range is 225 miles, but it also cruises with engine at half throttle, perhaps one of the best tests for aircraft of this category, at 60 m.p.h., giving a flight duration of 270 miles. Larger tanks can be fitted if required.

**The Luton "Minor"**

| *Specification.* | | *Performance.* | |
|---|---|---|---|
| Span | 25 ft. | Top Speed | 80 m.p.h. |
| Length | 19½ ft. | Cruising Speed | 70 m.p.h. |
| Wing Area | 125 sq.ft. | Landing Speed | 30 m.p.h. |
| Weight, empty | 380 lbs. | Take-off Run | 80 yds. |
| Weight, loaded | 600 lbs. | Landing Run | 30 yds. |

**Fuel Consumption**

Fuel consumption varies between 1 and 1½ gall. per hour at 60 to 75 m.p.h., or 60 miles to the gallon with negligible consumption of oil.

The "Minor" is available with a choice of six engines, of from 25 to 34 h.p., including such refinements as dual ignition and impulse starter, the price ranging from £180 to £200. For those enthusiasts who wish to build their own light aeroplanes, kits of materials and parts are available at £40 and £75 respectively, including in each case a set of Constructional blue-prints.

# HERE AND THERE

## A Fork with a Pocket

SOMETHING new in cutlery has made its appearance in America. This consists of a fork having a small pocket in the back of the handle for the accommodation of tooth-picks. In the handle also there is a little window which lets the guest know that the tooth-picks are there. Apart from its novelty, I fail to detect any virtue in this device.

## A Keyhole Searchlight

THE latest role of the tiny electric light bulb is played on the nose-piece of a pair of spectacles. An ingenious inventor has found a part for it there in a little recess which is lined with a reflecting coat to increase the illuminating power of the light. The bulb is covered in front by a cap containing a lens. Embedded in the frame of the spectacles and one of the ear-pieces are the leads. Current is supplied from a small battery which can be housed in one's waistcoat pocket. It is connected up to the light through a slender cable which resembles the cord attached to a monocle. The bulb is removably fitted.

The utility of this device is obvious. It enables one, like a cat, to see in the dark and whenever visibility is poor. The doctor and the dentist will find it convenient for examining the mouths and throats of their patients. And, oh, what a boon it will prove to the *bon vivant* who returning home very late—or early—after dining "not wisely, but too well," endeavours to discover the elusive keyhole!

## The Sea as Lamplighter

ELECTRICITY also plays a part in a newly devised lifesaving jacket for use at sea. In a pocket of this jacket there is an electrical generator having positive and negative poles which operate in saline solution. Consequently, when the generator is immersed, a lamp carried by the generator is automatically illuminated. In the event of a shipwreck, a passenger or sailor vested in this jacket would, by means of the electric light, have his position in the sea located. Moreover, the light would enable him to discover his whereabouts and help him to choose the direction in which he would have the best chance of being saved.

## How to Shut Up an Accordion

THE accordion, which to-day is very much in evidence, was originally a kind of rectangular concertina. It was sometimes played by juvenile strolling Savoyards whose repertoire was not as expansive as the alleged musical instrument they carried. The instrument has now blossomed into what is styled a piano-accordion, but, as its music is produced from reeds, it is really a portable organ. The bellows, it appears, are often made of cardboard and cloth glued together. As a result, this blowing apparatus is susceptible to the attrition of wear and tear. To protect the bellows when the instrument is not in use, an arrangement has been devised consisting of flanges which cover the edges of the bellows, and which can be fastened with a clasp. In the closed condition, I imagine that the instrument will not be unlike an old-fashioned family portrait album. Methinks folk in the neighbourhood of the learner who attempts to perform on the accordion will welcome a device which enables it to be shut up.

## A Collapsible Canoe

THE popularity of the collapsible canoe is gaining rapidly each year, and this phase of boating appeals to the newcomer and the old hand alike.

Now that outboard motors are small enough and light enough to propel these fragile but extremely capable craft at speeds in the neighbourhood of 6–7 m.p.h., a big demand has already been experienced by the British Motor Boat Manufacturing Co. Ltd. for their new Elto "Pal" model for this purpose.

The price of the Elto "Pal," which weighs only 14 lbs., is £10 10s., and the cost of a suitable canoe attachment is as little as 12s. 6d. extra.

The illustration herewith depicts the slightly larger Elto "Ace" outboard motor fitted to a "Folbot" folding canoe.

See also Constructional article in this issue.

## A New "Hard Facing" Welding Process

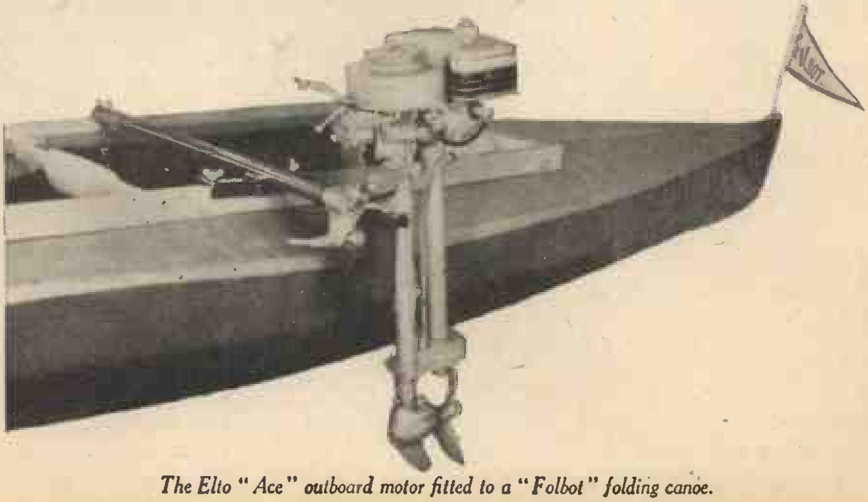
A NEW "hard facing" welding process is being used by Barimar Ltd., of 14/18 Lamb's Conduit Street, W.C.1, for the restoration of worn parts—particularly those belonging to motor vehicles. It is equally effective on steel and cast iron.

Although steel added by a welding process is amenable to hardening processes—particularly in electric furnaces—it is much better to use a weld feed rod that would become sufficiently hard in the air without any further treatment. This result has been achieved and it is somewhat remarkable that the feed rod can be used with equal reliability by both the oxy-acetylene and electric welding processes, and that the deposited metal retains its hardness even at a temperature of 1,250 degrees F. It should be emphasised, however, that this hard facing process requires a special technique as well as special welding material.

## See the World

A CHANCE in a thousand presents itself at the present moment to young men with a knowledge of engineering, whose future may be insecure. The Royal Navy can take them now for its Artificer branches—Engine Room, Electrical, and Ordnance.

There must be many to whom such a prospect will appeal; young men who have served their apprenticeship with shipbuilding and engineering firms or who have had experience in workshops and garages. But to those others who see themselves condemned already to a blind alley job a career in the Navy has much to offer.



*The Elto "Ace" outboard motor fitted to a "Folbot" folding canoe.*

# BUILDING A WORKSHOP

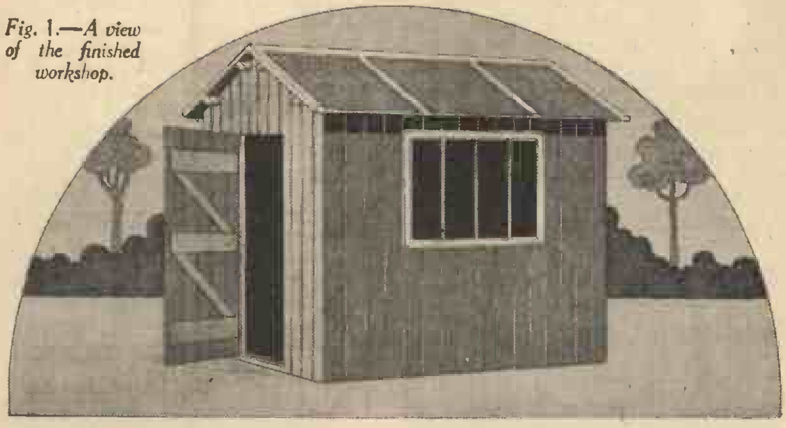


*Fig. 1.—A view of the finished workshop.*

By "Handyman"

## It is Inexpensive to Make and the Construction has been Simplified. Details of every Part of the Structure are Given.

THE handicap experienced by most amateur craftsmen is the lack of suitable workshop accommodation, for however skilled they may be, it is difficult to undertake any serious piece of work on the kitchen or scullery table. The really enthusiastic worker should endeavour to build a suitable workshop for himself. It need not be an elaborate or costly affair, and just the plan on which it should be built depends on local circumstances. If it is possible to utilise a wall of the dwelling-house, then a lean-to building is quite satisfactory; if not, the shop should be built on the lines suggested in Fig. 1. To the young man, a building of this description is not only useful as a workshop, but it may also be used as a shed for his cycle or motor.

### The Sections

A building of this kind is best made in sections, both for simplicity of construction and so that it may be easily taken down if it is ever necessary to move it. For a lean-to building, a front and two end sections will be required. The end sections should be about 6 ft. 6 in. high at the front and 8 ft. high at the back, the general method of construction being on similar lines to that about to be described.

The workshop shown in Fig. 1 is roughly 8 ft. 6 in. long by 6 ft. wide, but the dimensions may be altered if necessary. The framework should be of not less than 2-in. square deal, and both the sides and roof are covered with ¾-in. grooved and tongued boards. Four sections—two ends and two sides—are required, the ends being shown in Figs. 2 and 3, and the sides in Figs. 4 and 5.

### The Door End

The end shown in Fig. 2 is made with two uprights, two top, and a bottom rail. The two top rails are half-lapped together in the middle, as shown in Fig. 6, and both the top and bottom rails are half-lapped and screwed to the uprights as shown in Fig. 7. Two uprights are framed between the top and bottom rails to form the doorway, a rail is framed between the uprights to form the head of the door, and two middle rails are framed between the uprights. Only the outer members of the framework need be half-lapped and screwed together, the inner members being notched in and nailed as shown by Fig. 8. The end shown by Fig. 3 is made in a similar way to that just described, only, instead of the door framing, two horizontal rails are framed across between the uprights.

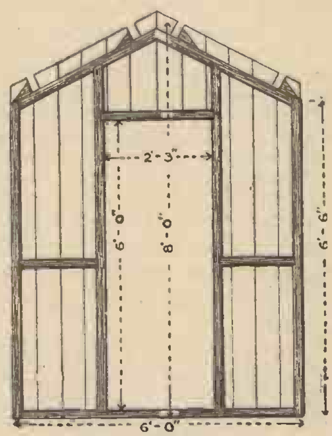



*Fig. 2.—The door end.*

The side shown by Fig. 5 is made with two uprights and top and bottom rails half-lapped and screwed together, a middle rail is framed between the uprights, two short uprights are framed between the middle and top rails to form the window opening, and a short centre upright is framed between the middle and bottom rails. The end shown by Fig. 4 is formed with two uprights, top and bottom rails, a middle rail, and two centre uprights.

### The Site

The framework being made as described, the site on which the shop is to be erected should be levelled, and a concrete bed or rows of bricks should be prepared for the framework to rest upon. When fixing up the sections, the door end and the window side may be arranged as is most convenient for entrance and light, the side sections are placed between the end sections, and they are bolted or screwed together.

### The Roof

The roof is carried on four purlins laid from end to end across the top rails. The purlins should be 4 in. wide by 2 in. thick; they overhang about 6 in. at the ends, and are fixed about 6 in. down from the ridge and 6 in. up from the eaves, being held in place with wedge-shaped blocks, as shown in Figs. 9 and 10. The blocks are nailed to the top rails, and bolts or long screws could be driven through the top rails into the purlins to keep them from shifting. The roof boards are laid across the purlins, and are nailed to them, and the boards are fitted together at the ridge, overhanging about 6 in. at the ends and eaves.

### Covering the Framework

The ends and sides are covered with grooved and tongued boards, fixed with the joints running from top to bottom. The door is made from similar boards held together with three 6-in. cross battens, and stiffened with two diagonal 4-in. braces, as shown in Fig. 11. Fairly long T hinges should be used to hang the door, and a lock and key should be fitted.

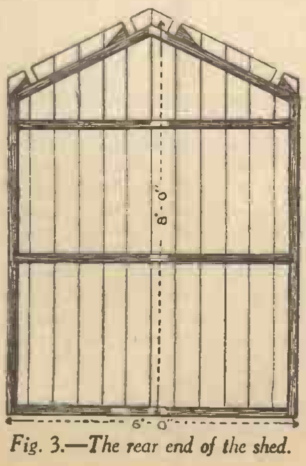



*Fig. 3.—The rear end of the shed.*

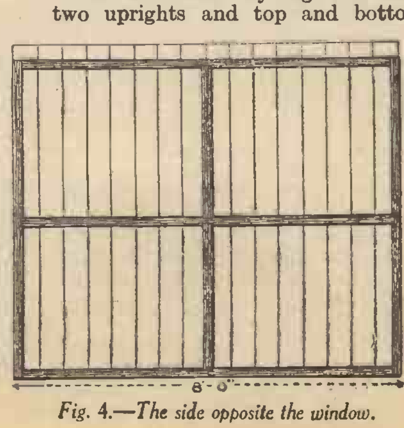



*Fig. 4.—The side opposite the window.*

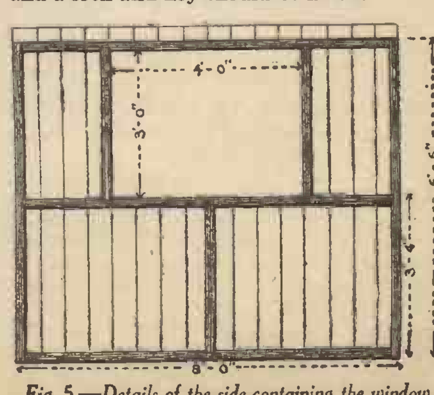



*Fig. 5.—Details of the side containing the window.*

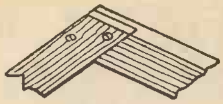


*Fig. 6.*

*Fig. 7.*

*Fig. 8.*

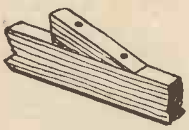


*Fig. 9.*

*Figs. 6 to 9.—Details of the various joints.*

**The Window**

Making the window is the most difficult part of the whole construction, and if any trouble is anticipated a frame could be ordered through a local joinery. The careful worker will, however, be able successfully to accomplish the task if thought is given in setting out. The frame is shown in Fig. 12, and is made with 2 stiles 2 in. wide by $1\frac{1}{2}$ in. thick, two rails $2\frac{1}{2}$ in. wide by $1\frac{1}{2}$ in. thick, and three bars $1\frac{1}{2}$ in. square. The stiles and rails are chamfered and rebated $\frac{1}{2}$ in. square, as shown in Fig. 13, and the bars are chamfered and rebated as shown in Fig. 14. The rails are tenoned into the stiles, and the bars are tenoned into the rails, as shown in Fig. 15, the joints being mitred into the depth of the rebates. The window frame fits in the opening in the framework; it is nailed or screwed in place, and is glazed in the usual way.

If a concrete bed has been prepared, it may perhaps be thought unnecessary to lay a wood floor. If a floor is desired, small joists should be fitted between the sides, as shown in Fig. 10, and the floor boards are laid on them.

**Painting.**

On completion, the building should be painted two or three coats, and the roof finished with an outer covering of roofing felt or some similar material, wood battens being nailed at the ridge and over the joints in the felt.

Very early in the progress of the enthusiastic craftsman, he finds the need for a "place for tackle." Sometimes it starts in a box, kept under his bed, and migrates to a few shelves in a handy cupboard or a place under the stairs. Then a bench becomes necessary, perhaps in the cellar or a back kitchen or scullery or in the attic. At this stage, the craftsman has obtained considerable experience and probably acquired a useful stock of tools and materials, along with a number of jobs half-finished or old models discarded.

Now is the time to erect this private workshop in the garden. You will be able to find your tools when you want them, as they will not be "borrowed for a minute" when you are not there. You can now buy a garden shed for a very small sum, made in sections, which you can put together for yourself. When it is up, you can paint it. Usually it is advisable to lay roofing felt while it is still fairly new, instead of letting it get leaky. A small paraffin hanging lamp will provide light and heat. Be sure you get it set dead level, and raise it a few inches above ground, on small piles of cemented bricks. Then it will not stand in water or soak it up. Fix yourself a small bench or shelf along one side, and shelving on the opposite side, and you have a place in which to work at any time without disturbance. Everyone should have his own workshop, no matter how small, in which to pursue his hobby, without the trouble of "packing up" every time he does a little job.

Quite obviously the size of the shed is dependent upon the space available, but it is hoped that the suggestions contained in this article will enable the practical hobbyist to vary the design according to his own particular needs.

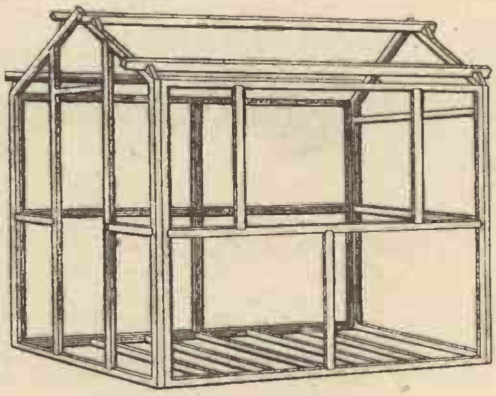


*Fig. 10.—The framework of the shed.*

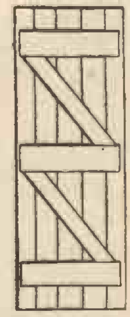


*Fig. 11.—The door.*

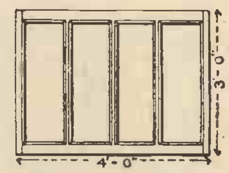
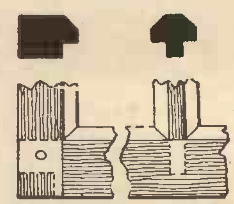
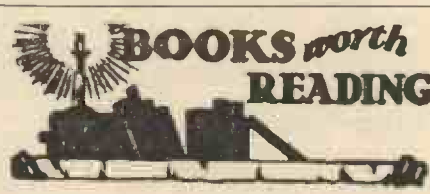



*Fig. 12.—The window frame.*



*Figs. 13 to 15.—The window frame joints.*




**"Hot Water Service: Design and Pipe Sizing," 12/6, post free, 192 pages. Published by G. A. Philpot, Ltd., Vulcan House, 56 Ludgate Hill, London, E.C.4.**

THIS book, by Sidney F. Greenland, M.R.San.I., M.I.H.V.E., is a useful work for the designer, student, and hot-water fitter, and anyone interested in this important section of domestic engineering. The book deals with the principles and practice of the subject, and describes exhaustively the complete design, lay-out, and technical calculations, for hot-water service systems. A very useful feature of the book is the complete detailed treatment of pipe-sizing, and complete worked out examples, and detailed calculations for various systems are described in the text. The book, which is well illustrated with explanatory diagrams, also contains many useful tables which should be of great help to all engaged in hot-water service engineering.

**"Modern Fixing Practice," 3/6 net, 192 pages. Published by the Rawlplug Coy., Ltd., Cromwell Road, London, S.W.7.**

FOR several years there has been a growing need for a handbook covering the subject of fixing, not only for domestic purposes, but also in the field of general engineering work. To meet this need, the well known Rawlplug Company have issued this comprehensive handbook which will be welcomed by all who are engaged in handling fixing problems either in the home, or in various trades. The book is divided into various sections, each being compiled by an authoritative writer. For example, the section dealing with fixings of interest to the architect is written by Mr. H. A. J. Lamb, A.R.I.B.A., and the section describing fixings used by engineers, is by A. Powis Bale, A.M.I.M.E. Other sections deal with fixings for electricians, heating and ventilating systems, and plumbing work. Several hints and tips on boring holes in various materials for Rawlplug fixings, and a number of useful tables are also given in this handbook, which is well illustrated with line drawings and half tones. Although published at 3*s*. 6*d*., readers of PRACTICAL MECHANICS can obtain a copy free of charge by applying to the address given above, and enclosing their letter-heading or business card.

**"Practical Building Terms," 2/6 net, 120 pages. Published by The Technical Press, Ltd., 5 Ave Maria Lane, Ludgate Hill, E.C.4.**

THE primary object of this book, which is a small dictionary of terms, is to provide an exhaustive list of definitions that will be of use to all those engaged in the building trade. Although a number of definitions given would have been shortened and illuminated had diagrams been introduced, the author points out that for various reasons these have not been included, and consequently, in such instances, additional text takes the place of illustrations. The subject of pronunciation and accentuation has been so treated that there should be no hesitation in recognising the correct sound of the word in any particular instance. Electrical and engineering terms, more particularly the former, are not included in the book.

**"Science versus Crime," 7/6 net, 304 pages, by H. M. Robinson. Published by G. Bell and Sons, Ltd., York House, Portugal Street, London, W.C.2.**

THIS interesting book, which reads like a real-life detective story, describes the hundred-and-one ways in which the criminologist is constantly endeavouring to outwit the modern criminal by the aid of science. The first chapter opens with a reference to that well known character of detective fiction, made famous by the late Conan Doyle, namely, Sherlock Holmes, and goes on to describe briefly the investigations of such men as Bertillon, Galton, Herschel, Colonel Calvin H. Goddard, and Chief August Vollmer, of the Berkeley Police Department, California. Amongst the subjects dealt with in succeeding chapters are fingerprints—the unforgeable signature; crimes in ink; detection by camera; clues in wood; and safe-makers and safe-breakers.

# STARGAZING FOR AMATEURS

A NEW SERIES

By N. de Nully

## A GUIDE FOR MAY

SUNSPOTS are increasing in number and size. Possessors of the smallest telescopes may almost any day find one or more isolated or groups of spots on the Sun's disc. The use of a solar eyepiece dark cap or smoked glass to protect the sight should not be omitted. Mercury, Venus, Jupiter and Saturn are temporarily out of the evening heavens; but Jupiter will be rising soon after midnight at the end of the month. Venus is a morning star and will be repeating its dazzling parade all over again in the eastern sky, but with its phases reversed. It will once more attain greatest brilliance on the 24th.

The return of Mars after each of its regular absences of nearly two years and two months, is always an event of outstanding interest to both professional and amateur stargazers. Its almost transparent atmosphere reveals more surface features than can be seen on any other celestial body except the Moon. Mars will be "in opposition" on the 19th and nearest to the Earth on the 28th. On the latter date its distance will be reduced to 47,250,000 miles; that is, 10,000,000 miles closer than in 1935. The planet rises soon after nine o'clock and, an hour or so later, may be seen low over the south-east horizon shining redly like a railway danger signal. It is now brighter than Antares, its adjacent stellar neighbour of similar ruddy tint.

### The Martian Surface

In order to discern the wonderful green and orange variegation of the Martian surface, an astronomical telescope with an object glass of not less than 2½ in., capable of bearing magnifying powers of at least 70 diameters, is essential. To perceive detail, apertures of four inches and upwards, with eyepieces x200 to x400 are necessary. But, even with powerful instruments, the extremely low altitude of Mars during this otherwise favourable opposition, makes detection of faint shadings exceedingly difficult. Definition is sometimes improved by using a pale-green or light-red (or reddish-yellow) tinted glass screen, in the form of either an eyepiece cap or "sun" spectacles such as are employed for reducing summer glare.

### Deserts or Seas

At first it was thought that the dark markings on Mars represented seas, and the indentations along their serrated edges, bays and inlets. But the absence of any traces of reflected sunlight from their dull surfaces, coupled with regular modifications of their prevailing tints, shapes and dimensions, caused this theory to be abandoned. The extensive ochre-coloured areas were however, and, in consequence of their unchanging appearance, still are regarded as arid deserts of something akin to red sand or pulverised ironstone.

Whatever the composition of either, it is definitely established that, with the advance of summer in the warmer southern hemisphere, the bluish-green patches increase in size, deepen in hue and alter in contour. Concurrently with these transformations the glistening white polar cap gradually shrinks and curious dusky smudges, linked together by numerous thread-like streaks, appear in the orange-hued regions. As autumn approaches, the shaded areas begin to fade and contract, and their verdant tones slowly turning to greyish-browns; while the circular spots and delicate wisps rapidly disappear as the polar cap steadily expands. In winter the dark regions become chocolate colour and the polar cap reaches its maximum distension. The advent of Spring witnesses a reversal of the autumnal order, starting at the poles and spreading towards the equator. In fact, the entire sequence is repeated every Martian "year." Similar occurrences take place in the opposite hemisphere; but they are not so striking owing to the seeming barrenness of the tropical and north temperate zones.

*Mars. Summer in the southern hemisphere. Note the shrunken polar cap. The illustration was taken through a red screen.*

### Ducts and Junction Bogs

The generally accepted interpretations of these happenings, is the growth and decline of perennial vegetation covering vast shallow swamps. These are believed to be seasonally inundated by a liquid comparable with water, which is liberated and withdrawn by the alternate melting and freezing of polar ice and snow. The round spots and thin streaks (the latter erroneously ascribed to artificial canals) suggest a natural system of irrigation, consisting of ducts and junction bogs carrying the overflow from the swamps to the parched districts. The annual conveyance by the Nile of the surplus rainfall in Abyssinia to the thirsty lands of Egypt is perhaps an analogous comparison. Nor do terrestrial resemblances end here. Immense cloud-like masses of varying opacity frequently float over the "landscape" heavily veiling normally prominent markings. Even the polar "snows" have been thus temporarily blotted out. These misty screens may not be composed of quite the same materials as Earth clouds; but the spectroscope indicates that the tenuous Martian atmosphere contains at least sufficient oxygen and water vapour to sustain low types of vegetation. Human and animal life would hardly find the rarified yellowish breathing medium and low average temperature of that miniature world conducive to their comfort. Day temperatures not exceeding 60 degrees at the equator and 70 degrees below zero at the poles, with intensely hard night frosts setting in at every sundown, do not suggest an attractive climate. Nevertheless, we must remember the Esquimaux and other Arctic peoples; besides those who live at very high altitudes where plain dwellers would gasp for breath. They may have their counterparts on Mars.

*Mars, showing large areas of the supposed swamps; also expansion of the northern ice cap during winter in that hemisphere.*

### "Canals" and "Lakes"

The illustration with the larger disc is a drawing of an aspect of the planet while the expanded north polar cap is turned towards the Earth. It portrays a considerable area of the supposed marsh lands in the south; and also indicates a few of the so-called "canals" and "lakes." They are not always perceptible at the same time, but have all been noted and recorded by experienced keen-eyed observers, when seeing conditions were specially good. The other picture is a photograph taken by Prof. Hale at Mt. Wilson, U.S.A., during an unusually brilliant opposition when the southern hemisphere was in sight. Although in this the forms of the swamps accord generally with what is seen visually—even in comparatively small instruments—the faint thread-like streaks are too delicate to impress the sensitive plate.

The diameter of Mars is 4,200 miles. It revolves round the Sun at an average distance of 141,500,000 miles in 687 of our days, and its highly eccentric orbit causes a difference of over 26 million miles in its greatest and least distance from that luminary. It is this variation that periodically gives us a closer view of our interesting planetary twin. The last of such favourable opportunities occurred in 1924 and the next will be in 1939 and again in 1941. Moreover, gradual shifts in our relative positions cause first one and then the other pole to incline towards the Earth. The rotation period of Mars is another terrestrial similarity being 24 hours 37½ minutes, or only 41½ minutes more than ours. But, owing to its lesser mass, the surface gravity is barely two-fifths of that exerted on the Earth. Mars possesses two tiny satellites visible only in giant telescopes.

# OUR GREAT NATIONAL MODEL AIR-

The "Petrel" just taking off.

This photograph shows the 2·3 cc. "Spitfire" mounted in the "Petrel."

## 1st PRIZE: £50

### Many other Valuable PRIZES
### NO ENTRANCE FEE!

# START BUILDING THE "PETREL" NOW!

**Further Constructional Details of this Fine Petrol-driven Model, and Rules of this Important Contest.**

I HAVE received an enormous number of post-cards from readers expressing their intention of building the "Petrel" and entering for our National Model Aircraft Contest—the first of its kind to be held either in this country or any other. The preliminary details of the Contest which were published last month together with scale drawings of the model has aroused interest in every part of the country, and I am assured that the competition will be the most fascinating and certainly the best supported of any ever held in this country. It is not too late for you to make up your mind to enter it. You have still a few more weeks to write a post-card expressing your intention of entering the model, for I have extended the date from April 30th until Friday, May 21st. The rules are reprinted and if you did not obtain last month's issue you may still obtain copies. The blueprints are now ready, and cost 5*s.* the set.

Preliminary details for the construction of the fuselage were given last month.

I should like to correct one or two small slips which crept into last month's article. Note that the top and bottom longerons are of $\frac{1}{8}$ in. × $\frac{1}{8}$ in. *spruce*, not balsa. Corrected diagrams of the rib and tail construction are given on page 446.

### Fuselage Construction (*continued*)

The top set of uprights can now be glued into position. After all are set hard the pins can be removed from either side of the longerons, and the two fuselage sides can be separated.

The rectangular three-ply formers can now be inserted and lightly bound and glued to the longerons in their correct positions. A streamline rail end to the fuselage is made from a small piece of solid balsa wood.

### The Engine Mounting and Fuselage Fittings

The engine is mounted on a detachable nosepiece which is an electron casting. Details of this mounting, and the position of the engine on the fuselage were shown last month.

This mounting will save endless damage to both the engine and the fuselage, because it is kept in position on the fuselage by stout rubber bands, and can be knocked out if the model makes a bad landing or strikes any object.

It will be observed that the mounting is located to the circular No. 1

*RULES*

*(Competition Rules to be given next month)*

1. *Only models built according to the designs and specifications here given are eligible.*
2. *Notification of intention to compete must be sent on a postcard, so that a register of competitors can be compiled. Address postcards to The Editor, Practical Mechanics, George Newnes, Ltd., Tower House, Southampton St., Strand, London, W.C.2, to reach us not later than May 21st, 1937.*
3. *The Editor reserves the right to refuse an entry without assigning a reason.*
4. *Professional model-makers, those engaged in the making of models for profit, or as a livelihood, are excluded from this competition.*
5. *Models must be the unaided work of the competitor, but they are allowed to purchase the usual finished parts—airscrew, ribs, wheels, engine, etc.*
6. *The competition is open only to regular readers, and competitors must, at a later date, send us the query coupons, as evidence of purchase, cut from the April, May and June issues of this journal.*
7. *The Editor of this journal, in conjunction with the S.M.A.E., will frame the competition rules (to be announced in the next issue) and will act as judges. Their decision is final and legally binding.*
8. *Each competitor may enter only one model.*
9. *Any variation in the design may entail disqualification, within the discretion of the judges.*
10. *Those competitors who will be unable to attend to fly the models themselves may appoint a delegate, approved by the judges, to do so.*
11. *The competition will be for time-controlled flight, marks being awarded for take-off, stability, duration of flight and landing. The model with a quick take-off may thus score points.*
12. *Other prizes will be awarded for workmanship and finish.*
13. *The date of the competition, which will take place at one of the large acrodromes, will be announced later.*

*Blueprints Available—5/- Per Set*

# CRAFT CONTEST

*The "Petrel" well up.*

former by a raised square built integral on its back plate which fits into a square cut out in the No. 1, $\frac{1}{4}$-in. thick, three-ply circular former. There are wire hooks on the mounting and wire hooks bound on to the No. 3 former (three-ply). Elastic bands of just sufficient tension to take the engine thrust keep the mounting hard up to the nose former.

The idea is simple, but extremely efficient, for not only does it prevent damage, if the rubber tension is correct, but it allows the engine to be withdrawn in a moment for adjustments, and it also allows alteration of thrust line and offset thrust to be made when testing the model by inserting wood packings of various thicknesses until the necessary corrections are made.

There are two methods of making this mounting. No. 1 method, although it may sound more difficult, and perhaps the only real difficulty in the whole model, is far the best method.

A casting is made in elektron, which is a very light alloy, 40 per cent. lighter than aluminium alloy.

A simple wooden "pattern" is made up in three-ply wood $\frac{1}{16}$ in. thick. The pieces of wood are glued and pinned with very fine model nails.

The pattern can then sent off to the Birmingham Aluminium Casting Company, Smethwick, Birmingham, who will make up four or half a dozen castings for a shilling or two each. These castings can be used for future engines, and the nosepieces are standardised so that engines will be interchangeable on the other models that the constructor will doubtless make.

If the constructor thinks that this casting method is too expensive or not worth while, it is possible to make a similar nosepiece with brass brackets bolted to a three-ply circle and a three-ply square bolted up to the rear of the circle. This method is satisfactory, but not so rigid, of course, as the brass brackets may bend and become damaged. It is also heavier.

## COMPONENTS AND MATERIALS REQUIRED

**ENGINE MOUNT.**—Elektron, as described.

**UNDERCARRIAGE.**—8 ft. 14 S.W.G. wire and 2 reels of florist's wire; 2 pneumatic wheels; 1 length $\frac{1}{8}$-in. sheet balsa for fairing of undercarriage legs; strip of silk for binding fairing.

**FUSELAGE.**—1 large tin of photopaste adhesive for silk covering; 1 pint of clear glider dope (full-strength); 1 pint of coloured dope; four 3-ft. lengths $\frac{1}{8}$ in. × $\frac{1}{8}$ in. birch or spruce for longerons; three 3-ft. lengths $\frac{1}{8}$ in. × $\frac{1}{8}$ in. balsa for uprights and crosspieces; 12 in. × 4 in. of $\frac{1}{8}$-in. three-ply for special formers; 4 in. × 4 in. × $\frac{1}{4}$ in. three-ply for circular nosepiece; small tube plastic wood for reinforcement; 12 in. × 3 in. × 1 m.m. three-ply for fuselage floor (forward); four sheets of 3 ft. × 6 in. × $\frac{1}{16}$ in. balsa sheet for side, top and bottom covering of fuselage; 12 in. of duralúmin or brass tube to take 14 S.W.G. wire for undercarriage anchorage in fuselage; 6-in. brass tube for tail wheel anchorage, to take 20 S.W.G. wire; 1 light tail wheel; 5 in. aluminium tubing, and cycle tubing to connect tank in wing; 6 in. × 4 in. thin celluloid for cabin windows; 6 in. × $1\frac{1}{2}$ in. balsa block to make stops for mainplane and tailplane; 36 in. × 20 in. silk for covering fuselage; 9 in. × 5 in. green baize to make anti-slip platform coverings for wing and tail unit; 2 reels binding thread; 3 ft. 18 S.W.G. wire for hooks.

**MAINPLANE.**—Four lengths of 3 ft. × $\frac{1}{2}$ in. × $\frac{1}{8}$ in. spruce for mainspars; four lengths 3 ft. × 3 in. × $\frac{1}{8}$ in. balsa sheet for ribs and riblets; two pieces $\frac{1}{16}$-in. three-ply for central ribs; 18 S.W.G. piano wire strengtheners at dihedral angle, fin, and undercarriage hooks; four lengths hard balsa 3 ft. × $\frac{1}{4}$ in. × $\frac{1}{8}$ in. for leading and and trailing edges; 2 ft. round cane $\frac{1}{8}$ in. diameter for wing tips; two solid balsa wing tip inserts, 3 in. × 6 in. × 1 in.; four pieces of jap silk 35 in. × 10 in. to cover wing.

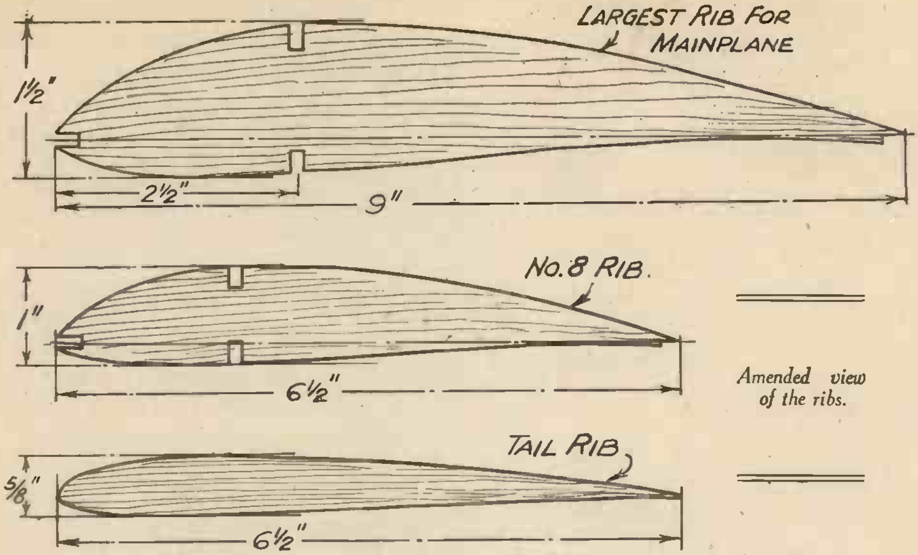
**TAILPLANE.**—One sheet balsa 3 ft. × 6 in. × $\frac{3}{16}$ in., and one sheet 3 ft. × $\frac{1}{8}$ in. balsa for ribs and riblets; one length spruce $\frac{1}{8}$ in. × $\frac{1}{8}$ in. for mainspars; two lengths $\frac{1}{4}$ in. × $\frac{1}{8}$ in. balsa for leading and trailing edges; two pieces of silk 23 in. × 7 in. to cover tailplane, and two pieces silk 7 in. × 8 in. to cover fin.

**ODDMENTS.**—Insulating tape; ignition wire; rubber bands; two wireless terminal clips; valve tubing for petrol connections; two wireless plugs and sockets; glasspaper; cellulose aero glue (six large tubes).

**ENGINE.**—Spitfire, Hallam, Graysper, Brown Junior or any engine up to 9 c.c.

*Another view of the 2·3 c.c. "Spitfire" mounted in the "Petrel."*

*The "Petrel" a few minutes after taking off.*




*Amended view of the ribs.*

The rest of the model is comparatively plain sailing.

From the sketches it will be seen that there are various wire hook fittings that must be attached to the 3-ply formers by binding with thread and glue. 20 s.w.g. piano wire will do for these.

First of all there are the hooks looking forward from No. 3 former. These allow elastic bands to hold in the engine. Then on the same former there are hooks looking upwards. Also at former No. 7. These hooks accommodate elastic bands to keep the wing in position. At former No. 13, there are similar hooks to keep the front end of the tailplane in position, whilst there is a single hook right at the stern of the fuselage to keep the stern of the tail down by means of a band from this hook to a hook fixed to the bottom end of the rudder or fin.

These wire hooks are all located about 1½ in. from the top run of the fuselage so that no unsightly bands go round or crush the fuselage, and yet there is sufficient elastic band to cause a springing effect, to prevent damage to either wing or tail unit if it receives a blow.

The undercarriage is detachable (see sketch). Therefore two brass, or better still, if obtainable, two duralumin tubes are bound across the bottoms of formers Nos. 1 and 3. These are also glued, and have to accommodate 14 s.w.g. wire prongs. Two smaller tubes are bound across the fuselage at formers 13 and 14, for the detachable tail wheel. Finally a wire hook is placed pointing downwards on each side at former No. 7. An elastic band passed from these hooks and around the bottom of the fuselage will keep the little rectangular battery for flight up to the bottom of the fuselage.

A few strengthening stringers of $\frac{1}{16}$-in. by $\frac{1}{16}$-in. spruce are placed around the nose between Nos. 1 and 3 formers. These help to merge the rectangular fuselage into a rounded nose.

The wing tips should be given a slight washout or negative angle of incidence of approximately 3°. This is best given when the wing has been doped and is laid on its wooden bed to dry with weights upon it. Small wooden packings can be inserted under the trailing edges of the wing tips and the weights so arranged that the rest of the wing is in contact with its wooden bed. When the glider dope is set dry this washout will remain permanently in the wing tips. It has a valuable effect with regard to stability.

The centre section is then dealt with and butt joints of the spars are made. These are merely glued together. Fourteen s.w.g. piano wire lengths are bent to the correct dihedral angle and then bound with thread along the spars for 3 in. on either side of the No. 1 ribs.

Between the main top and bottom spars $\frac{1}{8}$-in. balsa sheet is fitted in and glued. The L.E. and T.E. wire strengtheners have wire hooks soldered and bound on above the plane to accommodate the elastic wing retaining bands.

The centre section is now covered with 1 m.m. 3-ply both on top and bottom. A small petrol tank is built in behind the leading edge and the rear streamlined off with a piece of soft balsa. This tank measures 1¼ in. long by 1 in. diameter, and is usually supplied with the engine. If certain types of engine are used and a gravity feed tank is not necessary, the tank may be placed where desired. Bicycle rubber tubing is used as a petrol line.

The whole wing should now be covered with *thin* jap silk. The bottom surface is put on first, and each wing half is dealt with separately.

Photopaste should be used as an adhesive because if any mistakes are made the bad patch can be softened with water and unstuck. The wrinkles can then be taken out and the silk restuck down. The silk should be put on first roughly, and then sprayed with water from a scent sprayer. The silk should then be stretched taut with the fingers until the whole surface is even and without wrinkles whilst still damp. It is important of course not to overstretch the silk. Experience teaches good covering.

The bottom surface must next be stitched with a needle and cotton to each rib in order to retain the undercamber effect. Only a few large stitches are required for each rib, the cotton being passed through the silk and over and around the rib.

The top surface of the wing is next covered with damped silk, using photopaste, as before. The wing will then dry off perfectly taut and without a wrinkle.

Some constructors may feel that they like their wing split into two halves for carrying the model in a small space.

If so the two centre section middle ribs must be made of $\frac{1}{16}$-in. 3-ply. There is no need to fit a tongue or dowels.

Merely fit small wire hooks on the opposite ends of the main top spars to take elastic bands to hold the top of the wing together.

Similar hooks are fitted to the leading edge and trailing edge spar ends, and elastic bands keep these butted hard up against each other whilst the normal hooks and elastic described for the one-piece wing keep the wing down firmly to the fuselage top and prevent its breaking upwards.

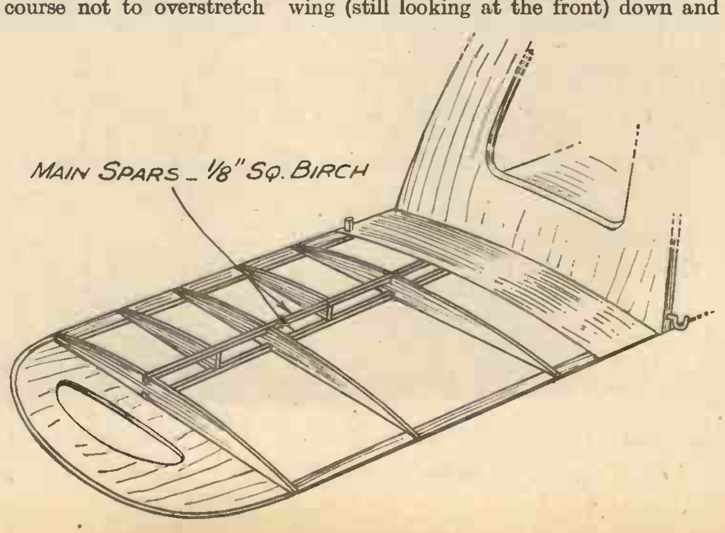
I have used this method on many petrol models including the record holder, the "Blue Dragon," which is still going strong after four years' flying.

A fixed wing is preferable if the owner's car will accommodate it, as it is lighter to build and quicker when assembling the model.

### Tail Unit

This is made up into one unit with the fin built on to the top of the tailplane. The reason of this is to eliminate unnecessary attachment fittings because the tail unit is detachable and can be knocked off in the event of a blow. Also the fin is permanently fitted dead straight in a fore and aft direction and cannot therefore get out of alignment and so give right and left rudder. Many people counteract engine torque by giving right or left rudder, but I maintain this is incorrect, and do not use it on my models because I want a straight glide after the power has ceased. Let us examine what happens if we use wing warp or left or right rudder to take up the engine torque.

Shall we say the engine revolves anti-clockwise looking from the front. The model will then tend to turn over the opposite way, i.e. the right wing (looking from front) will drop. Therefore the fin is put over slightly to the left, or the right wing may be given a little extra incidence which will cause extra lift. Either of these methods will counteract the tendency of the engine propeller torque to push the right wing (still looking at the front) down and




*Amended view of the tail construction.*

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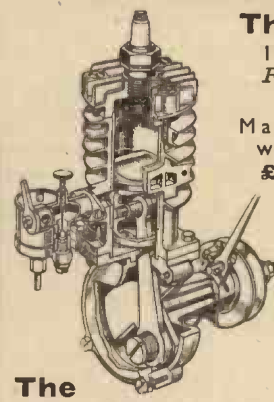

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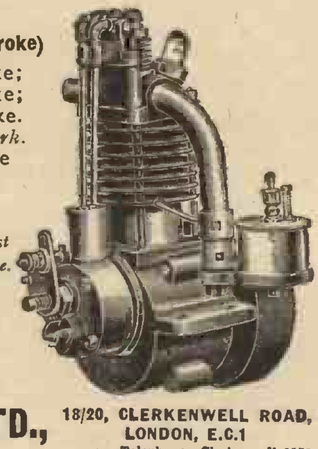

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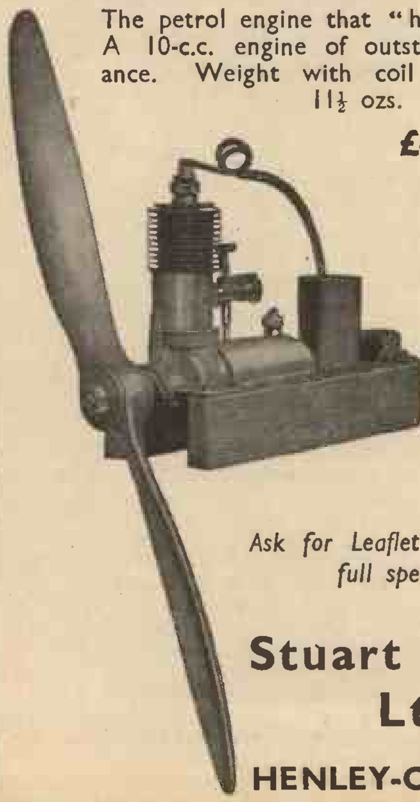

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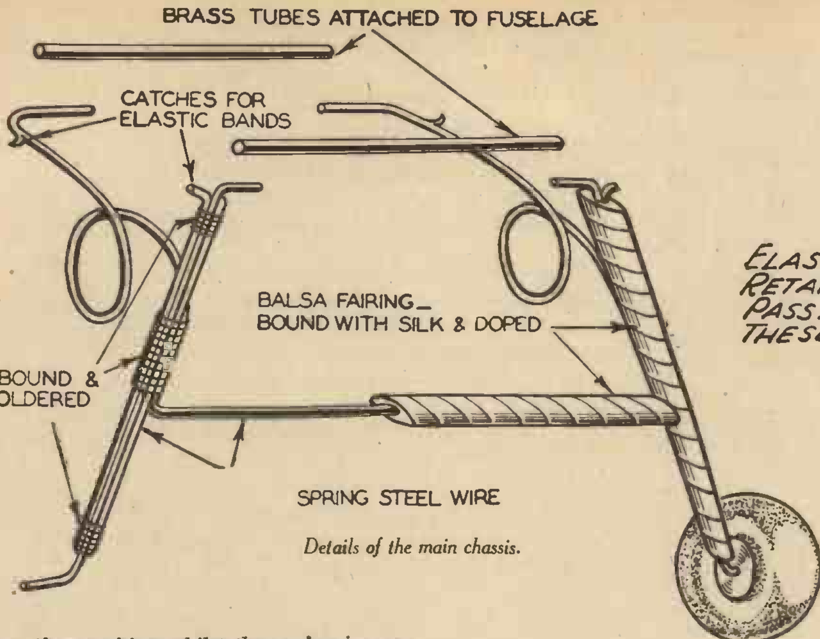
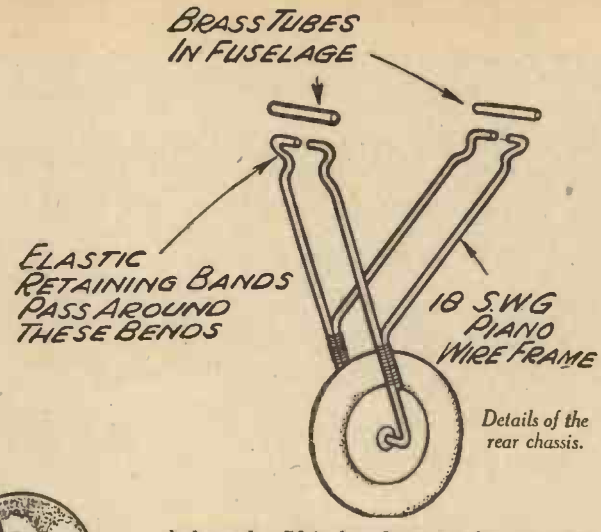



*Details of the main chassis.*




*Details of the rear chassis.*

turn the machine *whilst the engine is running*. The model will then keep on an even keel, but as soon as the engine is switched off the wing or the offset rudder will naturally be relieved of the torque and will bank the model over to the opposite direction whilst on the glide.

The model will then descend in a spiral or in an extreme case in a spin, so that on landing, one wing will be low and hit the ground. The result will be a "cart wheel" and much damage.

I maintain it is far better to set your fin straight and keep the lift on your planes even so that the model will glide straight and land on an even keel, and the engine torque can then be taken up by offsetting the thrust line to the opposite side upon which the torque reacts. If the offset is correct for the engine power developed, it will absorb the torque whilst the engine is running, and as soon as the engine stops firing things become normal.

This is all very simple and elementary, but it is surprising how many people offset their fins, or give wash in on one wing, and are even prepared to argue about it!

Anyway, on this model you will have noticed in the outline drawing that the engine has an "offset," and you will have to make slight variations to this until you have suited your particular engine. The detachable nosepiece allows you to easily adjust this by simply placing packings of wood between the nosepiece and the fuselage. The fin will be set straight when being constructed and remain straight all its life.

The tailplane is a simple rectangular affair entirely made up of balsa except the two main spars. It is 22 in. long with $6\frac{1}{2}$ in. chord.

The main spars are of $\frac{1}{8}$ in. by $\frac{1}{8}$ in. birch. The leading and trailing edge is $\frac{1}{4}$ in. by $\frac{1}{8}$ in. balsa, whilst the ribs are of $\frac{1}{8}$ in. thick balsa sheet.

A sketch showing the general construction of the tail unit is shown on page 446 and all the ribs are cut together by first of all making a 3-ply template and then making the necessary bundle of pieces of balsa, marking off the top sheet from the template, and cutting the whole lot together on the fretsaw machine. The whole operation is thus done very rapidly. If the constructor has no fretsaw machine, he will have to cut each balsa rib separately with a safety razor blade and use the 3-ply template as a pattern or gauge each time.

The tailplane tips are made by bending round cane to the correct shape by hand (it is very pliable) and sticking the ends to the leading and trailing edges by glue.

Now fill in the tips with balsa sheet $\frac{3}{16}$ in. thick, and cut out the centres as in sketch shown.

Put another layer on top followed by another, each slightly smaller than the first, and hollowed out in the centre. Glue each layer to the one below. When it is set hard, carve the tip to the correct streamline shape and sandpaper smooth. The result will be a very strong and light tailplane that will never suffer damage under ordinary circumstances.

The complete tail unit, covered silk, doped and painted, weighs $2\frac{1}{4}$ oz. complete.

Two little bamboo pegs are glued into the leading edge to take the rubber bands that will retain the front of the tailplane to the fuselage. There are two wire hooks on the fuselage to take these rubber bands.

At the rear of the fuselage there is a hook, and at the rear of the fin there is a hook glued into the fin. A rubber band of the correct tension keeps the rear of the tail unit to the fuselage.

These rubber bands must be just the correct tension to keep the tail unit from coming off by air pressure, but to easily allow the tail unit to knock off in the event of a crash. That is the secret of no damage.

### The Fin

As has already been said this is built on to the top of the tailplane and is set straight. It is made by cutting out the desired shape and area from a sheet of balsa $\frac{1}{8}$ in. thick. Now cut away the centre leaving about 1 in. around the edges. Another two fins are cut about $\frac{1}{2}$ in. less in outline size. These are hollowed out in the centre also and are glued on to each side of the original fin. A further two laminations in this way are then added, a size smaller.

The fin is then carved off to a streamline shape with a sharp knife or a razor blade and finished off with sandpaper.

The final result is a streamlined fin of hollow balsa weighing very little, but very strong owing to its shape and its laminated construction.

### Flying the Model

Make sure that your model is correctly balanced. If it has been made according to the instructions it will weigh 2 lb. to an ounce or two either way, ready for the air with battery and clock, etc., and the point of balance when balanced on the hand will be about one third back from the leading edge of the mainplane. This is correct; if your model is out on this balance, you will have to slightly shift your little battery fore or aft as the case may be.

Now try gliding the model into a slight wind with the engine very loosely attached for tests so that it can very easily be knocked off. With a very slight throw forward and slightly downward the model should glide slowly and flat and run nicely along the ground. If it tends to stall, pack up the leading edge of the tailplane a very little, and if the model tends to dive too steeply, pack up the trailing edge of the tailplane a fraction with a slip of balsa wood.

This tailplane adjustment must be very slight, however. If more drastic adjustment is required you must either have got your point of balance incorrect or your mainplane angle of incidence is not right.

Do not be satisfied until the glide is *perfect*. See that the fin or rudder is *straight*, and the engine torque must be taken up by offsetting the thrust line as already described in this article, for you require your model to glide straight and land without one wing being down. Check off that both wings are unwarped and showing the same amount of area from the front. The same applies to the tailplane.

Now give the engine a little extra downthrust by packing with a small piece of balsa wood between detachable engine mounting and the nose former. This is for safety to prevent a stall on the initial test flight. Put on extra tension of elastic bands to deal with engine thrust.

Set the clock to 5 seconds and gently hand launch the model directly into wind with the engine running all out, *having pressed the starting lever on the clock*. The model will probably lose height and switch off just before landing. This indicates that the extra packing and downthrust can be taken off. Now try again for a 10 seconds flight, and if the model climbs *very* gradually before cutting off, a longer flight can be tried, say 20 seconds, and it can be observed if the correct amount of offset has been given to counteract engine torque. If not, adjust to suit so that the model turns only very slightly in large circles.

Always make sure before each flight that the mainplane is on square with the fuselage, and the tailplane and fin are also square, and your model will be a success.

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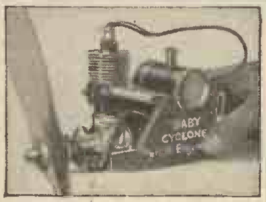


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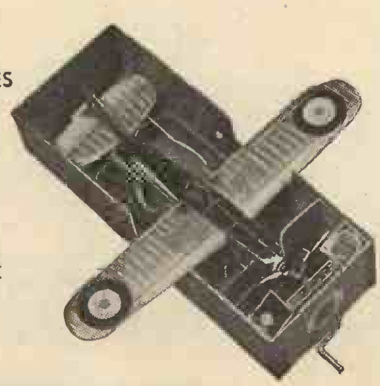

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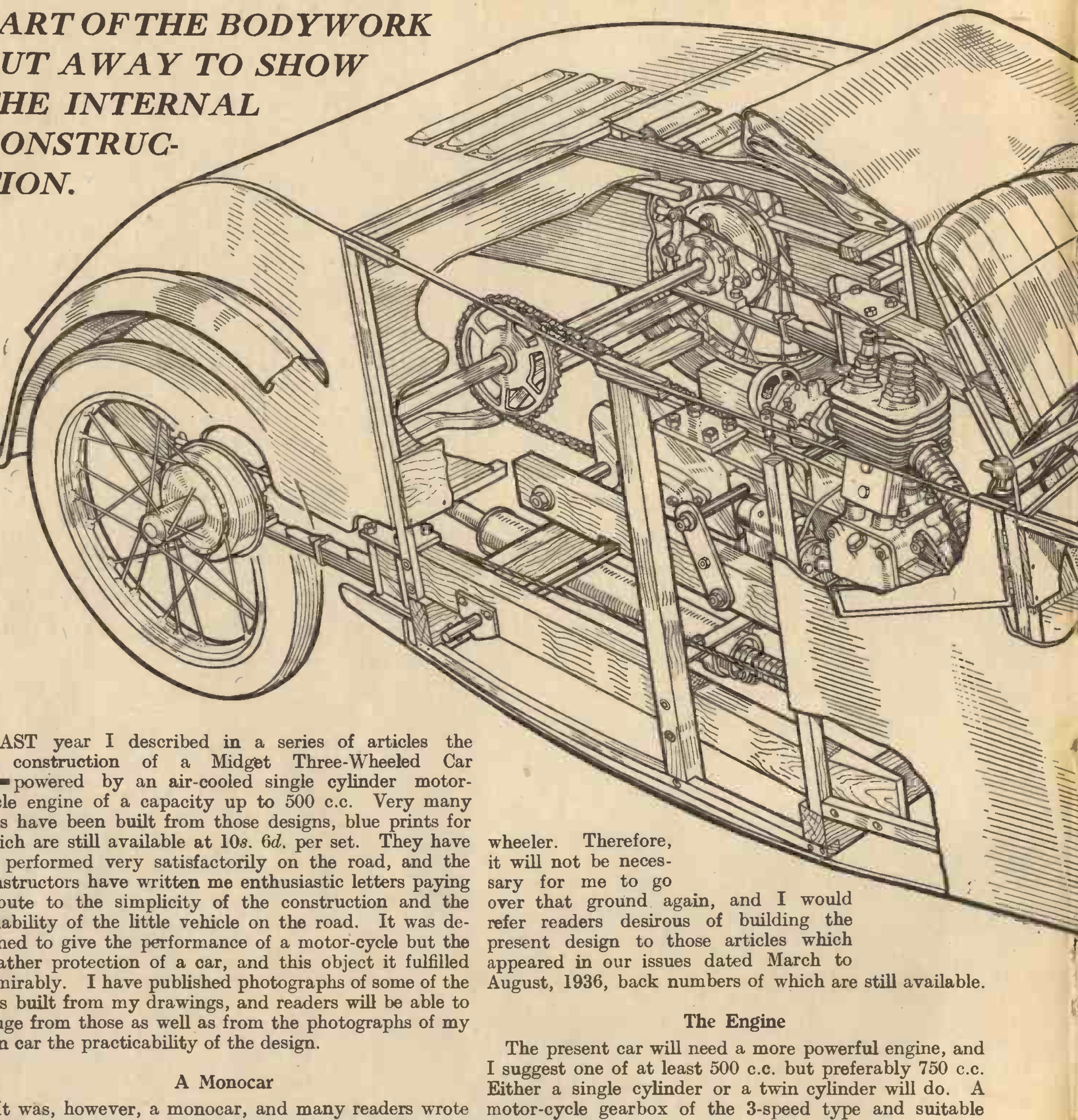


***A PERSPECTIVE SKETCH OF THE MIDGET CAR WITH PART OF THE BODYWORK CUT AWAY TO SHOW THE INTERNAL CONSTRUCTION.***

LAST year I described in a series of articles the construction of a Midget Three-Wheeled Car powered by an air-cooled single cylinder motor-cycle engine of a capacity up to 500 c.c. Very many cars have been built from those designs, blue prints for which are still available at 10*s.* 6*d.* per set. They have all performed very satisfactorily on the road, and the constructors have written me enthusiastic letters paying tribute to the simplicity of the construction and the reliability of the little vehicle on the road. It was designed to give the performance of a motor-cycle but the weather protection of a car, and this object it fulfilled admirably. I have published photographs of some of the cars built from my drawings, and readers will be able to gauge from those as well as from the photographs of my own car the practicability of the design.

### A Monocar

It was, however, a monocar, and many readers wrote asking whether they could widen the body to accommodate a passenger. I advised them against this, since the chassis members and other parts would have needed considerable modification to have made the car strong and roadworthy.

Ever since the conclusion of the series of articles I have received a steady flow of correspondence asking me to prepare a design on somewhat similar lines suitable as a two-seater. I have given a great amount of thought to the matter, and decided that such a design would not be satisfactory as a three-wheeler, and accordingly I set about preparing a design for a four-wheeler but adopting a somewhat similar form of construction as for the three-wheeler. Therefore, it will not be necessary for me to go over that ground again, and I would refer readers desirous of building the present design to those articles which appeared in our issues dated March to August, 1936, back numbers of which are still available.

### The Engine

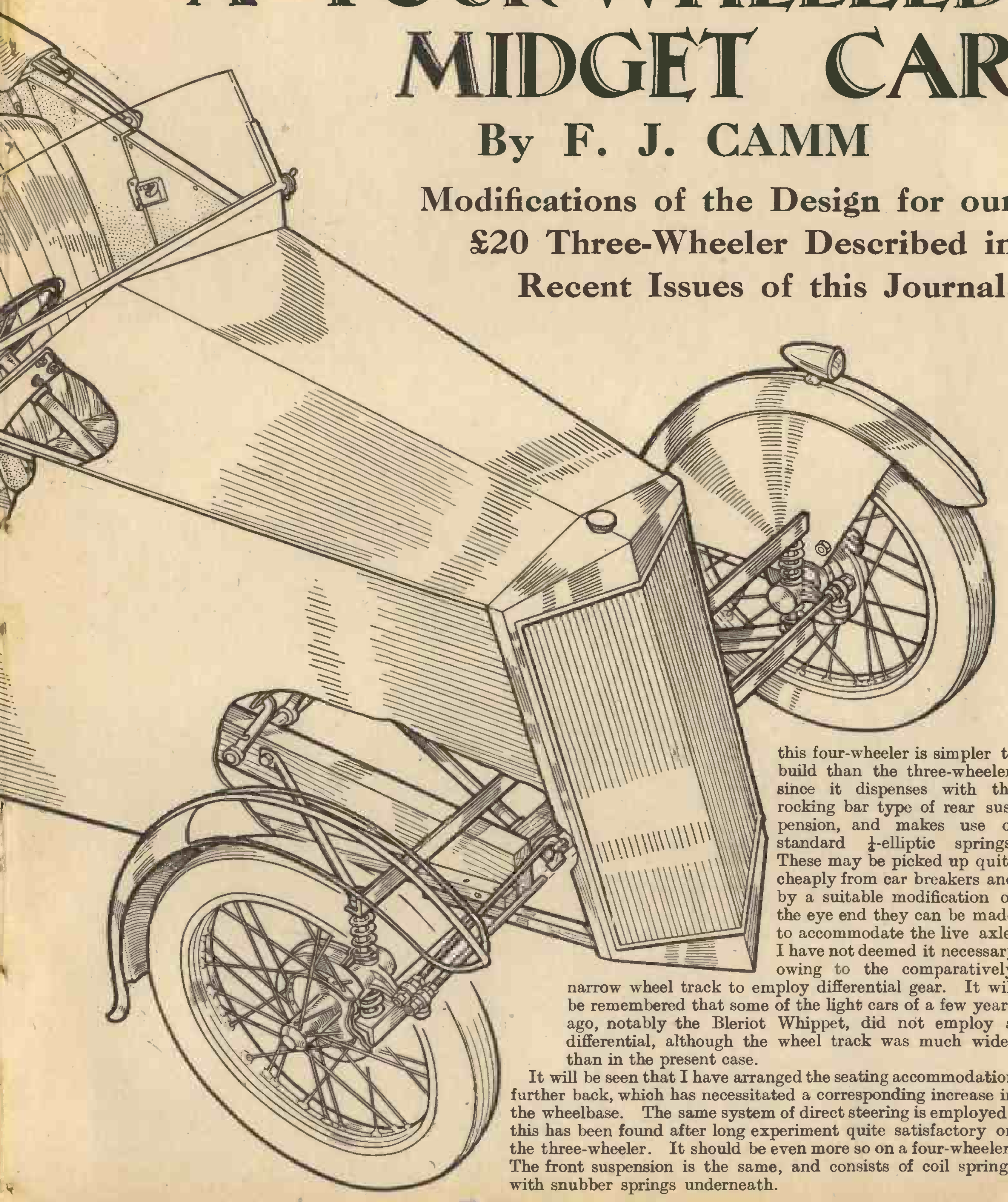
The present car will need a more powerful engine, and I suggest one of at least 500 c.c. but preferably 750 c.c. Either a single cylinder or a twin cylinder will do. A motor-cycle gearbox of the 3-speed type and suitable for the engine should also be obtained. The top gear ratio should be 7—1 to prevent the engine from overheating, and as with the three-wheeler, an air chute underneath the seats should direct a blast of air direct on to the cylinder.

Additionally, wheels fitted with at least 3-in. tyres should be used. Motor-cycle sidecar wheels with internal expanding brake hubs should be employed, and it will be a comparatively simple matter to couple the brake operating mechanism so that all wheels are braked simultaneously. The body is constructed as before from three-ply, but the framing allows of variation in body form to please individual ideas. In many ways

# A FOUR-WHEELED MIDGET CAR

## By F. J. CAMM

### Modifications of the Design for our £20 Three-Wheeler Described in Recent Issues of this Journal.

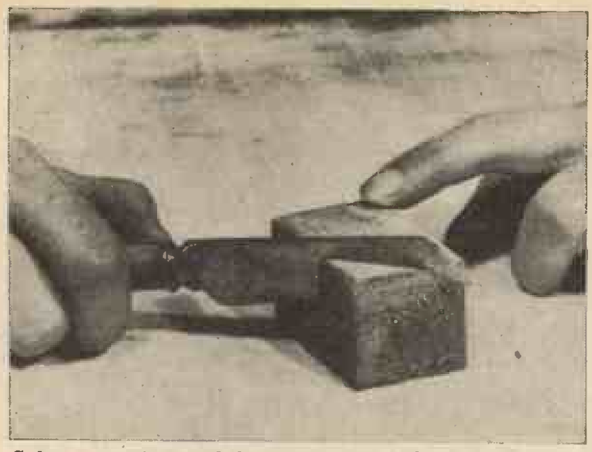


this four-wheeler is simpler to build than the three-wheeler, since it dispenses with the rocking bar type of rear suspension, and makes use of standard ¼-elliptic springs. These may be picked up quite cheaply from car breakers and by a suitable modification of the eye end they can be made to accommodate the live axle. I have not deemed it necessary owing to the comparatively narrow wheel track to employ differential gear. It will be remembered that some of the light cars of a few years ago, notably the Bleriot Whippet, did not employ a differential, although the wheel track was much wider than in the present case.

It will be seen that I have arranged the seating accommodation further back, which has necessitated a corresponding increase in the wheelbase. The same system of direct steering is employed; this has been found after long experiment quite satisfactory on the three-wheeler. It should be even more so on a four-wheeler. The front suspension is the same, and consists of coil springs with snubber springs underneath.

# SOME MARVEL-

## Some Curious and Remarkable



*Sodium is so soft a metal that it may be cut with a knife, like cheese.*

THERE are about seventy different metals known to modern science and, of course, the possible number of alloys which can be produced from these metals is well-nigh illimitable. For all that, however, the pure metals which serve a useful purpose in the present-day world are relatively few and even the alloys of these metals which have actually received commercial use are still relatively small in number.

We are all, perhaps, apt to employ metals for our various constructional purposes—without thinking much about them. There are, however, some extraordinary and truly amazing properties to be found among more or less common metals if we but care to look around us. Metals, there are, for instance, which are almost spontaneously inflammable, others which are marvellously light and others, still, which are capable of providing a number of most remarkable phenomena. It will be of interest, therefore, to most readers if, for a short time, we deal with a number of these curious metals and enumerate some of their most striking properties.

### Silvery-white Metal

Take, first of all, lithium. This silvery-white metal has not only the distinction of being the lightest of all metals, but it is also remarkable as being the lightest of all solid materials. Lithium is only seven times as heavy as hydrogen gas, which itself is the lightest material in the universe. Lithium's extreme lightness may be judged from the fact that it floats on the surface of petrol, a liquid which itself floats on water. Very unfortunately, however, no practical use can be made of lithium for constructional purposes. Exposed to the air, the metal quickly oxidises and crumbles away to a useless mass of oxide.

At the other end of the scale we have uranium, a radio-active metal, which is not only the heaviest of metals but, also, the heaviest known material substance. Uranium is over two hundred and thirty times heavier than lithium, but, unlike the latter, it may, one day come into commercial use, for it is moderately plentiful and it has been shown that it is capable of exerting an extreme hardening effect on steel.

### Radium

Closely allied to uranium we have, of course, radium, the wonder metal. Very few living people have ever seen radium metal, for the world's supply of radium is generally preserved in the form of a radium salt. Minute quantities of metallic radium, however, have been prepared, and the pure


*Radium is a self-luminous metal. A mass of radium photographed by its own light.*

metal shows itself to be a white silvery material which, when exposed to the air, combines with the *nitrogen* of the latter (not the oxygen) and quickly becomes covered with a black film of radium nitride. Placed on a piece of paper, radium metal chars it instantly. Like all its compounds, metallic radium is always at a temperature a few degrees higher than that of its surroundings. The metal, too, is self-luminous and surrounding a quantity of radium material there is always present a faint luminescence, a chemical will-o'-the-wisp, which outwardly signifies the enormous potential energy present in the material.

Radium in its metallic form seems to be pretty useless. It is distinguished, perhaps, merely as being the greatest material curiosity of modern science.

Mercury is well known as being the only metal which is liquid at ordinary temperatures. Yet there is another metal which will melt in the rays of the sun. This is gallium, an aluminium-like metal, which melts at the extraordinarily low temperature of 29 degrees centigrade. Place a lump of gallium in the palm of your hand and it will quickly melt into a silvery globule and run about like mercury. Despite the rarity of gallium it was once thought that the metal would have great use in the construction of high-temperature thermometers. It was fouud, however, that molten gallium " wets "glass, so that, unlike mercury, it sticks to the sides of a tube and does not form a clear convex top as does the latter metal. Hence gallium still remains a metal for which a use has still to be found.

Allied to gallium in properties is the metal indium. This is still costly to obtain, but its price is being reduced year by year and, no doubt, within a decade or so we shall be seeing indium-plated articles in jewellers' shops, for, suitably plated upon silver, indium presents an extremely bright and lustrious appearance.

### Metallic Sodium

Most amateur scientists are familiar with the properties of metallic sodium, the metal contained in common salt. Sodium is so soft that it can easily be cut through with even a blunt knife. It is lighter than water and when thrown on to that liquid it immediately melts and swims about, evolving a copious stream of hydrogen gas. Sodium is a bright silvery metal, but it is rarely seen in that condition, for immediately its bright surface is exposed to the air it becomes covered with a white film of oxide. For that reason, sodium and all its related metals are always kept under oil.

The metal, potassium, possesses all the properties of sodium, but to a more enhanced degree. If, for instance, you throw a fragment of potassium into a basin of

*A remarkable experiment with aluminium and mercury. (Left) Clear aluminium plate. (Centre) The appearance of the aluminium plate one minute after being treated with a solution of mercury in nitric acid. Note the white growth of aluminium oxide. (Right) The aluminium plate two minutes after its mercury treatment. Tufts of aluminium oxide have grown out of the edge of the plate and the growth on its surface has thickened.*

# LOUS METALS

## Properties of Metals and their Alloys

water, the metal at once catches fire. Actually, of course, it is not the metal itself which burns, but the stream of hydrogen gas which it liberates from the water.

Rubidium and cæsium are two extraordinary metals. They both have the properties of sodium and potassium. Both of them, too, have that curious property of light-sensitivity by means of which they liberate a copious stream of electrons when acted upon by light. Cæsium, in particular, has come to be regarded as a metal *par excellence* for photocell construction, since a cæsium cell can be made very sensitive to low intensities of light.

*"Ammonium amalgam," a mysterious and remarkable plastic metal which may readily be made according to the directions given in this article.*

But apart from the above, rubidium and cæsium are both extraordinary metals in view of the fact that they are both more or less spontaneously inflammable. Exposed to the air, these metals oxidise with such rapidity that within less than a minute they usually burst into flame. A cæsium incendiary bomb would be a great asset to a warlike nation, but, happily, cæsiun costs more than two pounds a gram and is not likely to become any cheaper.

What, do you imagine, is the least metallic of all the metals ? The answer is arsenic, that sinister substance whose many compounds are so excessively poisonous and yet so useful. Arsenic looks more like coke than anything else. Yet its physical properties just enable it to be classed as a metal and not as a non-metal.

### Magnesium

Magnesium is a well-known metal. Do you know, however, that magnesium can actually decompose water ? Obtain a small quantity of mercury and place it in a deep basin or, preferably, in a mortar. Now procure a few small scraps of magnesium ribbon and, after cleaning them well with fine sandpaper in order to brighten their surfaces, immerse them in the mercury and grind them together under the surface of the mercury. The mercury and the magnesium will then intimately mix together, forming what is termed a mercury-magnesium amalgam.

If, now, we place a little of this mercury-magnesium amalgam in a test tube of water, a slow but steady stream of hydrogen bubbles will ascend from the amalgam, proving that the water is being decomposed by the magnesium in the amalgam.

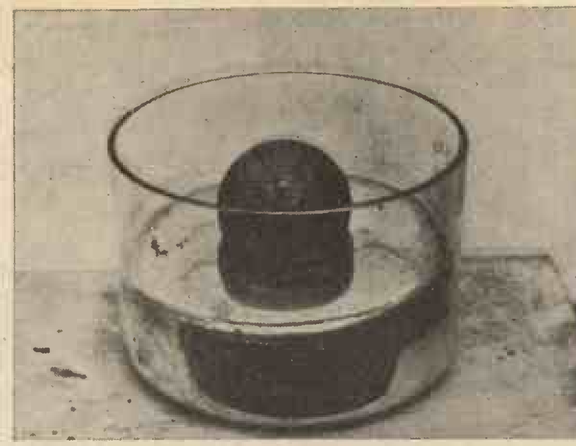
### Mercury

Mercury, although a fairly common metal, is capable of giving rise to many strange effects. Mercury is a very heavy metal, so heavy, indeed, that a ball of solid iron will float upon it just as lightly as a cork floats upon water.

It is, however, in its various mixture with metals — or *amalgams*, as they are termed — that mercury gives rise to its most curious effects.

Take, for instance, the strikingly lifelike phenomena which aluminium-amalgam gives rise to. If we dissolve a small globule of mercury in a little nitric acid and then rub the resulting liquid over a perfectly clean and grease-free sheet of aluminium, two things will happen. In the first place, a thin film of mercury will be deposited upon the sheet of aluminium in the

*"Invar," a remarkable alloy which expands less than one millionth of its length for every degree rise in temperature. It is used for high-grade pendulum making.*



*So heavy is mercury that a ball of iron floats upon the surface like a cork on water.*

form of a black powder. This film will immediately amalgamate with the aluminium and almost instantly there will begin to "grow" from the aluminium sheet white tufts of woolly-looking material which will slowly push themselves upwards and wave about in a most amazing and lifelike manner. These are threads of aluminium oxide and, within an incredibly short period, they will reach a length of an inch or more. If, now, we wipe them away from the aluminium surface, a fresh crop of the white material will at once begin to grow again and upwards of half a dozen or more batches of this material can be obtained from the same aluminium sheet.

What we are really witnessing here is the catalytic oxidation of aluminium under the influence of the mercury. The aluminium is oxidised away so rapidly that we actually witness a chemical reaction proceeding before our very eyes. In time the aluminium material will be entirely corroded away. It is for this reason that mercury or salts and preparations containing mercury should never on any account be placed in contact with any article of aluminium, otherwise the latter will most certainly be ruined.

### "Ammonium-Amalgam"

Another most remarkable amalgam of mercury is that mysterious plastic material which goes under the name of "ammonium amalgam." To make ammonium amalgam, obtain a few pieces of sodium and grind them up in a mortar under a quantity of mercury. As each fragment of sodium dissolves in the mercury it will give rise to a miniature explosion and a flash of light. The resulting solution of sodium in mercury is termed sodium amalgam and it is semi-solid in nature.

Take some of this sodium amalgam, place it in a deep saucer and just cover it with a strong solution of ammonium chloride (salammoniac). Instantly, the amalgam will begin to swell up and to grow upwards, forming a glistening, metallic, sponge-like mass which can be pressed together between the fingers. What this metallic material is no one really knows. It is called "ammonium amalgam" because it was formerly thought to consist of an amalgam of mercury with the "ammonium" radical, $-NH_4$. It may, however, comprise nothing more than a pasty mass of mercury blown up by hydrogen gas, for, after some hours, the swollen mass deflates again and mercury is left at the bottom of the saucer.

What are known as "pyrophoric" metals are those which, on exposure to air, become red-hot and, when thrown to the ground, emit a trail of sparks. Iron, nickel and lead

(*Continued on page* 462.)

# A Model G.W.R. Broad Gauge Locomotive—Part III

*By E. W. Twining*

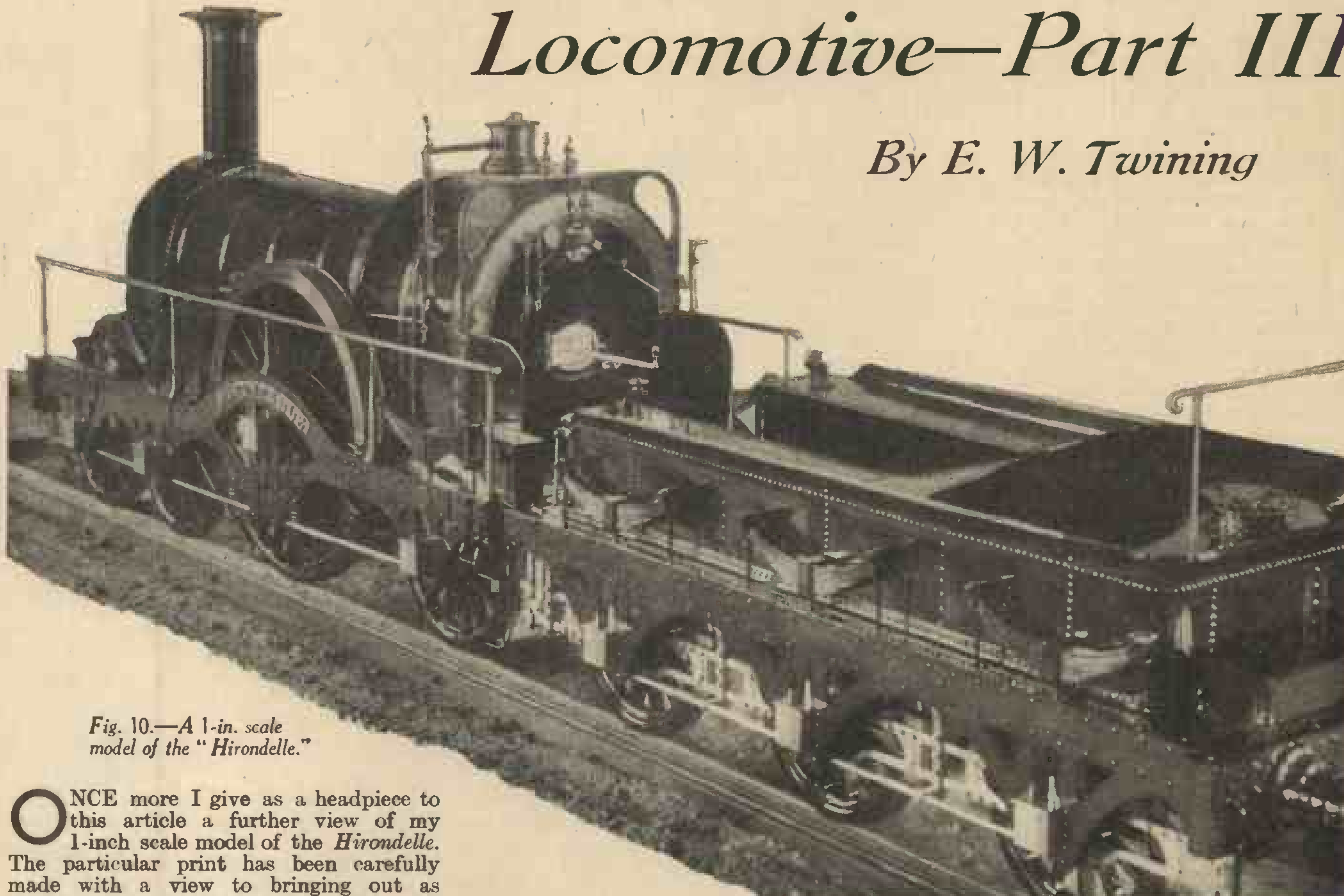


*Fig. 10.—A 1-in. scale model of the "Hirondelle."*

ONCE more I give as a headpiece to this article a further view of my 1-inch scale model of the *Hirondelle*. The particular print has been carefully made with a view to bringing out as sharply as possible details which will doubtless be useful to the reader. I can only hope that these details will be rendered with sufficient clarity in the reproduction.

It will probably be thought time that we set about dealing with the construction of the model, and I think I might very well say something regarding the order in which the portions of the engine had better be taken in hand. Although it perhaps does not matter very much which parts are made first, it would be as well to work systematically, and I would suggest the following order: First, as this is a most important item, the cylinders; then I should construct the smokebox which has to enclose the cylinders; after the smokebox I would recommend that the boiler be built complete, all except the fittings. After this is finished and fitted to the smokebox the inside engine frames, with the motion plate, can be cut out and joined up to the smokebox back and the firebox front corners. Then the whole of the motion, including the cranked driving axle, connecting rods, crossheads, and slide bars, can be made and tried in place. Next the whole of the valve gear, with the reversing shaft, the brackets, etc., which carry it. Then the driving wheels and the driving axle-boxes should be made and fitted on the shaft. After making and fitting the steam pipes and regulator the engine can then be tested for simple running by temporarily closing the openings in the boiler and using compressed air from a tyre pump.

The foregoing portions of the model can then be put on one side and the outside frames taken in hand with the six carrying wheels and their axles and axleboxes. Then the springs, buffers, and, lastly, all small parts and boiler fittings.

### The Cylinders

With the cylinders, of course, are included the valve chest, which is common to both cylinders. I show in Fig. 12 a sectional plan of the left-hand cylinder, valve chest, and both the valves; also a back elevation of one cylinder. Since the drawing gives all the necessary particulars of valve and port measurements there is no need to repeat them here. The question of the material in which the cylinders, cylinder covers, and valve chest shall be cast is one which the reader can decide for himself. Some people would prefer—although for a $\frac{3}{4}$-in.-scale model they are comparatively small—to have them in cast iron, but I do not hesitate to recommend the use of gunmetal. With cast iron, unfortunately, there is risk that if the engine should be laid on one side for a considerable time moisture left in the cylinders will cause rusting which will be almost sure to interfere with the perfect fitting of the pistons and, possibly, also of the valves. I know, of course, that a brass slide valve working on a gunmetal face is not ideal, but it is by far the lesser evil of the two.

### The Pistons

Then, with regard to the pistons, some model engineers would insist on fitting piston rings and those who have had experience with rings in model cylinders will make a perfectly good job, but the simplest packing is soft cotton—the woolly variety which is used for the wicks of methylated-spirit lamps. It is this which I have provided for when showing in the drawing grooves in the pistons. These grooves should be of considerable depth in order to obtain elasticity and compressibility in the packing.

In preparing the foundry patterns the bore of the cylinder will, of course, be cored out, but the size of the casting will be too small to render coring of the steam ports practicable. The ports will, therefore, have to be drilled out in the way which usual with small cylinders. A cross section through the cylinder valve chest and the whole smokebox is given in Fig. 11. In the section through the cylinder the drilled holes for the ports are indicated.

### The Slide Valves

The slide valves had better be made of brass. As will be seen, they are wider than they are long; the length is given in Fig. 12 as $\frac{5}{8}$ in., but their width or vertical measurement is $\frac{11}{16}$ in. The construction of them has been given before in one of my articles and is of my own design. Each valve consists of two parts—the main body of the valve itself and a cover made from bent brass plate, the two being silver soldered together. The cover plate as well as the valve body are shown in the cross section, Fig. 11. The U-shaped bend in the plate provides for the valve spindle and the advantage of this design over a solid cast valve is that it gives a much bigger exhaust space in the cavity, added to the ease with which the inner edges of the valve can be filed true to measurements.

The valve is driven by its spindle through

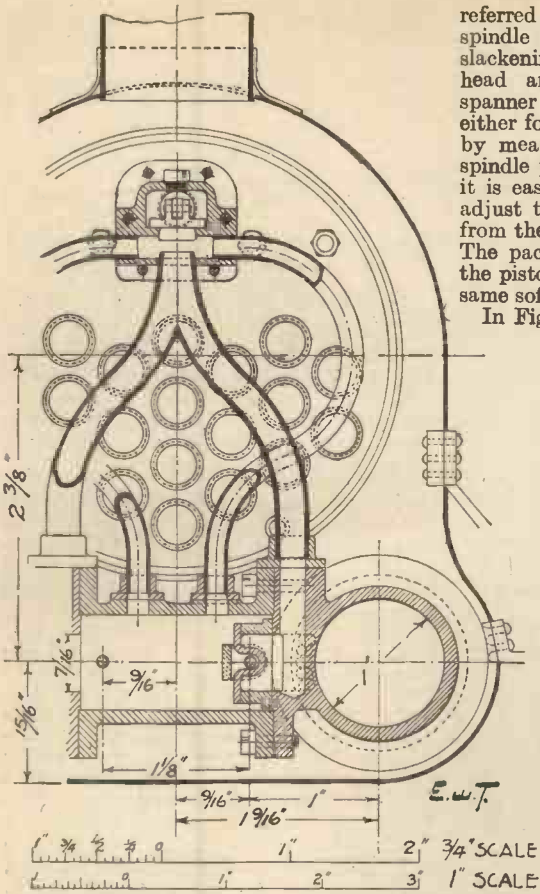



*Fig. 11.—Part cross section through smokebox and one cylinder.*

the medium of a bent steel plate buckle screwed on to the spindle as shown in the plan view. This arrangement facilitates greatly the setting of the valve in its correct position over the steam ports. In Fig. 12 it will be seen that the end of the valve spindle, which will connect up to the link motion, has a groove turned upon it. The valve spindle crosshead, as may be seen in Fig. 9 in my last article, is clamped to the valve spindle with a set screw, which screw fits into the groove referred to. The opposite end of the spindle is finished with a square. By slackening the screw in the valve crosshead and revolving the spindle by a spanner on the square the valve is moved either forward or backwards on the spindle by means of the screwed portion of the spindle passing through the buckle. Thus it is easy when the engine is in steam to adjust the valves until the exhaust beats from the chimney are regular and uniform. The packing of the stuffing boxes around the piston rods and valve spindles is of the same soft cotton as that of the pistons.

In Fig. 12 there is one little item which calls for mention, although its fitting will not be called for until later; that is the oil check valve. It is not possible to fit a large and efficient displacement lubricator on this engine. There is no position in which it could be rendered invisible, so I propose to lubricate the cylinders by means of a very small oil pump in the tender, a pipe being carried from the tender to this oil check valve. It is the only way in which, it seems to me, lubrication is practicable.

**The Smokebox**

As I have previously mentioned, the back end of the cylinder, together with the stuffing box on the valve chest, form spigots which fit into a cast gunmetal ring which is to serve as the back plate of the smokebox. This ring is shown in section in Fig. 12, whilst in Fig. 11 it is in elevation. In Fig. 12 the section is made through one of the lugs which project forward into the smokebox to receive the supporting bracket which carries the front end of the boiler on the outside frames. Both of the lugs are shown in Fig. 11 with the bracket riveted to them. The smokebox wrapper plate is so cut and shaped that it will pass over the gunmetal ring after the bracket is riveted up. The wrapper plate should be of thin steel, planished material, also the front plate. The wrapper and front plates can be joined either with a ring of angle brass or a casting of square section, as shown in Fig. 12. Rivet heads can be represented by being punched up in the plate, the wrapper being secured to the back gunmetal ring by countersunk screws at intervals of about 1½ in. apart. Whether the reader makes the front smokebox plate detachable from the wrapper is a matter for him to decide. I do not think that it will be found any advantage. It will be just as easy and more convenient to remove the whole smokebox if the regulator or any other fitting inside of the box is required to be got at for attention. In most cases the interior can be reached by simply opening the smokebox door.

From the smokebox we will pass to the boiler. This will be made throughout in copper. The first question which arises is, what thickness of plate shall be used? The barrel is, of course, best made from a piece of seamless copper tubing having an outside diameter of 3½ in. It is to this diameter that the smokebox gunmetal ring should be bored and the boring should be so carefully done that the barrel tube makes a nice sliding fit in the ring. First then, with regard to thickness of plate, let us see what we shall require. We must find the bursting pressure, then allow a factor for safety, and the result will be the maximum working pressure permissible. The formula is: $BP = \frac{TS \times t \times 2}{D}$ where $BP$ is the bursting pressure, $TS$ the tensile strength of the material, $t$ is the thickness of plate, 2 a constant used since two sides of the boiler are always under pressure in opposition tending to burst it, and $D$ is the diameter. For our purpose we can safely take the tensile strength of copper to be 28,000 lb.; for thickness we will adopt $\frac{1}{16}$ in. or ·0625 in. Therefore, we have:

$$\frac{28{,}000 \times \cdot 0625 \times 2}{3 \cdot 5} = 1{,}000 \text{ lb.}$$

It will be seen from this result that we can adopt a fairly high factor of safety, say 10, and we have $WP = \frac{BP}{FS}$. $FS$ being the factor of safety, we have a working pressure of 100 lb. Now since it is highly probable that if the safety valves were set for this blowing-off pressure and the regulator were opened, the driving wheels would slip, it looks very much as though we shall never need to press the boiler to the extent indicated and therefore copper plate of $\frac{1}{16}$-in. thickness will be amply strong.

*(To be continued.)*

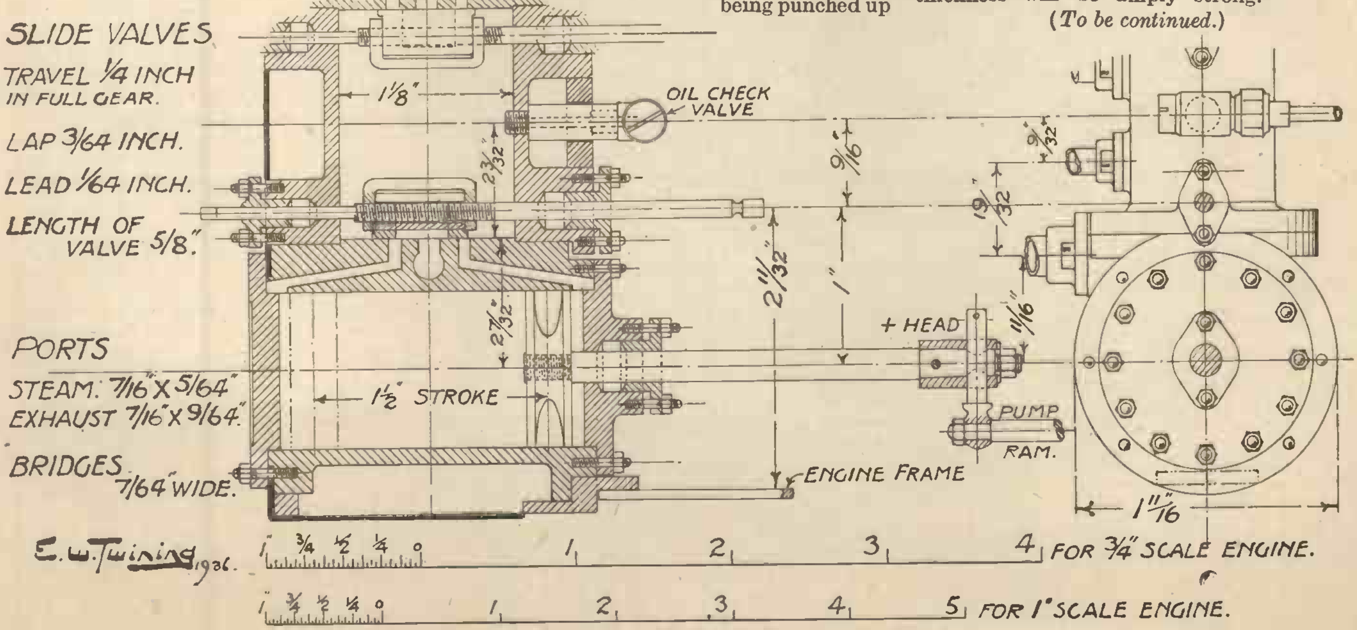



*Fig. 12.—One of the cylinders in sectional plan and back elevation.*

# MODEL AERO TOPICS

## BY F. J. C.

### Our National Competition for Petrol Models

AN enormous amount of interest has been evoked by the publication in last month's issue of details of our National Competition for petrol-driven models having engine capacities up to 9 c.c., and I have already received a large number of notifications of entry from intending competitors. A further article on the "Petrel" appears elsewhere in this issue, and next month we shall deal with the modifications necessary to accommodate engines of 6 c.c. up to 9 c.c. The present design will accommodate engines up to 6 c.c. This is the first time that a journal has sponsored a national competition of this sort, and it is the first time in the history of model aeronautics that such a large cash prize as £50 has been offered for the winner. There will be dozens of other prizes, and all competitors stand an equal chance since the rules are designed to eliminate the professional model maker. However far you live from London you may still enter your model and have it flown for you by an experienced model plane enthusiast, approved by the judges; there is no entry fee. Make up your mind to enter now! You will possess a fascinating model aeroplane and the chance to win either the first prize or one of the many other valuable prizes.



### The Huntly Boys' Model Aero Club

I HAVE received from Mr. G. Eddy, of 23 West Park Street, Huntly, Aberdeenshire, the photograph reproduced on this page which shows four members of the Huntly Boys' Model Aero Club with models in various stages of construction. The three models being held are a Hurricane (partly finished), a U.S. Navy Kinner, and an almost completed Goshawk. This Club only started 18 months ago and has no previous experience of model aircraft construction. The members have had to teach themselves by trial and error. Owing to the location of their district, they rarely see a real aeroplane, so a Club in this North Scottish country village provides residents with the next best thing.

*Four members of the Huntly Boys' Model Aero Club busily at work.*

### Northern Heights Coronation Gala Meeting

THIS year's Gala Day organised by the Northern Heights Model Flying Club will take place on Sunday, June 20th, from 11 a.m. until dark. This will be the fifth annual Gala Meeting held by this Club. The principal object has been to encourage model makers to bring their models along so that the lone hand can see for himself what others are doing. The meeting is not only a flying meeting but also an exhibition of all that is best in model aircraft. There are plenty of competitions during the meeting, and the rules are simple so that the greatest number of model makers can compete. The social side is also fostered. Many local clubs have started funds so that their members can visit the meeting by means of coach or reserved railway carriage. The competitions include a *concours d'élégance*, a duration competition, an inter-club team contest, a popular duration contest, a seaplane contest, a workmanship contest, a ladies' competition, flying scale competition, semi-scale competition, etc. Full details are obtainable from Mr. C. A. Rippon, 58, Hampden Way, Southgate, N.14, or H. C. Chatterley, 117, Cranston Road, Forest Hill, S.E.23.

### Club Affiliation

IT is in the best interests of the pastime that every Club should affiliate to the S.M.A.E. This not only adds strength to the movement but gives it impetus, and enables a more ambitious programme to be arranged. The percentage of provincial clubs affiliated to the S.M.A.E. during 1936 was 58·3 per cent. against the London Clubs 41·7 per cent. The latter supported competitions by 71·4 per cent. against 26·4 per cent. from the provinces. Only 2·2 per cent. were unattached entrants.

### Timekeepers

AT a recent meeting of the S.M.A.E. it was decided that the total number of timekeepers per club be limited to six, the official S.M.A.E. delegate being included in this number. In my opinion I think the S.M.A.E. should make a rule that only approved stop-watches be used. It is easy for a competitor by selecting a timekeeper with an inaccurate stop-watch to gain a record to which he is not entitled. I think that a rule should be made that no stop-watch should be used unless it has a constant rate (timing to be corrected after the flight has been timed) of not more than 10 seconds per day. Such watches can be purchased for a reasonable price and I should be pleased to supply lists of suitable suppliers. If this rule is not insisted on, the record situation will become fantastic. In other sports you cannot be a timekeeper unless you are in possession of a watch with a Kew A Certificate. When you give notice of record attempts, you have to agree to pay the timekeeper's fee. The present system of allowing any sort of watch is, in my opinion, unfair.

### Kanga Aero Models

I HAVE received from Kanga Aero Models, 1 Colonnade Passage, New Street, Birmingham, a copy of their new Model Aeroplane Catalogue which is packed with valuable information on models and materials, including balsa wood, silver spruce, plywood, glues, dopes, and cellulose paints, silks and tissues, books and periodicals, air-screws, gear drives, blue prints, petrol models, model autogiros, petrol engines, ignition coils, sparking plugs, engine mounting, kits for complete flying scale models, parts for model ships, etc., etc. Every aero modeller should obtain a copy of this well-illustrated catalogue which costs 4*d*.

*The "water immersion" test for the permanency and waterproof nature of writing ink. All Indian and iron-containing inks should be made to undergo this test.*

# INK MAKING FOR AMATEURS

## A Useful Field of Activity for the Home Chemist

THE manufacture of writing ink is one of the oldest chemical industries in the world. For centuries inks have been made by time-honoured methods, but in the modern world the production of various inks has become such a specialised task that entirely new methods of ink making have been devised and put into practice.

For the amateur chemical experimenter there is hardly a more useful sphere of interesting activity than that which is to be found in the home production of inks. Writing inks, after a little practice and experimentation, can be made cheaply and in almost numberless varieties. The amateur who embarks upon the interesting task of ink production may, at first, find that his inks do not behave just as he wishes them to. They may, for instance, tend to run unsatisfactorily from the pen nib, they may deposit insoluble matter in the ink bottle and they may blot badly. These tendencies, however, may readily be overcome simply by adjusting the various ingredients of the ink and, after a few trials, the amateur will learn how to produce inks which are quite free from such drawbacks.

### Permanent Ink

It must not be imagined that one can produce a satisfactory ink merely by dissolving a certain amount of dye in water. True it is that some of the cheapest writing inks which are sold nowadays consist of little else than a solution of a blue-black dyestuff in water. To be permanent, however, an ink must have more potent ingredients than a mere dye, although there is no gainsaying the fact that some of the modern dyestuffs are remarkable fast to light.

Most good black and blue-black writing inks, however, are of the iron-tannin type. They are made by combining a soluble iron salt with a tannin material. The iron-tannin compound, unless it is combined with a suitable dye, gives, at first a rather pale and washy writing but, after a time, the writing absorbs oxygen from the atmosphere and turns an intense black, becoming, at the same time, absolutely insoluble in water.

### Black and Blue-Black

There are literally hundreds of formulae for the making of black and blue-black writing inks of the above type. Below is a typical formula for black ink:

| | |
|---|---|
| Nutgalls . . . | 2 ounces |
| Sulphate of iron . | 3/4 ,, |
| Sugar . . . | 1/8 ,, |
| Gum Arabic . . | 2/3 ,, |

*In the production of "old-fashioned" black writing inks, the ingredients must be well shaken up in a bottle every day for a fortnight.*

Crush the nutgalls and place them into a large bottle together with a pint of water, the sugar and the gum arabic. Cork the bottle tightly and allow it to stand for a day. After this, add to the mixture the sulphate of iron and add, also, several large cloves and two teaspoonfuls of vinegar. Allow the mixture to stand for a fortnight, shaking it thoroughly two or three times a day. At the end of the fortnight, filter the ink into a clean bottle. It will now be ready for use.

The above ink gives a rather pale writing at first, but, after a day or two, the written characters take upon themselves a warm-black appearance of very satisfactory depth. This is what we may term an "old-fashioned" ink and the writing which it gives is of the old "copper-plate" tone.

A more modern type of blue-black ink may be made up according to the following formula:

### Blue-Black Ink

*Solution A*

| | |
|---|---|
| Sulphate of iron . | 3½ ounces |
| Water . . . | 6 ,, |
| Sulphuric or hydrochloric acid . | 4 drops |

*Solution B*

| | |
|---|---|
| Tannic acid . . | ½ ounce |
| Water . . . | 6 ,, |

*Solution C*

| | |
|---|---|
| Methyl or methylene blue . . | 12 grains |
| Methylated spirit . | ½ ounce |

Add Solution C to Solution A and then add to the latter Solution B and shake well. The ink will be ready for immediate use and will give a good blue-black colour. If the ink runs too freely from the pen, thicken it slightly by adding a small sprinkling of sugar and a little gum arabic solution.

### Dense Black Writing

A fairly recent type of writing ink which gives a dense black writing may very readily be made by mixing an eight-per-cent. solution of gallic acid with an eight-per-cent. solution of ferric chloride. Strong ammonia is then added to the mixed liquids until the smell of the ammonia persists. Finally, good quality methylated spirit is added to the mixture, drop by drop. This will precipitate a black powder. The latter should be filtered off and dissolved in a little water to which a few drops of vinegar or acetic acid and a little gum arabic solution have been added. The black solution, which contains ammonium ammonium-ferrigallate, gives written characters which, in a few hours, become an intense black and which, next to Indian ink, are absolutely permanent.

Indian ink, of course, is the most permanent of all writing or drawing inks, since it contains insoluble carbon suspended in a suitable gummy medium.

To make Indian ink, we start with lampblack or vegetable black. Place a little of the black at the bottom of a mortar or deep basin and add to it a small amount of thin gum arabic solution. Grind the lampblack and the solution together. Add more lampblack and more gum arabic solution and continue the grinding process. The task is a rather tedious one, for it is difficult to get the lampblack and the gum arabic solution to mingle together properly. When however, the latter aim has been achieved, the black liquid should be filtered through cotton wool. It will not filter easily and will probably have to be pressed through the cotton wool.

To each ounce of the resultant black liquid add two drops of a strong solution of potassium bichromate. This will render the writing insoluble after it has been on the paper for a short time. Add to the ink, also, a few drops of clove oil, or some other preservative in order to prevent the gum arabic from becoming mouldy. If clove oil cannot be obtained, a few drops of a strong extract of ordinary kitchen cloves in water will suffice.

### Indian and Coloured Inks

Indian ink prepared as above will produce a somewhat "warm" black writing. To get a dead black writing, it is usually necessary to incorporate a trace of indigo or of some deep blue tube-watercolour with the ink. If the ink flows too freely from the pen, add a few drops of strong gum arabic solution. If, on the other hand, the ink tends to clog the pen, add to it a drop or two of water.

Coloured inks are not difficult to make. They are not, of course, as permanent as the black and blue-black writing inks and many of them will fade in the sun. Nevertheless, coloured inks have many uses nowadays and there is little doubt that the amateur ink maker will desire to prepare a number of these coloured writing fluids for his own use.

Coloured writing inks are generally solutions of suitable dyestuffs in water. To the resulting aqueous solution of the dyestuff is usually added a little methylated spirit, sometimes a trace of glycerine and a trace, also, of some thickening agent such as gum arabic.

To make such inks, we dissolve the dyestuff in water until a suitable "strength" of ink has been made. To the resulting solution, add a few drops of gum arabic solution, a drop or two of methylated spirit and a small pinch of sugar. Also, since gum arabic and sugar are present in the solution, a drop of clove oil or other preservative must be added to prevent souring of the ink.

### Dyes for Coloured Inks

Whilst any dye will dissolve in water to give a coloured solution, not every colouring agent will thus produce a satisfactory ink. For the preparation of coloured writing fluids the dyestuffs employed must be of the "basic" or "acid" variety. Suitable dyes for coloured ink preparation are given herewith :

*Red.*—Eosin. Magenta. Erythrosine. Rhodamine. Cotton Scarlet. Ponceau Scarlet.

*Making Indian ink. The ground-up mixture of lampblack and gum arabic solution being filtered through cotton wool.*

*Green.*—Diamond Green G. Acid Green. Malachite Green. Neptune Green. Light Green, S.F.

*Yellow.*—Acid Orange. Fast Yellow. Tartrazine.

*Brown.*—Bismarck Brown. Naphthalene Brown.

*Violet.*—Methyl Violet.

*Blue.*—Soluble Blue. Methyl Blue. Methylene Blue. Alkali Blue.

*Black.*—Nigrosine.

All the dyes above can be obtained fairly cheaply from chemical supply firms and, of course, only small amounts of them are needed for ink making on a small scale.

Novelties in ink shades can be produced by mixing various coloured writing fluids together and, indeed, the number of colours and shades which such inks can be made in is almost infinite.

As mentioned at the commencement of this article, the beginner in ink making may possibly experience trouble, not in getting the desired shade of ink, but in producing an ink of the correct consistency. If an ink is too thin so that it "blobs" off the end of the pen nib and gives a badly defined outline on the paper, it may be thickened up by adding, drop by drop, a quantity of strong gum arabic solution. If, on the other hand, an ink is too thick, it is best thinned down by adding to it a little methylated spirit. Inks which contain too great a proportion of sugar will dry with a shiny surface and they will not be waterproof.

It should, perhaps, be pointed out that none of the coloured inks prepared from dyestuffs is waterproof, since when characters written in such inks are placed under water, the dyestuff "bleeds" and is absorbed by the surrounding areas of the paper.

All iron-containing inks and, of course, Indian ink should be waterproof, since it is in such inks that all permanent records are written.

### Waterproof Ink

To test the permanency and waterproof nature of an ink, write with the ink on two sheets of glazed paper. Do not blot the writing. Let it dry spontaneously and then allow it to remain exposed to the air for twenty-four hours. At the end of this period take one of the sheets of paper and immerse it bodily in a dish of water for an hour. Then withdraw the paper from the water bath and allow it to dry. The paper which has been immersed in water should now be closely compared with that which has not been so treated, and any "running" or "bleeding" or other lack of permanency of the ink will at once be discernible. A good black writing ink after this immersion treatment should be almost indistinguishable from a comparison sample of the ink which has not been thus treated.

Finally, it is well to remember that if any ink is to achieve its greatest degree of permanency, the writing should not be blotted. The act of blotting written characters removes some of the ink from the paper. The "balance" of the ink ingredients on the paper is thus disturbed and, particularly in the case of iron-containing inks, the ingredients cannot thereafter undergo efficient atmospheric oxidation to produce the insoluble black compound which is so vital to the permanency of the ink.

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## MARVELLOUS METALS

(*Continued from page* 455)

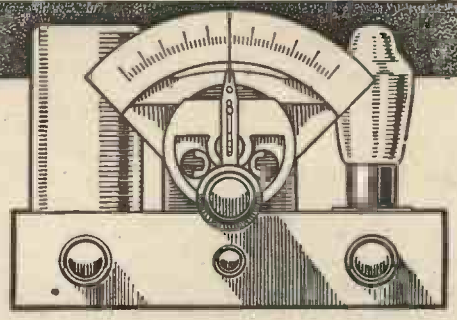
can be obtained in the pyrophoric condition. Of these, the most easily prepared is pyrophoric lead. Take a solution of a lead salt, such as lead nitrate or lead acetate, and add to it a solution of tartaric acid or cream of tartar. A white precipitate of lead tartrate will instantly be formed. Filter off this precipitate, wash it with a little water and allow it to dry in a warm oven. Now take a quantity of the dry lead tartrate and heat it gently in a test tube. Fumes will be evolved and the lead tartrate will turn black. After the fumes have ceased to be given off, cork the tube tightly and let it cool down. The black substance inside the tube will now consist of metallic lead in so fine a state of powder that when it is scattered on a sheet of paper it will glow brightly for a few minutes. Or, alternatively, if the powder is shaken out of the tube it will give rise to a shower of sparks as it falls to the ground. Pyrophoric lead should never be made in large quantities, since it has a nasty trick of self-ignition at unexpected moments.

Another extraordinary fire-producing metal is cerium. If metallic cerium and, in particular, a cerium-iron alloy, is struck with a flint, it will emit a copious shower of sparks. This property is taken advantage of in the production of modern cigarette-lighters, the so-called "flints" of the lighters actually consisting of some alloy of cerium and iron.

All metals, it is well known, expand when they are heated and contract when they are cooled. There is, however, one metal, or, rather, one alloy in which this expansion-contraction process is reduced practically to nil. This is the alloy which is now universally known as *invar*, a word which has been aptly coined as an abbreviation of "invariable." Invar is a bright, shining alloy, consisting of steel alloyed with 36 per cent. of nickel and 5 per cent. of manganese. Such an alloy is most remarkable in regard to the fact that at all ordinary ranges of temperature it does not expand or contract more than one-millionth of its own length for every degree which it may be raised or lowered in temperature.

Antimony is a common metal and it is used for many purposes. It is not generally known, however, that antimony can actually be obtained in an explosive condition. To make explosive antimony, it is necessary to electrolyse a solution of antimony trichloride in hydrochloric acid, using an antimony anode and a platinum wire as a cathode. The explosive antimony will be deposited on the cathode in the form of a firmly-adhering graphite-like material. When rubbed or scratched, this material will explode sharply, giving off white fumes.

# The PRACTICAL MECHANICS WIRELESS EXPERIMENTER



ALTHOUGH tried and tested circuits are always to be preferred for reliable and consistent results, there is much to be gained from a trial with a novel circuit. By novel, I refer to unorthodox arrangements, as the adoption of the two elements of a Class B valve as a separate detector and amplifier, or the combined Class B and driver valve to make up a three valve circuit with reflex working.

The experimenter is always trying out new arrangements and no doubt many novel schemes are invented from time to time. The super-regenerative circuit is one which has always been a favourite especially with the short-wave listener, and the merits of this circuit are already well-known. A version of this circuit which has been developed in Australia is shown in Fig. 1 where it will be seen that the modern triode-hexode valve (used for frequency-changing in the superhet) is pressed into service for a single valve receiver.

## UNUSUAL CIRCUITS

THE EXPERIMENTER WILL FIND IN THIS ARTICLE, SOME INTERESTING DEVELOPMENTS, WHICH HAVE ARISEN AS A RESULT OF THE PRODUCTION OF NEW VALVE TYPES.

### Super-Regeneration

In this valve the various elements are used in such a manner that they function as two separate valves. The normal rectification is carried out by means of the hexode section of the valve, whilst the triode portion is employed for the quenching oscillator. The standard coils may be employed for tuning, reaction, and quench coils. These may be home-made, or the standard commercial coil units. The H.T. applied to the oscillator section may be found critical, and a suggestion is made to use an entirely separate battery for the purpose. In this case the two negative terminals should be joined together and to earth. Obviously, the circuit is an experimental design with which considerable latitude is possible and some adjustments may be found very critical.

### Volume Expansion

A circuit which is receiving much attention on the other side of the Atlantic is known as automatic volume expansion, and this aims at restoring the correct level or balance of volume. It does not appear to be popular in this country, and some valves which were formerly developed especially for the purpose in England have now been withdrawn by the manufacturers on this account. In America, however, a new valve has been introduced recently, and takes the form of an L.F. pentagrid. With the aid of this valve several interesting circuits are possible, and two suggestions are given in Figs. 2 and 3. In Fig. 3 two additional valves are required for the complete circuit which is the design incorporated in certain Radio Corporation of America receivers. All values recommended by this company are shown on the diagram and it will be noted that in addition to the volume control, a separate control for the degree of volume expansion is included.

The input is fed to both the control grid of the special valve mentioned as well as to the triode valve, the grid of the latter being joined to the arm of the expansion control. Thus any desired degree of input voltage may be fed into this valve. Standard resistance-capacity coupling is used between this triode and a double diode, or full-wave rectifier, the output of which is fed back into the special L.F. pentagrid. Here it mixes

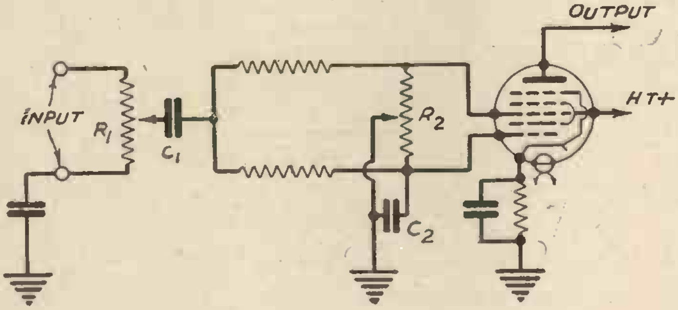



*Fig. 2.—Another American circuit, known as a programme expander. The arrangement is shown diagrammatically in Fig. 4 overleaf.*

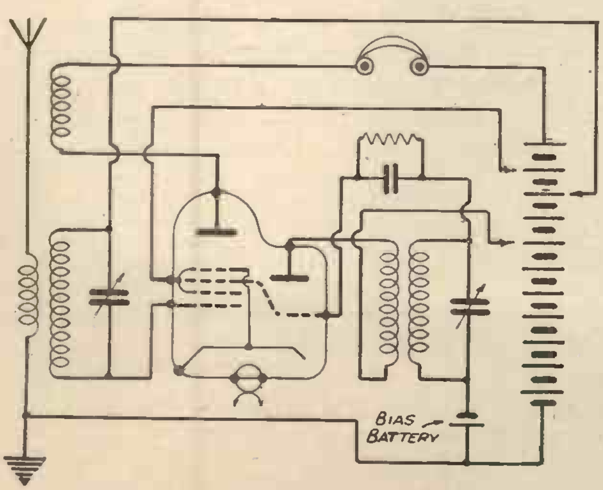



*Fig. 1.—A suggested form of super-regenerative receiver employing a triode-hexode valve.*

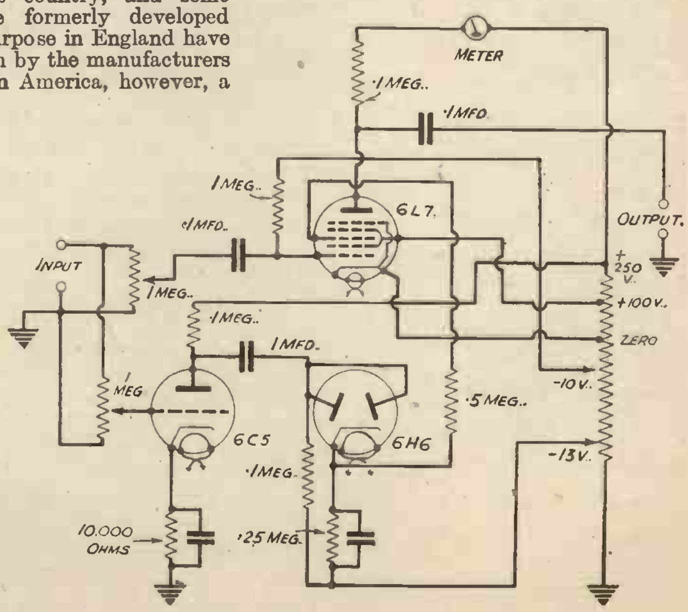



*Fig. 3.—A novel circuit used for volume expansion. This arrangement is now being incorporated in certain American receivers.*

with the normal signal in a rather peculiar manner. The rectifier is so connected as to feed a positive voltage to the 6L7 valve, and a very large initial negative grid bias is already applied to this. The positive input reduces this bias so that a low volume input will be very slightly affected, but a large volume will be greatly amplified, and thus the quiet passages are rendered very subdued whereas the loud passages are inceased in strength, and thus the arrangement is referred to as 'volume expansion.' The control P must be adjusted for the particular characteristics of the 6L7 valve in use and the makers recommend that it be set to provide an anode current of about .15 mA with no signal.

### An Alternative Scheme

Utilising the same valve, the makers of the Midwest receivers have evolved a different circuit with a similar result. Here, however, the lower musical frequencies are amplified separately and are then combined with the remainder of the musical scale, and the makers have christened this scheme—'The Dual Channel Audio Fidel-A-Stat Program Expander.' The theoretical arrangement is given in Fig. 3 from which it will be seen that a push-pull effect is obtained, the input being developed across a standard volume control, and the arm of this being fed through a condenser to a pair of resistors. These feed two grids in the 6L7 valve, but a potentiometer is connected

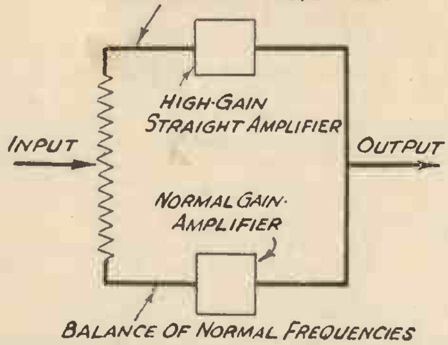



*Fig. 4.—A diagrammatic representation of the circuit arrangement shown in Fig. 2.*

across these grids with the arm earthed. The selection of the grids is made so that one portion has a greater amplification factor than the other, and the scheme may be re-drawn as shown in Fig. 4. The condenser C2 serves to by-pass the low-frequencies from that part of the circuit and thus leaves only the higher frequencies for treatment by that part of the valve, whilst the setting of the potentiometer R2 governs the proportion of the two signals which is fed into the valve. It will be noted that the great advantage of this scheme is that the arm of the control potentiometer R2 may be so set that one portion of the valve becomes inoperative, that is, the grid will be directly earthed, and this leaves the circuits in quite a standard form, giving normal reproduction. As this control is turned, the lower frequencies are fed into that part of the valve and consequently appear in the output circuit in an increased proportion, due to the added amplification. As the control is adjusted to reduce the higher frequencies, the amplification is automatically increased to compensate for the apparent decrease in amplification, and thus a very wide range of reproduction effects is possible.

The valve mentioned in this article type 6L7 is on sale in this country and may be obtained from advertisers in this paper. Unfortunately, there is no English equivalent for it.

# HOW VALVES ARE VACUATED

## Modern Methods in Construction

IN industry to-day it is quite commonplace for large sums of money to be spent in achieving this or that, but valve manufacturers spend a lot of money in making quite sure that their valves are absolutely full of nothing, or, to be technically accurate, to ensure that they are full of as little as possible. Readers will be well aware that a valve would not work unless the air was pumped out of the bulb, but few who turn on their radio to enjoy the programme (or be desperately bored) have any idea of the enormous expenditure of time and money directed towards producing the very highest possible vacuum, for not only must the vacuum be high when the valve is made, but it must stay so throughout its long life, because any air or gas trapped in the metal or glass itself could easily be released by bombardment from the electron stream, which is the life-blood of the valve.

### Baking Process

Precautions start in valve manufacture at a very early stage by making sure that the nickel and other metals used are absolutely free from impurities which could lead to trouble.

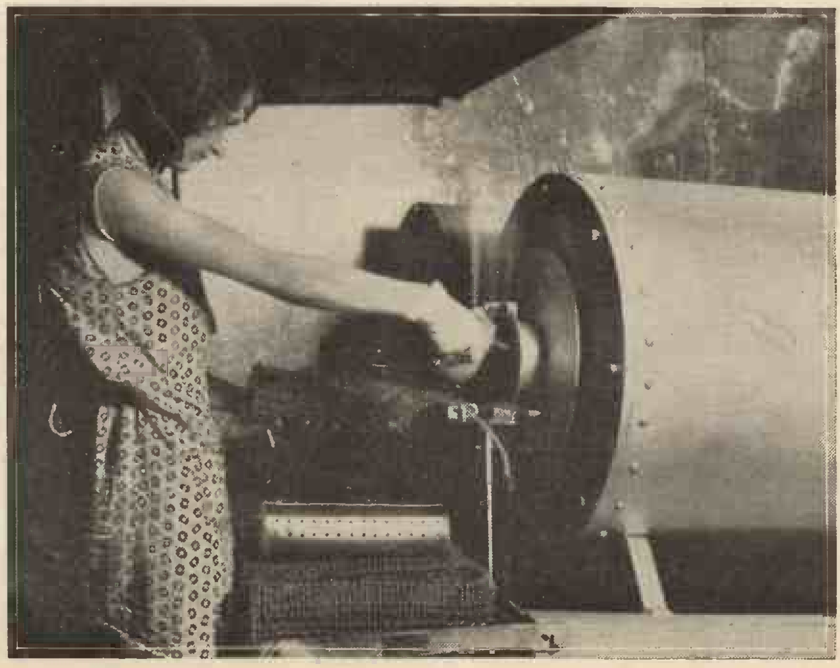
When the innumerable metal parts of a valve are made, before they are assembled they are put into an oven and baked at round about 1,500 degrees Fahrenheit, with a view to driving out any gas that may be trapped beneath the surface. Precautions are then taken to see that they are not touched by fingers, and assembly proceeds until the parts are safely housed in the glass bulbs which are sealed on gigantic pumps which commence the work of removing the oxygen, nitrogen, and other gases in the bulb. Ten years ago the precautions outlined above would have been considered more than sufficient, but to-day far more elaborate precautions follow.

### Sealing the Bulbs

While the actual pumping is in progress, copper coils attached to a short-wave oscillator drop over the valve, and heat the metal electrodes to a cherry red, this process being repeated two, three, or even four times according to the type of valve. Eventually the glass bulb containing the electrodes is sealed, and the valve is cemented into its base.

However carefully a valve is pumped, there are bound to be stray atoms of gas, as there is no medium between these atoms and the pump itself. To overcome this difficulty a small piece of magnesium ribbon, or other suitable substance, is placed within the valve, and called the "getter." At the appropriate time the magnesium ribbon is heated by bringing an intense magnetic field to play upon it, resulting in the instant disintegration of the magnesium, which, due to the absence of any air pressure, flies outwardly, the leading atoms picking up the stray atoms of gas and carrying them to the glass bulb, where they are duly imprisoned by the subsequent layers of magnesium which deposit themselves, forming the familiar mirror-like backing associated with the modern valve.





*A process in the heat-treatment of Cossor valves. One of the electric furnaces that heat the valve parts in an atmosphere of hydrogen so that all traces of unwanted gas are driven from the metal; the temperature used often reaches 1,500 degrees Fahrenheit.*

# The Latest Novelties

## Interesting Items Now on the Market

### A Musical Alarm Clock

INSTEAD of being aroused each morning by the usual strident alarm bell, it is now possible to be awakened by the soothing strains of " The Blue Danube," or if one has dined unwisely the previous evening to be roused by " The Music Goes Round and Around " would perhaps be more appropriate. These are just two of the tunes obtainable with a musical alarm clock which has now made its appearance on the market. When purchasing the clock you have the choice of one hundred tunes

*The attractive appearance of the musical alarm clock.*

from which to make your selection. Special tunes can be had on demand.

The clock is fitted with a luminous dial and is attractively finished in chronium. It is obtainable with either a round or square base. Tunes obtainable: John Peel—Should I ?—Auld Lang Syne—Here's a Health unto His Majesty—God Save the King—Home Sweet Home—Widdicombe Fair—Blue Bells of Scotland—Happy Days are Here Again—Down at the Old Bull and Bush—Washington Post March—Old Folks at Home (Swanee)—A Gipsy Song—Easter Parade—Angels Serenade—Come, Landlord Fill the Flowing Bowl—The Music Goes Round and Around—Who's Afraid of the Big Bad Wolf ?—The Blue Danube—The Merry Widow—White Horse Inn—Dollar Princess—Gold and Silver, etc.

### A Self-contained Electric Razor

MOST men look upon shaving as a tiresome necessity. On this page we show a self-contained electric razor known as the " Telerazor " which has been designed to give a perfect shave in the minimum of time. It is only necessary to hold the razor in the hand and guide it slowly over the face. There is no need to scrape or apply undue pressure. You just let the " Telerazor " shave you.

It derives its energy from a tiny battery within the handle. This actuates an ingenious electro-magnetic oscillator which sets up thousands of vibrations per minute. Due to their special nature and high frequency, these vibrations are singularly effective, yet they are so fine that they cannot be seen and are scarcely felt.

The vibrator strikes the inner walls of the

*The self-contained electric razor which is designed to give a perfect shave in the minimum of time.*

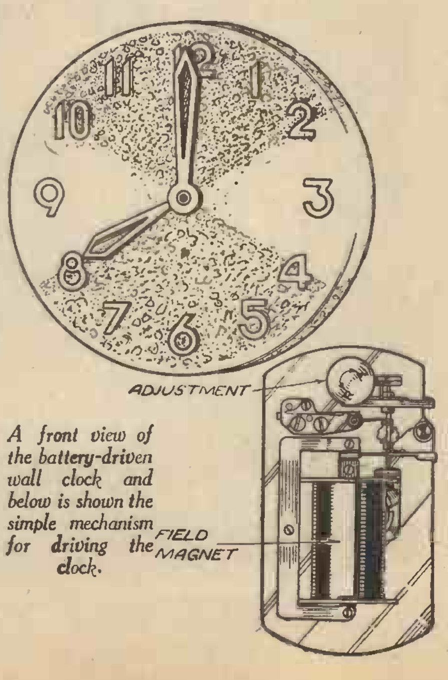
handle with a double hammerhead impact, the direction of the vibrations being parallel to the edge of the blade. This gives an imperceptibly fine action that shaves you closely and smoothly.

The stroke imparted by the vibrator is reversed sharply and at such high speed that there is no " dead " point or period of rest.

The curved razor head is of the most advanced Sheffield design and bends the blade to the correct shaving angle. Individual adjustment is made by a milled nut which also releases the head for blade renewal and cleaning.

The " Telerazor " is perfectly balanced, the handle being made larger than usual so that it is comfortable to hold, and the electric mechanism is safely housed within the upper part of the handle, which is water-tight and rust-proof.

The razor costs one guinea, additional batteries costing 2d. each.




*A front view of the battery-driven wall clock and below is shown the simple mechanism for driving the clock.*

### A Battery-driven Wall Clock

WE have recently had on test a serviceable and attractive battery-driven bakelite wall clock, known as the " Betty." It is obtainable from Orel-Micro Electric Ltd., 39-41, Berners Street, London, W.1., and is supplied in mahogany oak, walnut, green, black, blue, red, orange and grey bakelite finishes. It has a 9-in. dial and the simplicity of the mechanism can be seen from the illustration on this page. The movement is actuated by means of an ordinary pocket lamp battery obtainable anywhere at a trifling cost. When in use a battery will last six or nine months—it varies according to make. This is due to the very low current consumption of the clock, which under test, was found to be only 0·0005 amps.

We also tried the experiment of working the clock off a practically exhausted battery, and although only the minimum of current was passing, we found that over a period of three hours the clock did not slow down but kept perfect time. It costs 30*s.*, and in addition to the above finishes can be supplied in white or ivory at an additional cost of 2*s.* 6*d.*

### HEALTH AND STRENGTH

IN his search for health and strength Charles Atlas made a remarkable discovery. It is an entirely natural way of building massive but well-rounded muscles, through-and-through health and tireless vitality. Atlas does not believe in apparatus, springs or gadgets of any kind.

" Using apparatus in an effort to obtain muscular development," Atlas declares, " is like using a pair of crutches to help you walk. Use them long enough, and you won't be able to get along without them even if you started with a pair of perfectly good legs."

" Tigers, lions and leopards don't get their supple, steel-like, lightening-quick muscles by using dumb-bells. They use the self-same secret I discovered—Dynamic Tension. And they get only one kind of exercise—natural exercise."

To-day, Atlas has helped thousands of men from all walks of life, of all ages, from every corner of the earth. What work could be more worth while, more satisfying? He can help you too, if you fill in the coupon on page 476 of this magazine, he will send you his illustrated book *Everlasting Health and Strength* free.

### FLOODLIGHTING FOR THE CORONATION

FLOODLIGHTING is to play a very large part in the various decoration schemes designed for the coronation this year and, with its aid, many famous buildings in London and the provinces will be completely transformed next May. One of the leading firms who will be responsible for the biggest scheme is Philips Lamps Ltd., who have two systems of floodlighting which are being widely used all over the country. The Philips " Philora " sodium lamp has a remarkably beautiful natural golden light which picks out and accentuates every architectural detail, while the " Philora " mercury lamp has a blue and white light which is specially designed for floodlighting on festive occasions.

The lamps are remarkable for their high efficiency, long life, and low current consumption. A notable point is that colour filters, which greatly reduce the light output of ordinary lamps, are quite unnecessary as the colours are obtained by the natural characteristics of the lamps.

# MASTERS OF MECHANICS

*The passing of the air blast through a Bessemer "converter" is a spectacular operation resulting in the production of a shower of flame and sparks.*

## No. 21.—An Epic of Engineering

### The Remarkable Career of Sir Henry Bessemer, Master of the Modern Steel Industry

IT has been said that, next to the invention of the steam engine, Sir Henry Bessemer's introduction of mild steel about the middle of the last century contributed more to the progress of engineering and mechanical science than any other single discovery. Previous to Bessemer's first introduction of mild steel in 1856, the majority of heavy machinery had been made in iron—wrought iron and cast iron. True it is that almost a century before Bessemer's epoch-making invention steel had been made in one form or another. We are told, for instance, that in the eighteenth century, certain types of steel came from India and that this material sold for as much as five guineas a pound. Huntsman, a Doncaster clockmaker, in 1740, succeeded in producing small quantities of an impure steel for spring making and other purposes, but, apart from such usages, there was no demand for steel in the engineering world before the advent of Bessemer.

*Sir Henry Bessemer in a characteristic pose.*

#### Born in Hertfordshire

Henry Bessemer was born in the little Hertfordshire village of Charlton on January 19th, 1813. He was the youngest son of one Anthony Bessemer, an individual who in many ways was himself something of a mechanical genius. The parent Bessemer, although London born, had spent a good deal of his lifetime on the Continent and had distinguished himself as an inventor. Settling in Charlton, however, Anthony Bessemer had sought to live a retired life and it was during this period of his existence that the future Sir Henry Bessemer was born.

Henry Bessemer received a good education and from his earliest years evinced a great aptitude for things mechanical. When he was seventeen years of age the entire Bessemer family removed to London, and young Henry Bessemer, who had picked up the art of making castings in metal, began to commercialise his hobby. Very soon he was making art castings for exhibitions and, at the age of twenty, he devised methods of reproducing such castings mechanically.

#### An Early Disappointment

It was at this period of his life that Henry Bessemer made the invention in reward for which he was knighted years afterwards. This invention comprised a method of mechanically perforating Government stamps in order to prevent their misuse. The invention was a simple one and it was adopted by the Government. Bessemer, however, it would seem, received not a penny in payment for his invention. He had foregone the patenting of his invention, relying upon the official promises of an adequate monetary reward for it which had been made to him. As a result of this early disappointment in life, Bessemer became a shrewd and a hard-headed business man and never again did he allow himself to be "caught" in matters respecting his subsequent inventions.

*A Bessemer "converter" in action. Air is being blown through the molten iron in order to burn away the impurities.*

It was about this time that Bessemer invented a bronzing powder for the colouration and protection of metals. With the aid of his brother-in-law, he commenced the manufacture of this material. So successful was the bronzing powder that its manufacture was carried on for nearly forty years.

In addition to devising the above powder, Bessemer, before he hit upon the steel-making invention which has made his name famous in the annals of engineering, brought out many ingenious processes and devices in one direction or another. Among these, we may mention a machine for grinding and polishing plate glass, and also several processes for purifying sugar and for mixing oils, paints, and other materials.

#### A New Type of Shell

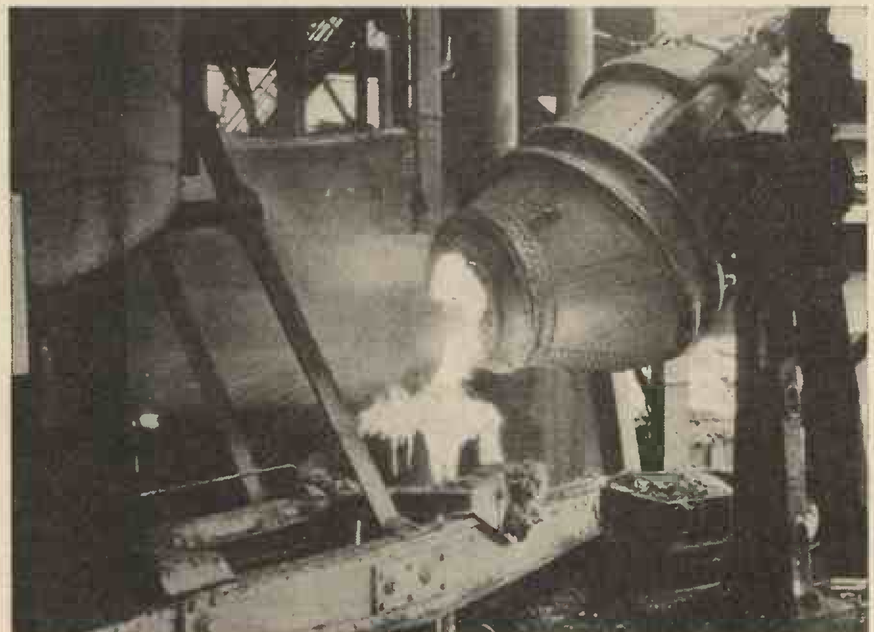
In 1854—the year of the Crimean War—Bessemer invented a new type of rotating shell or projectile which he considered to be superior to all existing forms of shells. He submitted his projectile to the British War Office and to the authorities of the arsenal at Woolwich, but from both quarters he met with a blank and uncompromising refusal to have anything to do with the invention. Bessemer, therefore, decided to look for an outlet for his invention abroad. He met with great encouragement at the hands of Emperor Napoleon III, who not only granted the inventor many facilities for demonstrating his new projectile but also actually placed funds at his disposal in order to enable him to defray his expenses.

Bessemer's demonstrations of his projectile were eminently successful, but one of the French military experts, a Commandant Minnie, remarked, when giving his judgment: "The projectiles rotate properly, but if Mr. Bessemer cannot get a stronger metal for his guns, such heavy projectiles will be of little use."

Bessemer took these words deeply to heart. A new metal for guns. At that time the heaviest cannons were constructed throughout of cast iron—and how could iron be made stronger ?

Bessemer, at this period, had very little knowledge of metallurgy. Nevertheless, he was a fervent adherent of the theory that if you enter a trade or a sphere of activity of which you know very little or nothing at all, you are, at times, more likely to make headway in it and to devise improvements than are many individuals who have been connected with that sphere of activity throughout their careers. Bessemer, therefore, convinced of the truth inherent in Commandant Minnie's judgment, gave up the whole of his energies to acquiring knowledge and information on the subject of metallurgy in general and of iron manufacture in particular.

Up to the year 1856, almost the entire bulk of the iron used in the world's industry was either cast or wrought. Cast iron could be obtained in large amounts and produced in intricate designs and mouldings.



*Molten steel mechanically poured from a Bessemer " converter " into waiting pads.*

Wrought iron, on the other hand, although stronger and more enduring, was produced only with comparative difficulty, whilst steel, apart from its very restricted uses, was almost unknown in industry.

**Producing Steel**

Having acquired as much knowledge as he could on the subject of ironmaking, Bessemer, with characteristic definiteness, settled again in London and, purchasing an old factory at St. Pancras, gave himself over to the task of producing steel in commercial quantities.

Of the many semi large-scale experiments which Bessemer devised at this particular juncture we have not the space to relate. Eventually, however, the indefatigable experimentalist discovered that by melting up cast iron in a special type of furnace and then by blowing a current of compressed air through it, the impurities were, to a large extent burnt out of the molten metal which, ultimately, was almost completely converted into soft, malleable " wrought " iron. If the air-blowing operations were stopped before all the carbon was burnt out of the molten iron, a product was obtained which showed properties intermediate between those of cast and of wrought iron. This of course was steel, and before long the Bessemer steel came to be known as " mild steel."

Cast iron, as the reader no doubt will be aware, contains many impurities, chief among which is carbon. When the carbon is burnt out of the iron and most of the other impurities are removed, the iron is obtained in an almost pure condition, in which state it is known as " wrought iron." If, however, a definite small percentage of carbon is allowed to remain in the metal, the product is then known as " steel."

**Success and Failure**

Bessemer was quick to commercialise his process of steel manufacture. By means of it, the molten iron was run into a barrel-shaped vessel which he called a " converter " in which it was subjected to the action of an air blast. Large quantities of steel, Bessemer showed, could be manufactured by his process and, after patenting it, he profited to the extent of some £27,000 in respect of payment for licences to work the process which he granted to competing iron-producing firms.

Bessemer's success, however, was but short lived. The licencees of the process found, after repeated attempts, that, even when they followed Bessemer's instructions to the letter, the steel-making process simply did not work.

At this stage, the circumstances which Bessemer found himself in were not enviable ones. He was regarded as a trickster and a charlatan, as a mere opportunist and a selfish money-maker.

Bessemer himself, however, was quite unable to explain the failure of his process. In his attempts to solve the perplexing problem, he enlisted the aid of eminent chemists to make analyses of the materials involved in the failure of his process. Eventually, these investigations showed plainly that the failure of his process in the hands of the iron manufacturers was due to the fact that the latter were all using as raw material iron which contained relatively large amounts of phosphorus. Now Bessemer's " converting " process did not remove the phosphorus from iron. Bessemer, himself, had been successful with his process simply because, in his trials, he had happened to use iron which was practically free from phosphorus.

**Costly Experiments**

Nearly two years were spent by Bessemer in costly and laborious experiments in the removal of phosphorus from pig iron before it was subjected to his " converting " or steel-making process, but all these experiments ended in failure. Ultimately, therefore, he had to rely for the success of his process upon supplies of foreign pig iron which were very low in phosphorus content.

It now remained for Bessemer to arrange for an ample supply of Swedish iron ore, low in phosphorous content, to be imported into this country and to be placed at the disposal of the iron manufacturers. This he did, but, unfortunately, the iron manufacturers, frightened at the memories of their former losses and disappointments, would have nothing more to do with Bessemer or bis process. Instead, they continued to pin their faith to cast iron as the strongest form of iron which could be produced commercially in large quantities.

The Bessemer Company itself, however, forged ahead with its production of mild steel by its own process. Gradually it became able to introduce its steel into commercial undertakings. For instance, in 1861, rails made from Bessemer steel were laid down at Crewe railway station, and at the International Exhibition of 1862 the Bessemer Company exhibited steel forgings comprising gun barrels, cylinders, shafts, and so forth, all of which demonstrated the great and enduring value of the new Bessemer steel.

After the advantages of the new steel had been proved, the demand for licences to manufacture it began to grow once again. Bessemer, it has been estimated, netted more than a million pounds in royalties from his steel patents alone and, before long, he found himself one of the most talked of men in the industrial world.

**Other Countries Interested**

The manufacture of Bessemer steel soon spread to other countries. Bessemer steel plates gradually began to be employed by shipbuilders and, after a few more years had elapsed, the all-wood sailing vessel had become a thing of the past.

It is curious to note that, despite the universal success of Bessemer steel, which, indeed, had originated from Bessemer's attempts to make a strong metal for guns and other military purposes, the authorities at Woolwich Arsenal remained for a long time conservative and refused to have anything to do with Bessemer's steel, placing their faith, instead, in cast iron as a metal for ordnance construction.

Bessemer, at the height of his success, received the honour of knighthood as a reward, it was mentioned, for his early invention of a means of making Revenue stamps " forgery-proof."

The subject of astronomy also occupied Bessemer's attentions. He had constructed for his own use, a number of powerful telescopes with which he made observations and, at the time of his death, which took place on March 15th, 1898, the famous inventor and steel maker was busily occupied with plans for the construction of a giant telescope of his own special design.

# A SCALE MODEL OF THE "GREAT BRITAIN"

By W. J. Bassett-Lowke

ONE of the most famous and, at that time considered the most daring ship known, was built in 1843 for the Great Western Steamship Company.

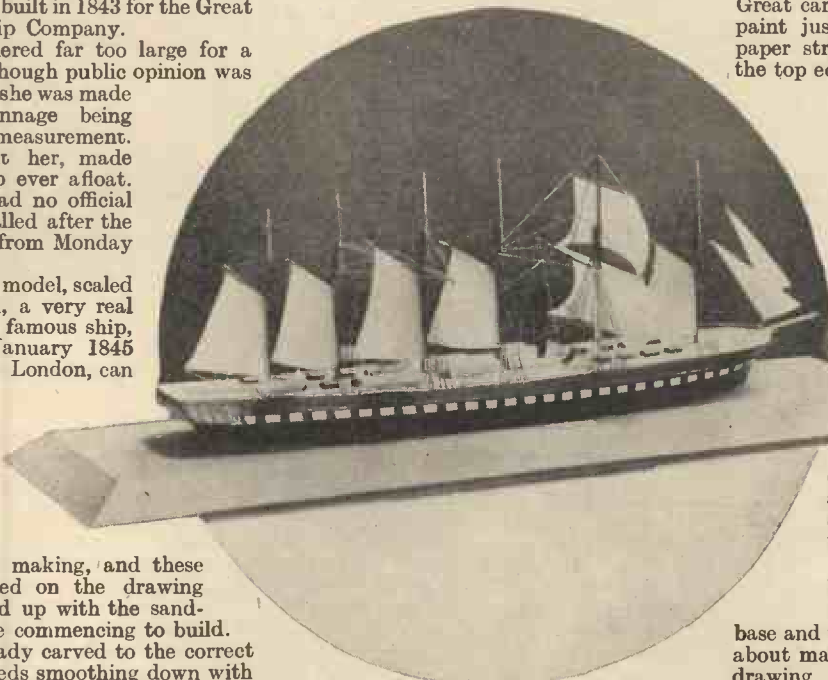
She was considered far too large for a wooden hull, so, though public opinion was greatly against it, she was made of iron, her tonnage being 3,448 in the old measurement. Brunel, who built her, made the strongest ship ever afloat. Her six masts had no official names, so were called after the days of the week from Monday to Saturday.

In building this model, scaled 50 ft. to one inch, a very real impression of this famous ship, as she was in January 1845 steaming down to London, can be pictured.

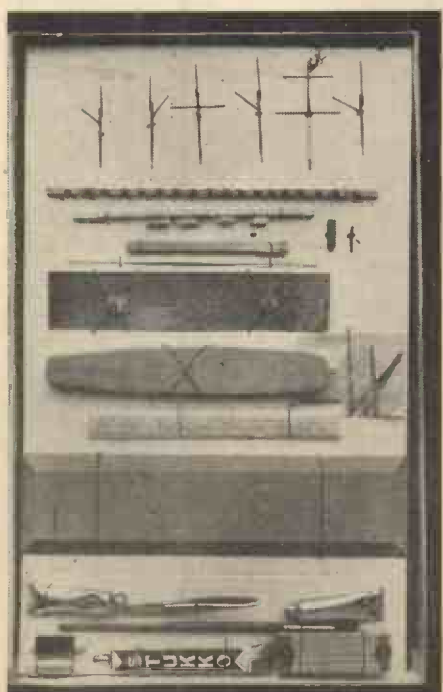
### The Construction Set

The construction set described contains all the parts which go to her making, and these should be checked on the drawing and gently cleaned up with the sandpaper block before commencing to build.

The hull is already carved to the correct lines, and only needs smoothing down with fine sandpaper, then the piece of planked decking is glued neatly into position. When this deck is dry, trim off carefully close to the hull with a sharp razor blade. This decking must lie perfectly flat or your deck fittings will not lie down. The two narrow strips of white paper in the set are glued to the side of the hull, the correct position of these being taken from the drawing. These strips are to help you to line the position of the mock gun ports, so they must be carefully fitted. The sides of the hull are now painted with a nice even coat of white paint, making quite sure you cause no runs. Now leave the hull to dry and paint white the rest of the unpainted fittings; these consist of deck houses and companionways. It is best to mount these parts on pins before painting them, allowing them to dry in an upright position. The little brown skylights are already painted and mounted for you and will be vastly improved by painting the tops with light grey paint (make by mixing a little black and white paint together).



*The finished model.*



*The kit of parts for making the model.*

### The Windows

Then the suggestion of the windows may be put in with a fine-pointed pencil. Alternately, instead of painting, you may use the strip of blue paper enclosed in the envelope to stick on the hatches for the window effect, cutting tiny squares from the strip and sticking into position, and indicating the frames with pencil lines. Make these windows before the skylights are stuck to the model, as they are much easier to handle. When the white paint on the hull is hard and dry, you can proceed to apply the black paint. Great care must be taken to line the black paint just up to the edge of the white paper strip, and from the deck down to the top edge of the strip, leaving the white band round the hull. The black portholes marked on the white band can be lightly sketched in pencil before painting in with black with a fine paint brush. Or, as before, the portholes can be cut from the black paper in the little envelope. The stern windows look more realistic if they are painted in with light grey paint, or stuck from the blue skylight paper, and will convey the impression of glass when picked out with fine brush strokes of black paint. A touch of gilt to represent the carving on stern and bows which always graced these old ships will also enhance the appearance of the model.

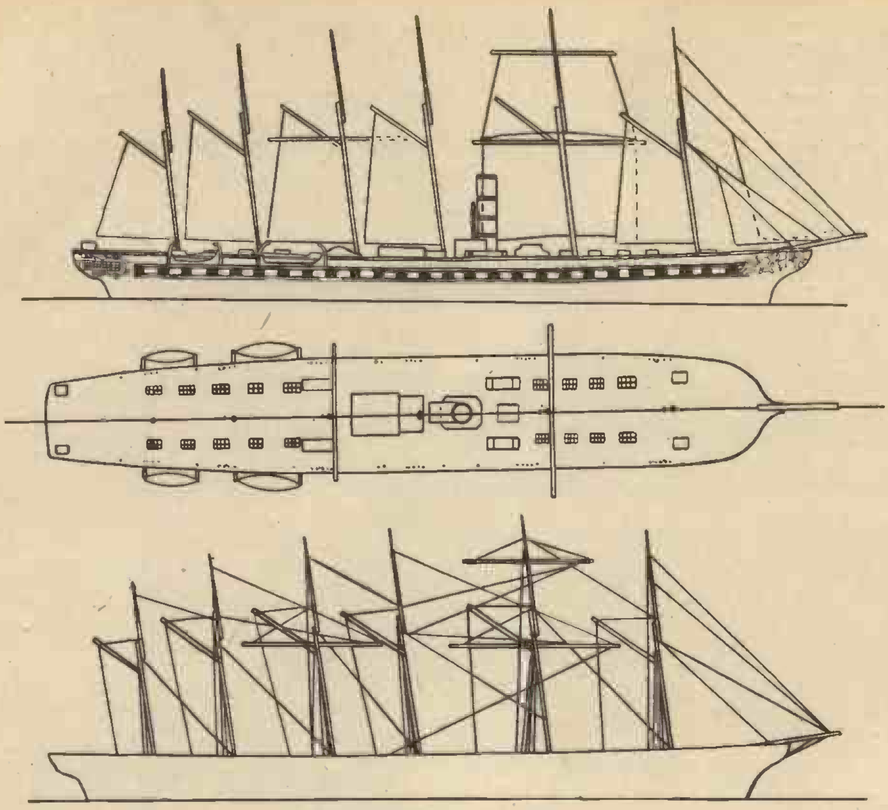
### The Hull

The hull is now fixed to the blue base and when thoroughly dry you can set about marking the mast stations from the drawing. The holes to take the masts should be drilled with a drill made by placing a stout pin in a wooden skewer or penholder and filing the end. Drill the holes carefully and try not to spoil the lined decking. Stick the masts in position with glue and see they line up, to follow each other in correct rake with the drawing. The bowsprit is fitted in the same manner, the end of the sprit being bent at right angles and fixed with glue into the holes drilled at the bows.

Mark the positions of the skylights on the deck, and fix with a little adhesive. The deckhouses and companion ways are easily located from the drawing and stuck in the same way. Before commencing to rig, mark accurately the position of the lifeboats and drill the holes to take the davits.

The funnel and steam pipe have already

*Details of the sails.*



*Details of the masts and rigging.*

been painted, the funnel is fitted by sticking with glue into the deckhouse shaped to receive it, a hole is then drilled behind the funnel, large enough to take the steam pipe, the pipe is then fitted to the height shown in the plan.

Now comes the interesting task of rigging. With a fine drill make all the holes of either side of the masts to take the standing rigging. Commence rigging the foremast with black cord, by tying the first rope just below the stepping in the mast. Keep all the knots, which need only be single ones, at the back of the mast.

### Fitting the Shrouds

Take one end of the cord and fit into the first hole, say on the port side of the ship, making fast with glue. The other end of the rope is fitted into the first hole on the starboard side. Following the plan you can fit all the shrouds to the masts in this manner. The forestays are ropes which run from the front of one mast to the foot of the next, but again the rigging plan will help you. Fit the lower forestays first, then follow through with the top forestays. Tie the backstays, ropes which run on either side of the masts in the manner of shrouds, with knots at the back, and make fast in the holes following the shrouds.

For running riggings use the cream rigging cord. Commence by tying a length of cord at the end of each gaff, and making the rope, which is called a vang, fast in the hole which should be drilled in the deck following the shrouds and backstays. The lifts on the three yards are easily traced on the rigging plan. The rope on the main mast lower yard runs back and is made fast between the third and fourth mast, in a small hole, with glue. Trace the lifts of remaining yards on the rigging plan, the main mast yard back to the third mast, and the lift of the fourth mast yard back to the fifth mast.

### Sprit Sails

The two ropes which run from the foremast to the bowsprit are to carry the sprit sails, and the end of these two ropes may continue below the sprit and be made fast in the stem post, thus giving a suggestion of rigging to the bowsprit.

With the rigging complete, you can fit the lifeboats, after cutting the davits to correct length as shown on the drawing. All knots of the rigging should be touched with adhesive to ensure durability.

Cut out the sails with sharp scissors, one at a time, and fit. Start with the gaff of the fore mast first, fixing with a little adhesive, and follow through, completing each mast. Sheet lines may be fitted to the main sail and sprit sails by running a length of cream cord through the lower corners of the sails, the ropes being fastened on the port and starboard sides respectively.

# OUR BUSY INVENTORS

### For His Majesty the Baby

THE evolution of the baby's feeding bottle is an interesting study for those who are concerned with the welfare of the child. I am informed that a calf's teat was originally used in the artificial feeding of an infant. An inventor has devoted his attention to the improvement of the current mechanical foster-mother. His conception has produced a bottle having a feed of liquid to a contractible and expansible chamber formed by an elastic-walled teat. There is a liquid one-way device between the bottle and the teat, and provision is made for the admission of air to the bottle. The aim of this invention is to prevent the drawing in of air with the food, which causes digestive troubles. His Majesty the Baby is not a pneumatic tyre.

### Transparent Trousers

THERE has just been patented in the United States a summer garment for ladies of a texture which may be described as a distant relation of chicken wire. A pair of trousers has been designed which, as far as each leg portion is concerned, is made of mesh-like fabric. It not only permits the cooling zephyr to have access to the nether limbs, but it reveals the contour of the latter. This super-diaphanous garment will at least match the tennis net.

### Washing Made Easy

WASHING day is always more or less a trying time for the housewife. Therefore, any means of reducing its inconvenience to a minimum is welcome. An improved domestic washing machine recently patented appears to possess features which commend it. This machine comprises the usual cylindrical drum which is made of sheet metal with perforations. But when the clothes have been washed and the cover is opened for their removal, the cover closes the perforations in the part of the drum adjacent to the opening. As a consequence, the arms of the housewife or her assistant are protected from the steam.

After the clothes have been washed, the water can be drained off, and the heating continued to cause hot air to circulate through the drum, which is preferably rotated at a higher speed than that used for washing. The machine can then be employed for the purpose of drying clothes—a boon on a wet day.

### Good News for Grass

WHAT may approximately be described as the common or garden method of watering a lawn consists in the use of a hose and sprinkler. This certainly resembles the practice of Dame Nature. But it is contended that the roots of grass have a tendency to move upwards to the surface to gather the moisture artificially sprinkled thereon, and that, consequently, they are liable to become scorched by the sun subsequent to watering. Also it has been asserted that the sun acting on the watered surface causes a hardening and thereby restricts the ventilation of the ground, which is essential to the health of vegetation.

To obviate these disadvantages, an inventor has conceived the idea of a lawn with a perforated pipe system beneath the ground level. The special character of these pipes is that the spacing of the perforations decreases or their size increases with increase in distance from the source of supply.

DYNAMO.

# BURGLARS
## 2nd Article
# AND HOW TO FOIL THEM

### A SYNOPSIS ON THE APPLICATION OF SIMPLE MECHANICS

THE previous article on this subject dealt with various types of electrical alarm circuits, and although the employment of the circuits dealt with would very well meet the majority of requirements, certain cases necessitate the inclusion or sole adoption of protective devices of a more mechanical nature, such as "double or counter locking," "mechanical rigger alarms," "protective blinds," etc.

Continuing with the question of alarms,


*Fig. 3.—A modification of a door lock.*

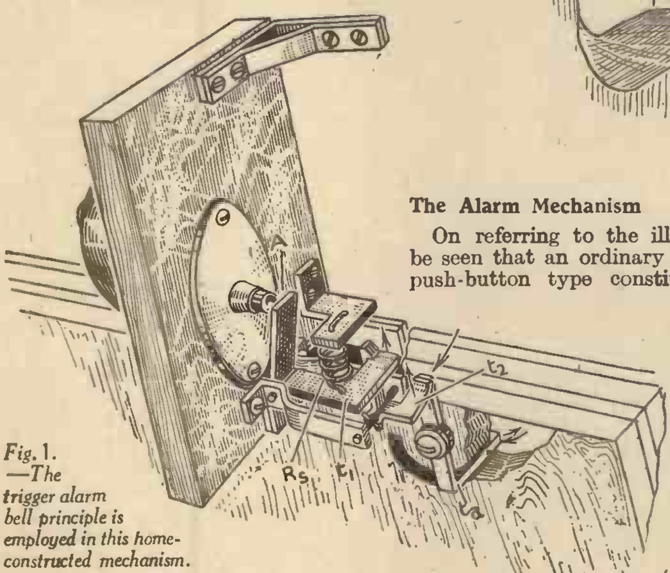



*Fig. 1.—The trigger alarm bell principle is employed in this home-constructed mechanism.*

t is sometimes necessary to employ an alarm system which is so designed that it may be brought into service at any given time; possibly after long periods of disuse, and therefore the employment of batteries is out of the question, since new cells are very seldom to hand when the alarm is to be used, and the life of a battery cannot be guaranteed for effective use over indefinite periods. Thus the trigger alarm bell principle can be employed.

Fig. 1 shows one type of home constructed mechanism which can be relied upon to fill the above needs, and would prove of admirable service in guarding, say, a connoisseur's collection, or prizes, exhibited at various public sports functions and temporarily locked in a room during the events.

**The Alarm Mechanism**

On referring to the illustration it will be seen that an ordinary door bell of the push-button type constitutes the alarm mechanism, whilst the trigger movement is constructed out of brass. Rigidity and permanency being important factors, it is preferable to employ rivets in place of screws where possible; the whole assembly, excepting the trigger arm *ta* should be mounted on a wooden or metal base, and again, in making a dust cover, the movement limits must be ascertained primary to cutting apertures in the cover for the protruding trigger parts $t_1$ and $t_2$.

**Operation**

To reset the alarm, wind the bell mechanism the usual way, by rotation of the bell dome. The trigger movement is reset by depressing the armature catch bar *Ab* against the tension of the retaining spring *Rs*.

(i) The tip of $t_1$ engages with $t_2$ and is held.

(ii) Bring trigger *ta* into position immediately under protruding arm.

**Release on Opening Door**

The trigger arm *ta* is brought to bear upon the protruding piece, thus causing $t_2$ to release $t_1$, and consequently the armature *A* strikes and compresses the push button of the bell mechanism (owing to the tension of *Rs*), remaining so until the bell is run down, and the whole assembly reset.

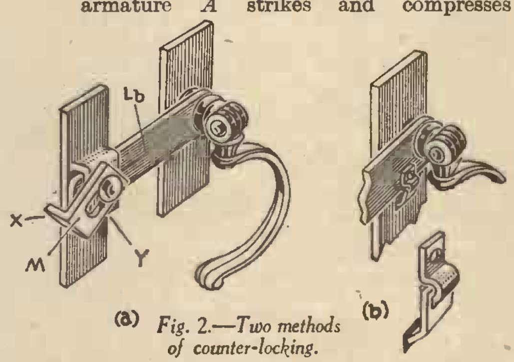



*Fig. 2.—Two methods of counter-locking.*

Counter-locking usually takes the form of small alterations or additional fitments to existing locks, but owing to the necessary limitation of space for this article we will only broach upon the commercial designs and products so far as is occasioned by an improvement shown in Fig. 2 (*a*) and (*b*).

Here it will be noticed, is a common form of door catch fitment embodying a protective piece of metal so fitted that on the restoring of the shank or locking bar *Lb*, opening

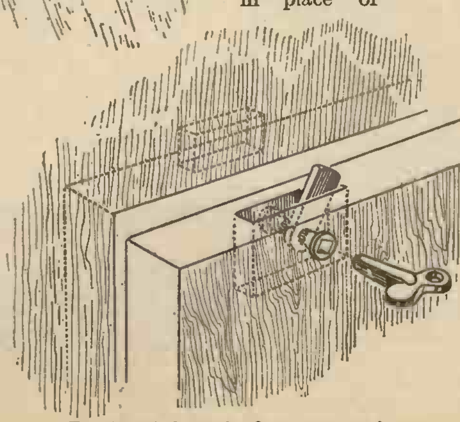


*Fig. 4.—A device for fitting to a window.*

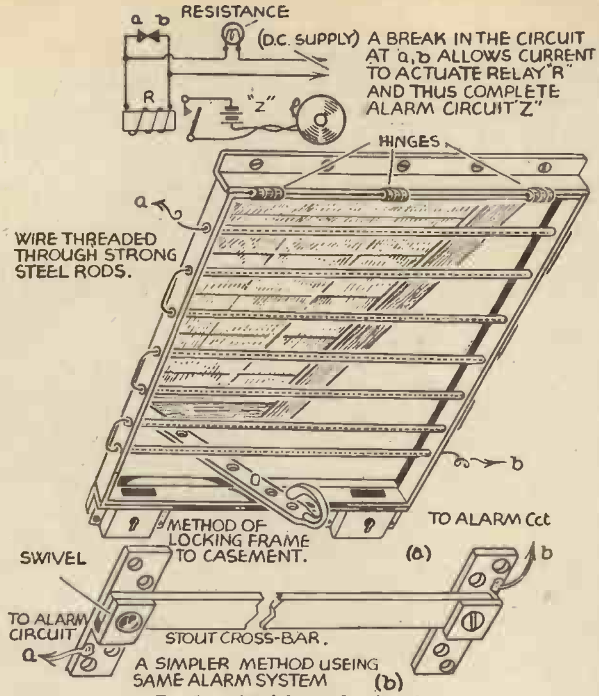



*Fig. 5.—An elaborate burglar alarm.*

may be prevented by slipping this piece of metal *M* round, thus causing the angle piece *x* to cover the opening *y* and prevent the downward thrust of the shank *Lb*.

Other simple modifications to door locks which may be applied extensively, include the method shown in Fig. 3; from which it will be seen that extra precaution is assured by the simple expedient of inserting a small piece of steel rod into a hole drilled into the tongue of the lock. The rod may be retained on the end of a short length of chain or carried about on one's person.

**Window Protection Devices**

These devices may be classed in two categories, namely:

(*a*) Light equipment for average purposes.

(*b*) Heavy equipment for exceptional circumstances.

Now class (*a*) is applicable generally and, as such, includes the requirements of the small property owner, but although numerous designs have and can be effected, it will be preferable, from the reader's point of view, to outline a general and more common measure, and this is shown in Fig. 4 which is self-explanatory.

Class (*b*) affords a rather more interesting light on the subject, since exceptional cases sometimes require most unusual precautionary measures; and the most ingenious fitment to the writer's knowledge was that employed by a collector of old coins. Fig. 5 (*a*) illustrates the elaborate yet interesting design created by the collector to safeguard his coins.

Referring to the sketch, its neatness and effectiveness predominate, but simple cross bars *b* would have served the same purpose just as well, and possibly an invisible-ray equipment with the alarm bell fixed in his house, would have given him absolute ease of mind. This gives one another aspect of foiling burglars, and Fig. 6 clearly explains the fundamental operation of an invisible-ray alarm system. There are, of course, a great many ways in which this type of equipment may be employed, but one method only is shown and it may prove tuitional to those readers who have not actually experimented or handled this class of mechanism.

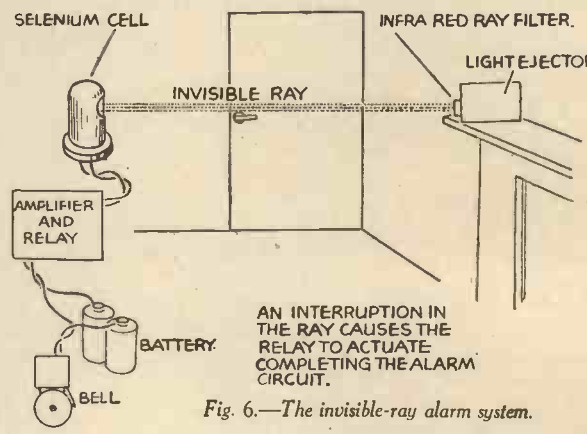



*Fig. 6.—The invisible-ray alarm system.*

# Looking Forward into the Past

ELECTRICAL engineers in America have a device which makes it possible to obtain an actual photographic record of a phenomenon which has already occurred, Dr. A. W. Hull, of an American research laboratory, announced in his recent talk on "An Oscillograph with a Memory."

"As quick as lightning," is no idle saying, for a flash of lightning requires very few millionths of a second; and yet laboratory workers can obtain a record not only of the lightning stroke itself but of the conditions immediately preceding the stroke—and obtain the record with the lightning stroke as the impulse to cause the photographing of the time even before it existed as a stroke.

## To Study Lightning

"To study lightning one needs a device that is not only fast but can be brought into action quickly," said Dr. Hull, "otherwise it misses the show completely. If the device were human, we would say it must have a short reaction time. In recent years engineers have succeeded in developing lightning recorders with a reaction time of less than a millionth of a second. Even this is scarcely short enough, however. The ideal would be a negative reaction time—a device which would have a premonition of when the lightning is going to strike, and begin recording ahead of time. Such a device would be able to report the whole story of events before, during, and after the stroke.

"Impossible as it may sound, this feat has been accomplished. The new electric detective, the pre-recording oscillograph, may be depended upon to be on the job and ready with pencil and paper a twenty-fifth of a second before the lightning strikes. As its name indicates, it uses memory as a substitute for fore-knowledge. One makes sure that it does not miss the event by the simple ruse of putting it on the job long enough ahead of time—hours or months—with instructions to record continuously on its tiny slate, and erasing as fast as it writes, except for the last few lines.

## The Thyratron Tube

"When at length the important event occurs, another electric servant, this time a Thyratron tube with a magnet as an assistant, opens a camera shutter and takes a picture of the slate. The Thyratron tube does not have to hurry; a fiftieth of a second after the event is soon enough to open the camera. The lines written just before the event and not yet erased are photographed, and the camera is left open long enough to record also what is written during and after the event.

"The pre-recording oscillograph is a very simple device. The robot which writes the record is a cathode-ray tube; its pencil a beam of cathode rays; its slate a glass plate covered with a thin coating of willemite, a phosphorescent mineral which glows with a brilliant green light when the cathode rays fall on it, and which continues to glow for about a twenty-fifth of a second. That is the memory."

The device described by Dr. Hull is being used to-day in the study by engineers regarding the life of power rectifiers, Thyratron, and other electronic tubes. The times when the tubes will fail for one reason or another are unknown—the events are as unpredictable as is lightning.

*Dr. A. W. Hull with the pre-recording oscillograph.*

# AN ELECTRIC FURNACE

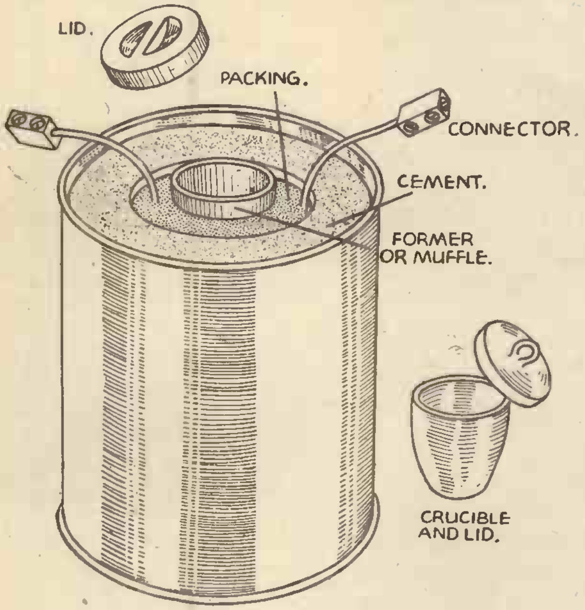



*Fig. 1.—The completed furnace.*

## THE FURNACE DESCRIBED BELOW IS SIMPLE IN DESIGN AND BOTH THE INITIAL COST AND CURRENT CONSUMPTION ARE LOW

FOR some time we have been experimenting on electric furnaces for the home-worker, trying to design one that could be used for most work, but which was low in initial cost and current consumption. Advanced readers will know that the calculations relating to furnaces can be very complicated, as it is necessary to know the dissipation in watts, etc. To avoid this, we have used a standard heater element so that the spiralling and wire calculations are neglected. The materials required are a tin of fire cement, an old firebrick and some ordinary cement, and a fairly large tin box or can.

### The Shape of the Former

First determine the shape of the former required as this will give the size of the muffle of the furnace. It should be quite small, about 3 in. long and $1\frac{1}{2}$ in. in diameter, the most convenient shape to adopt being an inverted U, as this gives a flat bottom on which to stand crucibles and pots. On the other hand, a tube furnace is easier to make, and we recommend the beginner to try one of this shape first. The finished muffle must measure 3 in. long and $1\frac{1}{4}$ in. in inside diameter. Select a wooden rod of this diameter about 6 in. long, sandpaper it quite smooth and level off the ends. Fire cement is obtainable in tins from 1 lb. upwards, costing 6*d*. for a 2-lb. tin. One tin will be ample for several muffles, but it is essential to study the directions on the tin and work according to them. Fire cement is obtainable at all ironmongers, and in these days is as common as ordinary putty. Wet the former, and with damp hands mould a mass of the cement round it to form a tube about 3 in. long. It is better to start with a small piece, adding to it until a complete ring is formed, and then lengthening it to the required size. With a wet hand or trowel, smooth off the surface of the cement. Take a metal rod or tool about $\frac{1}{4}$ in. in diameter, carefully mark a spiral in the soft cement, running from end to end, and, after marking out, deepen to about $\frac{1}{8}$ in. so as to accommodate the wire. There should be about nine turns on a former 3 in. long. Transfer the former and muffle carefully to a hot oven, *i.e.* the ordinary kitchen oven, place it on the top shelf and leave for half an hour, and then place on the bottom until baked hard. Some cracks may appear, but unless these are deep they may be ignored, but with large cracks soak the muffle in water, fill up the spaces with cement, forcing down on to the wooden former, and rebake as above. The wooden former, if smooth, will easily pull out of the muffle when hot, but if it sticks, it must be burnt out by placing over a Bunsen burner or blow lamp. We have never had a straight muffle stick yet, but can recommend the method of burning out, as we have made conical and spiral tubes this way. (See Fig. 1.)

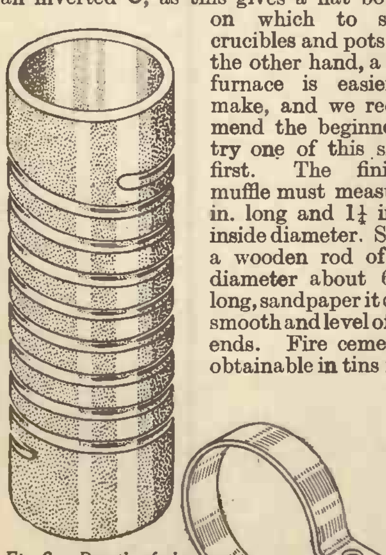


*Fig. 2.—Details of the home-made former and clamp.*

### The Heating Element

The heating element is sold as a replacement spiral for electric fires, price 6*d*., but for serious work we advise the best, although it may be as well to make the first furnace with a cheap element. The disadvantage of the cheap elements, however, is that if used for high temperatures, they burn out sooner than the costly ones. This furnace is designed for a maximum loading of 1,000 watts, as this power can be taken from almost any plug point. The recommended size, however, is 600 watts, which takes just over two amperes on the normal supply. Cut two strips of sheet iron $\frac{1}{4}$ in. wide and about $\frac{1}{32}$ in. thick, bend them round the muffle and secure with $\frac{1}{8}$-in. bolts. These form the anchor plates for the element and connecting wires. Take the element, and remove carefully from the card. You will find that at each end there is about 3 in. or 4 in. of unspiralled wire, and this must be straightened out and then doubled and twisted together, so as to form a stout connecting wire; twist one free end round a connecting bolt. The spiral must be pulled out until it just fills every turn on the former, and this must be done by trial, pulling the wire out about 1 in. at a time. Having found the correct length, connect the end to the bolt so that there is a slight tension on the wire. Two leads of No. 20 bare copper wire must be connected to the bolts, and loop the ends and secure between two washers and a nut, it being essential that these nuts be screwed up very tightly so that they bite into the wire. The electrical part of the furnace is now complete and should be tested by connecting to the mains. Have a resistance such as an electric fire in series and, as soon as the coils warm up, switch off.

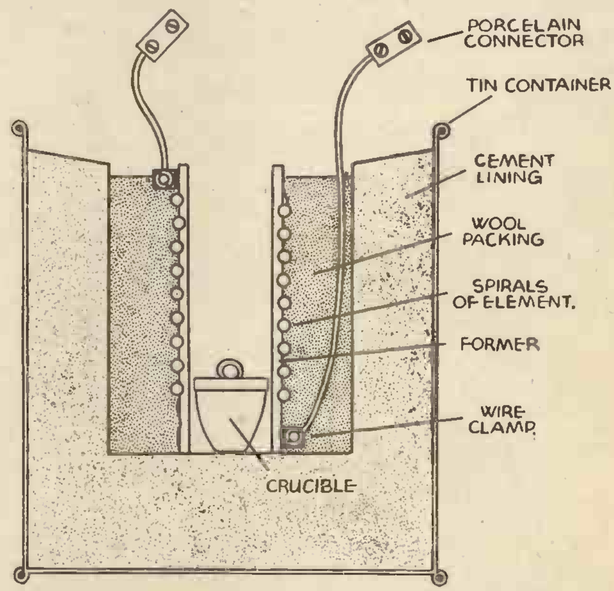



*Fig. 3.—A sectional view of the furnace showing the method of assembly.*

### Mounting the Muffle

There are two methods of mounting the muffle, one is to embed it permanently in cement, the other to pack it into a cement-lined box with asbestos wool. The first method has the disadvantage that if a connection goes, the whole furnace must be scrapped, which is very annoying especially if in the middle of an experiment. With the asbestos-packed method, however, even after a complete burn out, the muffle is easily removed for rewinding. We are describing the second method, and do not recommend the first. Select a tin about 6 in. in diameter and 10 in. deep, which may be of square section, but a better plan is to build one up from sheet iron, riveting all the joints. Take an old firebrick and pound it down to a powder, making sufficient to just fill the tin when loosely packed, and mix this dry with the cement in the proportion of two of cement to three of brick until a homogenous powder is formed. Mix to a very thick paste, in fact, add just sufficient water to prevent the mass from breaking up after squeezing in the hands. Pack a 1½-in. layer of this on the bottom of the tin, ram it down hard with a bottle or wooden rod, place in the centre a large bottle about 3 in. or 4 in. in diameter, and round this pack the remainder. The bottle is used as a former to keep the space for the furnace, after a few minutes remove it and transfer the whole to a warm room. Do not place near to an oven or fire, but allow to dry naturally for 3 or 4 days, and at the end of this time it can be dried out in a warm oven. If the selected tin is painted, this must be burnt off before packing, or else it will burn and smell every time the furnace is used. (Fig. 2.)

### Packing the Furnace

Asbestos wool is used to pack the furnace, and is obtainable at 4*s*. per lb., an ounce or two being plenty for our needs. Wrap the muffle with a layer of the wool, putting it on with great care, so that the spirals are kept in the grooves and not stretched. Add more wool until the muffle will just go into the space made for it in the fireclay, and very carefully add more wool and pack it down the sides until the whole is quite rigid. The two connecting wires should be kept as far apart as possible but it is not necessary to thread them through beads or tubing. The furnace may now be tested out, with, if possible, an ammeter and variable resistance in series. Start the current at a low value and gradually increase it until the maximum is passing; this should take about five minutes. In half an hour the furnace may be switched off, as it will have reached its maximum temperature, higher temperatures being obtained by fitting a lid. Decide whether the furnace is to be mounted in a horizontal or vertical position. In the latter case it may be stood on end on the two firebricks, but when required for horizontal work, make a small cradle of cement on a firebrick and mount the tin in this. A lid may be made from fire cement, or from the firebrick cement compound, and should be about 1 in. thick. (Fig. 3—Finished furnace.)

### Melting Points of Metals

The furnace will be found ideal for melting brass, zinc, aluminium, lead, solder, gold, and silver. Gold melts at 1062° C. or 1940° F., thus a fairly high temperature is obtainable, but unless using a good quality spiral we do not advise keeping the furnace at high temperature near the melting-point of gold. Exact tempering of tools is an easy matter, and this type of furnace is ideal for case-hardening small parts. For this we made a special crucible from fireclay to just fit the furnace tube, and the parts and compound were placed inside it. Lasting heats at low temperatures are obtainable by leaving the lid off or partly off, and gauging the temperature by the melting-point of some substance as lead 327, tin 232, zinc 418, aluminium 651, brass 1050, silver 987, gold 1062, pure copper 1084. The above are in degrees Centigrade.

# MERCURY VAPOUR DISCHARGE LIGHTING

THE application of Osira mercury vapour electric discharge lamps for lighting purposes will be considerably extended as the result of the introduction of 80 and 125 watt ratings.

Preliminary announcements concerning these lamps have created considerable interest in the lighting world and a great

*Newly designed small "Oxford" lantern for Osira low wattage mercury discharge lamps.*

future undoubtedly lies before them. They will create an entirely new technique in the science of applied lighting for many purposes. In shape they follow the general lines of the gas-filled tungsten filament standard lighting lamps, but they have no filaments. Their efficiency, however, is considerably greater, for the 80 watt type has a lumen output of some 3,040 lumens, and the 125 watt type, 5,000 lumens, which is higher respectively than the lumen output of the 200 and 300 watt size tungsten filament lamps. In addition their life is approximately half as long again. The new lamps have a 3-pin cap. This has been incorporated to prevent their being inadvertently fitted with an ordinary B.C. lampholder, for they must be used with a choke coil in series.

### Correctly Designed Lanterns

To obtain the fullest advantage from the increased light output these lamps are designed to provide, it is necessary that they should be housed in correctly designed lanterns or fittings, and for this purpose The General Electric Co., Ltd. has designed three new types of lanterns to accommodate 80 and 125 watt Osira lamps.

The first of these (Z.8155 Oxford) has a non-axial asymmetric light distribution, which directs the two main beams along and across the road both in plan and elevation. For street lighting purposes this unit is ideal, as it provides high and even road surface brightness without glare, due to the special type of bowl refractor in the unit. It incorporates a 3-slot lampholder.

An alternative to this form of lantern, the "Plafractor," is an innovation in street lighting units. It has a scientifically-designed silvered glass reflector which controls the light distribution in elevation, while mathematically accurate glass prisms on its lower edge control the distribution in plan, and also giving a non-axial asymmetric distribution in which the screening of the light at an angle close to the horizontal can be accurately controlled. The bottom of the fitting is open, as the temperature of the lower part of the lamp is so low that the lamps are not affected by rain splash in the same way as are high wattage discharge lamps.

*The G.E.C. "Plafractor" lantern is of totally new design and incorporates many interesting lighting features.*

### The Wembley Lantern

Supplementing the two lanterns described above is a modified form of the well-known Wembley lantern (Z.5013), incorporating a 3-slot holder and a rimpled glass outer bowl instead of the usual clear glass bowl.

A range of choke coils is provided to suit varying supply voltages and small condensers varying from 7½ to 12½ microfarads are available for power factor correction.

The mounting height for street lighting purposes recommended in the case of these units are not less than 15 feet in the case of the 80 watt, and 18 feet with the 125 watt type of lamp. For factory and industrial purposes similar mounting heights are necessary, but different housings are required, and details of these can be had on application to the Illuminating Engineering Department of the G.E.C.

*Rimpled glass bowl for use with Wembley lanterns where 80 or 125-watt Osira discharge lamps are used.*

# PRACTICAL MECHANICS Replies to Queries and Enquiries

If a postal reply is desired, a stamped addressed envelope must be enclosed. Every query and drawing which is sent must bear the name and address of the sender and be accompanied by the coupon appearing on page 423. Send your queries to the Editor, PRACTICAL MECHANICS, Geo. Newnes Ltd., Tower House, Southampton Street, Strand, London, W.C.2.

### SEVERAL IDEAS

**"I ENCLOSE rough sketches of various gadgets I have designed. Can you advise me as to their novelty, patent possibilities and commercial success." (K. C., London, E.1.)**

THE suggested cigarette extinguisher is thought to be novel, but in view of the number of devices having the same object in view which have been patented, you are advised to make a cursory search amongst prior patent specifications before incurring expense in protecting the invention. If novel, it forms fit subject matter for protection by patent, and any commercial success that may be possible will depend largely on the way it is marketed.

The improved hinge is a species of back-flap hinge, and is not thought to be either novel or likely to be commercially successful. Hinges for swing doors, so as to allow the doors to open either inwardly or outwardly, and which do not require that three pairs of hinges be fixed in a particular manner in order to function properly, are in common use.

The improved roller blind is not sufficiently worked out to embody a practicable construction. It is presumed that the "stop" or pawl is released to allow the blind to be rolled up. It is not thought to be either sufficiently novel or useful, in view of similar contrivances, to have sufficient subject matter to support a valid patent.

The improved balance does not involve any novel principle, which has long since been used in tangent balances formerly employed in letter balances.

It may be possible to obtain a patent for a particular construction of balance employing the principle, but it is not thought to have much chance of being made a successful commercial proposition.

### AN IMPROVED CAMERA

**"I ENCLOSE a photograph of a copying stand that I have recently made and shall be glad to know whether you consider that it could be patented or registered as a design and whether it would be likely to prove fit subject matter.**

**The main novelty is that the camera is supported by the lens mount, and in the case of twin-lens reflex such as that illustrated, the instrument can easily be focused by inspection, and when the camera is turned end for end the taking lens occupies the exact position vacated by the viewing lens, thus accurately eliminating parallax instead of fitting the makers' supplementary lens which gives an approximate average correction for parallax. The device can also be used as a microscope for photo-micrography in the same way. Another novel feature is the strainer at the top which clamps the slide in any position and assures rigidity, but if this were made commercially, the instrument would doubtlessly be made of metal in the same way as the ordinary vertical enlarger and this fitting would therefore be eliminated. (E. C. A., Liverpool 8.)**

THE improved copying stand for photographic cameras, apart from the particular construction and means for clamping the camera carrying slide at a variable height, is not thought to be novel. It may be possible to obtain a patent for the specific construction, but in view of the restricted nature of the claims of such a patent, it is not thought to have any great commercial value. The exact shape of the stand, if not previously registered, could be registered as a design, but since a registered design only gives very limited protection, it is not thought worth the expense of registering.

### HYGROSCOPIC PAPER

**"SOME while ago I wrote asking you how to make chemical paper for registering the humidity of the atmosphere.**

**"I found by using your method of cobalt chloride and blotting paper that while the air was at all moist the paper was damp and limp.**

**"I have, however, seen a chemical paper which is perfectly dry and stiff and has a glazed surface under all conditions.**

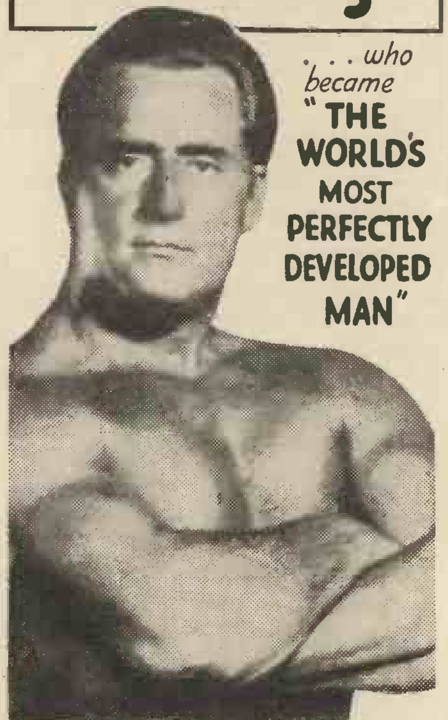
**"Could you inform me as to how this particular kind of chemical paper is made?" (J. B., Axbridge.)**

IF your cobalt chloride paper becomes too damp and limp in moist air, it is very probable that you have used too strong a solution of cobalt chloride with which to impregnate the paper.

You can make a different type of cobalt chloride paper by preparing a fairly strong gelatine solution and by dissolving a little of the cobalt chloride in it. This solution (which will solidify on cooling and which will have to be melted by immersing the bottle containing it in warm water), is brushed on to a sheet of good quality paper and allowed to dry. Finally, it is laid face downwards upon a sheet of glass and pressed with a warm iron. A cobalt chloride paper having a shiny surface will result. If required, you can harden the gelatine surface by immersing the paper for a few minutes in a bath of warm water containing four drops of commercial formalin solution per ounce of water, but we do not think you will find this treatment necessary.

### PLASTIC PASTE

**"CAN you inform me how to make up a plastic paste of a vulcanite nature, capable of being made into shapes, and subsequently hardened by heat?" (M. D., Ipswich.)**






MOST of the plastic heat-hardening pastes of a vulcanite nature which you refer to are composed of varying preparations of casein which have been treated with formalin. They are rough, horn-like substances which, when heated to the boiling point of water for a short time, become permanently hard.

You can purchase such materials from either Messrs. G. & T. Earle, Ltd., Hull, or The Dental Mfg. Co., Ltd., Brock House, Great Portland Street, London, W.1.

### PRODUCING ALCOHOL

**"1. HOW can 100 per cent. alcohol be produced from fermented sugar solution?**

**"2. Can nitrogen chloride be produced by electrolysis? If so, what electrolyte should be used?**

**"3. Can you tell me how to make a waxy substance suitable for recording on, the records thus made being played over with fibre needles? I only need to play each record 3-4 times.**

**"4. What needle should be used for recording on such records?" (G. S., Bristol.)**

1. DISTIL the fermented solution until about one-third of its volume of liquid has distilled over. This contains all the alcohol together with a certain amount of water. If the distillate is at all coloured, it may be decolourised by allowing it to stand in contact with a little animal charcoal for two days, and afterwards re-distilling.

The distilled alcohol solution is placed in a bottle or flask, and about one-quarter of its volume of quicklime (not slaked lime) is placed in the flask with the alcohol solution. The quicklime will absorb most of the water and, after two or three days, the liquid may be poured off and distilled, all the liquid distilling below 80° C. being collected. A further treatment with quicklime will remove further traces of water from the alcohol and will give a product fit for most technical purposes.

Alcohol which is absolutely water-free can only be obtained by standing the alcohol over metallic calcium for a week or more. The calcium absorbs the last traces of water from the alcohol and, on distilling the liquid, the pure and water-free alcohol boils and distils over at a temperature of 78° C.

2. Nitrogen chloride, $NCl$, can be prepared by electrolysis and, also, by purely chemical means. Since, however, nitrogen chloride is easily the *most dangerously explosive substance known*, exploding with the most extreme violence even, at times, spontaneously, we must request you to allow us to decline the responsibility of giving you details of the preparation of this material. Under no circumstances whatever should you ever attempt to make this explosive compound.

3. An effective record-blank material for home and experimental use can be prepared from the following formula:

| | |
|---|---|
| Sodium stearate, | 56 parts (by weight). |
| Caustic soda, | 3.5 parts. (Dissolved in 15 parts of water). |
| Red lead, | 3 parts. |
| Paraffin wax, | 16 parts. |
| Japan wax, | 2 parts. |

Melt the stearate in a suitable vessel. Add the dissolved caustic soda and heat the mixture, stirring constantly until every trace of water has evaporated. The red lead is then added and, after this, the paraffin and Japan waxes. Finally, the composition is passed through a sieve and poured into moulds. If the record material thus made is found to be too hard, add a little more of the waxes. Ordinary soap powder can be used in place of sodium stearate, but with inferior results.

4. A diamond needle is by far the best for recording purposes, although sapphire needles can also be used for this purpose. Steel needles do not give very good results in home-recording instruments.

### BUNSEN BURNER GAS JETS

**"1. IS there any formula, from which a bunsen burner can be made, including: length of pipe, pressure of gas, bore of gas jet, and size of air-hole? Where, in relation to the gas jet should the air-hole be placed? Would a bunsen as in accompanying sketch be a success?**

**"2. Could you give me any idea of how to make a foolproof arrangement for ringing an alarm bell when a pre-determined temperature is reached, not containing mercury?**

**"3. What units of pressure are used in measuring gas main pressure, and is it possible to thermostatically control a vent to open at a pre-determined temperature, say 150 degrees and close again at a lower temperature, say 80 degrees?" (H. B., Liverpool.)**

1. THERE is no special practical formula having any direct bearing upon the construction of bunsen burner gas jets. The pressure of gas, must, of course, be above a certain minimum so that as it flows along the pipe it will draw in air from the air-hole. Usually, in practice, the air-hole has a diameter approximately equalling the diameter of the supply pipe, although such a rule need not be followed. The bunsen burner which you sketch would not be successful, for a portion of the gas would tend to flow backwards out of the hinder end of the tube. If you placed the air-hole at the side of the delivery tube and sealed up the end of the latter, a good "bunsen" flame would be obtained at the gas jet.

2. A simple non-mercurial heat-operated alarm bell ringing device may be made by obtaining one of the new "dial" thermometers which operate by means of the expansion of a bimetallic strip and by arranging matters that when the latter strip reached a certain stage in its expansion it made electrical contact between two electrodes. In this manner, a bell could be made to ring at a fairly accurately pre-determined temperature and, provided the instrument was not roughly treated, it would be reasonably foolproof.

3. Gas main pressures are usually measured in 10ths of an inch of a column of water in a specially-designed water gauge, the gas-pressure supporting this height of the water column. For instance, the minimum permissible pressure of any gas supply pipe having an internal diameter of 2 or more is nowadays required to be not less than 20/10ths in. water-guage.

Yes, it would be possible to open a vent in a gas pipe thermostatically, the exact means to be adopted depending upon the precise circumstances obtaining in the matter. An electrical relay, thermostatically operated, would seem to be the best and the most accurate means of providing this requirement.

### A TRAFFIC INDICATOR

**"I SHOULD like your advice on the following idea which I think is quite workable.**

**"The idea is to cause motor-car indicator arms to drop 30 secs. (or any other pre-**

determined time) after they have been raised, to eliminate the arm being left raised by a forgetful driver. Briefly, the principle is based on the property of two strips of metal of widely differing co-efficients of expansion. When the two strips are riveted together at the ends and heat is applied, the unequal expansion causes the couple to bend with the metal with the lowest co-efficient inside the curve. The heating would be caused by resistance wire being wound around the strips but insulated from them by mica and being in series with the battery and the indicator arm. The bending would cause a break in the circuit and result in the arm dropping.

"The whole arrangement need not be more than 1 in. x $\frac{1}{2}$ in. x $\frac{1}{4}$ in., and could easily be slipped on between the battery terminals and the cable ends.

"Although my explanation is brief I think you will grasp it, so would you oblige me and inform me if :

"1. Platinum points would be required for the contacts ?

"2. This would be patentable ?

"3. A provisionable patent could be taken out and its cost ?

"4. What people would be most likely to purchase the patent ?" (A. G., Staffs.)

THE improved motor-car indicator forms fit subject matter for protection by patent. The idea is thought to be novel and provided the extra cost is not excessive should have a commercial value if properly marketed. In reply to the specific queries :

1. Platinum contacts would be advisable, and as the amount of the metal that would be required for this purpose is so small, the cost would be almost negligible.

2. As advised above, the invention forms fit subject matter for protecting.

3. There is no such thing as a "provisional patent." An application for patent can be made either with a provisional specification or a complete specification. You are advised to file an application for patent with a provisional specification, which will give you protection for about 12 months, during which time you should be able to ascertain whether the invention is likely to be commercially successful. The cost of taking such a step with professional assistance, which is strongly advised, would be approximately £4 4*s*. 0*d*., through a reputable Patent Agent, as advertised in this journal.

4. Any of the motor accessory firms would be likely to be interested in the invention.

### ANTI-DAZZLE

"I WAS very interested to read the article in a recent issue of "Practical Mechanics" on "Some Marvels of Polarised Light."

"Could you please tell me if Polaroid would be any good in a motor cyclist's goggles for night driving. As a motor cyclist of some years standing, I should welcome very much some method of seeing one's way in the face of approaching head-lights.

"At present, I only wear goggles in daylight, as at night the glass merely blurs the light, temporarily blinding one, whereas one can see a little with uncovered eyes.

If such a thing would be practicable, I should be glad if you would state whether it is possible to obtain "Polaroid" in small pieces, or only in a finished article. Also the address of the manufacturers or stockists." (G. N., Southsea.)

POLAROID screens used as goggles would be quite serviceable in cutting out head-lamp dazzle, particularly if such head-lamps were themselves provided with Polaroid screens. The chief drawback against the employment of this material for goggle construction is its price, which is high, a Polaroid screen 1 in. or $1\frac{1}{4}$ in. in diameter costing about thirty shillings.

You will be able to obtain all commercial and technical particulars concerning "Polaroid" by writing to Polaroid Products, Ltd., 39, Lombard Street, London, E.C.3.

### COPPER-PLATING

"I DESIRE to copper-plate an O.H.V. 4-cyl. cylinder head which is made of cast-iron. The object is to copper-plate the combustion chamber so that the combustion ratio can be raised without detonation taking place. I would be pleased if you could inform me how to make up a small plant to do this, using a car battery (6-volt or 12-volt is available)." (E. T. B., Oxford.)

WE doubt whether you will be successful in copper-plating the interior of a combustion chamber in order to reduce the volume of the latter and so increase the compression ratio of the engine, for, in the first place, a thick deposit of copper does not adhere well and, secondly, copper, being a readily corrodible metal, is not very suitable for the purpose required.

If, however, you decided to proceed with your experiments, the best mode of going about the work is first of all thoroughly to clean the metal parts to be plated, removing all traces of oil with hot soda solutions and finally by washing over the metal surface with dilute hydrochloric acid. Having thus thoroughly cleaned the metal surfaces, make up a solution of bitumen in benzole and paint two or three coats of this on to those areas of the metal surface which have *not* to be plated.

The article, thus treated, is then suspended in the plating bath and good electrical contact is made to it so that it becomes the negative electrode of a 6-volt accumulator, the positive electrode constituting a strip of copper.

The plating bath (which should be used at a temperature of 60°–65° Centigrade) should contain 2 lb. of copper sulphate and 6 oz. of sulphuric acid per gallon of water. This bath gives the heaviest deposit. If, however (as is sometimes the case) the deposit goes on badly, a thin coating of copper must first be plated on the metal surface by immersing the object in a copper-sulphate bath made alkaline by the addition of ammonia until the precipitate first formed dissolves to a violet-blue solution. The thin coating of copper obtained in this alkaline bath will then serve as a base upon which to build up the thicker copper coating in the acid bath. The alkaline bath may conveniently have a copper sulphate content of one-half that of the acid bath.

### INCREASING COMPRESSION

"I HAVE thought of an idea which, I think, should prove valuable to users of motor cycles, as it would be possible to increase engine compression by half as much again. Should you think a model of same would be best to show its possibilities, I am quite prepared to make one, as I possess a lathe and workshop." (S. B., Kent.)

THE improved piston or internal combustion engines is ingenious, and if novel, forms fit subject matter for protection by letters patent. The invention is thought to be novel, but only a search amongst prior patent specifications would establish its novelty. We think, however, that some difficulty may be experienced in obtaining a gas-tight joint between the auxiliary piston and the recess in the piston proper. A further drawback would appear to be the additional complication and cost of manufacture which may possibly outweigh any advantages obtainable from the increased compression. In increasing the compression it is necessary to bear in mind the liability of "pinking" or detonation with the usual fuels.

It would be advisable to test out the idea in practice, as it is not clear why the suggested improvement should be better than the simpler one of reducing the normal compression space of a cylinder.

## SKY-WRITING

**"IN a recent issue of "Practical Mechanics," I notice that you state that benzyl bromide is prepared by treating benzyl alcohol with sulphuric acid and bromide. Please could you tell me how this is done?"**

**"Also, does stannic chloride vapourise into a white smoke on exposure to the air? Is it the basic ingredient used in sky-writing, and how is it prepared?" (No name, Maida Vale.)**

PLACE a small quantity of benzyl alcohol in a flask in the neck of which is fitted a reflex condenser and a dropping funnel. Place in the flask, also, a quantity of potassium bromide crystals. Heat the flask on the water bath and from the dropping funnel drop into the flask slowly concentrated sulphuric acid, the quantity of the acid used being about half that of the benzyl alcohol. A vigorous reaction will set in. The flask should remain on the water bath for about an hour, after which the unchanged benzyl alcohol can be distilled off and finally the benzyl bromide. The latter boils at 199° C. You are not advised to attempt this experiment, for the effect of even *traces* of benzyl bromide vapour upon the eyes is exceedingly irritating.

In the presence of moist air, stannic chloride (tin tetrachloride, $SnCl_4$) gives off white dense fumes. It is used in sky-writings and in the making of smoke screens. It is prepared by passing a stream of dry chlorine gas over tin filings or granulated tin contained in a flask. The reaction commences immediately, and the contents of the flask quickly become hot, whereupon the stannic chloride distils away and is collected in a perfectly dry receiver. It is a thin water-white mobile liquid which quickly absorbs moisture from the air with the formation of a solid hydrate, $SnCl_4.3H_2O$.

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A LIGHT-SENSITIVE device may be included in an electrical circuit, and with the aid of relays may be made to carry out the most wonderful operations. For instance, a door may be made to open when a person approaches it; a garage may be opened as a car approaches; burglar alarms may be arranged; model railway points and signals may be operated by a passing train, and numerous other interesting arrangements carried out. A simple and highly-efficient device for this purpose is the Jefferies Bentham Detectaray, which is a selenium cell mounted in a small plug similar to the standard electric 5-amp. two-pin plug. The price is only 5s., and by using standard Midget Wireless components, a very neat piece of apparatus may be constructed with it.

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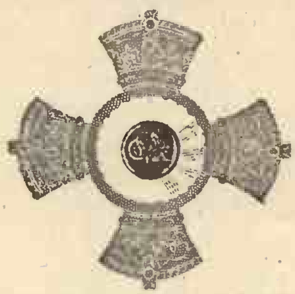

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