ELECTROPLATING AT HOME

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PRACTICAL MECHANICS

EDITOR
F. J. CAMM

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

By The Editor

Fair Comment

3-D DEVELOPMENTS

STEREOSCOPIC films have been much discussed in recent weeks in newspapers as though they were a modern invention. The fact is that from the earliest days of the cinematograph there have been literally dozens of inventions for three-dimensional films. In almost every case the viewer is expected to wear special glasses, and the three-dimensional films being shown to-day, with two exceptions, still make use of that system, which has many defects, not the least of which is that if one's eyes are not perfectly matched, or if there is myopia or astigmatism in one of them, the picture is not seen in three dimensions but becomes blurred.

Although colour films have made marked progress in the last twenty years they are still far from perfect. No one has produced a film in *natural* colours; they all look lurid and unreal. The same applies to colour photography.

With television the projection of pictures in colour has made some progress—no more than that. Such demonstrations as I have witnessed, including a demonstration by the late Baird and another by a well-known television manufacturer, merely indicate that colour television is possible at some distant date.

PROJECTION TV

UNTIL someone can discover a means of amplifying light as we can now amplify sound, the development of projection TV will be hampered, because as the picture is "blown up" the light diminishes and the picture takes on a woolly aspect. This is not particularly noticeable with pictures up to, say, 20in. square, but for big screen television the problem becomes more difficult of solution. It is my view, however, that eventually all TV receivers will make use of a tiny tube which is cheaply replaced, in conjunction with an optical system incorporating the Fresnel lens.

3-D television is already on the way and is being considered by the BBC. Viewers will not need special glasses, merely a simple attachment to the viewing screen. This system can easily be adapted for the cinema showing of films and would require only mild alteration to existing apparatus.

Great strides are being made almost every month in the science of television, one of the latest being automatic picture control, which was recently demonstrated in London.

In many TV areas to-day a certain amount of signal fading occurs. Some places are far worse than others, but in many districts, at some time during an evening's entertainment, controls have to be reset due to a change in signal strength. It is claimed that automatic picture control TV will provide a steady picture of constant contrast and brilliance even though signal strength varies by as much as 10 to 1.

This was proved convincingly at the demonstration, and although the picture blacked out completely on an ordinary TV receiver due to signal fading, the automatic picture control set was not noticeably affected.

A further advantage with this new set is the "interference damper," a device which makes for a considerable reduction of "snowstorm" interference. In the bright areas of the picture streaks of interference stay white, but in dark areas where they have shown up white before on the screen they now become grey and are practically invisible.

TV AS AN AID TO INDUSTRY

A RECENT application of TV is as an aid to industry and science in observation techniques, and the three companies manufacturing TV cameras are all producing apparatus for this purpose. Cameras have gradually acquired more lenses and up to six are now accommodated on the lens turret, providing a wide and flexible range of viewing angles. Dangerous research can be made more safe by the use of suitably sited cameras. Electrically, experiments connected with circuit breakers operating at high voltages are too dangerous for anyone to approach nearer than 200ft., whereas a camera can be placed into position only 3ft. from the main rotor of a 400 kV generator, providing the engineers with a close-up of what happens when a generator is short circuited through tests.

Remote control of a large crane by radio and TV permits the crane to handle dangerous products such as atomic material in bulk, and the operator can see what the crane is doing without exposing himself to danger.

DEVELOPMENTS IN SAFETY AT SEA

A NEW device for saving lives at sea was recently demonstrated in London. It consists of a transmitter fitted into a small box no larger than 12in. x 7in. x 5in. deep, bolted to the underside of the thwarts or seats of a lifeboat.

The only action that the unfortunates in the boat have to take is to mount the rod type aerial by a simple plug-in action and then turn the handle of the transmitter until a small neon light comes on and continue turning the handle until the signal is seen to be going out. This is shown by means of another neon indicator which blinks according to the morse signal being radiated.

Part of the signal is a continuous tone and rescuing ships can use it for direction finding and navigating on to those adrift.

It is true that, by regulation, wireless transmitters have to be fitted in a proportion of the ship's lifeboats, and although it may be possible in a large number of cases to find the lifeboat with the transmitter, it is virtually impossible, in anything like a heavy sea, for a flock of lifeboats not so equipped to keep within hail of the transmitting boat.

It is with the object of equipping these other boats that this transmitter has been developed.—F. J. C.

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ELECTROPLATING AT HOME

The Theory of Electroplating and its Practical Application in the Home Workshop

By E. HARRIS MORGAN, B.Sc.

ELECTROPLATING is the process of depositing on a base metal a thin, uniform, adherent, non-porous coating of some other metal, from a solution of a suitable salt of this metal, by the use of an electric current.

Reasons for Electroplating

There are many reasons why such a coating may be advantageous. For reasons of mechanical strength and ease of working, the two metals most commonly used in engineering are iron (including steel) and brass. Both iron and brass are subject to attack by gases of the atmosphere. In the case of iron, rusting with consequent loss of strength occurs, while in the case of brass, tarnishing spoils the appearance of the article. Electroplating both iron and brass with a coating of some suitable metal, such as nickel or chromium, prevents the process of tarnishing and at the same time provides a surface of permanent and attractive lustre. In the case of car lamp reflectors, the coating serves another purpose. The reflector is easily spun from brass, but brass tarnishes rapidly and would require constant polishing, and, added to this, brass has a yellow colour. Coloured objects possess their colour by virtue of the fact that they absorb and abstract certain wavelengths from white light; thus coloured objects do not reflect all the light which falls upon them. By coating brass with a "white" metal, a higher proportion of the light is reflected and the reflector is thus made more efficient. The metals commonly used for plating reflectors are chromium and silver. Whether electroplating beautifies an object is a controversial subject with which I am not going to deal here; some readers may hold one opinion and others another. There is one charge, however, that cannot be laid against electroplating, and that is that it covers slip-shod work. If anything, the very reverse is true, for the effect of plating a roughly finished article is to bring out all its deficiencies. More will be said about this later when the practical aspect of the subject is dealt with. Beside the advantages mentioned above, there are other specialised uses for electroplating which need not concern us here.

Theory of Electroplating

In order to understand the theory of electroplating, it is necessary to know a little about the atomic structure of the elements. The full theory of this structure is, of course, a complicated affair, and so, in the following paragraphs, I have attempted to develop a simplified version which covers just the ground that we require.

Atomic Structure

Every material thing in this world, indeed in the whole universe, is built up of an enormous number of minute particles which we call atoms. The atoms themselves are built up of three types of extremely small particles. These particles are known as protons, neutrons and electrons. The proton is a relatively large particle which possesses a unit positive electric charge. (The significant word here, is "relatively," since the actual mass of a proton is approximately 0.0000000000000000000000017 grams. There are about 28 grams in one ounce.) The neutron is a particle which is of approximately the same mass as a proton but which possesses no electrical charge. The electron is an extremely minute particle (about 1/1800th of the mass of a proton) possessing unit negative electric charge.

Now the atom is electrically neutral and therefore must contain an equal number of unit positive and unit negative charges, or, to put it another way, an equal number of protons and electrons. The positive charges,

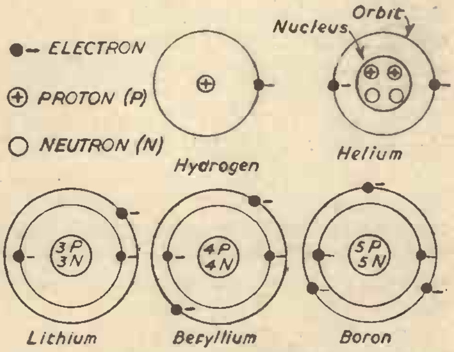


Fig. 1.—Diagrams illustrating the structure of the atoms of a few of the elements.

or protons, are clustered together in the centre of the atom together with a certain number of neutrons, and this cluster is known as the nucleus. Around the nucleus revolve a number of electrons equal to the number of protons in the nucleus. These electrons revolve in well defined paths, or orbits, about which more will be said later.

The simplest atom is one which has one proton and one electron. This is the atom of hydrogen. In Fig. 1 there are shown the atoms which result by taking first one, then two, then three protons, and so on. It will be noticed that in the nucleus of all the atoms, except that of hydrogen, there appear a number of neutrons. It so happens, that in the atoms illustrated in Fig. 1, the number of neutrons is the same as the number of protons but this is not necessarily always the case. In the case of the element lithium, it will be seen that the extra electron takes up a new path, and that we now have two orbits. Each additional electron enters the second orbit until there are eight electrons in this orbit, and then a third orbit is started. It is an interesting fact that the elements with eight electrons (or an octet) in their outermost orbit are all chemically inert; that is to say, they do not join with other elements to form compounds.

Electrolytes

There are two main classes of compounds, electrolytes and non-electrolytes. It is the electrolytes with which we are concerned in electroplating, and the theory which follows is confined to this class of compound.

The atoms of active elements, in combining to form compounds, either give or receive electrons so that the outermost orbit possesses a complete octet. In Fig. 2a the atoms of potassium and chlorine are shown diagrammatically. It will be noticed that the potassium atom has one electron in its outermost orbit, and the atom of chlorine has seven electrons in its outermost orbit. When potassium and chlorine combine to form potassium chloride, each potassium atom gives one electron to each atom of chlorine, as shown in Fig. 2b. Each potassium atom

Young soldiers receiving instruction in electroplating at the Army Technical School, Arborfield, Berks.

is now left with a complete octet and each chlorine atom also possesses a complete octet. There is a very important outcome to this change however. If the charges at the centre (the protons), and the charges in the orbits (the electrons), are balanced, it is found that the potassium atom now has an extra unit positive charge, and the chlorine atom an extra unit negative charge. Thus, potassium in potassium chloride is not in the form of a potassium atom but in the form of a *positively* charged atom, and the chlorine in the form of a *negatively* charged atom. These charged atoms are known as ions, and have very different properties from uncharged atoms. A positively charged atom is known as an anion, and a negatively charged atom is known as a cation. Since the ions of potassium and chlorine are present in equal quantities in potassium chloride, these charges cancel each other, and the net result is that potassium chloride has no charge.

The above theory can be applied to any electrolyte, and it therefore follows that any electrolyte can be divided into two sets of particles, anions carrying a positive charge and cations carrying a negative charge.

Electrolytes in Solution

When an electrolyte is dissolved in water it breaks up (or ionises) into its constituent ions (to a greater or lesser degree). Since these ions carry electric charges they are capable of carrying an electric current. Thus, solutions of electrolytes are conductors of electricity.

It is now necessary to consider the nature of an electric current. An electric current may be regarded as a flow of electrons through a wire or other conductor. A battery or generator can be considered to be a pump which promotes this flow. The direction of the flow is from the *negative* pole of the battery, through the circuit and then back to the *positive* pole. (This is in the opposite direction from the *conventional* direction of flow of an electric current, i.e., from positive to negative. This is because the convention was decided upon before the true nature of electricity had been established.) Fig. 3a is a diagram showing the flow of electrons through a circuit. If we replace the resistance of Fig. 3a by a vessel containing an electrolyte, leading the current into and out of the electrolyte by means of metal plates, we get the arrangement shown in Fig. 3b. The metal plates which are used to introduce the current into the electrolyte are known as electrodes. The electrode connected to the negative pole of the battery is called the cathode, and that connected to the positive pole is called the anode.

I have shown that the solution of an electrolyte contains charged particles, the ions. The effect of passing an electric current through an electrolyte is to cause the electro-positive ions or anions to move towards the cathode where they receive an electron, so converting the ion back into a free atom. The cations, on the other hand, move towards the anode where they are discharged and converted into atoms, their spare electrons being absorbed into the circuit.

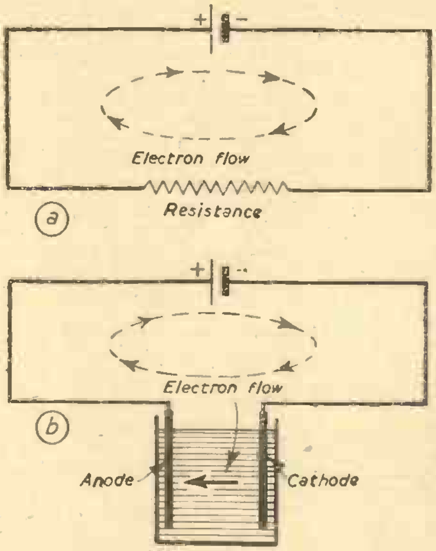


Fig. 3.—(a) Electron flow in a simple circuit. (b) Electron flow through an electrolyte.

It is thus possible to deposit the electro-positive or metallic part of the compound on the cathode, the electro-negative part being deposited on the anode. By a suitable choice of electrolyte, and by using the same metal for the anode as is present in the compound, it is possible to ensure that the element or group set free at the anode attacks the anode and dissolves it in the form of ions. Thus the strength of the solution is maintained and metal is effectively transferred from the anode to the cathode. This is the principle of electroplating, although for practical reasons certain departures are made from the simple theory outlined above.

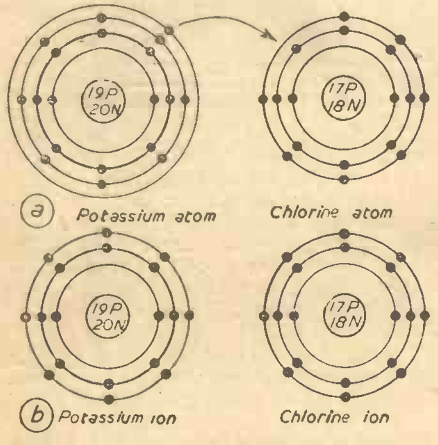


Fig. 2.—(a) Diagrammatic representation of atoms of potassium and chlorine. (b) Ions of potassium and chlorine formed by the transfer of an electron from the potassium atom to the chlorine atom. (Note that the ions have eight electrons in their outermost orbits.)

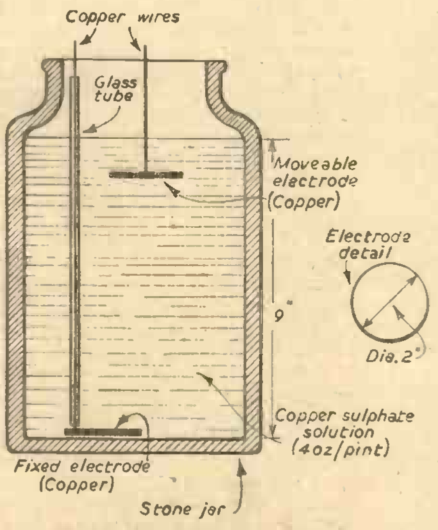


Fig. 4.—Circuit resistance. Variation of the resistance is obtained by altering the position of the movable electrode. Some simple arrangement for maintaining the electrode at the required height should be adopted.

Factors Governing the Nature of the Deposit

To be effective the deposit of the metal used for plating must possess certain properties. It must first be uniform. This condition is obtained by placing the article to be plated as a cathode between two anodes, or, in certain cases, by making arrangements for the rotation of the article during the plating operation. Secondly, the deposit must have good adhesion with the article being plated. In order to obtain this condition all surfaces to be plated must be scrupulously clean and free from grease. Details of the process involved in cleaning and preparing for plating will be given later. The third desirable property is a deposit which is already in a highly polished condition, or one which can be worked up to a high polish. This last property is one which is most difficult to obtain, as the nature of the deposit depends on a number of factors. The solutions used are not merely solutions of simple salts, but are solutions to which other chemicals, which play an important part in the process, have been added. The temperature of the plating solution is also of importance, different types of deposit being produced by solutions at different temperatures. Another important factor is the current density. This is the current flowing per square inch of surface area of the cathode. Beside these factors, others, such as the ratio of anode area to cathode area and the strength of the solution, play their parts. A good deal of research has been made on these factors enumerated above, and the result has been a series of formulæ and technical details which makes successful electroplating a practical possibility.

Apparatus Required

The apparatus required to electroplate successfully in the home workshop depends on the size of the article to be plated. In general, the larger the article, the more complicated and expensive becomes the apparatus needed. For small articles, such as the model engineer might require to electroplate, the apparatus can be reasonably inexpensive and uncomplicated.

Plating Vat

A glass beaker, such as is used in a chemistry laboratory, makes a most convenient plating vat for small articles. These beakers can be obtained in a variety of sizes from any laboratory suppliers or chemists and are not expensive. Since the plating solutions are used hot, a beaker made of heat-resisting glass should be chosen.

Thermometer

A thermometer which has the scale engraved on the stem is necessary. There are many types to choose from and one should be selected which can be read easily. Two temperature scales are in current use, the centigrade and the Fahrenheit, and for this reason temperatures will be given on both scales. The thermometers should read from 0 deg. C.-110 deg. C. in the case of the centigrade scale, and from 0 deg. F.-250 deg. F. in the case of the Fahrenheit scale.

Electrical Instruments

Suitable instruments can be purchased from advertisers in this journal. Two instruments are normally used, a voltmeter and an ammeter. Of these the ammeter is the most important, and, indeed, for simple work the voltmeter is not essential. The amateur is advised to dispense with the voltmeter. The ammeter range depends on the type of plating and the surface area to be plated. For most small work an ammeter reading up to 5 or 10 amps is suitable, but if large areas are to be plated, instruments reading up to 30 amps may be necessary. It is possible to purchase an instrument which can be converted to the required scale by adding simple resistances as shunts.

Circuit Resistance

The circuit resistance is capable of variation, so that the current flowing in the circuit can be controlled. The resistance should be variable between about 0 and 15 ohms, and should be capable of carrying the maximum current to be used. Ready-made sliding resistances are available, but they are expensive, and the reader is advised to construct one as shown in Fig. 4.

Power Supplies

For small work, an ordinary six-volt dry battery gives quite satisfactory results, but it is preferable to use a bank of three accumulators, which have the advantages of being able to deliver a much greater current and of being recharged. A six- or 12-volt car battery, if available, is admirably suited for the operation.

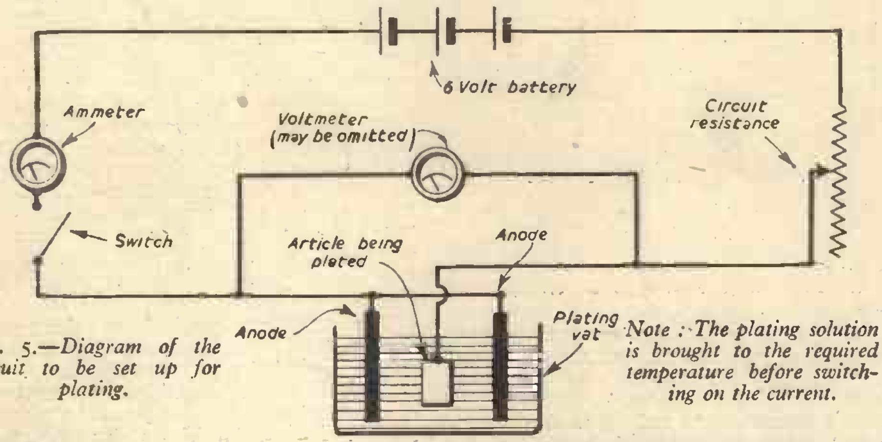


Fig. 5.—Diagram of the circuit to be set up for plating.

Switch

Some simple switching arrangement, capable of making and breaking the circuit at the particular current value used, is necessary. When the current is below 5 amps, a knife switch of simple design is satisfactory, but for higher current values a switch designed to make and break at that value should be used. (Of course, there is no objection to using a switch designed for 30 amps to break a circuit carrying 2 amps.) A low-voltage switch of the required type can be obtained from a dealer in car accessories.

Chemicals

The various chemicals used in the processes will be detailed under the appropriate headings.

Other Apparatus

A quantity of connecting wire (copper 16 gauge) and a few crocodile clips are necessary for setting up the circuits. A pint measure will also be required for making up the solutions.

Preparing the Article for Plating

The golden rule of electroplating is that the quality of the plating can never be better than the surface finish of the article being plated. Every care should be taken, therefore, to obtain as fine a finish as possible. All tool marks must be removed by the judicious use of emery paper or a buffing wheel.

During its manufacture, the article will inevitably have picked up an uneven layer of grease. This layer, being normally quite thin, has very little effect on the appearance of the finished article, but when we come to plate the article, the grease, being a non-conductor, will prevent the flow of electricity at various points and thus prevent the formation of an even coating of the plating metal. Moreover, when plating does occur, there will be poor adhesion with subsequent peeling of the plating. An oxide layer will produce the same effects, and it is important to ensure that once the article has been prepared it is plated without delay.

Degreasing

In order to degrease the article, it should be immersed in a hot solution of caustic soda for about five minutes. The caustic soda solution can be prepared by dissolving two ounces of caustic soda in one pint of water. A glass vessel should be used as a container for the solution. The article is then rinsed in clean water and immersed in a dilute acid. Sulphuric acid is used for the treatment of iron and steel articles, and nitric acid for articles of copper and brass. The dilute sulphuric acid is made up by diluting one ounce of concentrated sulphuric acid with three pints of water, and the nitric acid by diluting four ounces of concentrated nitric acid with three pints of water. (*WARNING.* It is important to note that the acid must be added to the water, and *not* the water to the acid. Stir well when carrying out the addition.) The time of immersion should be between one and two minutes. A further rinse in clean water follows, and the article is then given a final polish with a damp cloth charged with pumice powder. After these operations the article is given a thorough wash in running water and transferred immediately to the plating bath. It should not be dried between degreasing and plating.

During the degreasing operation, the article should not be touched by the fingers. It is an easy matter to bend up a simple pair of tongs from wire or strip, and these should be used to handle it.

Setting Up the Apparatus

The apparatus is set up as shown in Fig. 5 (the voltmeter being omitted if not available). The vat is filled with the plating solution at a temperature a few degrees above that given (in order to allow for cooling during the operation). The solution can be heated by placing the vat in a saucepan of water over a fire. A more convenient arrangement is to heat the vat directly, by standing it on a wire gauze placed on a tripod, and heating with a bunsen burner. In this way, a greater control over the temperature of the solution is obtainable.

Method of Operation

The surface area of the article is obtained by direct measurement (this should be done before the degreasing operation), and the current to be used is calculated by making use of the figure given for current density. Thus, if the article has a surface area of 20 sq. in., and the current density is 0.1 amp/sq. in., then the required current will be 20 x 0.1 = 2 amps. The article is suspended in the vat with the current switched off and the resistance set to its maximum value. The current is now switched on and the resistance gradually decreased until the ammeter indicates the appropriate value. If it is desired to inspect the article during plating, the current must be switched off before the article is withdrawn from the solution. If this precaution is not taken, a very high current density will be produced at the edges of the article and the plating will be marred at these points. When the plating is completed, the article is removed from the bath and given a thorough rinse. The plating can now be brought to a high polish by the use of a buffing wheel, or, if this is not obtainable, by the use of metal polish on a soft cloth.

Formulae :—Copper

Copper is rarely used as a final plating, but is generally used as an intermediate plating. Since, however, the process and formula are quite simple and the chemicals are comparatively inexpensive, I have included details of the process here so that it can be used as an initial exercise in electroplating.

Copper sulphate	4 oz.
Sulphuric acid (conc.)	1 oz.
Distilled water	2 pints.

The copper sulphate is dissolved in the water and the sulphuric acid added cautiously while stirring the solution.

Plating is carried out at room temperature and the current density employed should be 0.1 amp/sq. in. The plating time should be 20-25 minutes. Two anodes of copper sheet are used.

This solution can be used repeatedly since the copper deposited on the cathode is replaced by copper dissolved from the anodes.

Nickel

Although nickel plating requires a fairly high current density, it is a process which can be carried out quite easily and effectively by the amateur when small articles are plated. The metal is softer than chromium and the plating has a warmer colour. Nickel is often used as an intermediate plating on iron and steel in the operation of chromium plating.

Nickel sulphate	4 oz.
Ammonium chloride	¾ oz.
Boracic acid	½ oz.
Distilled water	2 pints.

The plating bath should be used at a temperature of about 90 deg. F. (32 deg. C.), and a current density of 1.5 amps/sq. in. The plating time is four to five minutes. The anodes should be pieces of nickel sheet, one being placed on either side of the cathode. As with copper, the plating solution can be used repeatedly.

Chromium

Chromium is one of the most popular metals for plating and there is no reason why successful results should not be obtained by the amateur if the instructions are followed. In the case of steel and iron, an intermediate coating of nickel will be found to be advantageous.

Chromic acid	5 oz.
Sulphuric acid (conc.)	20 drops.
Distilled water	1 pint.

The operating temperature of the plating bath should be about 104 deg.F. (40 deg.C.), and the current density 0.5 amps/sq. in. The plating time is 10-15 minutes. In this case anodes of lead are used, and after a certain amount of usage the bath will become exhausted. The quantities given above should be sufficient for plating about 1,000 sq. ins., after which the bath should be discarded.

Silver

The amateur is advised to avoid silver plating for two reasons. First, it is an expensive process, and, secondly, the chemicals used in compounding the bath are of an exceedingly poisonous nature. If an attempt at silver plating is made, great care should be taken that the plating bath does not come into contact with any cuts or abrasions on the hands. At this juncture it might be well to say that many of the chemicals used in plating are of a corrosive nature and should be kept out of contact with the hands, clothes, and so on. A bottle of household ammonia should be kept at hand, and if any of the plating solution is accidently spilled, mopping up should be preceded by a liberal application of the ammonia. If a large quantity of plating solution is spilled, it can be satisfactorily neutralised by adding washing soda. (Vinegar is a good antidote for caustic soda.)

Silver nitrate	1 oz.
Potassium cyanide	1½ oz.
Distilled water	1½ pints.

The working temperature of the bath is 68 deg. F. (20 deg. C.), and the current density 0.2 amps/sq. in. The anodes should be of silver, and the bath will last indefinitely.

Copper and brass can be plated directly, but iron and steel should receive an intermediate coating of copper before being silver plated.

Conclusion

The processes given above are not the only ones which can be used. Other metals beside copper, nickel, chromium and silver can be deposited electrolytically. It is also possible to deposit alloys, and, by suitable choice of solutions, various grades of brass can be formed. In general, however, the applications of deposits of metals other than those outlined above, are outside the scope of the requirements of the amateur.

Submarine Oil Drilling

A Scheme for Drilling for Oil in the Sea Bed, Employing an Aerial Ropeway for Carrying Men and Materials

BY the end of this year the first major submarine oil-drilling operation in the British Commonwealth from a platform fixed on the sea bed will be under way in the South China Sea, about a mile off the coast of British Borneo.

Initiated by Shell, the plan is to drill wells into the sea bed in an endeavour to find an under-sea extension of the Seria oilfield, largest single oilfield in the British Commonwealth and now producing 5,000,000 tons of crude oil annually. The under-water extension of the field has so far been explored only by deviated wells drilled from the land and from platforms erected in shallow waters near the shore.

Four Wells from One Platform

For this project, four separate submarine oil wells can be drilled from a single fixed platform. The foundation for the platform is a tubular steel jacket, which, prefabricated in harbour, is carried out to a selected location and securely fixed in position on the sea bed. It is capable of supporting a weight of up to 200 tons.

The technique of drilling four wells from the same platform is designed to obviate the expense of building a platform at each separate location. One well can be vertical, and the other three can be deviated, thus enabling a large area of the underlying formations to be tested.

Two Problems

The setting-up of a platform sufficiently rigid to permit drilling to proceed posed one problem. A second and, in this instance, even more formidable problem was to provide access to the platform itself during the long spells of stormy weather encountered in the South China Sea. Since vessels cannot be brought alongside on account of the heavy swell experienced in this region for most of the year, a solution was found in the construction of an aerial ropeway linking the drilling platform with the shore. By means of this facility, constant communication can be maintained with the platform, which has been specially contructed to accommodate all the equipment required for drilling.

Technical Description

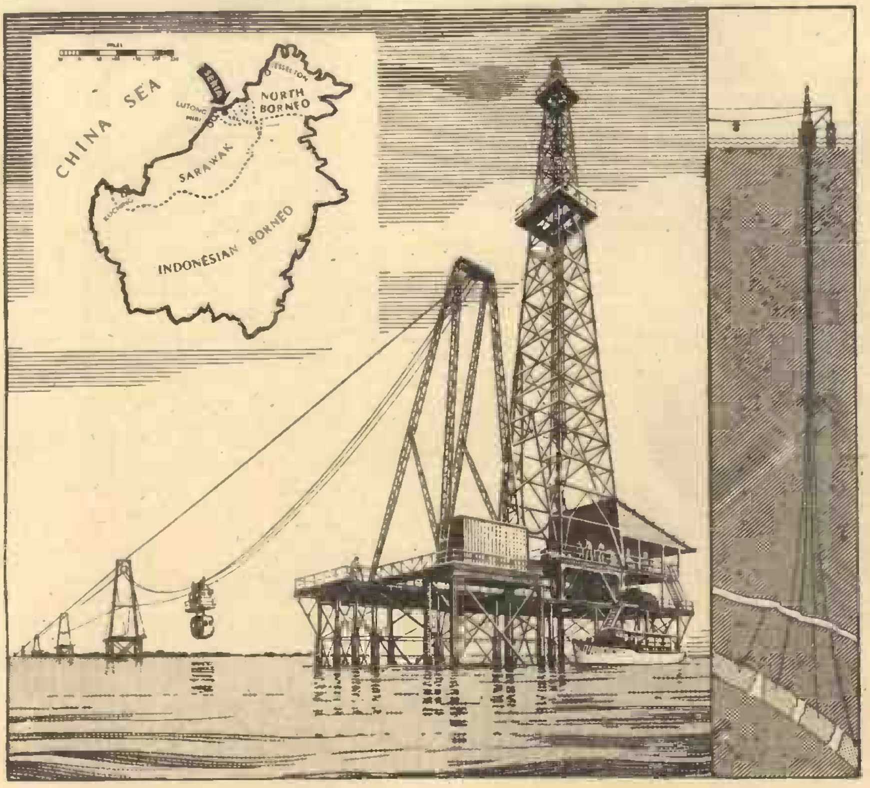
The drilling platform covers an area of 110ft. x 45ft., and is built on to a jacket composed of twenty-eight 24in. diameter vertical steel guide piles tied together by horizontal and diagonal bracings of angle iron. The jacket rests on the sea bed in about 30ft. of water, and before the drilling platform was erected steel bearing piles were inserted into the guide piles and driven deep into the sea bed until the required bearing capacity had been obtained. Four raking piles have also been incorporated in the structure in order to give greater stability and strength.

A special technique had to be employed for assembling and placing the jacket. It was decided, therefore, to fabricate the jacket alongside the shore in the sheltered river at Kuala Belait and support it on two barges clear of the water, each barge being equipped with special framework made up from Bailey bridging. The whole assembly was then towed out to sea and the jacket lowered on to the bottom by means of winches. This operation was carried out without incident and, soon after the jacket had been lowered into position, four corner bearing piles were driven home by a steam hammer in order to anchor it securely. This was necessary as the main piling operation was a long job occupying several weeks and was frequently interrupted by unsuitable weather conditions.

The Aerial Ropeway

The long span of the aerial ropeway connecting the drilling platform to the shore made it necessary to place intermediate structures on the sea bed at 840 ft. intervals, these structures being supported on smaller jackets of a similar type to those employed for the main drilling platform, each being securely anchored by four bearing piles. Lifts of up to five tons for materials and equipment can be handled over the ropeway and a transporter car for personnel has also been provided.

Royal Dutch/Shell engineers were responsible for formulating the whole project and designing the steel structures and the drilling platform.



Underwater drilling project in the South China Sea, off Seria, British Borneo. Four separate submarine oil wells can be drilled from a fixed platform.

PLASTER CASTING

Making the Master : Forming the Mould : Casting : Painting and Finishing

By E. S. WEERA

Fig. 1.—A wall plaque in plaster.

MAKING plaster models is an easy and fascinating hobby. There is a ready market for good quality work and this should well repay the initial cost.

The following method of making plaster wall plaques, statues, ornaments, etc., is well within the scope and pocket of everyone. In the past the greatest difficulty in this kind of work has been in making a suitable mould ; but now there are a number of rubber or synthetic resin products on the market which solve this problem for all. These moulding materials are melted and, when set, form a rubber-like, flexible mould which will wear long enough for several hundred models to be cast. The material can be melted down and used again and again.

Making the Master

While it is desirable to make models from your own ideas and work, it is not essential. A mould can be made for any small, non-porous object ; there seems little point, however, in merely copying something that has already been made by someone else.

Clay, china-clay, plasticine or even putty can be used to make the original model. Of these, plasticine is the best to use for the novice modeller. If this is used it is necessary to coat the finished job with three or more coats of cellulose varnish. This holds the shape of the model long enough for the hot, molten mould to take its form.

The wall plaque models illustrated in Figs. 1 and 2 were made in this way. Try to model something from life, a good drawing, or photograph ; it is not nearly so hard as it seems, and after practice you will soon be able to fashion a good likeness to the subject. Use a reputable brand of plasticine. By warming, flattening out and rolling, it soon becomes easy to work with and the only tool required is a small, pointed stick, with which to put in tiny lines, marks, etc.

If clay is used it needs slightly more skill to produce a good model. The clay must be kept moist while modelling and be dried off before making the mould ; it need not, however, be baked to hardness.

Putty is perhaps the most difficult to use but quite good results can be obtained. Here again it is necessary to dry off the finished model. Putty and clay can be used again after making the mould ; plasticine, on the other hand, is usually melted and mixed up with the cellulose skin. If a large model is made it is possible to recover some of the plasticine by scraping off the cellulose.

The Mould

As previously mentioned, there are a number of brands of flexible moulding materials on the market. Prices range from six shillings up to 18 shillings per pound. Two pounds of low-melting-point moulding material were needed to make each of the illustrated models. These are roughly 6in. x 4in. x 2in.

Instructions as to melting temperature and setting time are sent with orders ; but the procedure is much the same for most kinds of this product.

Before melting down, the moulding compound looks and feels like medium hard rubber blocks or slabs. It is necessary to cut

Fig. 2.—Another plaster wall plaque.

these up into smaller pieces and drop them into a saucepan.

It is very important not to melt quickly ; a very low gas or electric stove will do the job admirably. The product will give off a strong rubber-like smell but, generally speaking, it will only give off fumes when over-heated.

A low gas will satisfactorily carry out the melting in 20 or 30 minutes, but the time varies acording to the type of material used. By using a full gas it can be melted in a few minutes but will then be burnt and too hot to pour. If you do not have a thermometer the best and safest policy is to take plenty of time over melting.

The liquid should be stirred gently with a clean stick or rod. While the melting is going on the master model can be made ready.

The clay, putty or plasticine model will have been dried or cellulosed and the next step is to place it in a box, which can be wood, tin or even strong cardboard. An ordinary cooking dish or bowl can also be used for this. Make sure that there are no holes in whatever is used to hold the mould. Any holes which do exist can be plugged with putty or plasticine.

After completely melting the compound, take it off the gas and allow it to cool down for a few minutes ; this will prevent the hot liquid from bubbling when it is poured on to the master. After making certain that the model is flat and firm against the bottom of the box, take a round stick or rod and hold against the lip or side of the saucepan.

The liquid should then be poured down the rod quickly (see Fig. 3), and into one corner of the box ; not directly on to the master. At first there may be slight bubbling, but this should soon stop, and the liquid begin to set. Tiny air bubbles will probably form round the sides of the box. These can be ignored, but should they form over the model itself, they can be burst by jabbing quickly with a needle. If there are too many to burst, it is a sure sign that the liquid has not been cooled down enough. With moderate bubbling it is still possible to get a good mould but the top surface will be pocketed with holes and tiny bumps.

Three to four hours should elapse before attempting to take the master model from the mould. This is done by running a sharp knife round the box, pressing the mould with the fingers away from the walls of the container, and then by turning over same and gently knocking the bottom. The mould, complete with model, should then slide out.

By flexing the mould the model can be withdrawn. If this is plasticine, it may leave traces inside the mould which must be removed with a soft cloth. A clay or putty model will pull out cleanly and will be in the same condition as when made.

It may be necessary to split the mould. A statue or similar ornament will need this treatment, but it does not require halving. One side of the mould can be cut with a sharp knife and the mould flexed to allow the model to be eased out. (See Fig. 4.)

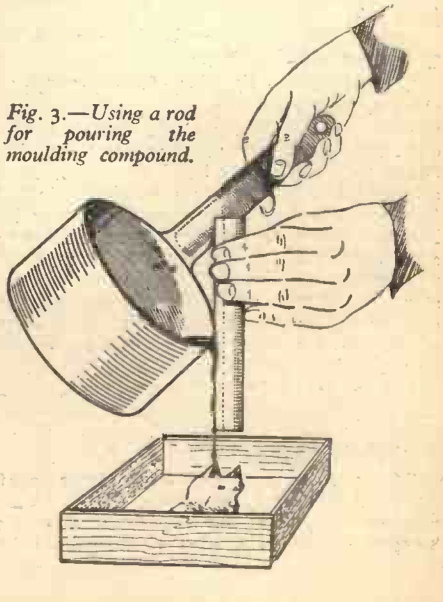
A split mould will still hold the liquid plaster if it is held together by rubber bands, making sure that the joint matches up cleanly.

Casting

Having made the mould the next stage is casting a plaster replica of the original model. Fine white plaster is used, costing a few coppers per pound ; one pound will make several models.

The plaster is mixed in a suitable basin and added to the water ; do not add water

Fig. 3.—Using a rod for pouring the moulding compound.



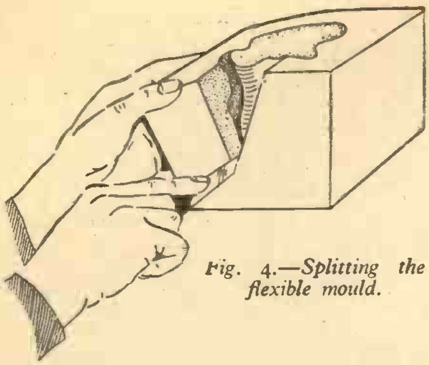


Fig. 4.—Splitting the flexible mould.

to plaster or great difficulty will be experienced in mixing properly.

For a model of the size illustrated, one tea cup of water is sufficient. To this was added seven tablespoonfuls of plaster, one spoonful at a time. Each helping of plaster added to the water should be quickly and thoroughly mixed in before adding any more.

It is advisable to mix the plaster quickly because it reaches the stage when it will rapidly begin to set and harden. It should still be liquid when poured into the mould. If it has begun to set, it will not flow into every corner of the mould, and a model with holes or parts missed off will be obtained.

The mould must be laid on a flat surface before it is filled with plaster. After pouring in the plaster quickly a brief shake of the mould will get rid of any air bubbles.

A wall plaque may have been made, in which case a hook will be required in the finished job. A good method is to bend a paper clip and simply drop it into the liquid plaster. The plaster will set hard and the clip be cast in, the bend in it preventing it from pulling out when the plaque is hung on a wall. (See Fig. 5.)

In ten minutes the plaster should have hardened and is now ready to be taken from the mould. Due to it still being wet, the model will break rather easily, and a little care is needed here.

With the finger tips gently flex the mould away from the plaster, gradually working it off the model. In the case of flat objects, such as wall plaques, calendars, or similar things, all that is required is to place one

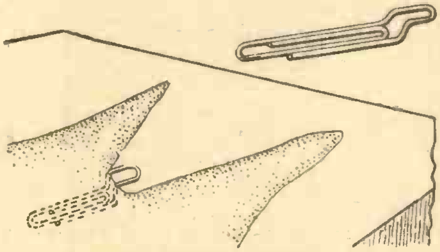


Fig. 5.—Method of fixing a hook for supporting a plaque.

hand under the mould and carefully bend one end away from the model. (See Fig. 6.)

The plaster model is dried in a low gas or electric oven. It can also be satisfactorily dried by placing before an open fireplace or even in the strong sunlight. The one thing to remember is that if the drying is done too quickly, the model is liable to distort and most certainly to crack. Having got this far, it is wiser to take three or four hours in slowly drying the model.

Painting and Finishing

No matter how well cast a plaster model might be, it can be completely and horribly spoilt by haphazard, careless painting. A badly-cast model, however, is vastly improved, the faults hidden, by careful painting.

Ordinary, water colour, poster or cellulose paints will take on plaster. Of these, water colours combined with poster paint give the best results and also the widest range.

Should the model be of an animal or something from life, a common-sense study of the real thing will make it easy to decide which colours to use.

Plenty of water is needed with poster and water colour paints. The plaster will absorb the water and, after painting, it should be dried for about twenty minutes. A coat of clear cellulose varnish brushed on the dried model will preserve the colours and finish the model off. The models illustrated were painted in this way.

Cellulose paint can be brushed straight on to the model, and no other treatment is required. This is the best paint to use when the effect needed is that of one or two colours only.

Ordinary paints will give good results but have the snag of taking a long time to dry. Here again, a coat of clear varnish can be applied to the finished job.

There is no limit to the things that can

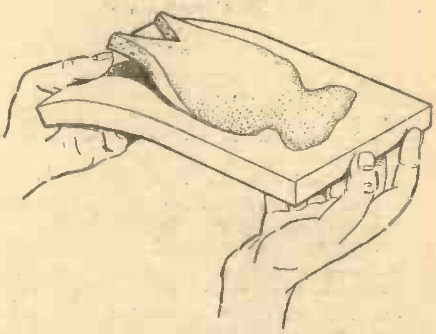


Fig. 6.—Bending the mould away from the cast.

be made from plaster or to the effects that careful painting can give. Aim at life-likeness, unusual design and original ideas.

B.R. New Hopper Wagon

To meet the requirements of bulk conveyance of chemicals such as soda ash, sodium tripolyphosphates or catalysts, this wagon has been designed at Derby, and to obtain the maximum capacity within a total gross load of 35 tons, the body takes full advantage of the loading gauge.

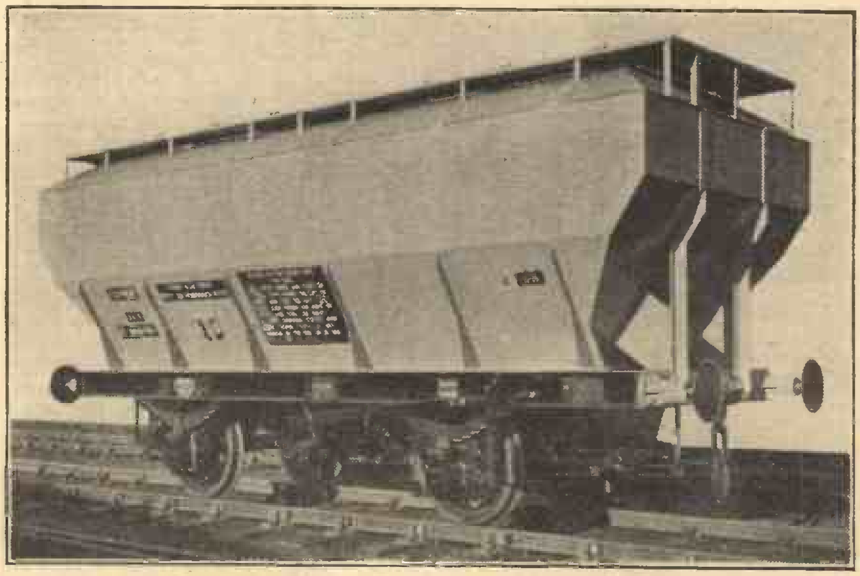
The length of the vehicle over buffers is 24ft. 6in. and the wheelbase is 10ft. 6in.

The underframe is of special design to accommodate the hoppers through which the load is ejected between the frames. It is of all-welded construction and is 21ft. 6in. long with standard buffing and drawgear with three link couplings. The wheel diameter is 3ft. 1½in. with 10in. by 5in. journals and fabricated steel axleboxes. Standard laminated springs 3ft. 6in. long are fitted with standard spring shoes.

The most recent design of brake used can be applied from either side of the van and operates one block on each wheel of one axle.

The body is of welded construction and is built up of ⅛in. mild steel plates for the roof and sides whilst ¼in. thick plates are used for the ends and the hoppered portion of the body. Tee sections and gusset plates stiffen the body and are welded to the underframe; the combined body and underframe giving adequate strength and stiffness. A ¼in. thick partition divides the body into two compartments and two 2-hinged doors 6ft. 11in. long and 2ft. 5in. wide are provided in the roof, fitted with rubber weather seals and secured by screwed eyebolts. A roof vent is used with or without valve, according to traffic, and a cat walk is also provided to give ready access to the filling doors. The interior is completely flush and the hoppers can be completely discharged by gravity through two sliding doors per compartment. The opening mechanism for each door is a rack and pinion operated from either side of wagon by a removable handle. The doors can be sealed by wire seals.

In the case of soda ash or sodium tripolyphosphate a coupling of a quick detachable vibrator is welded to the sides of the hoppers to assist unloading.



The new hopper wagon for British Railways.

THE SHAPE OF WINGS TO COME

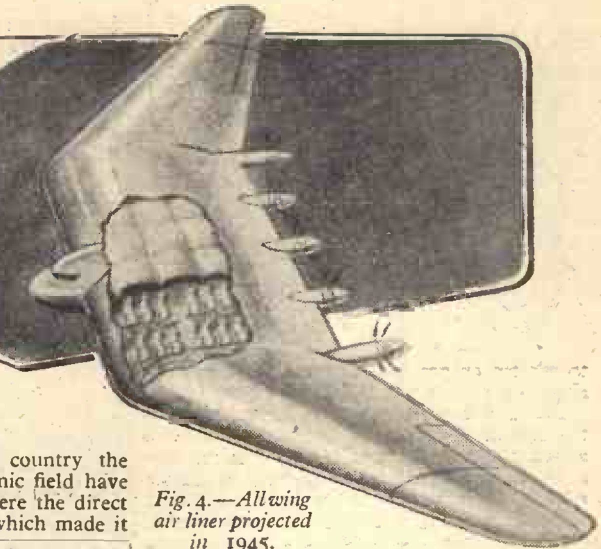


Fig. 4.—*All wing air liner projected in 1945.*

The Reasons for Sweptback Wings and the Problems Which They Introduce. Delta, V and Crescent Wings, and Possible Shapes for Supersonic Speeds

BETWEEN 1939 and 1945 we, in the United Kingdom, were too busy winning the war to do as much fundamental research in aerodynamics as we ought to have done. The Germans, rather curiously, found time to do much more basic research, and if the war had continued much longer we should have found ourselves in a difficult position against the rocket propelled, swept wing fighters which were just beginning to come from the German aircraft industry.

War always provides a stimulus to technical advancement, but in this country the biggest strides in the aerodynamic field have been taken since the war and were the direct consequence of jet propulsion, which made it possible to fly at higher speeds and enhanced the importance of being able to do so.

"The Shape of Wings to Come" was first presented as a paper by David Keith - Lucas, B.A., M.I.Mech.E., F.R.Ae.S., Chief Designer at Short Brothers, Rochester, in Belfast, September, 1952.

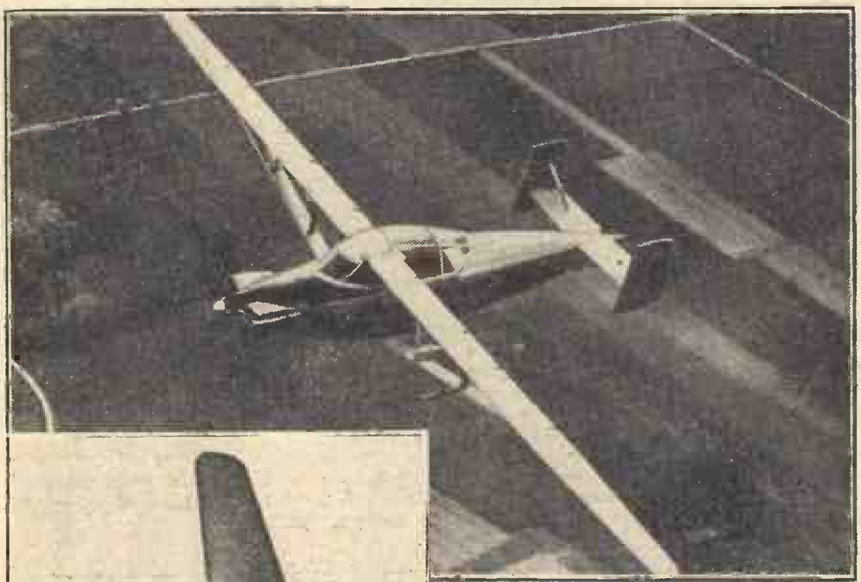


Fig. 1.—Hurel-Dubois HD10 with aspect ratio of 32½.

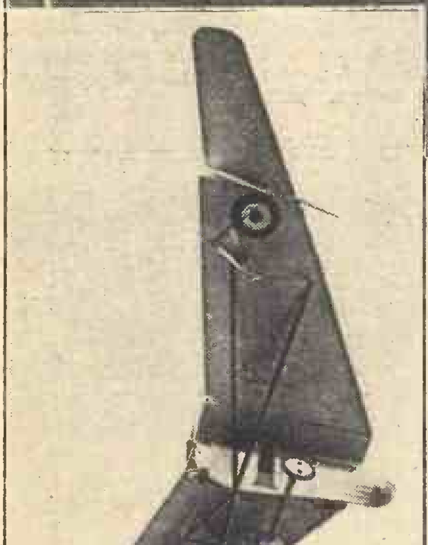


Fig. 3.—The Hill Pterodactyl of 1925.

Germany had reacted sooner than we to the challenge of jet propulsion and we owe a lot to the lead given to us by the German research work. It is healthy, if a little frightening, to recall that Lippisch, in Germany, was working on a high-speed delta design even before the last war.

It is intended to review the reasons which have led to the sweptback, crescent and delta wing forms and try to see where these developments are leading us.

I shall deal mostly with high-speed aircraft, although recent researches have led to at least one rather intriguing shape for low speeds, namely the Hurel-Dubois light 'plane which is shown in Fig. 1. As will be seen, the wing of the Hurel-Dubois has a very large span and small chord. Its aspect ratio, that is, the ratio of the span to the mean chord, is 32½ compared with a maximum of about 12 on the wartime bombers and about four on modern fighters.

It is quite possible that it may be the forerunner of others like it, and it is included here to show how low-speed aircraft are developing in comparison with high-speed types.

Before the war the difference between a high-speed and low-speed aircraft was mainly one of degree. They were both flying at subsonic speeds and aerodynamic laws were the same for both. The high-speed aircraft therefore had more power and less drag, but was not necessarily very different in outward shape from one designed for low speed.

To-day the picture is quite different, because by "high speed" we have come to mean that the aircraft flies at supersonic or, at least, very high subsonic speeds, and, by passing through or even approaching the speed of sound, it has entered a new regime of aerodynamics. It is a natural corollary that the aerodynamic shapes have to be different, too, and as aircraft speeds increase we can expect a continuing divergence between the design of "low speed" and "high speed" types.

The Purpose of Sweepback

The outstanding development in high-speed aircraft is the swept wing in its different guises.

It is often stated that sweepback enables a wing to "slide" through the air in rather the same way as a bread knife or a scythe is drawn across what it is cutting. This, of course, is the principle of the guillotine, which always had a swept back or "delta" blade. But we are talking of air, which behaves differently from bread, grass or the human neck. Indeed, the analogy is dangerous, if not actually misleading, for at low

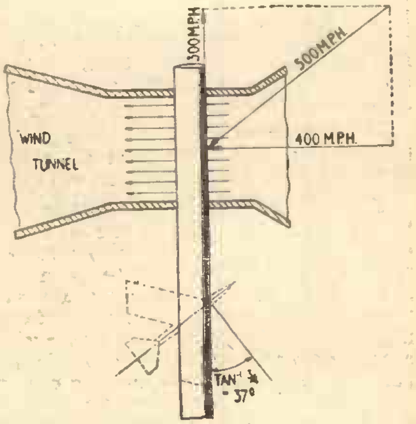


Fig. 2.—Diagram of a swept wing in a wind tunnel.

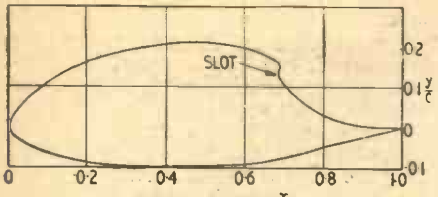


Fig. 5.—Suction wing aerofoil section.

speeds the drag of a swept wing is no less than that of a straight one; the advantage is only at high speeds.

Perhaps the best way to illustrate the purpose of sweepback is to take a rather far-fetched example from a wind tunnel. Let us suppose that we have an untapered wing which spans the tunnel and, if you like, sticks out a bit at either side. The tunnel speed is 400 mph and the pressure distribution round the wing is, clearly, appropriate to its incidence to the airstream and to the speed.

Now let us suppose that the wing is made much longer, so that it sticks a long way out from one side of the tunnel, and that we proceed to push it through the tunnel at 300 mph at right angles to the airflow. Apart from some slight corrections due to skin friction, the pressure distribution over the wing is unaltered and is still that appropriate to 400 mph. But if we consider any one point of the wing it is, by simple vectors, in an air stream of 500 mph to which the wing is swept back at tan $-1\frac{3}{4}$, or about 35 deg. This is shown diagrammatically in Fig. 2.

The flow round the wing is therefore behaving like that round a straight wing at 400 mph, whereas the actual speed is 500 mph. An aircraft with swept wings can therefore fly much faster than a corresponding one with straight wings before meeting the compressibility troubles which, on a straight wing, occur at and around the speed of sound. These troubles include increase of drag, loss of lift, changes of trim, deterioration in stability and control, and also the possibility of unpleasant buffeting.

This explanation really amounts to no more than saying that we can resolve the velocity into two components, one at right angles to and the other along the wing, and that we can then neglect the flow along the wing. For some strange reason most people find the wind tunnel analogy easier to visualise.

In practice, due to boundary layer and end effects, the advantage that can be realised is only about half of that indicated by this over-simple treatment. But, in spite of that, sweepback has two very important contributions to offer. In the first place, it reduces the adverse effects of compressibility and in this respect a swept wing behaves in much the same way as a much thinner straight wing. In the second place sweepback postpones the compressibility effects to higher speeds and, if the angle of sweep is sufficient, can even postpone them to speeds well above the speed of sound, which is something which thinness by itself cannot do.

Both contributions are important, but the second one is particularly important if the aircraft is designed for a maximum speed anywhere between, say, 80 per cent. and 150 per cent. of the speed sound, i.e., for a mach number between 0.8 and 1.5.

All-wing Aircraft

Now sweepback was first introduced into aircraft design for quite a different reason. With the development of cantilever monoplanes designers began to think in terms of thicker wings and explored the possibility of using aerofoil section of up to 25 per cent. thickness : chord ratio. As the size of the aircraft increased it became tempting to try to submerge the fuselage by putting it athwartships in the wing, so saving the weight and drag of the fuselage. It also reduced the bending moments at the wing roots, arising from the upward lift forces, by spreading the load more uniformly across the span. The obvious development of this idea was to dispense with the tail because there was no longer anything to support it. The longitudinal stability and control of the aircraft was then restored by sweeping the wings back and, in effect, carrying the tailplane on the wing tips.

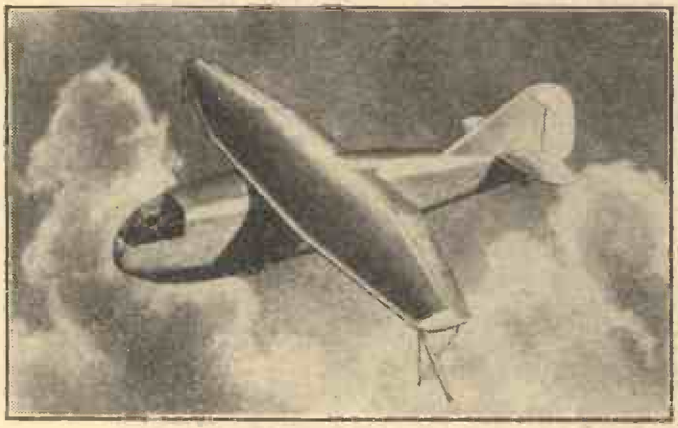


Fig. 6.—Australian suction wing glider.

The Hill Pterodactyl of 1925 was a pioneering effort in this direction and is shown in Fig. 3, from which it will be seen that although there is still a fuselage it is only a small one. Fig. 4 shows an example of a design which was projected by Short Brothers in 1945 as a transatlantic airliner to much the same specification as the Brabazon. With a wing of 22 per cent. thickness : chord ratio, it had to be a very large aircraft to provide sufficient headroom in the cabin.

On paper it showed an advantage in payload and speed over a conventional design, but the passengers' view would have been poor and the stability and control problems needed further investigation.

Boundary Layer Suction

One of the objections to using the thick wing sections demanded by this sort of design is that the drag of the wing becomes unduly high. A thick boundary layer of relatively stagnant air builds up round the wing and is shed as a wake from the trailing edge. The drag can be very much reduced if this boundary layer is sucked away near the trailing edge of the wing and it becomes possible to use very thick sections, such as that shown in Fig. 5, without incurring any penalty in drag over normal thin sections. The engineering difficulties are considerable as the quantity of air which has to be removed is very large, but it can be done, and it makes the all-wing design both feasible and attractive.

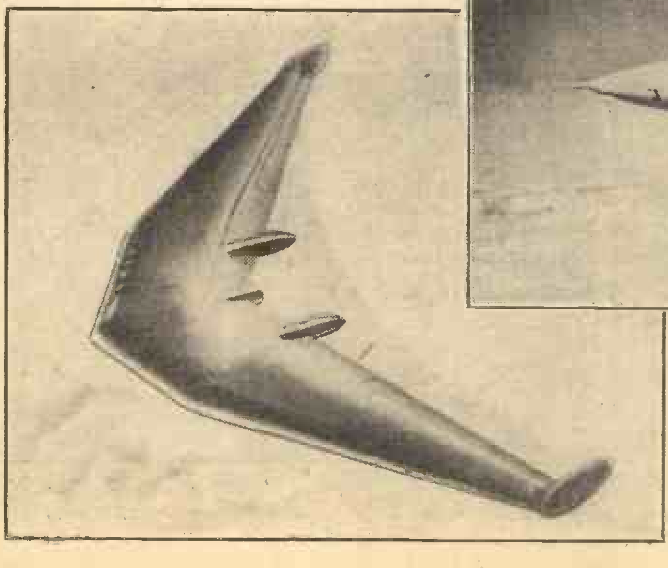
Fig. 6 shows an experimental glider developed and flown by the Australian Aeronautical Research Laboratories.

It has a wing section of 31½ per cent. thickness : chord ratio with boundary layer suction. In a lecture before the Third Anglo-American Aeronautical Conference, Mr. T. S. Keeble explained that the experiment was directed towards an all-wing air liner and that, basing the design on the results of the glider tests, he calculated that such an air liner could carry 40 per cent. more load 40 per cent. faster than one designed on conventional lines, while still consuming no more fuel for the same range, offering a large advantage in operating costs.

Fig. 7 shows the general arrangement of Keeble's air liner. It is an attractive proposition and looks like a high-speed aircraft, although, in fact, it cruises at under 300 mph.

Alternatively the same devices may be

Fig. 7.—(Below) Proposal for a suction wing air liner.
Fig. 8.—(Right) Aircraft with delta wing—Avro 707.



used to obtain wings of very high aspect ratio like the Hurel-Dubois, but without the need for the strut and therefore of lower drag.

The great problem with such slender wings is to provide sufficient stiffness and strength in the wing structure without making it too heavy, and so cancelling the aerodynamic advantage. The thicker sections possible with boundary layer suction make the idea more practical and it becomes very attractive for low speed, long-range aircraft, and especially for those which require long endurance as opposed to range, as, for example, Coastal Command aircraft engaged on anti-submarine patrol.

Tailless Aircraft

We have got so used to the conventional arrangement of aircraft with a straight wing, a long, slender fuselage and a tail, that we are apt to look on a tailless design as something of an unnatural freak. But if we observe nature carefully we notice that seagulls and ducks and many other birds are, in effect, tailless, at least in straight flight, and bats are tailless at all times, and are probably the most manœuvrable of all fliers. Gulls use their tails in manœuvring but, as far as one can see, more as air breaks than as elevators, and, incidentally, they use their feet in the same way.

There is a strong argument for a tailless design on structural grounds. In a pull out from a dive or a high-speed turn there is a large up-load on the wing and usually a download on the tail. On a conventional-tailed aircraft with sweptback wings the moments due to these loads cancel each other out only through the long path up the fuselage and the wing to the centre section. With a tailless design, on the other hand, the download of the tail occurs at the wing tips, and so we not only avoid the need for a structurally strong and stiff fuselage but reduce the bending moments in the wings also. There is therefore a potential gain in structure weight as well as in drag, which must be offset against the fact that the tailplane, if we may call it that, has a shorter moment arm and therefore has to be larger.

Delta or V Wings

Even without bondary layer suction there is a good case for the all-wing and tailless aircraft. In America the controversy between that type of design and the high aspect ratio wing with a long, slender fuselage has been dubbed the "big wing" against the "big stick" and long-range bombers have been developed to both formulæ. Both types of aircraft were designed for relatively low speeds. As the speeds of military aircraft have increased, the old controversy has died away and a new one has come to take its place. The new argument is between the different shapes of swept wings, and the big wing and big stick appear now as the delta wing and the sweptback or V wing as used on the Boeing B47 and B52 and on the Consolidated B60 jet bombers. These two types are shown in Figs. 8 and 9.

Aero-elastic Effects

We have already seen how sweepback was first introduced as a means of providing longitudinal stability and control on tailless aircraft. The odd part of the story is that nowadays we are concerned with the ill-effects of sweepback on stability, both longitudinal and lateral. It seems as if it had turned about and was now kicking for the other side; but still, if we keep a careful eye on its behaviour it is very well worth its place in the team for its high-speed qualities. The instability in its character shows itself in various ways, of which the most pernicious are aero-elastic effects, tip stalling and rolling moment due to sideslip. It is the aero-elastic effects, the aerodynamic effects of structural distortion in flight, which often have the biggest influence on the choice of wing planform.

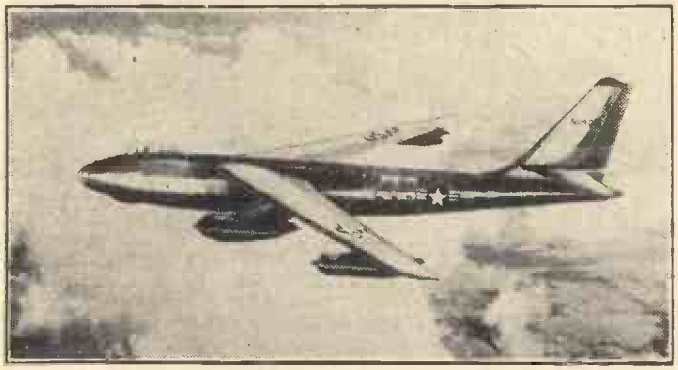


Fig. 9.—Aircraft with V wing—Boeing B47.

The fact that the sweepback is employed to allow high-speed aircraft to fly at still higher speeds is, in itself, a fair indication that we are likely to meet severe aero-elastic problems because at high speeds even quite small distortions may give rise to large aerodynamic forces.

Aileron Reversal

An example of the sort of problem that I have in mind is the designer's old bugbear of aileron reversal. Consider, say, the starboard wing of an aeroplane on which the aileron is deflected downwards with the intention of increasing the lift on that side and making the aircraft roll to port.

On a perfectly rigid wing the resultant rolling moment would increase as the square of the speed, but in practice wings cannot be perfectly rigid and the behaviour is more complicated. The air loads due to the downward aileron produce a twist in the wing, up at the trailing edge and down at the nose, so that the wing loses incidence and loses lift and so produces a rolling moment which is in the opposite direction to that due to the aileron itself.

The amount of the twist increases with speed because the air loads become greater in comparison with the elastic restraint of the wing structure. Finally, there comes a speed at which the rolling moment due to the twist equals that due to the aileron and the ailerons become totally ineffective.

At still higher speeds the effect of the twist exceeds that due to the ailerons and the aircraft rolls in the opposite direction to that intended by the pilot.

The designer has to see that the "aileron reversal speed" falls well outside the operating speed range of the aircraft and to do this he may have to make the wing much stiffer in torsion than would otherwise be necessary.

Aileron reversal is a problem which was well known in the days of straight wings, but sweepback has made it a more subtle enemy. Not only must we now consider the stiffness of the wing in torsion but also we must see that the bending deflections do not cause a loss of aileron power. It is not immediately obvious why this should happen.

The best way to see it is by deflecting an actual model. Fig. 10a shows a model of a sweptback wing. The pointer at the tip shows the incidence of the wing in the line of flight. The two vertical rods show whether the wing is twisted along its span. In Fig. 10a the wing is undeflected and untwisted. In Fig. 10b a load applied centrally at the tip has deflected the wing while leaving it untwisted but, as the pointer shows, there is a severe loss of incidence at the tip. This in turn means a loss of lift which opposes the intended effect of the aileron. This characteristic of sweptback wings may, as we have seen, produce a serious loss of aileron power but cannot, by itself, produce aileron reversal because the effect dies away to nothing as the aileron power diminishes.

(To be continued.)

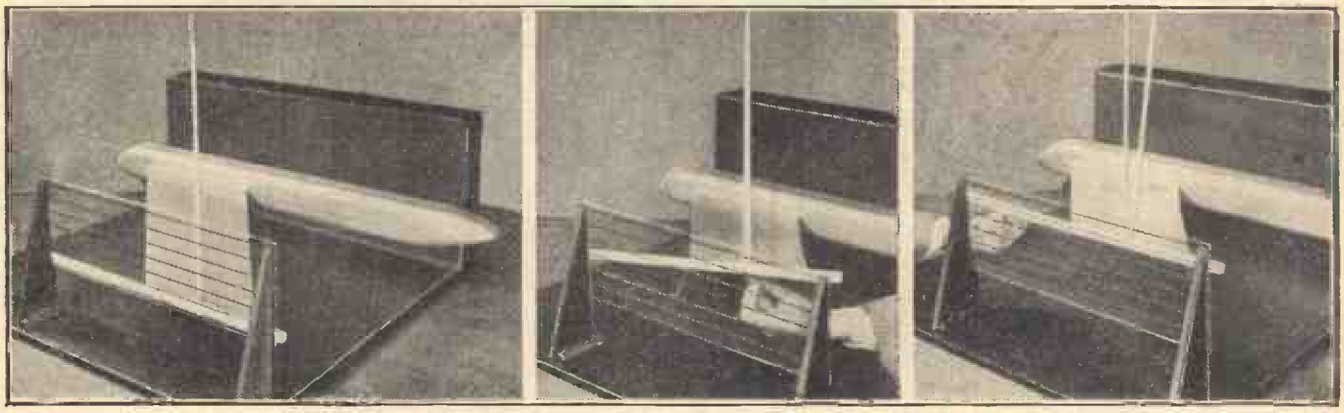


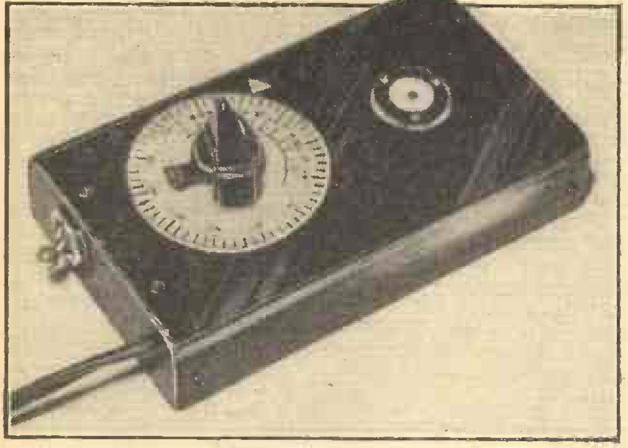
Fig. 10.—Distortion of a model sweptback wing.

a—undeflected. *b—untwisted but with loss of incidence at the tip.* *c—no loss of incidence at the tip, but the wing is twisted.*

A Grease-spot Photometer

Constructional Details of an Inexpensive Instrument for the Amateur Photographer

By W. L. PEACOCK



The completed grease-spot photometer.

THE instrument described below is similar to a commercial grease-spot photometer and can be constructed for little outlay by the average home mechanic, as no doubt most of the required components will be found in the oddments box.

Basically, it consists of an electric bulb fixed below a grease spot, the brightness of the bulb being regulated by means of a variable resistance. If such a system is placed beneath another light source the grease spot will either appear light against a dark background or dark against a light background, depending upon whether the upper light source is weaker or stronger than the lower one. By altering the brightness of the lower source the grease spot fades into the background, and at this point the relative intensities of the two sources are equal. Hence it is possible to measure the intensity of the upper source.

To obtain as great a sensitivity as possible the range of brightness controlled by the variable resistance should be spread over as great an arc as possible. This is arranged by choosing a value for the fixed resistance such that it cuts down the brightness of the light to about the greatest that will be required for normal enlarging purposes, and using a variable resistance of such a value that it dims the light to almost zero over an arc of about 180 deg. This represents an exposure range of about 30 minutes on the final scale prepared for the instrument.

The values of the resistances; 10 ohms for the fixed and 25 ohms for the variable one are not claimed to be the most effective, but gave in the original instrument a fairly long scale as mentioned in the previous paragraph, when an initial voltage of about 5 volts was used.

The blue filter was included to compensate for the greater percentage of red light emitted by the low voltage bulb compared with the normal enlarging bulb, and also to enable the balance point to be arrived at more easily.

The actual filter used, was the pale blue compensating one supplied with Dufaycolor, but a piece of celluloid tinted with photo tints or a square of blue gelatine (1½x exposure as used in portraiture) may be purchased.

If the photometer is to be used in conjunction with a voltage control unit the switch may be omitted, it only being necessary if a bell transformer is used direct on to the mains.

Filter Mount

The filter mount is of card and the same size as the ring used in the grease spot assembly.

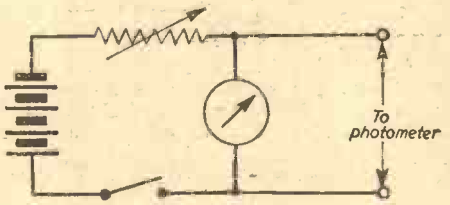


Fig. 2.—Circuit diagram of control unit.

As the cord is opaque, and mounted close to the bulb, it serves to restrict the beam of light reaching the grease spot.

Assembly

The wooden base and ends and the aluminium top and sides, were given a coat of black cellulose after being drilled to take the various components.

Preparation of the Grease Spot

The grease spot itself is made by dropping candle grease on to a piece of art paper and scraping off the excess grease. It is better to prepare a few such spots on one piece of paper and to retain and use the best specimen, which should be about ⅛in. dia. and symmetrical.

A celluloid ring and disc as shown in Fig. 1 are prepared and after painting one surface of the ring black the three parts are cemented together, as shown.

To save space the bulb-holder was dismantled, only the threaded portion, the soldering tags and the insulated spacing washer being retained. These parts were then fixed to one end with a wood screw, as shown.

The other components can now be added, care being taken to adjust the height of the filter so that it is just above the bulb.

The switch, if used, fixed and variable resistance and bulb are now connected in series, the leads being taken direct to the voltage control unit or the bell transformer.

It will be noted that a lug has been soldered to the locking nut of the scale to ensure ease of locking.

Voltage Control Unit

The photometer as described here originally operated from dry batteries, but if an A.C. mains supply is available it may be connected to this via a suitable bell transformer.

The control unit, Fig. 2, consists of a 10 ohm variable resistance, a voltmeter fitted with a plain scale with a mark at about 5 volts, a switch and a 6 volt dry battery. An Ever-ready 6 volt battery, No. 996, will supply current for this instrument for a few years before its voltage drops to the minimum required for its accurate operation.

In practice, the power supply is switched on and adjusted to the mark by means of the variable resistance when the variable resistance in the photometer is fully out of circuit, i.e. the lamp is at its brightest.

It could equally well be set with the resistance fully in the circuit, so long as this procedure is always adopted.

Calibration

The method of calibration is to use the height of the enlarger head above the easel and the iris to obtain a series of light intensities one-half of the previous one. The

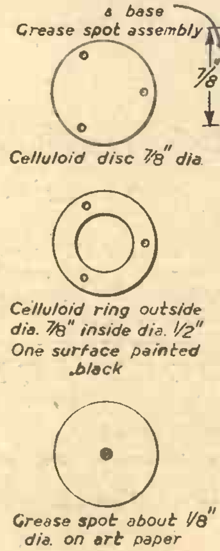


Fig. 1.—Details of celluloid disc and ring, and grease spot disc.

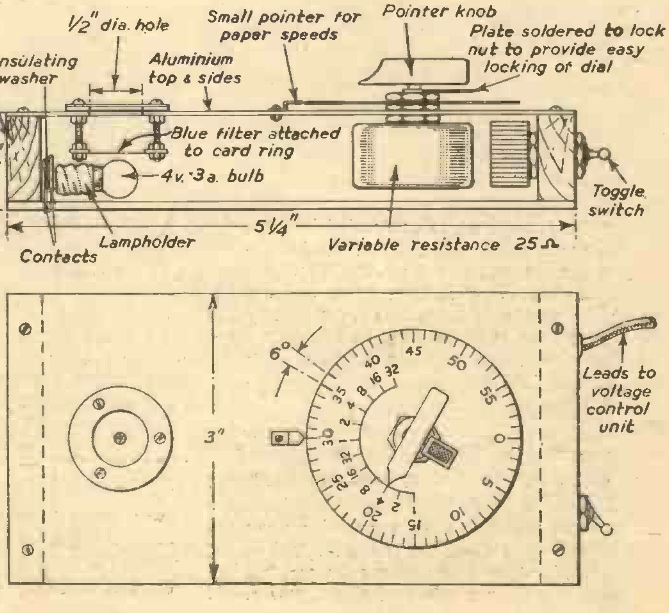


Fig. 3.—Sectional elevation and plan of the grease-spot photometer.

spot is balanced out for each setting and the position of the knob marked on a dummy scale.

Prepare a dummy scale (2in. dia.) and attach to the photometer, locking it in position with the lock-nut provided ; replace the pointer knob.

Set the voltage control unit as already described and with the enlarger head in the lowest position in which it is used in practice, open the lens to the first "whole" stop number and throw slightly out of focus. Place the photometer in the centre of the easel and balance the two light sources by moving the knob until the grease spot is not visible against the background.

Under these conditions the intensity of the light from the enlarger will never exceed that used in practice, as with a negative in position even in the highlight there will be some cut in the intensity. If a bulb of higher voltage is substituted later, however, it may not be possible to balance the spot with the head in this position and the lens wide open.

Care must be taken to ensure that a series of stops are used which will give half the light intensity of the previous one. Two methods of marking are in general use, the English and Continental, a suitable series of stops being 2.8, 4.0, 5.6, 8, 11, 16, 22, and 3.2, 4.5, 6.3, 9, 12.5, 18, 25, respectively. If any intermediate values are employed the scale about to be prepared will not be linear.

When balancing out the spot for each setting of the light intensity it is desirable to approach the balance point from each side in turn, and to take the average value as the actual point recorded.

After marking the first point, close the lens one whole stop and balance again, continue until the lens is fully closed.

Next, reset the pointer back one division and opening the lens to the original stop used, raise the enlarger head until a balance is obtained, close the lens one stop and rebalance, proceed as previously described until about 12 points have been made.

By setting the pointer back one division before rebalancing by raising the enlarger head it is possible to check the accuracy of the last mark.

When a sufficient number of points have been recorded remove the scale, draw radial lines through each mark and measure the angle subtended by each pair.

Total and average the results. Any deviation from the average is due to the non-uniformity of the variable resistance employed.

Next prepare on a piece of plain card and mark off 6 deg. intervals along its edge, so making 60 divisions, which will eventually be used as paper speeds ; number as shown in Fig. 3.

Using the average angle subtended by each point on the dummy scale mark off a concentric scale in such a position that the pointed knob is just in line with it, and number the points 1, 2, 4, 8, 16, 32 (secs.), 1, 2, 4, 8, 16 (mins.) as shown in Fig. 3.

Cement the finished scale between two pieces of celluloid and fix it to the photometer.

Determination of Paper Speeds

The speed of any type or batch of paper is determined as follows:

Set up the enlarger with a negative most suited to the type of paper whose speed is being determined, and make an accurate test strip using the middle tones of the negative. Develop, wash and fix in the usual way, and decide the correct exposure by examination of the strip in white light. If a test strip holder of the type which exposes a small square of a piece of paper, in turn in the same position each time, is available, the calibration will be all the more accurate, as there can be quite a variation in tone along a large test strip. Alternatively, test strips of the shadow and highlighter can be prepared and the average exposure used.

Now place the photometer on the easel in the position occupied by the test strip at the portion of it which was correctly exposed ; balance out the spot. Leaving the knob in this position unlock the scale and rotate until the correct exposure required is in incidence with the pointer, then lock the scale. The paper speed may now be read off against the pointer on the outer scale.

To obtain the correct exposure for any other negative printable on this paper take a reading on the middle tones or an average with the dial set at this particular speed, and read off the exposure required against the pointer at the balance point.

Measurement of Contrast Range

The comparison of the contrast range of a negative with that of available papers enables the most suitable grade to be chosen.

The contrast range of the negative is determined by taking a highlight and shadow reading and expressing the results as a ratio:

Highlight reading ...	10
Shadow reading ...	480
Contrast range ...	48:1

To determine that of paper, raise the enlarger head high up on the column, stop down the lens slightly and throw out of focus. Using this dim light source, place a strip of paper on the easel and prepare a grey scale, each section receiving twice the exposure of the previous one: Ex. 5, 10, 20, 40, 80, 160 and 320 secs, may be used.

Develop, rinse and fix the test strip.

The ratio of the exposure required for the last pure white divided into that required for the first pure black gives the contrast range of the paper.

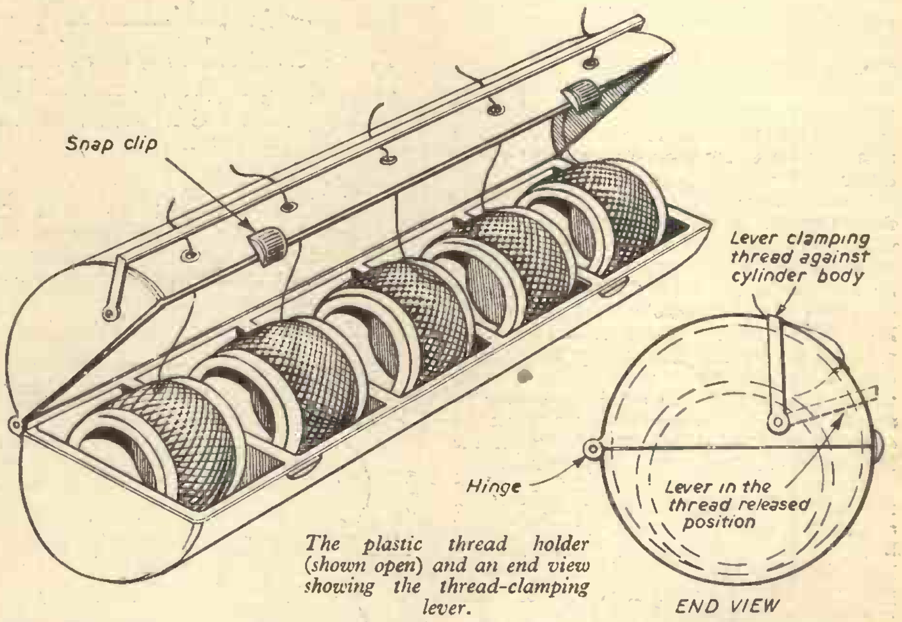
Contrast range:

$$\frac{\text{Maximum exposure for pure white.}}{\text{Minimum expossture for pure black.}}$$

Plastic Thread Holder

This Device, Submitted by Mrs. M. Garrick, Won a Prize in Our Recent £200 Prize Competition

WHILE looking at my card of tangled-up stocking threads, the idea came to my mind that if a container were available to separate the different shades of threads and also stand up to a lot of rough handling it would save a lot of time and frayed tempers. This magazine type of holder would be suitable for workbaskets or handbags. I think it could be made of plastic, of a cylindrical shape and hinged to open, as in the sketch. The various shades of thread on spools could be placed in the lower half, each spool in a separate compartment. The free ends of thread could be fed through holes above each reel to the outside of the top half of the case, the protruding thread being stopped from moving, except when required, by a locking rod, as shown in the diagram.



The plastic thread holder (shown open) and an end view showing the thread-clamping lever.

Modern Inventions and New Ideas Exhibition

Some of the More Interesting Exhibits at the Recent Show

By THE MARQUIS OF DONEGALL

THE Modern Inventions and New Ideas Exhibition opened recently under the patronage of H.R.H. the Duke of Edinburgh contained much of interest in a small space.

One presumes that the sub-division of "New Ideas" was an afterthought to cover the large number of commercial stalls selling a diversity of novelties from tubes of plastic for blowing bubbles to a new and very efficient needle-threader.

The "New Inventions" section was under the auspices of the Institute of Patentees, of which Professor A. M. Low is president. "Unhappily," said Professor Low, as usual making a great deal of sense, "the inventor seldom receives more than honour. Yet it is often from the humblest beginnings that commercial sucess has sprung. This exhibition sets out to show how, by concerted effort, inventors can be encouraged."

There has long been a need in this country—whether Government sponsored or private—for some central organisation to help inventors on their way. Most of them are befuddled with the intricacies of patent law and are awed by the cost, operating on a rising scale, of attempting to protect their property from the machinations of unscrupulous persons. Obviously, no individual can afford the kind of litigation that ensued right up to the House of Lords such as that in which the Raleigh Industries' "Dynova" patents were eventually set aside.

In the inventions part of the exhibition a number of recent industrial inventions or discoveries were displayed. One development was in the use of the cathode-ray tube to reduce the regulation of watches from days to minutes by making the "tick" visible. As I sauntered along a rotary machine was replacing broken-off handles on tea-cups at the rate of twenty a minute.

(Above.) Mr. W. Glinski, of London, with his new invention of Hexagonal Chess. By employing hexagonal cells instead of square the movements of the chessmen have been increased.

(Left.) A new Ironing Chair which was demonstrated at the exhibition. A tubular steel crank links the ironing board to an ordinary chair, enabling a person to sit in a comfortable position. Invented by Mr. J. Vickery, of Croydon, Surrey.

Another part of the exhibition contained individual models by about a hundred inventors. These were displayed in the hope of catching the eye of the potential commercial sponsor.

Cyclists' hand-signals and a stop-light for the bicycle were useful and topical contributions and, while on the subject of accidents, mention should be made of the deck-chair that is guaranteed not to collapse.

Chess Improvements

As though checkmate were not already a difficult enough operation, somebody has invented hexagonal chess, played on hexagons of three colours. I am open to correction from infuriated chess players, but I believe that this gives the King twelve possible moves, the Queen twelve directions and the Knight twelve possible cells—or squares, as they would be in the old game. All that I can say about it is that it would appear to be not quite as bad as three-dimensional chess, which I once saw demonstrated, or playing against a machine which was guaranteed to win, as I once did at an exhibition in Geneva. Not the least infuriating part of this machine, which was the invention of a Spaniard, was a metallic voice from the machine's inside which cried "Jaque al Rey!" every time it was check; added to which, if you tried to move into check, the machine said in Spanish, "You can't do that there 'ere," or words to that effect.

Housewives would approve of the ironing-chair—indeed, I have often wondered why it has been thought necessary to make ironing even more tedious by standing up to do it.

Improved Car-park

The mechanised car-park, of which there was a scale model to be worked by turning a handle, was one of the best things in the exhibition.

One mechanised section or unit of the car-park was shown, and there could presumably be any number of these units for which space is available. Each unit takes twenty cars on an endless belt. The time calculated for releasing any given car is one and a half minutes, and it is reckoned that three hundred cars could be parked on this system where previously only two hundred could be stored with any degree of working practicability.

Even with two hundred cars the average time for releasing the least-conveniently parked vehicle would be seven or eight minutes. One can only hope that this invention did, in fact, find a sponsor through the exhibition.

Still in the Inventors' Section, there was an anti-dazzle screen, with a cut-out section for looking through, while the remainder eliminates the glare. Another device I noticed was an animal controller, for clamping the noses of such animals as bulls as an improvement on the usual nose-ring. The egg-boiler, which automatically switches-off when the eggs are ready, seemed a useful device, as did the very simple idea of the bread-board with a slit to keep the knife straight, thus ensuring a regular slice.

Home Improvements

A compact unit to supply hot water, warm air for space-heating, and ventilation, was one of the many exhibits contributing to living comfort, as were the convertible bed-settee, the office-chair on which all the leg-joints were rubber-mounted, the portable oven and reversible windows for cleaning from inside.

There were many ideas which were by no means new to me. For instance, I had, several years ago, a device for recording telephone messages in my absence installed in my office. There was nothing wrong with the machine except that callers, on hearing "Lord Donegall is out. Will you please speak a message!" usually thought that a gremlin had got into their telephone and rang off in a panic.

There is nothing particularly new about a thermostatic fire-alarm, either, although the one exhibited was undoubtedly a very simple device, relying on the fusing of a piece of metal at 160 deg.F. to establish an electric-bell circuit.

Finally, in the Inventors' Section, there is much to be said for a picnic-seat giving back support and folding-up into the size of an umbrella.

There was a wool-winder transforming the skein into a ball, the strands being crossed over in such a manner that the ball could not unwind accidentally.

In the industrial field, I liked the strap and rollers for attaching to a suitcase, much as has been done for many years with golf-club bags.

A revolving gear-box, claimed to increase mileage per gallon by 50 per cent., was also exhibited. It eliminates gear-changing, but whether it is an improvement on existing methods of eliminating gear-changing in motor cars is impossible to judge by looking at it. It appeared no more bulky than an ordinary gear-box.

Lastly, there is no doubt that were we all to install stoves such as the "M.I.," invented and produced by an Anglo-Polish inventor in Bournemouth, or the many other stoves of somewhat similar design, we would get warmer houses and save a good fifty per cent. of our fuel bill. But will we? I am afraid that there is something about the old English open fire that will cause inventors of more efficient heating devices a headache for many years to come.

Making an Anemometer

A Simple Device for Gauging the Speed of the Wind

An anemometer, or wind speed measurer, is easily made, but, at the same time, is a most fascinating piece of apparatus. Four semi-circular cups form a kind of horizontal windmill which spins slowly or

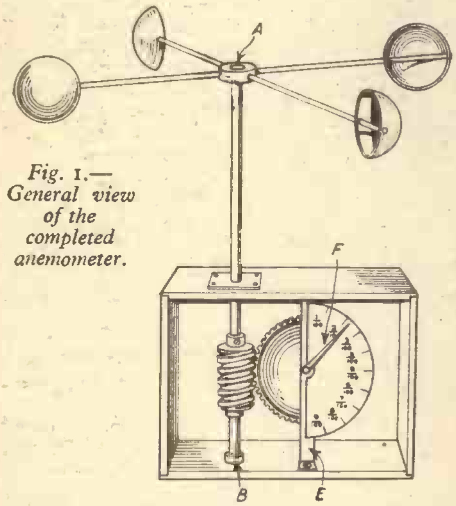


Fig. 1.—General view of the completed anemometer.

rapidly, according to the velocity of the wind. By means of a worm and pinion gear a pointer moves over a graduated scale, from which can easily be found the speed of the wind in miles per hour.

The cups are beaten out of circular pieces of sheet copper, exactly 4.71in. in diameter, and when finished must be exactly 3in. in diameter. If you do metal work this is a simple task; if not, you can get them made quite cheaply.

The Four Arms

These are made of $\frac{3}{16}$in. diameter brass rod, 11¾in. long. The vertical spindle consists of a suitable length of ¼in. diameter mild steel rod. The boss, A, is 1¼in. diameter and ½in. deep. Run a thread on the end of the rod and tap the hole in the centre of the boss; then tap four holes ½in. deep exactly at right angles, to take the threaded ends of the four arms. Solder the cups firmly in position as shown and screw the arm firmly into the boss, which is then tightened down on the spindle.

The worm wheel is fixed securely to the spindle by its set-screw (see Fig. 1). The bottom of the spindle is pointed and runs in a hollowed bearing block of steel, B. A collar and set-screw, C, keep the spindle in place. The pinion, which engages in the worm, has 56 teeth, and is fixed firmly by a set-screw to a spindle, D, which runs in bearings in the two brass strips, E E.

A dial of cardboard, graduated into 20 equal parts and numbered $\frac{1}{100}$, $\frac{2}{100}$ up to $\frac{20}{100}$ is glued to the front strip. The front strip and half the dial is shown in Fig. 1.

The Box

This is about 6in. long, 3in. deep and 4in. high. It should be firmly screwed together. A sheet of glass forms the front, through which the dial is read. The bearing in the top of the box is formed by screwing a piece of sheet brass on and boring a hole just large enough to allow the spindle to revolve freely. The hole in the wood should be a little larger to allow perfect clearance. Fix the model firmly in an exposed position, as high as possible, but so that it can be read easily.

If made exactly to these dimensions, 56 revolutions of the cups—i.e., one revolution of the pinion and pointer—equals $\frac{1}{5}$ of a mile. Each division on the dial is thus $\frac{1}{100}$ of a mile.

When the wind is blowing, watch the pointer and note carefully how many divisions

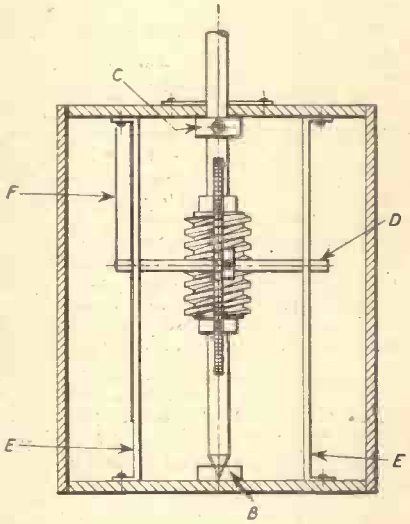
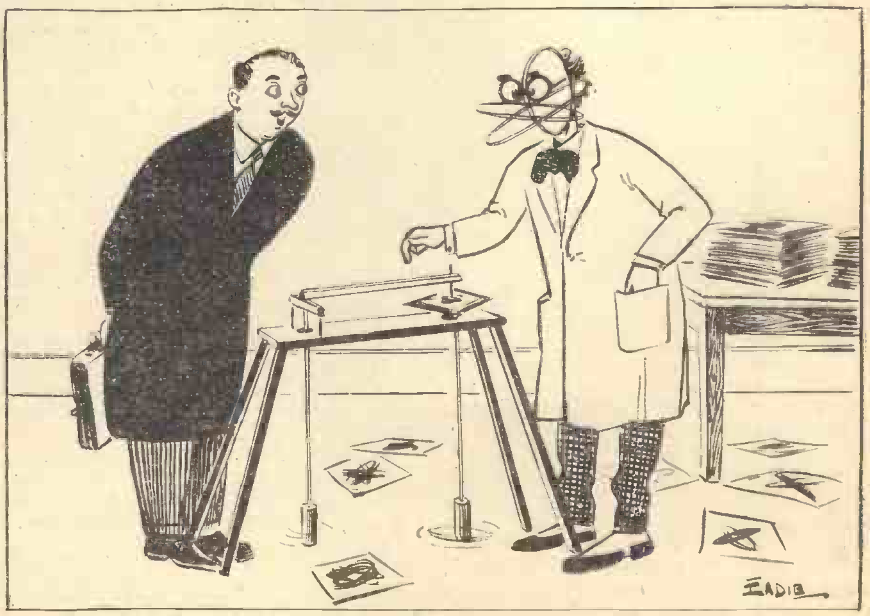


Fig. 2.—Side view of the worm and pinion.

it passes in one minute, or five minutes. Suppose it moves from 0 to $\frac{10}{100}$ in one minute. This means a speed of $^1/_{10}$ miles in one minute or six miles per hour. If the pointer does four complete revolutions in one minute, this is $\frac{4}{5}$ of a mile per minute, which is 48 miles per hour.



Boffin says: "It's amazing how Camm's harmonograph gets you after a time."

Radio-controlled Model Actuators

Notes on Their Construction, and How They Operate

By F. G. RAYER

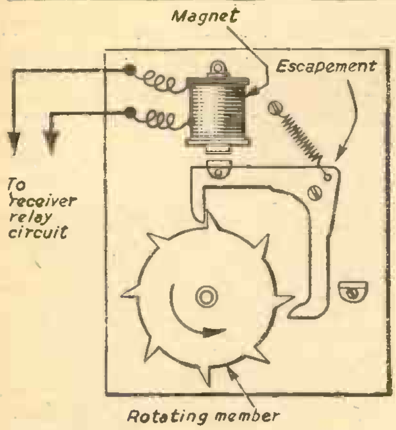


Fig. 3.—An escapement actuator.

THE equipment in a radio-controlled model may be divided into three sections. First comes the receiver, which may employ one or more valves. There will also be a propulsion motor (except in sailing craft) and similar equipment connected with the actual powering of the model. Between receiver and propulsion and/or guiding motors and mechanisms comes the third section of the equipment—the actuator. Many different types of actuator can be made up, and the actual construction of suitable units is not particularly difficult. In a sense, the actuator transforms the received impulse into the desired action, which may be starting, stopping, reversing, or speed-control of the propulsion motor, or so on.

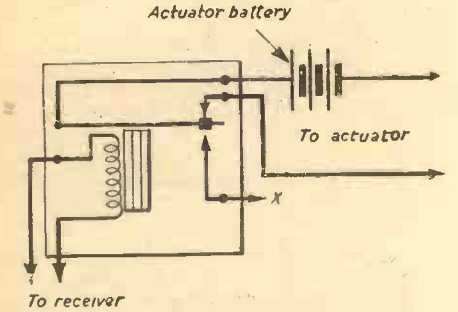


Fig. 1.—Connections for receiver relay.

The types of actuator described here are primarily intended for single-valve and other single-channel receivers. With such receivers, all desired operations in the model must be controlled by the opening and closing of a single circuit. Accordingly, in all but the very simplest model, some type of actuator is essential. Without an actuator mechanism, radio-control (with a single channel receiver) would have to confine itself to one purpose only; for example, the starting and stopping of a model boat's propulsion motor. With an actuator there is almost no limit to the amount of control which may be exercised. For example, the propulsion motor could be started, stopped and reversed. It could also be made to run at half speed in either direction. In addition, steerage of the model, both when in motion forward or astern, could be effected. If desired, other actions (such as the rotation of gun-turrets) could be provided for. It will, therefore, be seen that the realistic operation of a model makes an actuator mechanism essential.

Principles of Control

With a single-channel receiver, the transmitter is keyed so that a carrier-wave is radiated when desired. This causes the anode current in the receiver to fall, so that a relay is released. Such a relay is shown in Fig. 1. It is of sensitive type, so that it will operate with a current change of as little as .1 milliamp, and various relays are especially produced for this purpose, and should be used.

When the transmitter is operated, the armature is released, thereby completing the battery circuit shown. If this circuit were wired directly to an electric motor, the motor would run when the key at the transmitter was depressed, and stop when the key was released. This would only be sufficient in the very simplest type of model.

A further circuit might be connected to the lead "X," but this would, in most cases, serve no useful purpose. One circuit would *have* to be switched on when the second was off, since the armature cannot be brought to rest in a central position. As a result, the second circuit could not be used to operate a steering motor, or for any similar purpose.

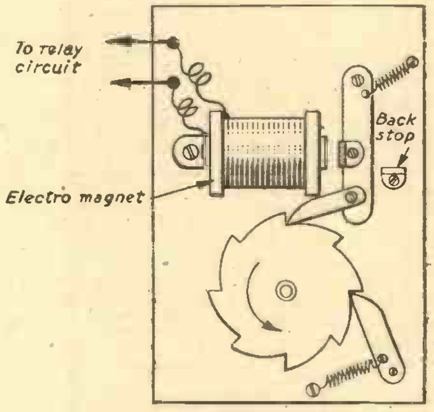


Fig. 2.—A magnetic actuator.

Without an actuator the degree of control is, therefore, the same as that which would be afforded by a single on/off or change-over switch in the model.

How Actuators Function

All actuators change the simple making and breaking of a circuit (as provided by the relay) into more complex functions. One method of doing this is shown in Fig. 2.

Here, an electro-magnet and pawl assembly causes the rotation of a toothed wheel. Each time the magnet is energised, the wheel is caused to rotate one tooth. Such an arrangement is quite straightforward to make up. The magnet needs to be fairly powerful, and the pawl should move just sufficiently to take one tooth each time the circuit is energised.

By keying the transmitter, the wheel may be made to take up any one of eight positions. If necessary, undesired positions may be passed through almost instantly by keying the transmitter a number of times in succession.

A different type of actuator is shown in Fig. 3. Here, the wheel is constantly endeavouring to rotate in the direction shown. Each time the magnet is energised, the wheel is allowed to rotate one tooth. This arrangement has a number of advantages in some cases. The magnet only acts as a release, and the actual rotary force does not have to be provided by it. As a result, heavier mechanisms may be operated.

In simple models, rotation is frequently provided by a twisted skein of elastic. A small clockwork motor can also be used, or some similar form of spring-driven mechanism. Where some other source of continuous power exists, as with a steam-driven model, the toothed wheel may be driven through a friction clutch. It will then rotate each time the transmitter is momentarily keyed.

Rotation of the axle upon which the wheel is fixed is made to fulfil some useful purpose. One means of accomplishing this is made clear in Fig. 4. Here, a disc with projecting pin is fitted to the axle. This disc may be made to take up any one of eight positions. With the steering arrangement shown, this would enable the rudder to be set in any one of five positions, namely, straight ahead, half to port or starboard, and fully to port or starboard. Steerage of the model to this extent would thus be possible.

A rotary switch with eight contacts is also driven by the spindle. In the circuit shown, provision is made for forward and astern running, with "Off" positions between each. It would also be possible to wire up so that only one contact was unused, providing an "Off" position. Other contacts could then bring a resistance into circuit for "Half Speed" running. Or, if desired, only one "Astern" setting need be provided.

In all cases switching of the circuit will take place simultaneously with movement of the rudder. Eight different combinations may be arranged for, and a good degree of control will, therefore, be secured. A sequence such as the following would be possible.

Position 1. Rudder straight, full speed ahead.

Position 2. Rudder half to port, full speed ahead.

Position 3. Rudder fully to port, full speed ahead.

Position 4. Rudder half to port, half speed ahead.

Position 5. Rudder straight, half speed astern.

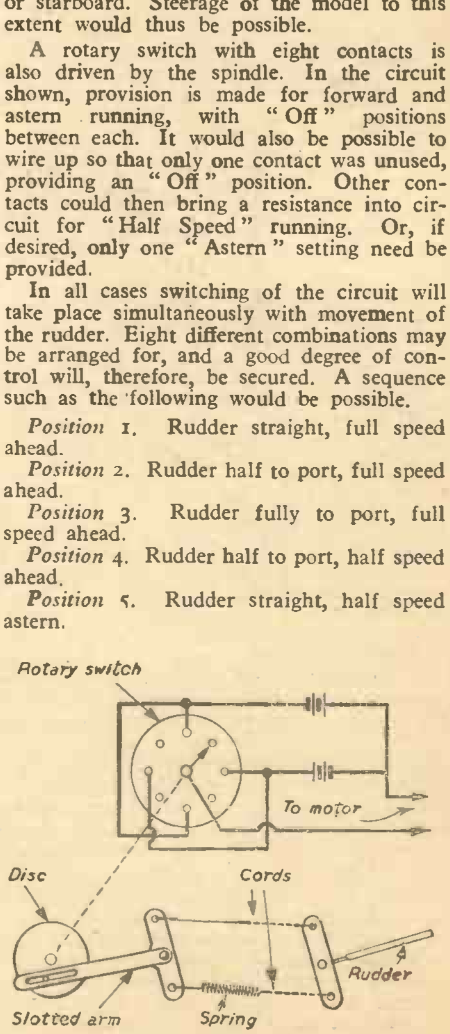


Fig. 4.—A reversing and steering arrangement.

Position 6. Rudder half to starboard, half speed ahead.

Position 7. Rudder fully to starboard, full speed ahead.

Position 8. Rudder half to starboard, full speed ahead.

In each case undesired positions are passed through quickly by keying the transmitter a number of times in succession. The model may thus be controlled to an extent permitted by the selection of any of the positions.

Many of the simpler actuators provide no intermediate position of the rudder, and even these are quite effective, since the model can be turned upon a new course in either direction. If reversing were not desired, such an actuator could provide for full speed ahead, full speed to port, full speed to starboard, and "Motor Off" with rudder ahead. The wheel on the actuator mechanism would require only four teeth. This would make the method shown in Fig. 2 impossible, but that shown in Fig. 3 would be equally suitable.

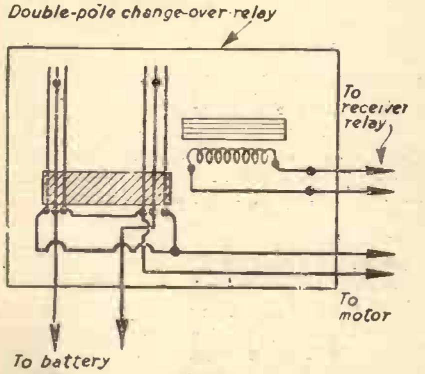


Fig. 5.—Motor reversing by means of a secondary relay.

In Fig 4, reversing of the motor is obtained by reversing the polarity of the supply. This can only be accomplished by using a permanent-magnet motor. If the motor has a wound field, the polarity of the supply to either field or armature should be reversed, to reverse the direction of rotation.

Secondary Relays

The receiver relay may complete a circuit which energises a secondary relay with additional contacts. More complex circuits may then be used. A reversing circuit is shown in Fig. 5. A double-pole change-over relay is used, and wired so that the motor is reversed.

This type of circuit has a number of applications, usually in conjunction with an actuator such as has been described. The type of relay used here is of about 200 to 500 ohms resistance, is quite small, and normally energised by a 3 to 4.5 volt dry battery. The sensitive type of relay such as used in the receiver is not required. For example, the controlling circuit may be transferred from one motor or actuator to a second, by the change-over switching of the relay. This change can, in turn, cause yet other relays and mechanisms to come under control.

Secondary relays must also be used when the current flowing is heavy, or of fairly high voltage. The contacts of the receiver relay operate a trifle slowly, and the contact pressure is small, especially when the model is at range. Accordingly, the contacts will not satisfactorily make or break circuits passing a large current. They will, however, ably deal with small currents, at low voltage, and can, therefore, serve to control the energising of a second relay. Such a relay might be powered by a 3 or 4.5 volt battery, as mentioned, and its contacts could deal with higher voltages and currents. Such a secondary relay is essential in non-mobile mechanisms where mains-voltage circuits are interrupted.

Motor-driven Switching

A small motor may be used to operate a rudder, or other units, including switches of suitable rotary type. Such switches become almost essential when very complex circuits are necessary.

A method of operation is shown in Fig. 6, where a small motor drives a rotary switch through worm gearing. "Yaxley" rotary switches, such as used in radio receivers, are suitable, provided the spring locator mechanism is removed.

When such a method of switching is adopted, there is almost no limit to the complexity of the circuits which may be used. The motor should, for preference, be reversible, as described. Such switches may bring into service further sections of equipment, such as small motors to rotate turrets, latching relays to switch on lights, and so on.

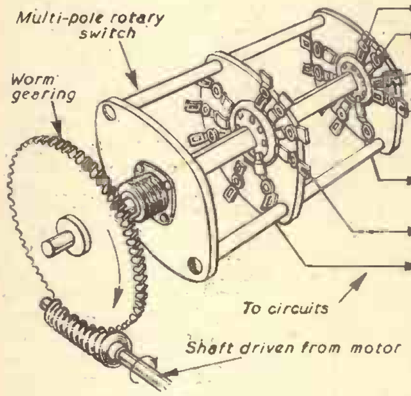


Fig. 6.—Multi-circuit switching.

Back to First Principles

4.—Gravitational Force

By W. J. WESTON

THERE, indeed, is one of the things that we are bound to accept, without explanation, as a condition of our life in the world. Through experiment and observation we are able to say much with confidence about the force—about the *results* of this tendency towards a centre of attraction. We speak of the "law of gravitation" as being that whereby "the attractive force of bodies varies *directly* as their masses and *inversely* as the square of the distance between them." But, assuming that Newton's wonderful guess is absolutely correct, this is a statement of what happens, and what we are impotent to change. The explanation of why each particle of matter tries to come closer to every other particle still eludes us; we only know that it does.

The Problem : A ball is thrown vertically upwards at a speed of 128ft. per second. Find where it is after 5 seconds, and the total distance it has actually travelled. If it falls past the point of projection into a well 120ft. deep, find when it strikes the bottom.

The Comment : We work on the assumption that the accelerating effect of gravity—we shall denote this by g—is 32ft. per second; it is a little less than this up the mountain, a little more than this down the mine. If we denote the number of seconds by t, then gt is the acceleration due to gravity; and $\frac{1}{2}gt$ will be the average speed. The distance travelled, therefore, is $\frac{1}{2}gt^2$.

If now we denote an initial upward acceleration as u, we are able to express these three equations :

I. The velocity at any point is : $v=u-gt$

II. The space travelled is : $s=ut-\frac{1}{2}gt^2$.

III. And, combining I and II : $v^2=u^2-2gs$.

Since, therefore, at the highest point—which we denote as h—$v=0$, then $u^2=2gs$.

The Answer $\therefore s=128\times 5-\frac{1}{2}(32)\times 25=$ 240ft. up.

But the greatest height is reached in $\frac{128}{gt}$ seconds, i.e., t is 4 seconds.

After 5 seconds, therefore, the ball has been moving downwards for 1 second, i.e., over 16ft. The total distance, therefore, is 240+16 up+16 down=272ft.

Since the ball falls below the point of projection, s becomes negative. So :

$$-120=128\times t-16t^2$$

$$\text{i.e. } 16t^2-128t=120$$

$$\text{i.e. } t^2-8t=\frac{15}{2}$$

$$\text{(Add 16 to each side) } t^2-8t+16=\frac{47}{2}$$

$$\therefore (t-4)=\sqrt{\frac{47}{2}}=\sqrt{23.50}=4.82$$

$$\therefore t=8.82 \text{ seconds.}$$

The Problem : If a stone falls past a window 8ft. high in half a second, find the height from which the stone fell.

The Comment : This involves the calculation of the velocity of the stone when it reached the window: that velocity would operate during the passage of the window over $\frac{1}{2}$ second. We need to calculate also the space through which the stone, starting from rest, would travel in $\frac{1}{2}$ second.

As regards the first calculation, since the positive direction is now downwards, the equation of motion is : $v^2=u^2+2gh$, or since $u=0$ (the stone starting from rest), $v^2=2gh$.

The Answer: Space through which a body starting from rest falls in $\frac{1}{2}$ second $=\frac{1}{2}gt^2=(16\times\frac{1}{4})$ft. $=$ 4ft.

The velocity of the stone when it reaches the window is 4ft. in the $\frac{1}{2}$ second, i.e., 8ft. per second.

And, since $v^2=2gh$,

$$8^2=2\times 32h=64h.$$

That is, $8=8\sqrt{h}$ or $1=\sqrt{h}$

The height above the window is, therefore, 1ft.

The Problem : A ball is propelled vertically with a velocity of 56ft. per second. At what height is it moving at 40ft. per second ; and what is the time between the instants when it is at this height ?

The Comment : This is merely a variant of the first problem studied, and we apply the equations with the necessary modifications.

The Answer : The equation of motion where u is the initial upward acceleration and v the velocity at the time, and h is the height in feet reached is $v^2=u^2-2gs$.

$$\text{or } 40\times 40=56\times 56-2\times 32s$$

$$\text{i.e., } 64s=56^2-40^2=(56+40)(56-40)=96\times 16$$

$$\therefore s=24\text{ft.}$$

An upward acceleration of 40ft. per second is wholly lost in

$\frac{40}{gt}$ seconds, i.e., in $1\frac{1}{4}$ seconds.

And since a downward acceleration of 40ft. per second is gained in the same time, the total time required is : $2\frac{1}{2}$ seconds.

TELESCOPE OPTICS

The Work of Bernhardt Schmidt and its Relation to Telescopy and Other Sciences

By FRANK W. COUSINS, A.M.I.E.E., F.R.A.S.

(*Concluded from page 292, April issue*)

Our artist's impression of the Schimdt telescope at Mount Palomar.

THE second departure is due to Maksutov [9, 10, 11]. Dr. Linfoot discussed this in "The Observatory" and referred to the optical system as the Meniscus-Schmidt. The arrangement is seen in Fig. 12. The aspheric Schmidt corrector plate is replaced at focal ratios of f/3 and apertures up to 2 or 3ft. by a meniscus lens, the spherical surfaces of which are nearly concentric with the mirror surface. The primary colour error of the meniscus is corrected by a spherical interface which takes the form of a doublet with its two glasses of different dispersions and the same mean refractive index. The off-axis colour errors introduced by the spherical interface though not negligible are harmlessly small.

Folded and Solid Schmidt Cameras

Finally, two adaptations of the classical Schmidt are not without interest. The solid Schmidt camera, Fig. 13, and the folded Schmidt camera, Fig. 14, due to Hendrix, which places the image surface in a readily accessible position.

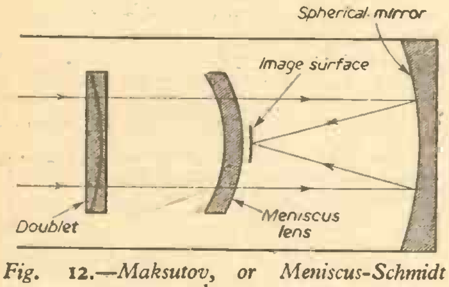


Fig. 12.—Maksutov, or Meniscus-Schmidt telescope.

In considering the folded Schmidt camera it is convenient to draw attention to the optical system used in modern projection television. Fig 15 shows the system used by Mullard[12]. In contra-distinction to the telescope aspect we have considered throughout: the television application places the image on the image surface as its initial step in the light path; and the image surface is the fluorescent screen of the cathode-ray tube, AB (Fig. 15). Consider point A, a single picture element. Light radiated forward from picture element A reaches the spherical mirror, D, which reflects it as a convergent beam on to the flat mirror, E, at 45 deg. to the axis of the cathode-ray tube. The light from E passes through the Schmidt corrector plate, F, on to a second mirror, G, and finally on to the screen, S, at K. This provides an enlarged image of the picture element, A, at K, and is applicable to all the other picture elements.

One other use of the Schmidt system outside of astronomy is that of its part in roentgenology. It has been stated by Brockman[13] that the Schmidt system is used to detect cancers of the stomach. Cancer, like tuberculosis, can be detected by X-ray methods, but the examination is hindered by the very much lower transmissivity of the gastro-intestinal regions to X-rays as compared with the transmissivity of the chest, and this means that the fluroscopic image is faint. To avoid long exposure and over-dosage of the patient with X-rays a fast lens system is essential. Here Schmidt's system lends itself to a really fast camera design, and this, though in the early stages of development, may make possible mass-radiography of the stomach as now done for the chest in the war on tuberculosis.

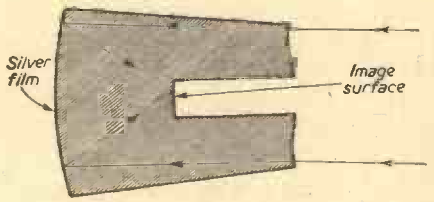


Fig. 13.—Solid Schmidt.

Newton Telescope at Hurstmonceux

In closing this appraisal of Schmidt's work it is gratifying to report that the Isaac Newton telescope[14] which will be erected at Hurstmonceux in Sussex will be of the Schmidt construction and the largest in the world. The main mirror is to be 98in. dia.; with a corrector plate of 85in. dia., and the photographic plates will be 14in. x 14in. What will such great instruments tell us of our universe? The answer to such a question is not possible. We can read again, in humility, the words of Prof. Grant quoted in the preamble to this article, and note that the telescope has ever been an iconoclast in its treatment of the contemporary view—reducing the speculation of many philosophers to ashes. The future may well be iconoclastic for many current ideas; the enigma of the universe is far from solved.

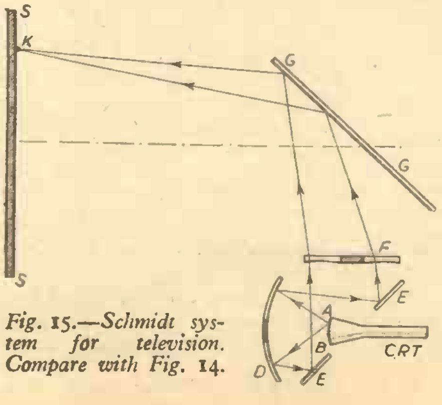


Fig. 15.—Schmidt system for television. Compare with Fig. 14.

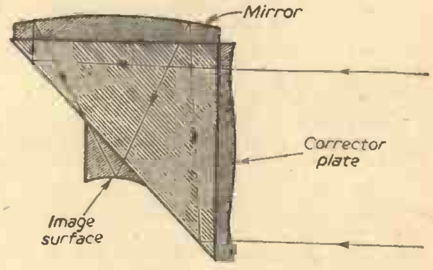
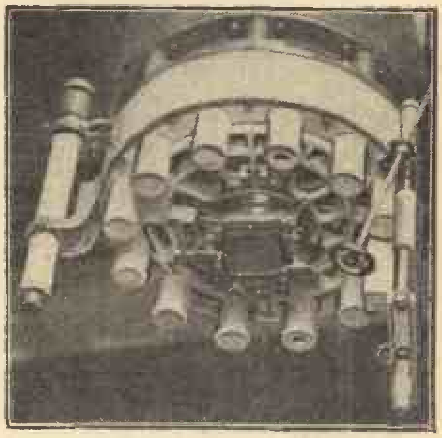


Fig. 14.—Folded Schmidt.



A close-up veiw of the eyepiece end of the Schmidt Cassegrain telescope at St. Andrews University.

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Making STEREOSCOPES

Instruments Suitable for Viewing Two-lensed Camera Slides and Single-lens Camera Stereos

By E. W. TWINING

PEOPLE who have lost the sight of one eye can never see objects in the round or in relief, and are only able to judge distances by moving the head from side to side. The normal sighted person, using both eyes, can judge distance without moving the head. The reason why this is so and why all objects in nature appear in relief; why they have depth as well as breadth and height is because the images formed on the retinas of the two eyes are not exactly the same; the right eye sees the subject from a different viewpoint from the left. This is readily proved by placing on a table a bottle and a candle; let the candle be the nearer almost in line with the bottle. Now close and then open one eye, then the other; do this repeatedly in rapid succession and it will appear that the candle keeps moving, first to one side of the bottle and then to the other. This is stereoscopic vision.

If we substitute for the eyes two photographic lenses attached to a double-width camera, fitted with sensitised plates or films, we can photograph exactly what the two eyes have seen. The two resulting pictures, taken by different lenses from slightly different positions, may appear to be alike, but if the subject photographed was a simple one, like the candle and the bottle, then careful examination and, perhaps, measurement, will show that the candle in one picture is a little nearer to the bottle than in the other. This is stereoscopic photography, the result of which is a pair of photographic prints, mounted side by side, which, in order to be viewed stereoscopically, must be looked at through a stereoscope.

Obviously, the two prints must be mounted in correct order. If the left-hand photograph were placed on the right side of the mount and the right-hand on the left, then the more distant object would appear in front of the other and the perspective and solidity of the objects would be reversed and all wrong.

The stereoscope compels the left eye to see the left-hand picture and the right eye the right-hand. The two views are then superimposed by the optic nerves, producing, in the brain, the effect of one picture possessing all the solidity and relief of the original subject.

Stereoscope for Two-lensed Camera Pictures

It is proposed to give drawings of two stereoscopes, dealing with the larger one first.

This is of the size and type which is required for viewing pairs of pictures taken with a double-lensed, orthodox, stereoscopic camera, using single plates which are long enough to accommodate two views, side by side, each measuring 3¼in. by 3¼in. This means that the optical centres of the lenses must be 3¼in. apart, which they nearly always are. In the stereoscope two lenses are required, one for each eye. Now, as the human eyes are approximately 2½in.

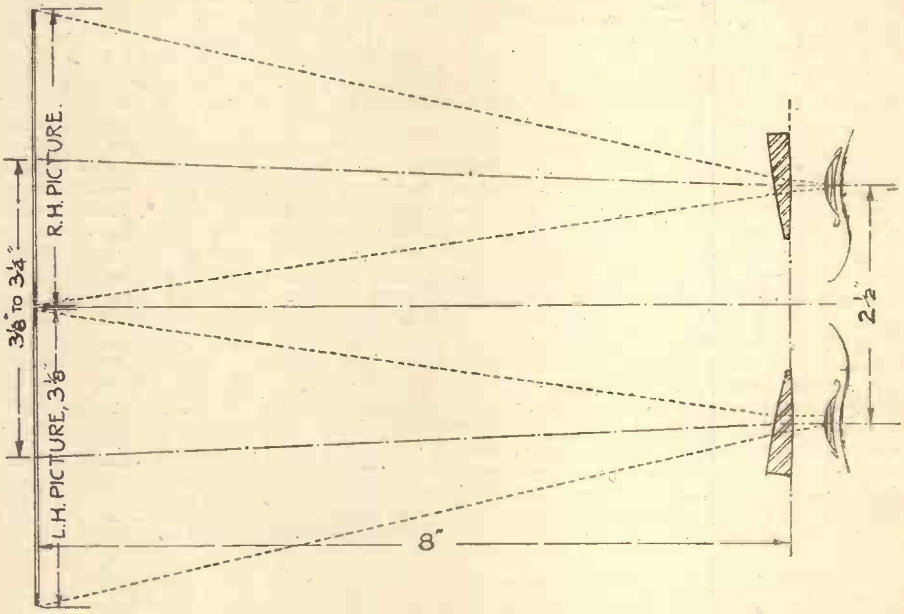


Fig. 1.—Showing how the lenses bend the light rays.

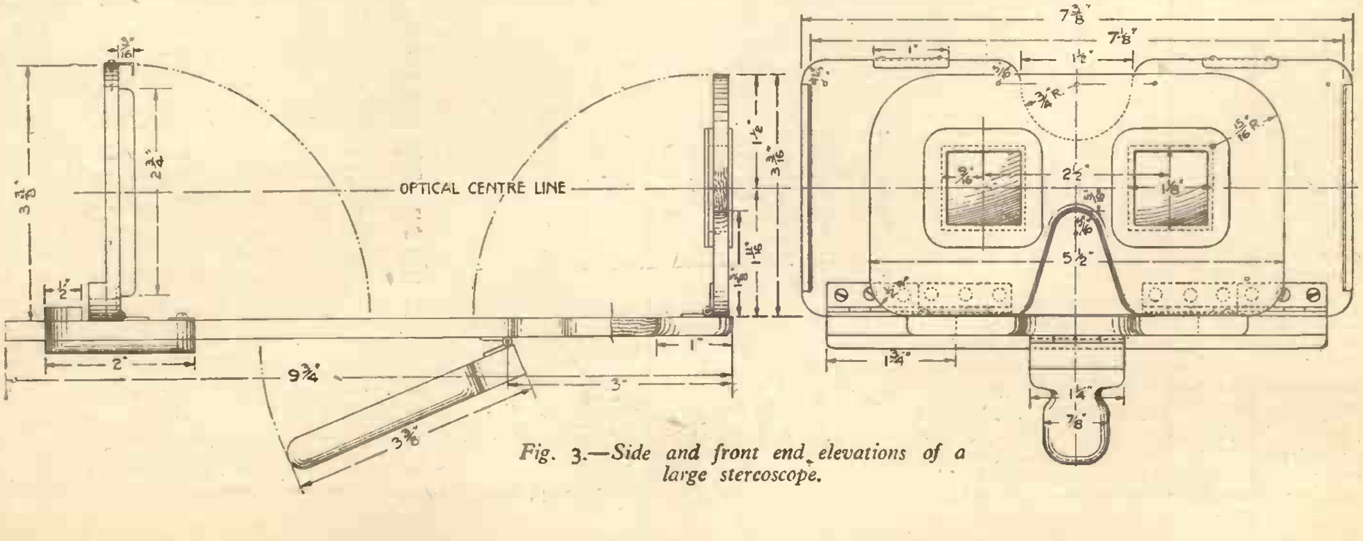


Fig. 3.—Side and front end elevations of a large stereoscope.

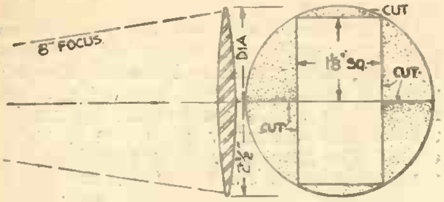


Fig. 2.—Cutting up the reading glass.

apart and as they have to view pictures spaced at 3¼in. centres the lenses must, to some extent, act as prisms and possess the faculty of bending the light rays from the pictures and at the same time magnifying the images. In this type of stereoscope, therefore, ordinary circular lenses are not usually used, but they are shaped as shown in Fig. 1, which figure also shows how the picture images are caused to converge to the eyes. Such a pair of lenses can be made by simply cutting into halves, on its centre-line, an ordinary reading-glass lens of about 8in. focus and 2½in. dia. With the further removal of other thin portions, near the edge, two square prismatic lenses, as drawn in Fig. 2, are the result. The stippled portions are the parts to be removed.

The cutting of such a lens as this is a somewhat delicate operation, unless one is a skilled glass-cutter, and it is one which should be done with a glazier's diamond in preference to the ordinary glass-cutter's wheels. It is recommended that all of the cuts be made with the diamond before any one fracture is completed; then, obviously, the first cut to be parted is the main one across the centre of the lens. It might be advisable to get a glass-cutter to do the job.

The two lenses are mounted as shown in Figs. 3 and 4, which drawings give all the details of the construction of the stereoscope. Both the lens panel and the picture stage, together with a handle underneath, are made to fold, for convenience in storing. As may be seen, the stage is made to slide, for adjusting the focus to suit different sights. Looseness in sliding is prevented by a strip of spring-brass, which should, at its middle, press downwards on the main bar, or baseboard.

Although ordinary grained wood is shown in the drawings, plywood will be most suitable for all the principal parts and only a few bits of straight-grained material will be called for. To hold the lenses in the lens panel, either wood veneer or cardboard may be used; the former being best for appearance, if the whole instrument is polished or varnished natural colour.

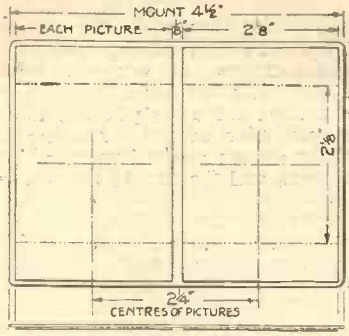


Fig. 6.— Pair of 3⅛in. × 2⅛in. prints mounted.

Using the Single-Lens Camera

I have mentioned the two-lensed stereoscopic camera for the taking of pictures, and when it is necessary, or advisable to make both exposures simultaneously, the double-lensed instrument is essential, but for ordinary landscape work a quarter-plate single-lens camera can quite well be used, mounted upon a cross-sliding head to the tripod stand. In this case the two views are taken one after the other, first with the camera on the left and then on the right. In some respects, and wherever it is possible, this method has advantages, because both pictures are taken with the same lens and with exactly the same stop value. When two lenses are fitted on a stereo-camera they have to be perfectly matched: for colour in the glass, for equivalent foci, for diaphragm apertures and for mounting on the front of the camera, factors, any one of which can affect the results enormously.

The second scheme for making stereoscopic pictures and a stereoscope for viewing them may be welcomed by thousands of people who own and use ordinary box-type cameras, or any hand-camera which, having a flat underside, will stand upon a flat surface. There are quite a number of modern cameras of this type on the market, ranging in price from £50 or more down to a little over £1, all taking pictures either 3¼in. by 2¼in., or 2¼in. square, and all suitable for use in the manner I propose to describe. There are others which fold up, with bellows extensions, and these also can be used, though the tripod top may have to be made a little differently to suit the bottom of the camera.

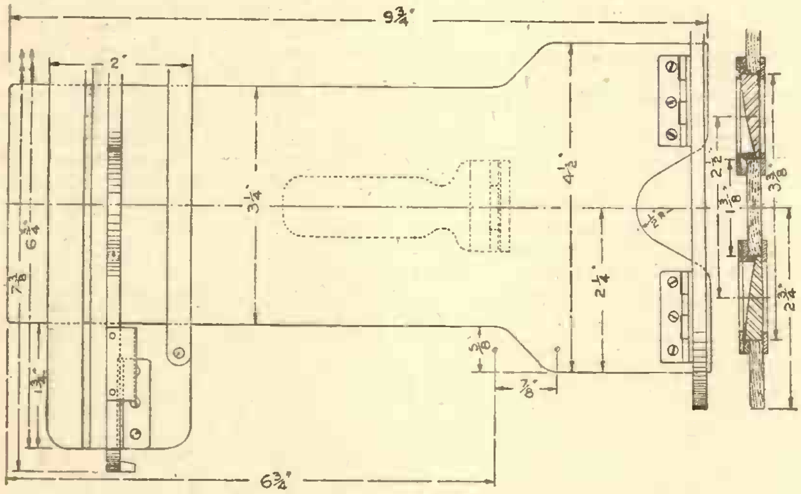


Fig. 4.—Plan view of the stereoscope.

Stereoscope for Standard Negatives

First with regard to the steroscope: Fig. 5 shows a somewhat simply constructed viewing instrument. Fig. 6 shows the correct measurements and arrangement for a cardboard mount carrying a pair of stereo prints, either 3⅛ x 2⅛in. or 2⅛in. square, the latter being, of course, taken by one of the many cameras which are made to produce square pictures. These mounted photographs are sometimes termed "stereoscopic slides," and, for want of a better title, I shall use the word, although they do not in any sense slide. The double dot-and-dash lines across Fig. 6 indicate the positions which the 2⅛in. square pictures are to occupy. Any titles to the pictures can be written underneath, and should appear under one picture only, so as to be read by one eye. With 3⅛in. pictures, titles may be put on the backs of the mounts or in fine writing at top or bottom.

The stereoscope is made of cardboard; the yellow-brown type which is known as "strawboard." It is cheap and is readily obtainable. The thickness should be not less than 1/16in. All the pieces shown and dimensioned in the drawing, Fig. 5, should be cut out with a pointed knife and steel straight-edge, cutting being done preferably on glass. Then all the parts should be given a good soaking coat of strong size and allowed to dry thoroughly.

The bottom of the stereoscope is made to form a box which, when closed, should hold from 15 to 20 slides, according to their degree of flatness. If prints are pasted on both sides of a mount, back to back, the card does not tend to curl, and the slides should remain flat. In this way thirty or forty views can be got into the box of the stereoscope.

The folding parts of the instrument are joined to each other by hinges formed by strips of fabric, arranged as in the enlarged sketches, at the left-hand lower corner of

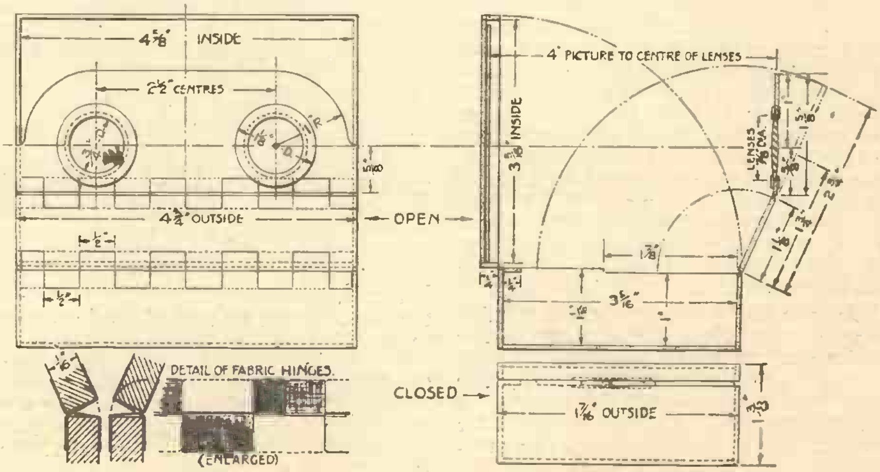


Fig. 5.—A folding stereoscope for 3¼in. by 2¼in. pictures.

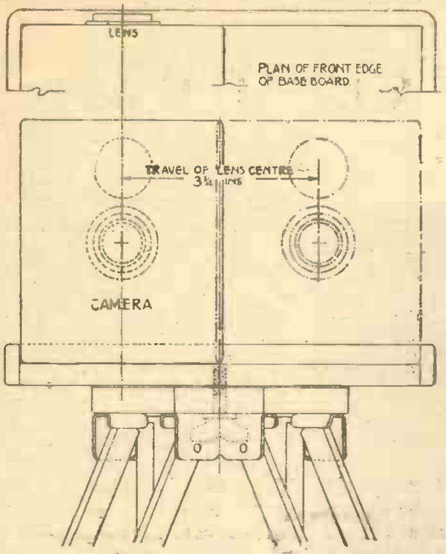


Fig. 7.—Using a box camera for taking stereoscopic pictures.

Fig. 5. These strips are not allowed to stick to the edges of the card but only to the inner and outer faces, so that the hinged piece of card has a full 180 deg. of movement.

I suggest that the stereoscope be covered entirely with good quality bookbinders' cloth of any approved colour, preferably dark green or black, and if this idea is adopted, bits of the same cloth can be used for the hinges, such hinges being put on before the cloth covering.

The lenses, since these will be approximately the same distances apart as the centres of the pictures, do not need to be prismatic, and two exactly similar lenses, either plano-convex or double convex, will be required. They should each have a focus of 4in. and diameter ⅞in. If they are plano-convex, insert them in the spectacle plate with the convexed sides towards the pictures. They need not be cemented or stuck in any way, but will be held in the "plate" by two rings of card, glued on either side of the strawboard. The remaining details of the stereoscope will be obvious from the drawing.

The Tripod

The camera arrangement for taking the pictures involves the use of a folding tripod of the size usual with quarter-plate field cameras, having folding and sliding legs and a wooden top. There are tubular brass-legged tripods, with small metal tops, but although they are somewhat smaller when shut up and a trifle more convenient for carrying, they are too large to go into the pocket; and, what is of greatest importance, are too subject to vibration, even from light wind pressure, to be of any use in making time exposures in stereoscopic work. I have one wooden tripod which folds and slides, made of ash, which weighs, with its top, only 2¼lb., and it is the upper part of this which is drawn in Figs. 7 and 8. I strongly recommend the interested reader to obtain one of these.

The Platform

The most simple arrangement for a fitting to go on the tripod top is a rectangular wooden platform with a ledge around three sides of it, as shown in Fig. 7. On this the camera is placed, first on one side and the first exposure made, and then on the other side for the second exposure. No dimensions for the platform are given, the reason being that since the lens must move, between the two camera positions, a distance of 3¼in., the cross length of the platform between the side ledges will depend upon the width of the camera. Cameras vary greatly in width, as well as in other dimensions, and the reader must make the platform to suit his own particular camera. Measure the width of the camera at the bottom, add the result to 3¼in., and the sum of the two will be the length for the platform between the ledges. In using the platform the camera must be pressed up into the angles formed by the front as well as the side ledges, thus the camera will be kept square and point in the same direction for both exposures.

Varying Lens Separation

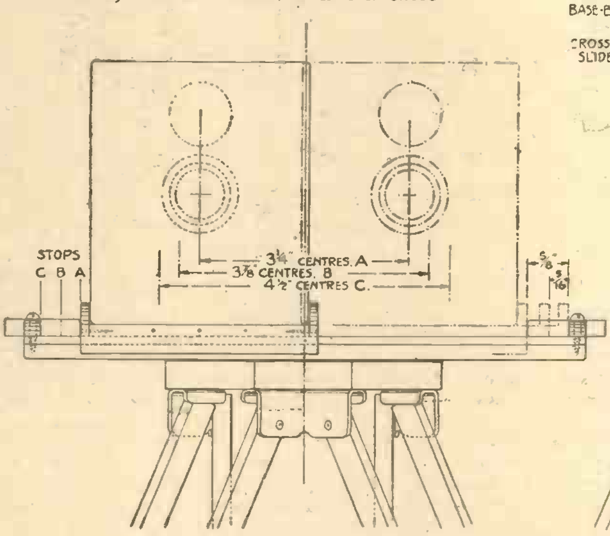
Another, more elaborate scheme is drawn in Fig. 8, where provision is made for varying the amount of movement of the camera, in order to increase the separation of the lens positions from the standard 3¼in. to 4½in. with several intermediate measurements. The purpose of increasing is sometimes important and this ability to increase is where the single camera scores over the full, double-lensed, type, where the lenses are fixed. If photographing a distant landscape, with mountain scenery, without foreground and no objects nearer than, say, 100ft., a separation of 3¼in. would not be sufficient to give the necessary amount of stereoscopic relief and solidity. In such a case 4½in. would be only just enough to yield a realisable amount. In taking pictures for the stereoscope it is the variety of distances of foreground objects which are all-important. The following may be looked upon as a safe guide—A: 6ft. to 20ft., 3¼in.; B: 20ft. to 50ft., 3⅞in.; C: 50ft. and beyond, 4½in. The lowest figure, 6ft., is the shortest distance that can be allowed between the nearest part of the foreground and the camera; not because it would be out of focus—that can be corrected by stopping down—but because, were it nearer than 6ft. there would be difficulty in seeing that particular bit of foreground stereoscopically; when the two pictures are mounted the eyes would not be able to superimpose the two images though all the rest of the picture may be in proper relief.

Fig. 8 shows the platform, on the tripod top, with rebates, on each of the long edges, to receive a sliding carriage or cross slide, which carriage is made so that the camera fits snugly into it. The platform is made longer than is required for 3¼in. separation and, at each end, it is fitted with a turn-button having unequal ends. When the longer ends are both turned inwards to A, the cross travel of the slide is 3¼in.; when the shorter ends are inwards, the carriage is stopped at 3⅞in. separation, while if the turnbuttons are placed parallel with the ends of the platform and with neither end inwards, the full travel is available for 4½in. separation. Other intermediate travels are possible by having the buttons differently placed at opposite ends. The plan view of one end of the platform, with a bit of the camera cross-slide showing, is added at the top of Fig. 8. The platform and the main part of the slide should be made of plywood, the latter of 5 mm. and the former of 9 mm. thickness, that is to say 3/16in. and ⅜in. The rebating of this can be such that two of the plys are left the full width of the platform and three plys removed to form the rebate. The finish can be shellac varnish, leaving the wood natural colour or, on top of the shellac, a coat of eggshell-black lacquer can be given.

Close-up Stereos

Should the reader wish to make stereoscopic views of really close-up objects and can put magnifiers over his camera lens, he can make slides of such things as still life, fruit and flowers and models, etc. In that case the camera movement will require to be less than 3¼in.; probably much less, say, 2 to 2½in. or according to the size and distance of the object. Whatever the camera movement is, be it 2in. or 4½in., flowers or distant landscape, the mounting of the prints will be the same, as given in Fig. 6.

I think it is perhaps advisable to remind the reader, before he sets out to do stereoscopic work with his one and only hand camera, that only "still" pictures can be taken. There can be no snapping of moving objects; even in pure landscapes there must be no wind-blown tree movement, but the use of the instantaneous shutter can be



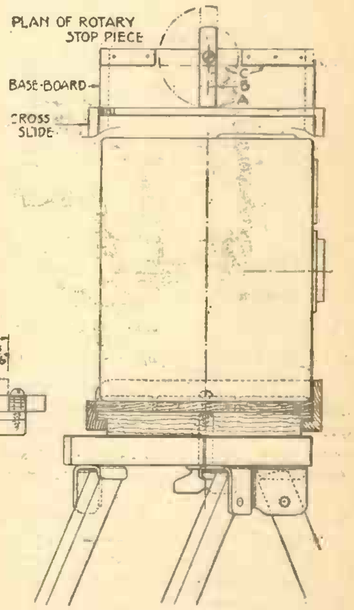


Fig. 8.—Tripod top with cross-sliding camera carrier.

dropped, in most cases of doubtful light, with advantage. The best way is to stop right down, get perfectly sharp detail in foreground and distance and make "time" exposures, though, of course, the timing of both exposures must be exactly the same. With the smallest stop and long exposures there is no difficulty in getting the timing exact. Of course all this depends upon the camera, the lens, the type of shutter fitted and the speed of the film being used. With an expensive outfit having a lens working at a big full aperture and depth of focus and with high-speed film, time exposures would be rarely necessary; only perhaps in building interiors.

The Manufacture of Pins

With a Description of the Types of Machine Used

By H. SANDERS

A QUANTITY of the wire produced in most countries goes into the manufacture of safety-pins, particularly those embodying a sheath of metal to act as a receptacle for and protection of the point. In making these, the preliminary stage comprises straightening, cutting off and pointing the wires. This cannot be done exactly as with needles. In the first place, it is vital that the cut-off wires should be of identical length, or it would be impracticable to perform the later operations. The necessary accuracy cannot be secured when the grinding of the points is done by means of a wheel running away from the point. The grinding must be done towards the point, and in Figs. 1 and 2 the principle of the machine used is indicated.

The wire supplied in the normal coils is placed on a swift to the rear of the pointing machine, and pulled forward by a revolving straightener consisting of a number of pegs in a revolving frame. The actual drawing through of the wire is carried out by two feed rolls actuated by a double-crank feeding mechanism. Each stroke of either crank carries forward sufficient wire to form one pin. This pin is then cut off.

The Drum

To the front of the machine is a barrel or drum which rotates on a horizontal axis, and as the wire comes forward it protrudes over this. The drum is composed of three individual discs, two of them, those external, have teeth round their peripheries. These teeth are generally inserted so as to make replacement easier in the event of damage. The middle disc is rubber-covered and caused to revolve by interior gears at twice the rate of the toothed sections, but in the same direction.

Precisely as the wire is severed from the stock, a finger descends and forces the wire squarely into the gaps of the drum teeth. The teeth thus engage the wire and carry it forward until it is forced to pass under a saddle formed like the drum periphery. The wire is held square by the teeth, and simultaneously it is rolled over against the saddle by the rubber drum. Behind the drum is a plate against which the wires butt, and this ensures the dead accuracy of their frontal protrusion.

In front of and alongside the drum on the right is a swiftly revolving steel mill, having teeth of file type. This is concave, as shown in Fig. 2, and is located in such a way in relation to the drum that the requisite curved taper is acquired by the pin point. The mill revolves in the direction of the point, and the grindings are removed by means of an exhauster. The diameter of the mill is approximately 2-2.5in., but it revolves at 5,000 r.p.m. and rubs rather than cuts away the metal. The file teeth are speedily worn down, after which the mill functions in the same way as a circular friction saw used for cutting up steel girders. In short, its high speed causes it to burn rather than cut its way through. Eventually, when the serrations have worn down to nothing, and the mill has acquired a high polish, it is removed and re-toothed. The friction of the mill brings the wire to a red heat, but as safety-pins do not have to withstand stresses likely to be serious, this heating up of the wire need not be taken into account.

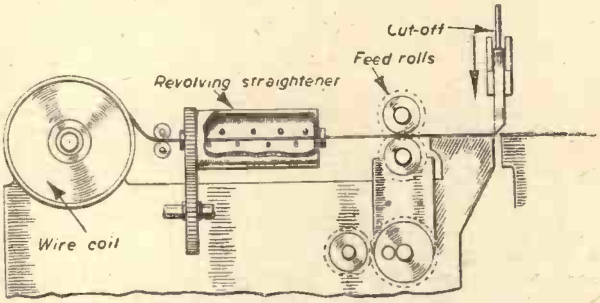


Fig. 1.—Method of grinding the points of the pins.

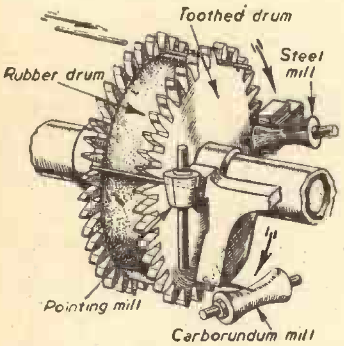


Fig. 2.—Details of the drum and the steel mill.

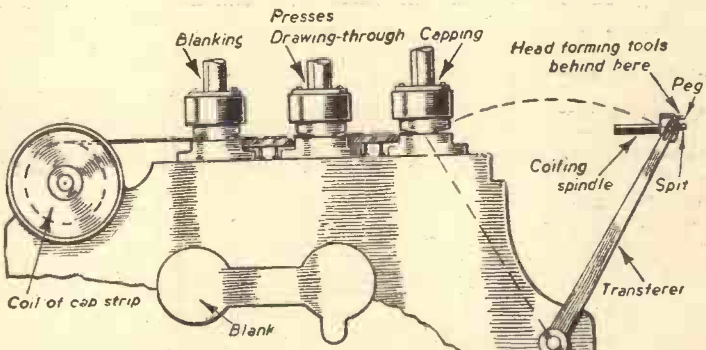
The Steel Mill

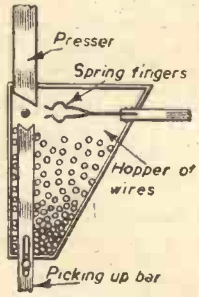
From the steel mill the wire passes to a similar carborundum wheel situated as shown in Fig. 2. Though this mill may be at an angle to the drum, as shown, it is sometimes placed in a frame parallel with the drum face, and reciprocated in such a way as to follow the form of the point. Lastly, a third mill barely makes contact with the point at a rather obtuse angle, thus giving it a set corresponding to that of an edge tooth.

A steel mill is used in advance of the carborundum mill because otherwise the latter would be too quickly destroyed by having to grind the square point. This the steel mill is much better fitted to do.

From these pointing mills the wires are passed to a hopper, whence they are periodically removed.

There is another method in which the pin is wholly made in one single machine. Figs. 3 and 4 show the principle of one such machine, the invention of B. L. Goodman. In this machine the strip is fed by a couple of rolls across a drum, which slightly oils the underside of the strip. It then passes between two press tools, which form a blank, as shown in Fig. 3. This blank is then carried through to another press, in which a blunt-nosed punch drives the blank through a hole in the die, thus making the cap in one operation. Under the die are two fingers, which are rocked forward as soon as they receive the cap and force it through a slit in the bolster. The cap is then transported to a capping press, with its open end to the front, awaiting the shaped wire. Care must be taken to prevent the drawing-through tools from scratching the metal, these scratches being due to the presence of a slight fash or burr on the upper edge of the blank, which, if not perceived, scores every cap and quickly grows bigger, since they become glass-hard and can only be eliminated by hand rubbing.





Figs. 3 and 4.—The principle of the pin-making machine invented by B. L. Goodman.

Head-forming Tools

The pointed wires are fed from a hopper on the right-hand side of the machine, and are picked out singly by a rising bar, whose upper edge is nicked with a vee, so that each time it lifts it takes a wire. A light presser maintains the wire in the vee until horizontally moving spring fingers arrive and seize it. These transport the wire to the head-forming tools, as in Fig. 5. The stub end of the shank is held between punch and bed. The middle of the wire is supported by a stationary spit emerging from the end of a coiling spindle. This spindle also has an out-of-centre driving peg which bears

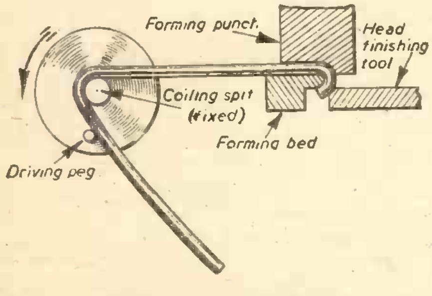


Fig. 5.—Showing how the horizontally moving fingers transport the wire to the head-forming tools.

against the other side of the wire and coils it about the peg as the spindle revolves. The spindle revolves $1\frac{1}{2}$ times so as to make the spring loop, while simultaneously the head-finishing tool functions and finishes the shaping of the J-end to be fixed in the cap.

Thus, the wire shank is now finished, and is released by the reversal of the coiling spindle for a quarter of a revolution. This liberates the central spit from the grip of the wire. Axial withdrawal of the spit then occurs, and the coiling spindle draws back to permit the transfer fingers to seize the pin. Immediately the fingers seize, the head-shaping tools let go the other extremity of the wire.

Other processes following include scouring, cleaning, plating and the like. It is probable that the machine described above is no longer obtainable, but the patent can, no doubt, be consulted. It serves as an indication of the ingenuity devoted to the manufacture of these useful articles.

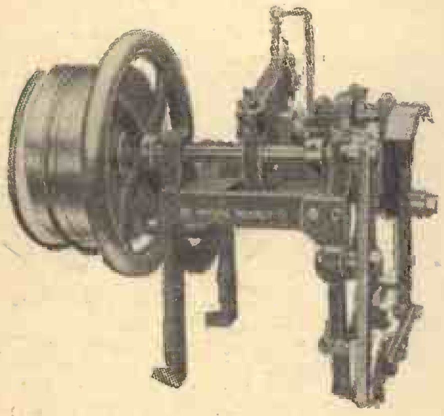


Fig. 6—Safety-pin coiling machine.

Safety-pins

In Fig. 6 is shown a different type of machine, made by Edward White, of Redditch. In this machine the wires are coiled into the form of a safety pin. The method is to begin with wires already pointed on the lines previously indicated, and then to pass them through this machine. The caps are then soldered on, being made with a hand press, the result being the finished safety-pin.

There are, naturally, other forms of safety-pin in addition to those with a metal sheath or cap. One such pin is composed wholly of wire, having a coiled loop at each end, and is manufactured in machines based on similar principles to those already described. In these instances, the pointed wire is removed from the hopper, and one end inserted in a press having a vee notch in the anvil, with a corresponding tool above. The coming down of the press presses out the wire end into a spoon shape whose recess finally serves as a sheath for the pointed end of the pin when closed.

Another outlet for wire is the hairpin, though this, of course, is less popular than it was some forty years or more ago. Fig. 7 shows White's automatic hairpin-making machine, which automatically produces hairpins complete, straight from the coil of wire, either plain or crimped. The actual work of bending the pins is easy, being done by simply tugging a length of wire by the middle between two stops, thus folding the two ends together.

The principle of this machine is that the wire is coiled, placed on a swift, and pulled through a number of pegs that serve to straighten it. The wire when straight is projected for cutting off by a cam-actuated tool. The wires are then rolled forward on their own axes and travel across the faces of two mills, running at high speed, and provided with file teeth. The angle of presentation ensures elimination of the burr or fash due to the cutting tools, and forms a blunt, cone-shaped point, which is all that is necessary. The wires then move forward and fall on to guides where the bend is made. If crimps are desired, crimping tools then seize the wire and carry out their work.

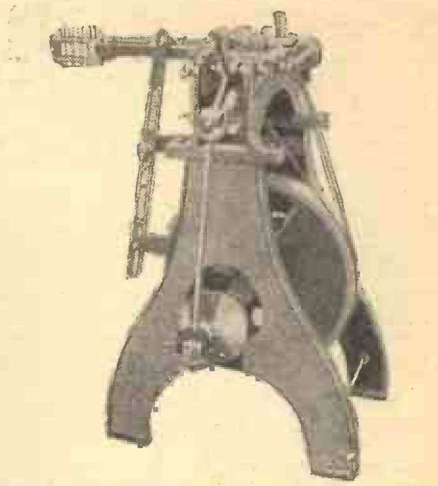


Fig. 7.—White's automatic hairpin-making machine.

ADJUSTABLE WING RESEARCH AIRCRAFT

THE Short S.B./5—the "adjustable wing" research aircraft which first flew last December—has now completed a considerable number of flights. The research programme for the aircraft is well under way and further details about the S.B./5 can now be released.

Its main task is to investigate problems which arise in the handling of swept-back wing high-speed aircraft. Difficulties are encountered in maintaining full and immediate control of swept-wing aircraft at low speeds owing to a tendency for the airflow to break away or "spill" in the region of the wing tips, thus causing loss of stability and a tendency for the controls to appear not to respond at critical speeds such as taking off or landing.

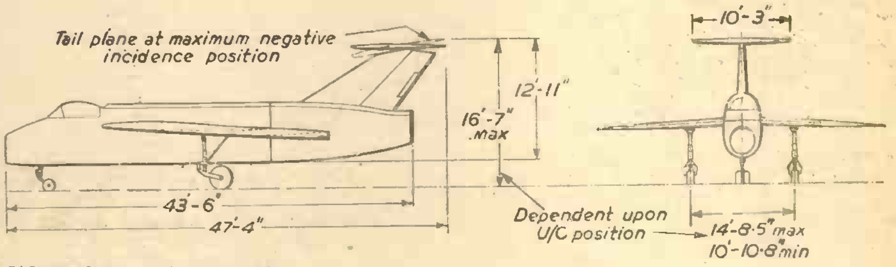
The results of the flying investigations carried out by the S.B./5 will be made available to the whole of the aircraft industry for the benefit of British aviation.

Adjustable Sweep-back

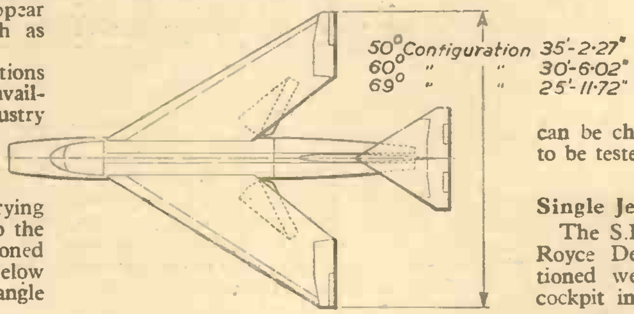
The S.B./5 was designed so that varying degrees of sweep-back can be applied to the wings. The tail plane can also be positioned either at the extreme top of the fin or below the rear part of the fuselage and its angle of incidence is variable.

A programme of test flying to investigate the low-speed handling characteristics of all the combinations available is to be carried out.

The varying degrees of wing sweep-back angle are achieved by fitting alternative components and four configurations can be tested. These are:



Side and front elevations and plan of the Short S.B./5.



50 deg. .... High tail unit.
60 deg. .... Low tail unit.
60 deg. .... High tail unit.
69 deg. .... High tail unit.

The angle of incidence of the tail plane can be varied in flight and set to any desired angle between 10 deg. above or 10 deg. below the horizontal.

All-metal Wings

Full span leading edge flaps are fitted and the wings are all metal structure with plywood covering the leading and trailing edges.

The undercarriage is a non-retractable main- and nose-wheel unit. The attitude of the undercarriage can be changed to enable each configuration to be tested at various C.G. positions.

Single Jet Engine

The S.B./5 is powered by a single Rolls-Royce Derwent jet engine which is positioned well aft of the pilot. The pilot's cockpit incorporates an ejector seat.

The aircraft is fitted with anti-spin and braking parachutes.

Pilot in all the test flying has been Tom Brooke-Smith, chief test pilot to Short Brothers & Harland Ltd., of Belfast, manufacturers and designers of the S.B./5. So far all flying has been carried out with a sweep-back of 50 deg.

LETTERS TO THE EDITOR

The Editor does not necessarily agree with the views of his correspondents.

Melting Milk Bottle Tops

SIR,—With reference to the query by Mr. H. G. Williams, of Twickenham (March issue), the idea of melting down milk bottle tops in sufficient quantities to make castings is almost a practical impossibility, if, as he says, his only source of heat is a laboratory Bunsen burner.

In our school workshops we have successfully melted large quantities of tops in a carborundum crucible on the forge fire, using coke as fuel and a variable speed fan blower for the forced draught.

As pointed out in your reply, oxidation and fusing must be overcome, and in order to combat these troubles the tops must be bulked together in some way. For this purpose we use a vice as a press, and an old metal bush about 2in. bore as a die.

By this means we have, so far, recovered about 28lb. of pure aluminium, which we have cast into ingots of about 1lb. each. Allowing for loss due to unavoidable oxidation, our recovery is about 65 per cent., and we reckon that about 2,000 tops are required to produce 1lb. of pure metal.

Whatever form of heating is used, it is important to note that melting should be fairly rapid to prevent gasification, and the crucible should be covered during melting. Pouring must also be done quickly as aluminium freezes quickly, especially when casting thin sections. The life of the crucible will be prolonged if it is internally painted with a solution of water-glass before use, and cleaned out after each melt.

If your correspondent requires any further details I will be pleased to help him, if possible.—H. E. WHITE, A.M.S.E. (Derby).

SIR,—We, the undersigned, read with interest the letter regarding the melting of milk bottle tops in the March issue of PRACTICAL MECHANICS.

At our metalwork centre at Darnall, Sheffield, we melt them with a blowpipe and then add a little copper. From this alloy we make castings for small diesel engines, ash-trays, etc.—F. PRINCE, D. PALMER (Sheffield).

Electric Chime Timing Unit

SIR,—In the March issue of PRACTICAL MECHANICS there appeared a letter from Mr. Jas. L. Sewell concerning my electric Chime Timing Unit published in the March issue of 1950 under the nom-de-plume "Handyman."

I have since made an improvement to the unit which may interest Mr. Sewell and others.

In the published circuit the time lag between the first two notes depends on the time the front door push is kept pressed only (this does not apply to the trademen's door push, which only sounds the last two notes).

By connecting another condenser of similar value to the existing ones across the coil connections of relay No. 1 we have a time lag also between notes one and two.

Should the push be rapidly pushed and released several times the first two notes will not now be kept repeating, to be sedately followed by the third and fourth.

I might mention my own unit had a two-year test before the article was published, and is still in good order.

In conclusion I would like to thank Mr Sewell for his appreciative letter.—A. F. PARKER (Swanage, Dorset).

Toning Wallpaper

SIR,—With regard to the above query of C. S. Brown in the February issue of PRACTICAL MECHANICS, I would say that it would be impossible to evenly stain or tone a grained imitation wood wallpaper without obliterating the printed pattern unless it was sized first to prevent the stain penetrating the paper. This is best done after the paper is hung.

A practical method is as follows: Paste the paper rather liberally with good strong paste and allow to soak for some minutes. Several lengths of paper can be pasted at one time, folded to delay drying, and hung in sequence. When dry, the wallpaper is sized by applying a coat of hot jelly-size, using a clean distemper brush, and brushing on lightly to avoid frothing. Re-heat the size as the work proceeds, and make sure that the whole of the surface is covered. When dry, a second coat of size is applied. When bone dry, the wallpaper may be stained to the desired depth with a "scrumble" stain such as Mander's "Matsine," thinning this out to directions and applying sparingly and evenly. As an alternative, a stain could be mixed up using "burnt umber ground in oil," mixed quite thin with equal parts of linseed oil and turpentine, and adding a small quantity of paint dryer. If this is thought too warm in tone, a little green could be added. If jelly-size is unobtainable, the packeted powdered size can be made up to the directions and allowed to cool and "jell" to test the strength. It should set like a weak table-jelly.

The surface can afterwards be coated with copal varnish if a glossy finish is desired, and it will then give many years of service.—H. POSTLETHWAITE (Easton Grey, Malmesbury).

"The Mystery of Time"

SIR—The opening sentence of that portion of your editorial dealing with the above subject implies, I believe, that time extends infinitely into the past and will extend infinitely into the future. I suggest to you, however, that, in the light of present knowledge, this is by no means certain.

Dunne, in his "Experiment in Time" (which, by the way, was *not* a "novel"), conceives that time does not "flow" nor do fresh events keep on happening in it but that *all* events, both (to us) past and future, happen together simultaneously and that it is our consciousness that travels through these events observing a cross-section of them only, corresponding to our "present," as it passes. This theory appeals to me as providing the only adequate explanation for the undoubted occasional occurrence of cases of precognition of "future" events. But Dunne, who I think wrote his book before the implications of the theory of relativity were widely known, still conceived an infinite series of events stretching away from our "present" in both directions.

We are taught that space is not infinite but curves back upon itself to form a boundless but finite whole in much the same way that the surface of the earth—in two dimensions—is also boundless but finite. Now, "space" and "time" are in modern teaching closely inter-related and it therefore seems to me unlikely that a finite space can exist in infinite time. Relativity teaches us that for each individual "observer" time has a different meaning and a "time" in which no space and hence no observers exist can have no meaning at all! I suggest, therefore, the probability that, like space, time is also finite and curved back on itself so that, in it, only a finite number of events take place. To round off such a theory we may speculate that the total time length possible in our particular cosmos is equivalent to the time it would take a beam of light to travel round finite space and arrive back at its starting point (though the idea of an expanding universe and hence an expanding time raises some difficulty).

Summarising the foregoing we arrive at a cosmos in which both "space" and "time" are finite and in which, therefore, only a finite number of "events" occur and occur simultaneously. Through it each "observer's" consciousness travels observing only that cross-section of these events which corresponds to his individual "present." It is to be noted that an "observer" may equally well be you or I, a prehistoric man existing 50,000 years ago or a super-intellectual existing 50,000 years in the future (as we imagine it). In this cosmos occasional cases of precognition occur and are due to a temporary shift of the "observer's" consciousness from his individual "present" to some other cross-section of the events. The shift being caused either by some abnormal circumstance or to a loosening of the tie binding his consciousness to his own "present" during sleep.

What happens when the "observer's" consciousness has travelled full circle is difficult to conceive though no more difficult than trying to conceive infinity. The views of yourself and of other readers of your paper on this and the foregoing ideas in general might be interesting. — T. H. MORRIS (Farnborough).

Einstein's Theory

SIR,—I thank Mr. P. H. Jackson (Buxton) for his reply to my letter (PRACTICAL MECHANICS, December issue), but am still unable to appreciate that there can be any difference whatever in the time a 'plane would take for an out and back journey across wind compared with the same length out and back journey parallel with the wind. I feel there is something wrong with his premises and/or calculations. If, for instance, one works out his figures for, say, three examples where the wind speed in relation to 'plane speed is progressively greater, the results show increasing disparities in times, and if a wind speed of 75 m.p.h. and a 'plane speed of 100 m.p.h. are used the disparity between the times is so great as to be very improbable.

I think the true conditions are that in the cross-wind flight the 'plane, in order to keep on its ground course, must trim its centre line towards the wind at an angle to the ground course equal to the proportions of wind speed to 'plane speed. Thus, if the 'plane speed is 100 mp.h. in still air and the wind speed is 25 m.p.h. the 'plane will be turned at an angle which results in the 'plane facing the equivalent of a direct head wind of one-fourth of the wind speed of 25 m.p.h., viz., 6¼ m.p.h. The 'plane's net speed along the ground line will thus be 93¾ m.p.h. which, if the distance out and back is 200 miles, gives a time of 2 2/15th hours—precisely that occupied by the 'plane out and back parallel with the wind.

So far as I can see, any theory which results in different times for the two journeys would be just as impossible in practice as is perpetual motion.

As regards my possibly unfortunate choice of a book on the subject, I have since read another book by one of the best-known physicists. His way of showing that the out and back cross-wind journey would take a shorter time to accomplish than a similar journey parallel to the wind is by assuming the cross-wind journey to have been done in still air—a second example of what appears to be a wrong appreciation of the conditions affecting the Michelson-Morley experiment. —C. W. CARR (Eastbourne).

Interplanetary Space Travel

SIR,—In the March issue, Mr. P. Mansfield (Interplanetary Space Travel) states that a rocket at the commencement of firing is only concerned with gravity as air resistance V^2 and V=O. Whilst it is true that gravity in regard to the rocket must be overcome when firing commences, it is also true that air pressure affects the rocket's thrust from a pressure ratio point of view.

Thrust T_0 is equal to the product of the mass flow of gas $\frac{dM}{dt}$ and the exhaust velocity V_e, when the gas is expanded in the nozzle to a pressure equal to that of the surrounding atmosphere. This is called *momentum thrust* and the gas is said to be correctly expanded. Thus, a rocket with a chamber pressure of 375lb./sq. in. and a pressure ratio of 25 : 1 will have an exit pressure equal to that of the surrounding atmosphere at low altitude; i.e., 15lb./sq. in. We then have $T_0=\frac{dM}{dt}V_e$.

If the rocket ascends, and the atmospheric pressure decreases, say, to 2lb./sq. in., the change has no effect on the gas in the nozzle, as it is supersonic. It does, however, introduce *pressure thrust* T_x. This can be defined as the product of the difference between the exit pressure P_e and the atmospheric pressure P_a, and the exit area of the nozzle in sq. ins. A. The extra thrust in the above case, then, is 13lb. multiplied by A, and may be stated as $T_x=A\ (P_e-P_a)$.

We see, then, that the total thrust T available from a constant fuel consumption air pressure; the total thrust being expressed as $T=\frac{dM}{dt}V_e+(P_e-P_a)\ A$.

It is easily seen from this that a rocket's fuel consumption would be less for take-off in a vacuum than for take-off in Earth's atmosphere.

Another aspect of air-resistance is the obvious one of *drag*. The rocket cannot attain *any* velocity whatsoever unless air molecules are displaced by the shaped nose. Drag due to cross-sectional area may be reduced, but skin drag then tends to increase. As a result, any streamlined form is but a compromise with air-resistance.

It is correct that much of the heat energy in the gas-stream is converted to kinetic energy through the nozzle. When we consider that in free space, where the exit pressure is zero, the pressure ratio term is at maximum and the pressure ratio is infinite. All heat energy is then convertible to kinetic energy; but this is impracticable as the nozzle would need to have an infinite exit area.

The suggestion that the rocket may move at a velocity far in excess of its own exhaust velocity is quite logical when considering projection in free space. The constant thrust adding to the ever-increasing velocity of the rocket would continue so long as the fuel held out. The *maximum* velocity, previously stated, would be in respect of fuel allocated for the outward journey and not *the* maximum of the "all-burnt" state. The motor certainly *would* be cut—with at least 50 per cent. of the fuel unburnt.

After all, one *may* wish to return. Oh yes, we should have forward motors capable of supplying thrust for speed reduction and manoeuvring.

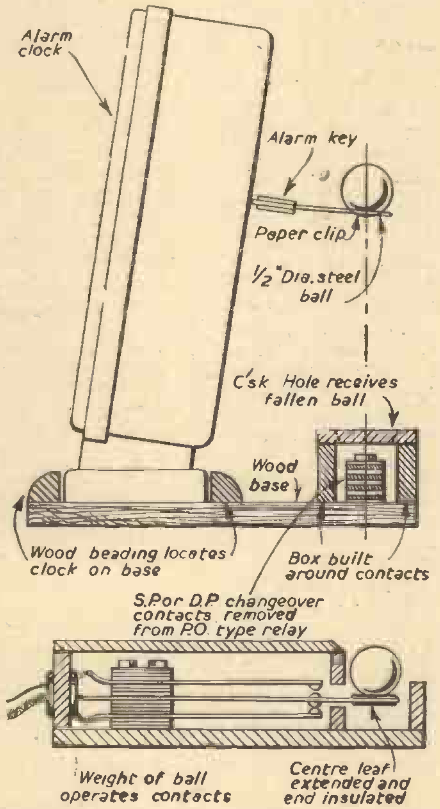
It would indeed be tragic that, having explored a new world, you were prevented from returning home through lack of fuel. Not only would your strange and wonderful odyssey be lost to mankind for ever, but your extinction would be imminent.—WILLIAM ELLWOOD (Hatfield).

Alarm Clock Switching Device

SIR,—The following drawing is of a simple device to make an alarm clock operate a switch. It is, to the best of my belief, original.

The idea is to enable a domestic clock to be used without any drastic modifications. The drawing is self explanatory and the idea and dimensions can be adapted to any clock where the alarm key revolves when the alarm rings. The hole receiving the falling ball is obviously located in a suitable position but, if necessary, a small funnel could be added to allow for slight deviations in its path.

The end of the centre contact-leaf is insulated to isolate the ball from any live metal work. The paper clip which holds the ball is of bent wire, but can be modified to suit any winding key.—EDWARD A. STOTT (Rochdale).



Side view of the alarm clock unit, and detail of the switch.

A Recording Weathervane

A Correction

IN the article on the above subject in the March, 1953, issue of PRACTICAL MECHANICS, a draughtsman's error occurs concerning the two cog-wheels. The wheel at the end of the vertical shaft should mesh with the bottom of the cog-wheel on the horizontal shaft, and not the top of the wheel, as shown in Fig. 1 of the above-mentioned article.

Club Reports

International Radio Controlled Models Society

THE International Radio Controlled Models Society announces that its Annual International Contests for Radio Controlled Models will be held at Southend-on-Sea, Essex, England, on July 25th and 26th, 1953.

A contest for radio-controlled model boats will be held on Saturday, July 25th, and contests for radio-controlled model aircraft on Sunday, July 26th. The aircraft sections of these contests, comprising a contest for power-driven aircraft and a contest for gliders, are held in accordance with the F.A.I. Regulations for International Contests. It is hoped that a large number of competitors, both from Great Britain and from overseas, will take part in these contests. Further details and entrance forms will be available soon to anyone who may write for information.—R. ING, 36, Sunny Gardens Road, Hendon, London, N.W.4.

Harrow and Wembley Society of Model Engineers

THE locomotive section committee has devised a series of locomotive trials, to be known as the "Arthur Pole Memorial Trials." A formula which will enable the smallest 3½in. gauge locomotive to compete on equal terms with the largest 5in. gauge locomotive is being worked out by the committee. A shield will be awarded to the owner of the locomotive giving the best performance during each season.

Starting on April 19th and on the third Sunday of each month until September 20th, a series of invitation days have been arranged, when individual clubs will be invited to run their engines on the society's 700ft. track at the British Railways L.M. Region sports ground at Headstone Lane, which is now being overhauled in anticipation of a busy season ahead.—Hon. Sec., K. D. CARTER, 21, Stanley Road, Northwood, Middlesex.

Aylesbury and District Society of Model Engineers

MR. ALLNUTT gave a talk to the society on March 18th on the making of tunnels. A large number of members turned up at Hampden Buildings to hear their colleague talk on a subject on which he is well informed. Mr. Allnutt is by profession an Admiralty civil engineer with quite a lot of experience of railway work. He illustrated his talk with lantern slides obtained from the London Transport. With Mr. East operating the lantern, he managed to throw light on what for some members was a very dark subject.—Hon. Sec., E. H. SMITH, Mulberry Tree Cottage, Devonshire Avenue, Amersham, Bucks.

BOOK REVIEWED

Model Steam Locomotive Designs and Specifications. Revised by Ernest A. Steel. Published by Cassell and Co., Ltd., 62 pages. Price 4s. 6d. net.

THIS book, which is a revision of an earlier work by Henry Greenly, gives specifications and brief constructional details of various types of model steam locomotives from No. 0 gauge to a 15in. gauge "Pacific" locomotive. There are also chapters on Fundamentals of Design; Cylinders and Valve Gear; Boiler Design and Handling Model Locomotives. The book is well illustrated with line drawings, including 20 practical working designs.

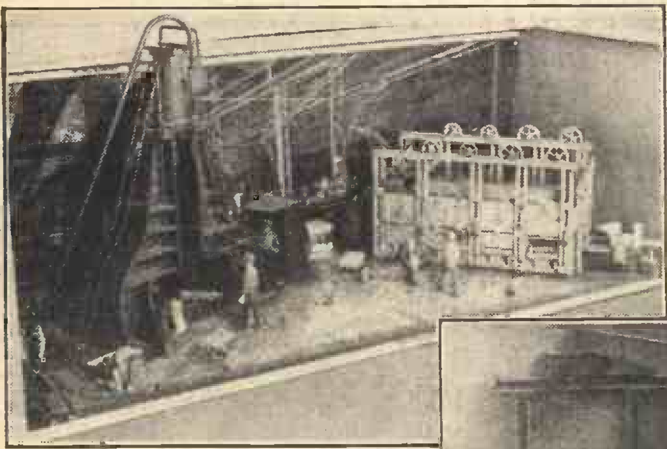
The World of Models

Model Steel Works Tableau : Scale Model Ambulance : Prize Sailing Ship

AT the International Machine Tool Exhibition at Olympia last year there was displayed a series of working models in tableau form which depicted steel production over the past hundred years at the works of Messrs. Samuel Osborne and Co., Ltd., of Sheffield. The models were to a scale of 1in. to 1ft., and the scale-model figures included in the tableau were made by students of the Sheffield Art School. The first three models showed a crucible melting shop, a pair of old-fashioned water-driven hammers and a rolling mill, all of about a hundred years ago. Model No. 4 (Fig. 2) represented a 6-ton Heroult electric arc furnace, as used nowadays for producing large steel ingots and castings, and included exact reproductions of melting-furnace equipment. The electric furnace is tilted so that the melted and refined metal is poured into a ladle, raised by a crane, carried to the casting pit and the metal poured into the moulds through a stopper in the bottom of the ladle.

Fig. 1 shows another realistic model, that of a 4-ton hammer shop. Compressed air now supplies the power instead of a water-wheel, and the heat of the furnace is controlled. In the forge, ingots are hammered down to billets or slabs, suitable for rolling into bars or sheets. A modern double-duo rolling mill was the subject of another model.

Fig. 5.—Model yachts and sailing ships at the Model Engineer Exhibition. Mr. Field's championship model of the "Cutty Sark" is in the glass case on the extreme left.



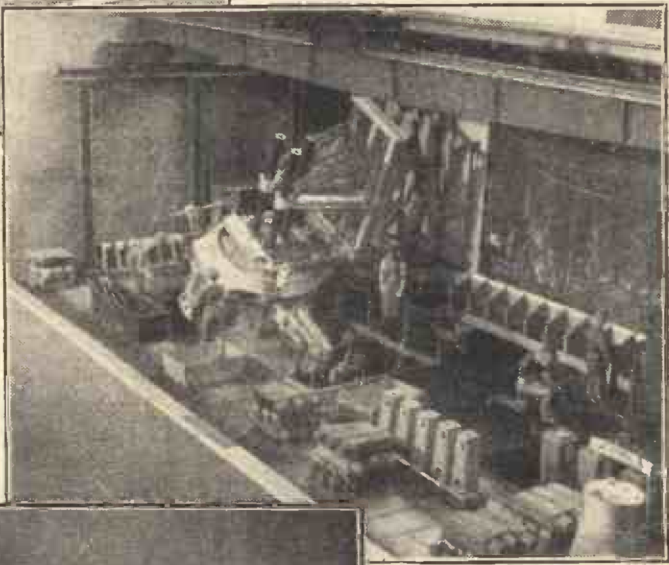


Fig. 1 (Left).—Model of a 4-ton hammer shop.
Fig. 2 (Below).—Model of a 6-ton Heroult electric arc furnace. Both of these are part of a tableau of working models depicting steel production over the past hundred years.

Model Yachts

The imposing display of model yachts and sailing boats shown in Fig. 5, and looking as though they are lined up for the start, were seen at the Model Engineer Exhibition.

Presentation Ambulance

The fine model ambulance displayed in Figs. 3 and 4 was made to the order of County Alderman Harry Lord, M.B.E., J.P., and was presented by him to the Lancashire County Council. The presentation was to commemorate the inauguration of the Ambulance Service under the National Health Service Act, 1945, and the model is to be used as a trophy for competition amongst the personnel of the service to encourage efficiency. The scale is one-tenth full size.

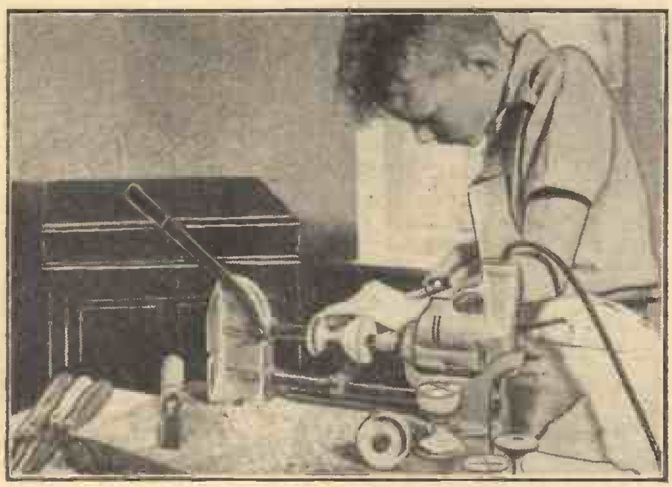
Figs. 3 and 4.—Two views of the 1/10th full-size model of a Karrier Ambulance, presented to the Lancashire County Council by County Alderman Harry Lord.

Trade Notes

Wolf Electric Tools at BIF

WOLF ELECTRIC TOOLS, LTD., are exhibiting the complete range of their electric tools at the B.I.F. and the display will incorporate some interesting newcomers to the already extensive list of industrial machines. There will be a new saw (type RS7), a new portable grinder (type GQ6) and a die grinder kit (type DG1).

The RS7 saw is a smaller counterpart of the popular 10in. saw and incorporates a new powerful motor of advanced design. It has a 7in. blade, is extremely compact and easy to handle and possesses abundant power for high-speed cutting at full capacity. To the range of portable grinders is added the GQ6—a heavy duty model which is powered by a new motor with exceptionally high speed-torque characteristics, and it is fitted with a resinoid bonded grinding wheel.



Wolf "Cub" equipment built up as a wood turning lathe.

The DG1 die grinder kit has been produced to meet the demands of industry for a versatile tool at low cost to tackle the numerous jobs in their tool rooms and maintenance departments. The power-unit of this kit is the well-known Wolf high-speed grinder, type EVG3.

Qualified technicians will be in attendance to provide continuous demonstrations of the Wolf range of portable electric tools including—drills from ¼in. to 1½in. capacity, screwdrivers, grinders, polishers, saws, blowers, hammer kits, chisel mortisers, valve seat grinders, valve refacers, valve seat grinding kits and the popular "Mobilectric" valve shop.

Apart from the full range of electric solderguns and soldering irons, there will be working displays of the fascinating Wolf "Cub" equipment for handymen and home constructors. The basic power unit is a ½in. drill, which with the various accessories can easily be built up into a drill press, portable polishing, grinding or sanding kit, a wood turning lathe or a circular saw bench.

P.I.B. Literature

THE free literature supplied by the Petroleum Information Bureau, 29, New Bond Street, London, W.1, includes "Notes About Oil," which is an account of the origin and early history of oil and the types of strata in which it is found. Prospecting, drilling, refining and transportation are also dealt with. Additional pamphlets on the various aspects of oil production include such titles as: *Drilling an Oil Well, Refining of Oil, Transportation of Oil, Drilling for Oil in England, Chemicals from Petroleum* and *Jet Aircraft Fuels.* A set of three 40in. by 30in. two-colour wall charts on searching and drilling for oil and its refining are available, price 4s. 6d. including P.T. and postage. Films, film strips, episcope photographs, lantern slides, sets of samples, molecular models and display material are available for free loan on agreed dates.

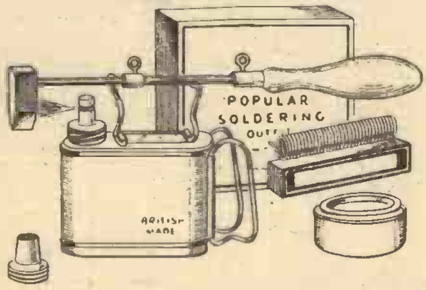
Johnsons Developer 468

JOHNSONS OF HENDON, LTD., have produced a new and improved M.Q. developer, known as Developer 468. In powder form this compound contains developer improver 142 and wetting agent 326. It is supplied in a tin to make 20oz. for subsequent dilution 1 to 1 for contact paper and 1 to 3 for bromide.

The developer has been evolved to produce an intense blue-black on all types of contact paper and copying papers, to have great exposure latitude and complete freedom from fog. Developer 468 is also excellent for bromide papers and permits prolonged development without risks of stains or veiling. Instructions are enclosed and the special two-part container keeps the contents in perfect condition. The 40-80oz. size retails at 2s. 9d.

Britinol Soldering Outfit

THE "Popular" soldering outfit consists of a "Britinol" self-blowing spirit lamp, a telescopic soldering iron, a coil of



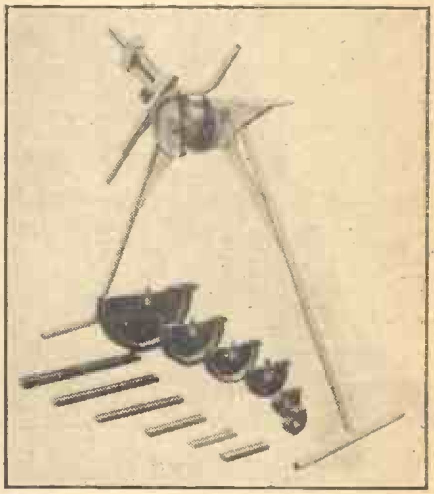
The complete "Britinol" soldering outfit.

"Britinol" self-fluxing wire solder, a tin of paste solder and a pair of extra wicks for the lamp. The lamp is self acting, easily lighted with a match, and has no valves to get out of order. It gives an intense heat and clean blow pipe flame 3in. to 4in. long. The lamp cannot leak when folded for the pocket and has folding supports to carry the soldering iron.

This iron has been specially designed for use on the supports of the "Britinol" self-blowing lamp and will fit into the pocket when closed. The paste solder comprises finely powdered tin and lead, combined with a non-acid flux of great cleaning power. The wire solder contains a core of the same non-acid flux. Each of these items is available separately and the complete kit, packed in a strong, partitioned, cardboard box costs 16s. 3d. The makers are Bi-metals (Britinol) Ltd., St. Mary's Works, Bridge Road, London, N.9.

"Truset" Hand Precision Bending Machine

ECONOMY in tube bending, especially where off-set bends are required, can only be effected when the straight length of tube between the bends is as short as possible. To tackle this problem Chamberlain Industries Limited, of Staffa Works, Leyton, E.10, have designed and produced the Truset Bending Machine incorporating an improved back stop with the centre forming block. The whole idea is based upon the back stop being as narrow as possible and yet so designed as to give the necessary grip and support to prevent slipping and distortion to the tube during the bending operation.



The bending machine on its light steel stand.

Precision bending to accurate dimensions is ensured by the back stop, attached to the tube former, adjusting its grip automatically in accordance with the load applied, a feature which will be appreciated by engineers who have suffered with tube slip. Formers are available for bending, cold and unloaded through any angle up to 180 deg., tube sizes up to a maximum of ¾in. (gas-tube) and 1½in. dia. in copper and light gauge tube.

Another advantage of this machine is the cunning design incorporated in the centre pin and handle to ensure that the correct angle of lead is maintained at all times. This is important, as too little will cause draw and too much, flatting, and is essential for the accurate bending of copper and light gauge tubing. Of course right and left hand bends well beyond 180 deg. can be produced in any completed form.

The machine consists of two main components—the base and bending arm. The base is circular and carries lugs suitable for universal mounting on either bench, vice, or bending stand, and around the base are holes for a stop-pin, which when used in conjunction with an additional stop screw on the bending arm, allows adjustment to any angle for repetition work. The bending arm, rotating about a centre-pin fitted to the base, consists of two accurately machined steel bars carrying an adjustable bending pin, fitted into the head block at one end, and the handle block at the other, this design rendering the arm extremely robust.

A light steel fabricated bending stand, illustrated, can also be supplied with the machine.

A small pipe vice can also be supplied for mounting on the stand so that the tube can be secured for further processing.

READERS' SALES AND WANTS

The pre-paid charge for small advertisements is 6d. per word, with box number 1/6 extra (minimum order 6/-). Advertisements, together with remittance, should be sent to the Advertisement Director, PRACTICAL MECHANICS, Tower House, Southampton Street, London, W.C.2, for insertion in the next available issue.

SITUATIONS VACANT

The engagement of persons answering these advertisements must be made through a Local Office of the Ministry of Labour or a scheduled Employment Agency if the applicant is a man aged 18-64 inclusive or a woman aged 18-59 inclusive unless he or she, or the employment, is excepted from the provisions of the Notification, of Vacancies Order 1952.

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WANTED URGENTLY, Teachers of Handicraft. Correspondence Courses, best preparation. Write only, specialised. College Secretary, Marriott's, Bushby, Leicestershire. Success assured.

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(Continued from previous page)

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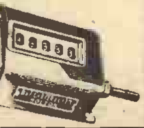

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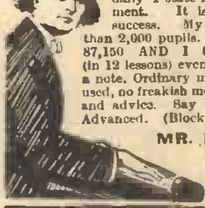

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QUERIES and ENQUIRIES

Use of Proportional Dividers

I HAVE been presented with a pair of proportional dividers made nearly a century ago which I hope to use in my work as a draughtsman.

There are four scales marked on these dividers, three of which I am not sure about. One scale for lines I have used; the others are marked "circles," "planes" and "solids." Please advise me what proportions of "planes" "circles" and "solids" can be found by these dividers and how the scales have been arrived at.—E. Denham (London, N.16).

THE scales are arranged to give the proportions marked on each scale as below:

Lines: Give proportionate lineal measurements.

Planes: Give proportionate areas.

Solids: Give proportionate cubic contents or volumes.

Circles: Give the side length of a polygon when the opposite points are set to the radius of the circumscribing circle and the fulcrum joint index has been set to the number of sides required for the polygon. To use the instrument, set the joint against the number of sides of the required polygon, open the long points to the radius of the desired circle, then the short points are at the required separation equal to the length of the polygon required.

The way the scales have been arrived at is as follows:

Lines: Index gives direct proportion between lengths of the long and short legs.

Planes: Index gives proportion between long and short legs, arranged to equal the square root of the index number. For instance, should you set the Plane Index to "3" and open the long legs to the length of side of a square area, the other legs will give the length of a square of one-third the area.

Solids: In a similar way the index here divides the lengths of the legs in proportion to the cube root of the index numbers. Should you set Solid Index to "3" and the long legs opened to the length of side of, say, a tank, the other will give the length of sides of a tank of one third the capacity.

Circles: The index is set to give the correct length of side when the long legs are opened to the radius of the circle circumscribing the desired polygon, the index setting being equal to the number of sides in the required polygon.

Reducing Vacuum Cleaner Discharge Pipe Bore

I WISH to utilise my vacuum cleaner to supply air under pressure for use with blowtorch and paint gun. How can I best reduce the 2in. diameter outlet to a bore of, say, ½in. so that I may use a less unwieldy pipe, without excessively affecting the efficiency of the unit? Can I increase the discharge pressure?

Will you please advise me on the design for a coal-gas/air blowpipe for use with whatever method you may advise for use of the vacuum cleaner. I need as small a flame at as high a temperature as possible.

The discharge pressure of my cleaner is approximately .45 lb. per sq. in. (11in. water gauge pressure).—A. L. N. Stephens, (Kingston-on-Thames).

THE only way you can decrease the bore of the discharge pipe without decreasing the capacity of the machine is to reduce the length of the pipe to a point where its resistance is equal to that of the existing 2in. diameter piping. You will also require a fitting reducing gradually from 2in. diameter to ½in. diameter in order to reduce frictional losses to a minimum. The only way to increase the delivery pressure is to increase the fan speed—i.e., the pressure varies as the square of the fan speed. It must, in so doing, be remembered that the horse-power required will also be increased, i.e., the power required to drive the fan varies as the cube of the fan speed.

The pressure quoted will be insufficient for the average commercial spray-gun, and it is considered that it is also too low for blowpipe operation if a high flame temperature is required. The design and construction of an efficient blowpipe is specialist work and it is suggested that a blowpipe is purchased from a reputable manufacturer.

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

Chlorophyll from Grass

I AM at present producing dried grass in commercial quantities. Please give me an outline of method for producing chlorophyll from same.—H. A. Taggart (Belfast).

WE suggest that you "kill" the grass, prior to drying, by immersion in a vat of boiling water. Drain superfluous liquor by spreading on racks, and then extract by means of industrial spirit (ethyl alcohol). The alcohol extract of chlorophyll is then distilled from a steam-jacketed still, the alcohol being thus recovered, while the chlorophyll remains behind.

We would suggest experimenting on the laboratory scale first, for you may find it unnecessary first to partially dry the boiling water extract—possibly pressing would suffice.

Moulding Kaolin

I HAVE 2 cwt. of powdered kaolin. Can you please give me a formula using this kaolin to produce a granite-hard product suitable for tiles or for casting?—Evan J. Thomas (Aberayron).

THE kaolin must be thoroughly pugged with water into a soft paste of such consistency that, when a piece about 2in. diameter is squeezed tightly in the hand, it will reproduce the fine lines of the skin. If paste is too hard, add a little water and re-pug. A wooden mould, preferably of teak, must be made, shod on top and bottom edges with steel strips about 1/16in. thick. The thickness of the mould should be that of the tile. Lubricate mould with water (slop moulding) or with sand (sand moulding). Next pick up a quantity of paste from the mass, "bump" it on the previously sanded or watered bench, turn it and bump it five times, and then by a taut steel wire in a frame slice the mass into "clots" a little longer than the tile and about ⅝in. thick. Dip the empty mould into water or sand and then place it on the bench which has been similarly treated. Lift a clot from the pile, and after throwing it forcibly into the mould, compress it and fill up the edges and corners by a series of blows or punches with the hands. Surplus paste is removed by drawing a wetted piece of wood over it. Drying-off can be done slowly in an open shed, the tiles being stacked in chequer work to aid ventilation. This can be done only in summer months. For quick drying and hardening, artificial heat must be provided or arrangements made to borrow the use of a kiln at some school of pottery.

Electrodeposition Queries

RECENTLY I saw in Practical Mechanics an article dealing with copper deposition on non-conductive materials. I should like more information on the following points.

What type of transformer is necessary for 230 volts 50 cycles A.C. input to give 1.2 volts, variable amperage from 6-40 amps D.C. output? What firms would undertake to build this? Is it possible to build this transformer from ex-government parts?

When dealing with a number of articles what is the best method of making contact? Could I put them on copper plate or hook them to a bar as a negative cathode?

When using plaster forms what is the best method of contact to the graphite film, also what other conductive coatings can be used and where can they be purchased?—A. Heywood (Ashton-under-Lyne).

PROBABLY the cheapest method of obtaining 6 to 40 amps at 1 to 2 volts would be by means of a car battery. You may be able to obtain quite cheaply an old car battery which has one or two defective cells; one 2-volt cell, or preferably two or more connected in parallel, would be suitable for your purpose. The battery could be charged locally or by means of a battery charger consisting of a step-down transformer and metal rectifier, and quite a low charging current could be used.

Another method of obtaining a supply of 6 to 40 amps at 1 to 2 volts is by means of a motor-generator set consisting of a mains voltage motor which drives a small D.C. dynamo, the voltage output being controlled by a variable resistance in the field circuit of the dynamo. Another method would be to use a rotary converter. However, such apparatus is likely to be rather expensive. Alternatively, you could use a step-down transformer to supply a metal rectifier having the required output. Messrs. Galpins advertise a transformer having an output of 50-70 amps at 2 to 10 volts, or we could supply constructional details for a transformer if required. A metal rectifier could be obtained from one of the following firms:

Standard Telephones and Cables, Ltd., Connaught House, Aldwych, London, W.C.2. Crypton Equipment, Ltd., Bristol Road, Bridgwater. Westinghouse Brake and Signal Co., Ltd., 82, York Way, London, N.1. Partridge Wilson and Co., Ltd., Davenset Electrical Works, Leicester.

You could either suspend the article or rest it on three contact points on a wire frame, not a plate, connected to the terminal of the vat. A preliminary coating which you may find useful consists of a hot mixture of one part of paraffin wax, two parts of beeswax, and two parts of powdered graphite, these being melted and mixed together and afterwards evenly applied to the article. When the coating has become quite cold a little powdered graphite should be sprinkled on the surface and brushed vigorously with a soft brush. However, this method should not be used on articles which will afterwards be washed in hot water or the wax may be melted and the coating stripped off.

Large's Storm Glass

I HAVE a barometer which is called a Large's Storm Glass. It is composed of a glass tube ½in. diameter and 5in. long, sealed at both ends, and contains a liquid and some sort of crystals in suspension.

When the weather is to be fine the crystals remain at the bottom of the tube and when rain is imminent the crystals rise to the top.

Could you give me some indication as to what the liquid is; what the crystals are; and method of construction?—N. Mather (Coventry).

THERE are several formulae for the mixture contained in a Large's Storm Glass, but all contain the same materials: 12oz. flake camphor, 3oz. muriate of ammonia, 3oz. nitrate of potash, 2½ pints alcohol, 2 pints distilled water.

A suitable amount of this mixture is placed within the glass tube and the end sealed by heat. It is not under vacuum.

Anti-fungus Creosote

I WISH to increase the anti-fungus properties of ordinary commercial grade creosote. It is to be used on floors, joists, etc., of a bungalow badly affected by the floods at Canvey. Can you help me, please?—T. Young (Isleworth).

YOU can adopt either of the suggestions given below:

(1) Copper naphthenate is soluble in creosote and can be applied to floors, joists, etc., in a single application.

(2) You can use the commercial grade creosote and when dry wash over all surfaces with a 4 per cent. solution of sodium fluoride. This substance is an excellent fungicide. You must remember that it is poisonous and etches glass, so the mixture should be made up in a pail. The chemical can be obtained from Vicsons, Ltd., 148, Pinner Road, Harrow, Middx.

Artist's Enlarger/Reducer

COULD you give me some information on building the type of photographic apparatus used by artists for reducing or enlarging the image of a photograph for the purpose of line drawing? I believe this is something like a camera obscura, and throws an image of the photograph on to a ground glass screen. Alternatively, I could make a line tracing of the photograph which could be placed in the apparatus and projected on to the drawing-board in the dimension required, the instrument being arranged to slide on a horizontal rod as shown in the accompanying sketch.

I have a spare 5in. f4.5 lens previously used in an enlarger and am wondering if this would be suitable.—G. Hodges (Essex).

FOR projecting a tracing made from a photograph the best scheme would be to place the drawing-board horizontally on a table, and the box carrying the lens, tracing slide and lamp vertically above it. The box could then be supported upon three detachable legs, as shown in Fig. 1.

Fig. 2 shows the manner in which the actual photographic image can be projected down on to the drawing-board.

Providing the angle of the 5in. f4.5 lens is wide enough, there is no apparent reason why this should not be used. It is certainly worth trying out.

You will have to provide adequate ventilation for the lamp or lamps.

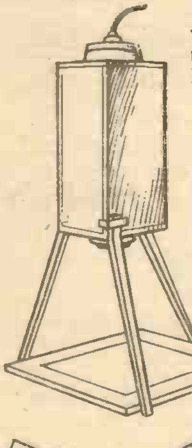

Fig. 1.

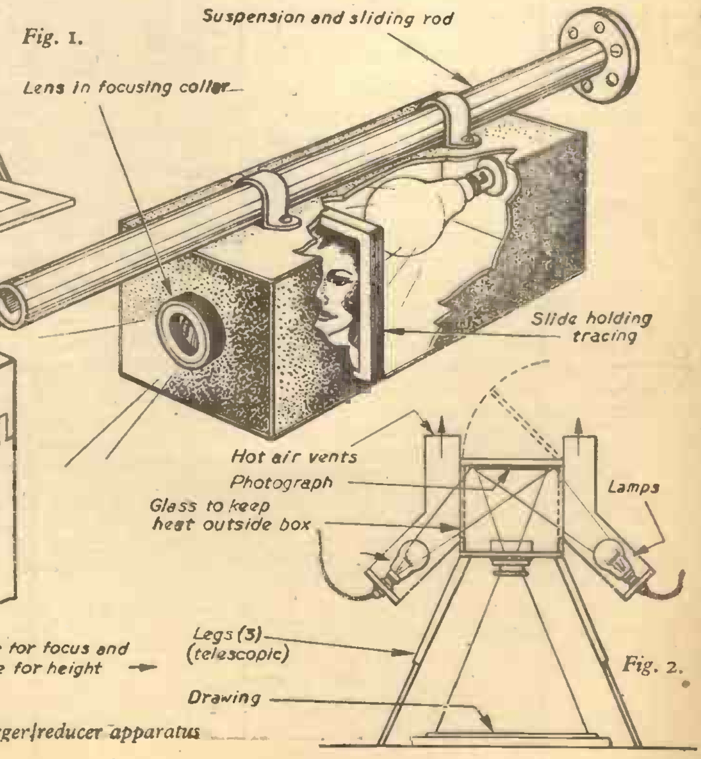

Fig. 2.

Artist's enlarger/reducer apparatus

Information Sought

Readers are invited to supply the required information to answer the following queries.

"Socredes," of Glasgow, asks: Could you give me some up-to-date information on the subject of "shaded poles" in electric motors?

I understand this consists of some slight modification to the pole face.

What form does the modification take?

Is such a modification possible on a permanent magnet, and if so, what effect might it be expected to produce?

Mr. F. E. Siggers, of Ceylon, asks: Have you at any time published a constructional article on exhaust-operated three-, four- or five-note horns for fitting to a car, please? Can you give me enough information to make one?

Mr. H. Comber, Ireland, writes: I wish to make a mixer to handle ice-cream mixes of from two to four gallons. My idea is to fit an extension to the shaft of a motor and invert the gadget into a large can.

(1) What horsepower and speed would the motor need to be?

(2) How should I join the extension to the motor shaft?

(3) Would the shaft need support other than that given by motor-bearings?

(4) Would a thrust bearing be necessary on the motor?

Mr. R. Hamblin, of Watford, sends the following query. I wish to construct a plug sand-blasting unit. I have a compressor, also a lathe.

Please tell me how to set about it.

Mr. J. B. Ball, of Morecambe, writes: Will you please tell me how to make a revolving lampshade which uses the convection currents produced by the heat from an electric lamp?

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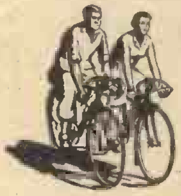

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