RE-SPRAYING YOUR CAR

NEWNES

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PRACTICAL MECHANICS

EDITOR: F. J. CAMM

APRIL 1953

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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

INFORMATION SOUGHT

WE often receive requests from readers for information which cannot be given in the form of a letter. Some expect us to prepare special designs for them, while in other cases the information would call for the preparation of a small text-book. Where we feel the subject to be of general interest it has been our practice in the past to publish the reader's request with an invitation to readers to supply designs and data in the form of short articles so that we may publish them for the benefit of other readers.

We now propose to introduce this as a regular feature, under the general heading of "Information Sought," and such commences in this issue on page 306. The published replies will be paid for at our standard rate. Readers in submitting replies should give the fullest possible information and include rough dimensioned sketches and indicate source of supply. We shall, of course, only be able to include a few readers' requests and the deciding factor will be whether the information sought is of general interest.

While we are dealing with this aspect of our information bureau, may we draw querists' attention to certain underlying principles which guide us in our replies. In the first place, whenever we describe the construction of some model or piece of apparatus, we receive a large number of letters asking us to modify the design to suit some piece of mechanism which the reader has on hand. This we cannot undertake to do.

Secondly, some limit must be set to the time which can be devoted to answering one particular querist. The other day, for example, a letter arrived, closely written on both sides of 12 sheets of paper, containing over 18 queries, ranging over seven different subjects. This querist had not enclosed a stamped, addressed envelope, nor in other ways complied with our query rules printed in every issue, and answering those queries would have involved several days of research and the preparation of over 30 drawings. The reading of the letter alone occupied over a quarter of an hour. Querists should be brief and they should come to the point straight away. We like to be prompt in our replies, and it wastes time when we have to read a large amount of irrelevant matter.

Other queries are sent to us which should be sent to the manufacturers of the apparatus concerned, while some merely request addresses of advertisers whose announcements appear in every issue! A final point—no telephone enquiries, please.

We receive some thousands of letters every year, and the speed of our replies and the usefulness of the information we give is often commented on by our readers. The efficiency of that service can only be maintained if readers will be brief without omitting important details.

It is worth while reminding readers that copies of this journal are on file in most good libraries, and they may readily consult back issues there. We mention this point because we receive many letters asking us the date of issue in which a particular article appeared some years ago. Some readers, we are glad to note, keep a file of our indexes, although they do not have their copies bound. Thus they are able to consult all of the indexes without having to pull down somewhat weighty volumes. It is only necessary to remove one volume from the bookshelf once the index has guided you to it.

THE INVENTIONS EXHIBITION

THE Modern Inventions and New Ideas Exhibition was an undoubted success for it staged a large number of practical devices worthy of being marketed. It occurred to us, however, that rather too much attention is being directed towards devices for the home, and that many of the exhibits could be classified as mere gadgets which could not be expected to have continuity of manufacture. That, perhaps, is the reason why so many of them fail to reach the market and disappoint their inventors. Some, indeed, gave us the impression that the inventor had first invented a need and then invented a device for the invented need. In the broader sphere of inventions there was little worthy of comment. We saw nothing which could be classified as a major invention.

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INDUSTRIAL ART BURSARIES COMPETITION

AN exhibition of winning and commended designs in the Industrial Art Bursaries Competition will be held at the Royal Society of Arts between May 11th and 22nd. Admission will be free.

The encouragement of industrial design has been one of the primary objects of the Royal Society of Arts since its foundation in 1754, since when awards of one sort or other have frequently been offered to promote this end. In recent years these annual competitions have been one of the society's major activities.

The primary purpose of the present form of competition is to help successful candidates to broaden their knowledge and experience by travel abroad and the study of foreign design, or, in certain cases, to obtain art training or industrial experience in this country.

Entry to these competitions is free, the administration being carried out and financed by the Royal Society of Arts. The society also contributes £200 a year towards the bursaries themselves, the bulk of which are provided by industry.

TWENTY-ONE NEXT YEAR

NEXT year we shall celebrate our 21st Birthday, and we shall signalise the event by the production of a special number. Our companion journal, *Practical Wireless*, celebrates its 21st Birthday this year, for it was on September 24th, 1932, that the first issue appeared.—F. J. C.

Re-Spraying your Car

Preliminary Work and How to Use the Spray Gun

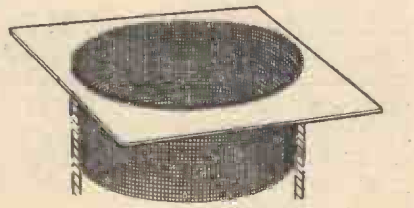
By F. J. FULFORD

WHEN cleaning your car, have you looked at those patches of red-spots of rust, and sundry odd chips, dents and scratches, and wondered whether it is possible to respray it yourself at home? After much thinking I decided to try my hand at spraying my own car. My experiences may be of help to other car-owning readers who like to do things themselves. It is not intended to attempt to replace the standard instruction book, but to add some information I have found most useful, especially in deciding whether the necessary facilities were available. If the few small requisites can be obtained, a first-class job can be turned out.

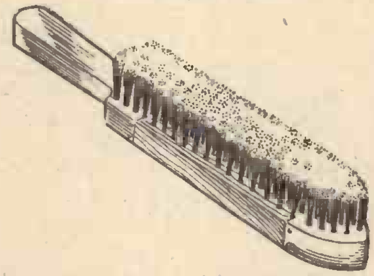
Where to Work

The first thing to consider is the place in which it is intended to work ; at least four feet of space all round the car is necessary to give elbow room for spraying, and few garages are so generous. If a large enough space is not available, it is possible to work in the open during the summer, but here there are two snags. Small insects will fly on to the wet paint. They can be papered off again, but they are a nuisance. The weather is a more serious matter. Wind will spoil the spraying and waste a lot of paint. A few spots of rain before the paint is hard will cause disaster. It is much better if a building can be used, but good ventilation is required to dispose of the fumes.

An electricity supply is, of course, necessary, with two or three five-amp. plug points. Very good illumination should be provided from all sides, and the room should be well cleaned to free it from dust before starting. Blowers with the air intake at the bottom of the unit will pick up dust from the floor, if it is not clean, and spray it with the paint.



A gauze paint strainer.



A wire brush is required for rust spots.

The Sprayer

Having decided about the work-place, we must next consider what sprayer to use. Some readers may have an air supply of some thirty pounds per square inch, and about four cubic feet per minute, in which case it will only be necessary to attend to the filtering of the condensed moisture and to hire a gun. The vast majority will, however, have to depend on a velocity type of unit, but there is no need to be dismayed on this account. Slightly more paint may be used and more rubbing down may be necessary, though a first-class job can still be done. By a velocity unit is meant a gun worked by a vacuum cleaner, or a specially built unit working on the same principle. A domestic cleaner with a really powerful blast will spray cellulose very well, but a poor air stream means a coarse finish. The Electrix paint sprayer is an inexpensive but very efficient unit. Some paint manufacturing firms let out spraying equipment to users of their materials, and it might be possible to hire a unit in this way. If the domestic cleaner is used, it is wise to remember other claims on its services.

A blower-type of spraying unit.

It is a good plan to check up on the bearings before starting to work and to grease sparingly if required. The outfit is in for some hard work. A failing bearing means a reduced air stream and coarser finish, but to stop and make replacements once the job is started should be avoided, if possible. On the other hand, excessive generosity with the grease is likely to result in some of it getting blown on to the work.

Guns for use with the vacuum cleaner can be bought for about one pound. It is worth while having one with a control varying the amount of material fed, as it is better to work full blast and to move the gun quickly over the large surfaces, but to cut down the feed and move more slowly around the windows.

If no sort of sprayer can be had, it is doubtful whether it is worth while attempting a brush job. It would take a very long time, and the brush marks are most difficult to remove completely.

Inspection

The question "how long will it take?" can only be answered after a close inspection of the car with a view to deciding just what is to be done. If the new paint can be sprayed over the old a lot of time will be saved, provided that the new paint takes well. If the old surface is in good condition, and has not been dabbed with enamel or otherwise touched up, it should take an overspray after thorough degreasing and rubbing down. If, however, the surface is crazed, that is, broken up into a pattern in the manner of crazy paving, it must be stripped. Advice on this matter will be found in any book dealing with this subject. In general, it can be said that it is much safer to strip down to the metal, and if in any doubt this is the wiser course.

Another matter that must be decided now is whether the wings are to be removed. This job may be lightly undertaken with great enthusiasm and deeply regretted later. If any rust is showing between the body and the wings then they will have to come off, but on old cars this task is likely to be a formidable one. Everything is certain to be rusted solid. Many nuts will break off and others will have to be cut. Captive nuts are popular for fixing the wings, since the inside edge is usually inaccessible. Rust will probably be found to have eaten away the clip, freeing the nut and making both removal and replacement very difficult. Several good soakings with penetrating oil applied well before starting work are helpful. There is no doubt that many extra hours will have to be expended if the front wings are taken off—the back ones are not usually so bad—but if it is not done there is the danger of rust appearing at the joint.

If the whole schedule is undertaken the

time required for a first attempt on a medium saloon will be about eighty hours. This means that the spare time worker will have to stick at it for all his spare time for three weeks.

The time has now come to make the decision whether to go ahead and, if so, to fix the date. Time should be given to get all the materials together and to have rusted-out panels repaired and any necessary places filled with solder. When everything is ready give the car a good wash down and then remove the door handles and any other fittings which might get in the way, as spraying around them causes runs and unevenness. The bonnet is more easily sprayed off the car. Any parts it is desired to have plated will now be sent away. The work can now begin in earnest. Individual operations can only be described briefly here, but full instructions are readily available.

Stripping

A chemical stripper is the best means of removing the old paint, as a blow lamp is likely to crack windows and melt any solder filling. It is applied with an old paint brush and left for ten minutes, when the paint can be scraped off with a knife. If any gets in the eyes, make a dive for the water tap. When the stripper has done its work it must be completely removed as paint will not dry over it. Remove all traces from the windows before masking or it will be a potential danger to the new paint. If the car does not require stripping, the equivalent operation is degreasing.

Priming

The best time to attend to the stopping with cellulose stopper is when rubbing down with coarse waterproof paper. As it needs overnight to harden, time will be lost if this job is not completed at an early stage. When the rubbing down has been well done the surface should be dried off and sprayed with red bare metal primer before the metal has had time to oxidise. Whilst primer is sometimes sprayed on neat, it will probably have to be thinned for use with a blower unit. This is a good time to find out what is the best consistency for the unit in use.

Runs

Paint which is too thick gives a rough finish, while if it is too thin runs are caused, especially on vertical surfaces. It will also be found that the first coat applied after a break in spraying will be much more likely to run because the paint beneath has had time to harden. It does not then soften and fuse with the new coat to the same extent. A test panel of, say, two feet square, on which to try each operation will make it possible to find out what will cause runs, so that they may be avoided later. Whatever precautions are taken, however, there are almost certain to be some runs. The best way to treat them is to wait until they are quite dry and hard, when they may be papered off. A big run will take a matter of hours to harden, and cannot be safely touched until the finger nail makes no impression on it. Should the paper be applied when only the skin is hard a shocking mess is certain. Do not try to wipe off the run with a piece of rag, for it needs a very deft touch, and is far better not attempted. Runs waste a lot of time and are best avoided. Spraying the doors when open avoids causing runs around the door pillars.

Filling

Enough filler coats must be put on after the primer to give a perfectly flat and smooth surface when rubbed down. If necessary some stopper can be mixed with thinners and sprayed on to cover rough places. The colour coats will not fill.

Finishing Colour

After filling, leave overnight to harden. If a colour, as opposed to black, is used, the very greatest care must be taken in mixing. A green finish, for example, will contain yellow and blue ingredients, having varying powers of staying in suspension. After standing, a dark green may be found on top and a lot of yellow in the bottom of the container. If this is not overcome, the colour will change as the spraying proceeds. As rubbing down is unlikely to penetrate to the same depth at all points, an interesting but undesirable variegated effect is produced. To avoid this, have a container which will hold all the colour when thinned, and thin the lot at one operation after thorough stirring. Then do all the spraying in one session, taking care to keep the paint mixed all the time. If the gun, containing some paint, is put down for only a short time, it is wise to empty it back into the container and mix it up again. Shaking the tin does not mix it well, but puts air bubbles into the paint which give trouble when spraying. Probably all cellulose does not behave like this, but it is better to be on the safe side.

Patience will also have to be exercised in waiting for the weather. Damp or chill air causes "bloom," which looks rather like a coating of frost on the work.

A cheap type of gun for use with a vacuum cleaner.

Flatting

When at least five coats are put on, it is time to flat with fine paper. Here, some forbearance is needed, as it is easy to cut right through the finish. Some colours are softer than others. A little orange peel surface can be dealt with by the burnishing paste. If a good job has been done it is possible to paste it down without recourse to flatting, and this is the safest, if not the easiest, course. Whatever is done, corners and edges are easily rubbed off and should be treated with caution. Sore finger tips when rubbing down with paper are a danger sign, indicating that even pressure is not being applied.

Cost

The cost of materials for the job will vary, but it should be possible to complete the spraying without spending more than £12.

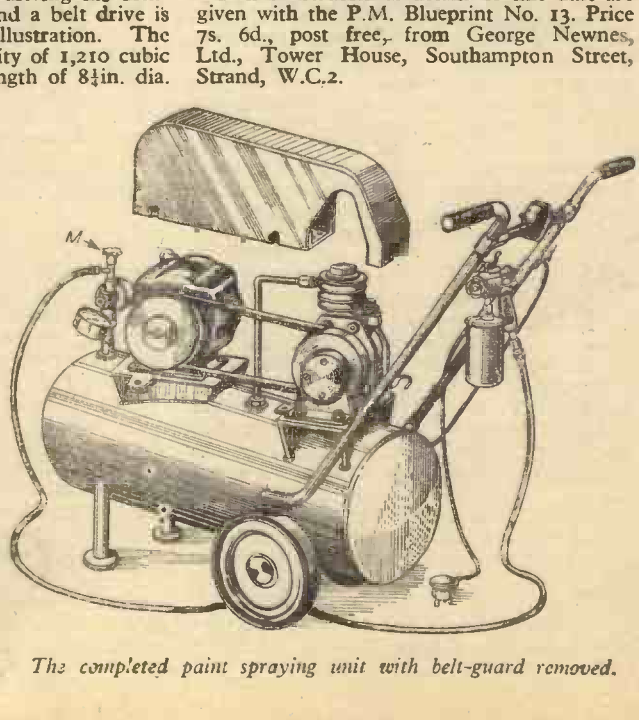
Finally, I would draw attention to the Petroleum Act governing the storage and use of cellulose.

A Portable Paint Spraying Unit

THE illustration given below shows a complete portable paint spraying unit, using a compressor obtainable from various surplus supply stores. The compressor is of the reciprocating air-cooled type, and at 1,200 r.p.m. is capable of delivering 160 cubic in. of air at a pressure of 50 lb. per sq. in. The motor for driving the compressor is rated at ¼ h.p. and a belt drive is used, as shown in the illustration. The receiver, which has a capacity of 1,210 cubic in., is made from a 2ft. length of 8½in. dia. steel tubing, the dished ends being welded in. The motor and compressor are bolted to saddle brackets welded in place on the receiver. Electrical conduit and tee pieces are used for the handles, the ends of which are welded to the sides of the receiver. Sheet metal of 18 to 20 gauge is used for the belt guard, which covers the entire belt drive, and is fixed by four ¼in. Whit. studs. The three-core electric cable is taken to a metal-clad switch mounted between the handles. A pressure gauge is fitted at the other end of the receiver.

The saddle bracket for taking the motor is machined on top, and holes tapped and studs fitted with locknuts underneath. The angular setting of the motor and compressor makes a more compact and balanced assembly. Side brackets are welded to the receiver for taking the axles. For the wheels, the heavy disc type of pram wheels should preferably be used.

Full constructional details of this unit are given with the P.M. Blueprint No. 13. Price 7s. 6d., post free, from George Newnes, Ltd., Tower House, Southampton Street, Strand, W.C.2.



The completed paint spraying unit with belt-guard removed.

Uses of Polarised Light

Solving the Problem of Dazzle on the Roads

By Prof. A. M. LOW

A FRIEND of mine has a pair of "sun glasses" which he fits over his ordinary lenses when he wishes to avoid being dazzled. He plays an amusing trick with them. The glasses are only faintly tinted and you can see through them with the greatest ease. But if he bends the springy wire that joins the two eye-pieces together so that one glass is over the other, you see a black wall when you try to look through. No light comes past the two glasses placed over each other, although individually they transmit nearly as much light as ordinary glass!

The "mystery" is explained by the fact that when one glass is slid over the other, it has to be turned at right angles to its normal position. The glass is of a special type which is made to polarise light; that is to say it only transmits light vibrating in one plane. When the glass is turned at right angles, it cuts off the light travelling in the other plane, and thus the two of them, although each is transparent, are together opaque!

Polarising Crystals

Polarised glass, or rather numerous polarising crystals held together between two transparent sheets, is one of the most remarkable inventions of the present century. The discovery that light could be polarised was made long ago, and its behaviour has played an important part in the various theories of light. We need not worry with the abstruse mathematics of these theories. For practical purposes we can think of light as a "vibration" in the horizontal and the vertical planes. If we take the analogy of a long piece of rope and imagine it being shaken by two men, one of whom moves his hand up and down and the other of whom moves his hand to and fro, we shall get the idea.

Certain types of crystal have the quality of acting as a "filter" on these vibrations. They will only pass vibrations moving in one plane—the others are cut off. This fact has been made use of in various ways. Some crystals polarise light to the "right," some to the "left" and this is of value in analysis. The common way of making a quantitative analysis of a solution of sugar is to pass light through a sample and measure the polarisation which gives an accurate estimate of the percentage of sugar dissolved. Special polarising prisms can be used for signalling. If a source of light is placed behind a prism and the prism is then turned, to the ordinary observer nothing appears to alter —the amount of light is not perceptibly diminished. But the observer equipped with a Nicol prism sees the light go on and off as the light which is able to pass through his prism is alternatively transmitted and cut off by the movement of the other prism.

To try and make what happens as clear as possible by analogy, imagine that signaller and observer have two postcards with very thin slits cut in them. The signaller has a powerful source of light behind his and holds it with the slit vertical transmitting a vertical beam of light. The observer holds his slit vertical and receives the beam. Now the signaller turns his card at right angles and sends a horizontal beam of light. This can be perceived by the observer, still holding his card vertical, only as a pin point. In actual practice, of course, there might be such a scattering of light that the system would not work. but in the case of a polarising crystal, all the light in the required plane would be cut off when it was turned.

What has this to do with motoring? My friend wears his glasses chiefly for fly-fishing. He says that by cutting off the glare—scattered reflected light—from the surface of the stream, he is able to see the fish below the surface in a way impossible with ordinary sun glasses. He also wears them for motoring, saying that they cut out glare from the road on very bright days. But the possible application of the phenomenon of polarisation to motoring is very much greater.

Polarised Headlamps

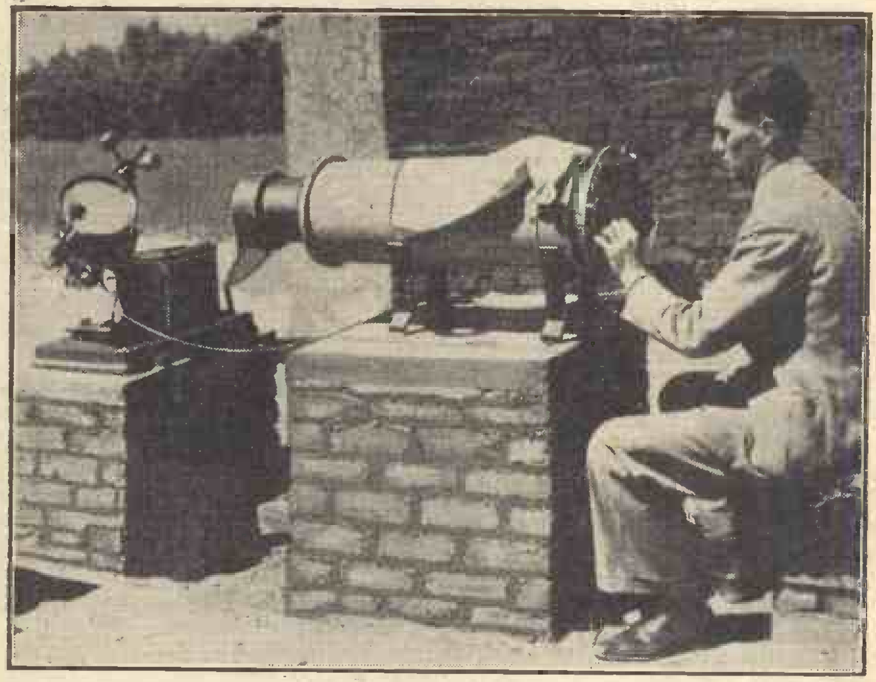
Suppose, instead of signallers, we imagine two motorists approaching one another in the dark, one with a "crystal" in front of his headlamp and the other with one in his windscreen. Only light vibrating in a horizontal plane would be able to pass through the headlamp. Only light vibrating in a vertical plane would be able to pass through the windscreen. Instead of the headlamp appearing to the approaching motorist as a huge sun, completely blinding him. it would appear simply as a faint light. But the light travelling in the horizontal plane would be quite sufficient to illuminate the road and the curb. There would be no difficulty in the approaching motorist seeing this (or the light from his own polarised headlamp) because it would be reflected back at all angles.

Equip every car with polarised headlamps and a polarising windscreen, and dazzle would disappear from the roads, saving much of the strain of night-driving in the busy days of peace, and preventing many accidents. Cyclists might be catered for by glasses which polarised light like the windscreen.

The difficulty lies in equipping every car. It would take several years to produce sufficient of the special polarising glass to fit all the cars on the road and compulsory fitting in a hurry would undoubtedly prove a hardship to many motorists. But once the principle was accepted, motor manufacturers would undoubtedly co-operate, and by a process of fitting all new cars and slowly changing earlier types, we should eventually arrive at the position where dazzle was something that motorists wrote about when recalling the good old days. Our children will probably regard it as one of the necessary discomforts of the early days of motoring —as we look upon the dust which our fathers gladly endured.

For Under-sea Vision

During the war a number of special uses have been devised although they do not differ in principle from those which are now generally understood. For under-sea vision the polarising principle has proved valuable, but perhaps the most important of all are the uses of a laminated polarised screen situated between layers of tinted glass, and the new stereoscopic method of viewing aerial photographs. In this case, the stereoscopic views are taken from two different points representing in some measure the distance between the eyes and polarised spectacles fitted with glasses, glazed for the photograph which was taken from that particular angle. By this method pictures stand out in such a way that aspects of the country or bombing results can be seen with great clarity. It has been suggested than an extension of this principle might one day lead to the discovery of the stereoscopic film, although the technique would be so necessarily complicated that commercial application seems still far ahead.

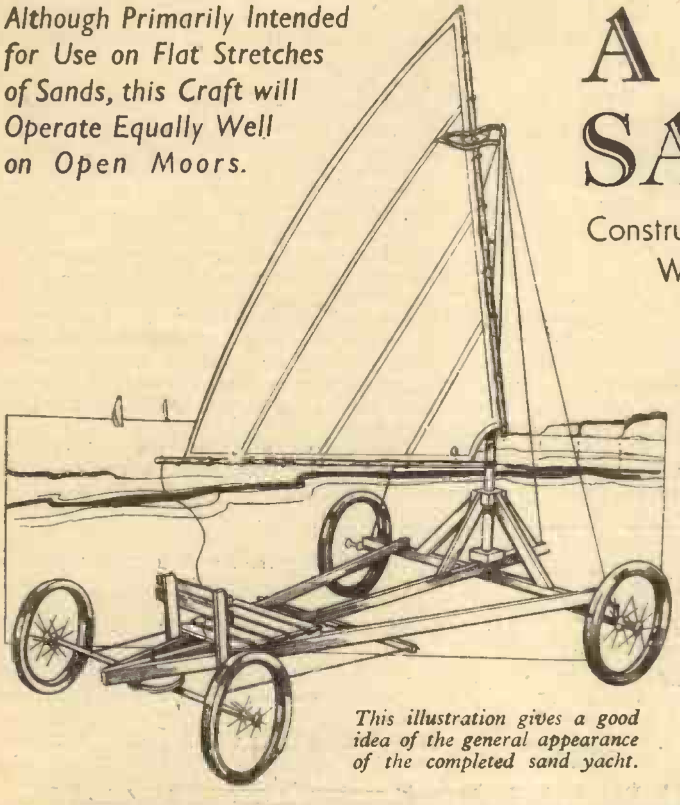


Dr. C. W. Allen, of the Commonwealth Solar Observatory, Canberra, Australia, using his polarisation camera, for investigating the direction of vibration of the light from the sun's atmosphere.

Although Primarily Intended for Use on Flat Stretches of Sands, this Craft will Operate Equally Well on Open Moors.

A FULL-SIZE SAND YACHT

Constructional Details of an Inexpensive Sand Yacht Which a Very Light Breeze Will Operate



This illustration gives a good idea of the general appearance of the completed sand yacht.

A SAND yacht is simple and inexpensive to build and anyone who can use a few tools will be able to make one without any trouble. Those living near or visiting the sea coast where there is a stretch of sands would be well repaid for building the yacht by the pleasure obtained from it, and those living inland will find it runs equally well on open moor or grassland. The illustrations show a single-seater yacht, but it will be an easy matter to increase the length and provide another seat, the sail area also being increased.

The chassis, which is built of wood bolted together, is mounted on four wheels. The back pair is pivoted and the yacht steered with the feet. The footrest is also pivoted and attached to the back axle with two lengths of wire.

The seat, which is fitted over the back wheels, is formed with battens nailed down to the chassis, and is provided with a back-rest, while the mast, which is fitted over the front wheels, drops into two blocks, and is stayed with wires fitted between the masthead and the front and sides of the chassis. In a strong wind the yacht will be subject to some strain, and it is necessary to see that it is soundly built and that the material is free from knots.

The Chassis

Figs. 1, 2 and 3 clearly show the chassis, and the method of its contruction. Deal, about 2in. deep by 1½in. thick, in section, will be quite suitable, the centre piece being 7ft. long, two side pieces 6ft. 2in. long and the head piece 3ft. 6in. long. The centre piece is first bolted to the head piece to stand exactly at right angles, while the side pieces are shaped to fit against the back end of the centre piece and are bolted to both the centre and the head pieces.

A circular bearing measuring 8in. diameter, and preferably of 1in. hardwood, such as elm, is fixed under the back end of the chassis, with the grain running from side to side. An alternative method of constructing this bearing is to use on old motor-car clutch plate with the cork taken out and three holes bored to take countersunk screws (see Fig. 6). A bolt is passed through the chassis, two clutch plates (the other clutch plate is fixed to the rear axle) and the axle bar. The blocks which carry the mast should also be of hardwood from 1in. to 2in. thick, the thicker the better.

The mast may be of stout bamboo and should be at least 6ft. long. Holes are bored through the blocks to receive the mast and the bottom block is nailed or screwed to the centre piece of the chassis with the grain running from side to side. The top block is supported and carried by four wood stays of about 2in. by 1in. section, fitted and nailed or screwed to the chassis and block. An alternative here is to use bent iron, twisted round the mast and bolted, and then screwed to the main bar of the chassis (see Fig. 6).

The Wheels

Cycle or pram wheels, not less than 1ft. 4in. diam., should be used, and large tyres are desirable as they will prevent the wheels from sinking in soft sand or soil. The front axle may be two arms bolted under the head piece, or in one length reaching from side to side. The back axle, which is shown in detail in Fig. 4, has a hardwood or clutch-

Fig. 4—(Left) Detail of the back axle.

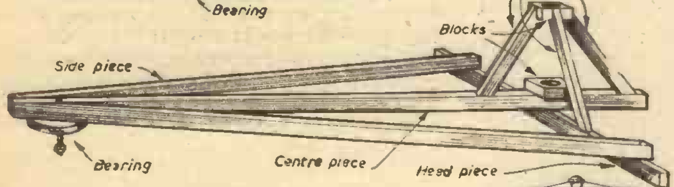


Fig. 3.—(Below) The chassis framework.

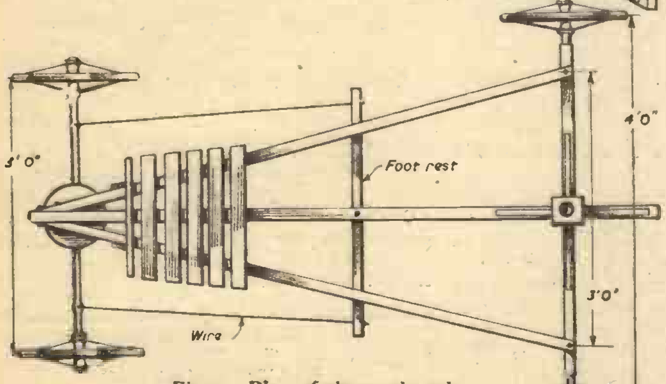


Fig.2.—Plan of the sand yacht.

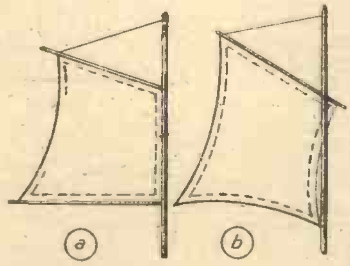


Fig. 5.—Alternative sail plans.

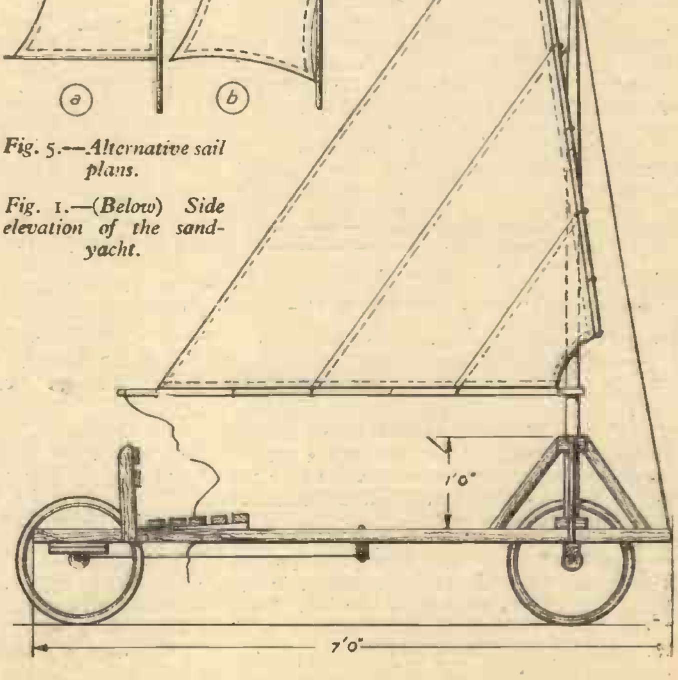


Fig. 1.—(Below) Side elevation of the sand-yacht.

plate bearing similar to that which has been fitted to the chassis, fixed to it with two bolts, and the axle is fitted with a long bolt which passes through the centre piece, the two hardwood or clutch-plate bearings and the axle itself. The bearings should be well greased.

The Seat and Footrest

Wedge-shaped blocks could be fitted over the side and centre pieces of the chassis to give a backwards slope to the seat. The five battens which form it, and which are 1ft. 6in. long by 2in. wide by 1in. thick, are nailed or screwed over the blocks. The backrest is carried by two uprights 1ft. 1in. long by 2in. wide by 1in. thick, bolted to the side pieces of the chassis. The rest is formed with two battens screwed to the uprights. The footrest is from 2ft. 8in. to 3ft. long, by 2in. deep by 1¼in. thick, and is pivoted to the centre piece of the chassis with a bolt. A trial should be made to find the best individual position for it, and it is connected to the back axle with two stout wires, as shown in the plan, Fig. 2. Holes are provided in the axle for this purpose. It is also possible to set the steering by fastening elastic from the front axle bar to the foot bar (see Fig. 6).

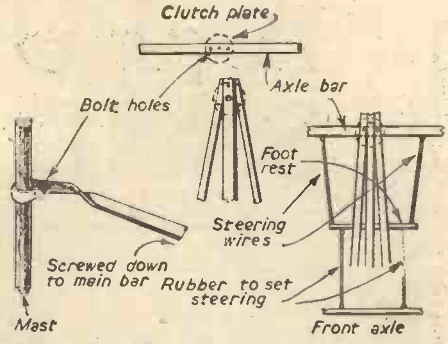


Fig. 6.—Details of mast stay, and method of setting the steering.

The Sail

The type of sail shown in Fig. 1 is generally found to be most satisfactory, but either of those shown in Fig. 5 could be adopted if preferred. The material for the sail may be stout, unbleached calico or light sail canvas, and the sheets are lapped at least 1½in. and double stitched. Hems with thick cords inserted in them are turned around all the edges. The spar and boom may be of bamboo, and the sail is laced to them, eyeholes being provided in the hems of the latter for this purpose. The sale is hoisted with a pulley and rope fitted between the mast and spar and, as mentioned before, the mast should be stayed to the chassis with wire guys.

On completion, the yacht should be painted for the purpose of both preservation and appearance.

Back to First Principles

3.—Problems Concerning the Lever

By W. J. WESTON

THE lever itself is a machine if we adopt the definition that a machine is a device for overcoming a resistance (weight) at one point by a force (power) applied at another point. It must have been among the first of contrivances whereby puny man became a power; for it is an obvious way of prising up an otherwise intractable weight. It is a rigid structure (usually a straight bar) fixed at one point, the fulcrum or prop, about which it can rotate, and acted upon by two forces; it has varied forms. Your steelyard, with the fulcrum between the forces, is a lever of the first order. Your nutcrackers, with the nut to be cracked midmost, is a double lever of the second order. Your lathe treadle, with the force midmost, is a lever of the third order; its advantage as a machine is to magnify the distance through which resistance is overcome.

The Problem.—A uniform rod 3ft. long is smoothly pivoted on a fixed horizontal peg at its centre C (Fig. 1). Strings attached to its ends A and B pass respectively through fixed smooth rings A′ and B′ and carry weights of 14lb. each; A′ is vertically above C and B′ vertically below C, each being 18in. from C. A weight of $x$lb. is hung on the rod at A. Show that if the rod is to rest in other than a vertical position, x must not be less than a certain value, and determine for what value of x the rod will be in equilibrium in a horizontal position.

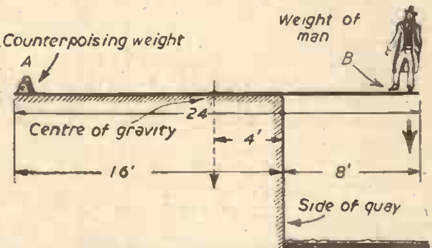


Fig. 2.—A problem of balance.

The Comment.—One component of the tension in the string through A′ pulls A to the right; one component of the tension in the string through B′ pulls B to the left. This component diminishes as the beam swings to the vertical where it becomes zero.

The weight x resists the swing to the vertical, its resistance growing less as the vertical is reached; at the vertical x would balance the weight through A′ and keep the beam in equilibrium.

If x is to keep the beam in equilibrium in a horizontal position, it must have a resistance equal to the combined rotating forces.

The Answer.—The beam being in equilibrium in a vertical position, x will balance

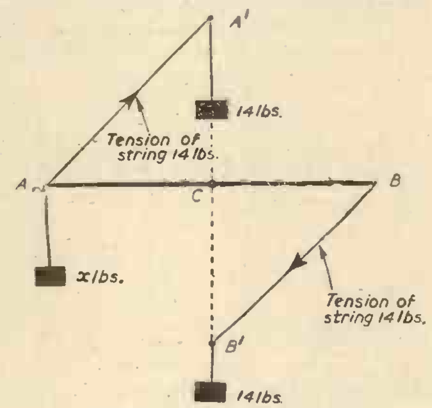


Fig. 1.—The pivoted rod.

14lb. Any addition to x will produce equilibrium to the left of the vertical.

Each rotating force at the horizontal is the component of the 14lb. tension perpendicular to AB. This is $\sqrt{\frac{1}{2} \times 14^2}$, since ACA′ and BCB′ are both isosceles right-angled triangles.

That is x must be $2 \times \sqrt{\frac{1}{2} \times 14^2} = 14\sqrt{2}$

The answers therefore are 14lb. and $14\sqrt{2}$lb.

The Problem.—One-third of a plank, 24ft. long and weighing 200lb., projects over the side of a quay (Fig. 2). What weight must be placed on the end of the plank so that a man weighing 150lb. may be able to walk to the other end without causing the plank to tip?

The Comment.—The counterpoising weight acting over 16ft. from the fulcrum (the quayside) plus the 200lb. weight of the plank acting 4ft. from the fulcrum is to balance 150lb. acting 8ft. from the fulcrum.

The Answer.—Let x = the number of pounds needed.

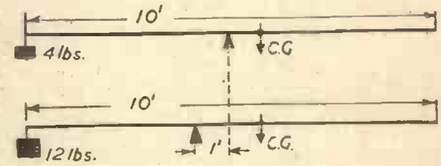
Then: $x \times 16 + 200 \times 4 = 150 \times 8$

That is: $16x = 150 \times 8 - 200 \times 4$

$= 1{,}200 - 800 = 400$

$\therefore x = 25$

The Problem.—A heavy non-uniform bar, 10ft. long, can be balanced at about its middle point when a mass of 4lb. is hung from one end. If a mass of 12lb. is hung from that same end, the balancing point is 1ft. from the middle. Find the weight of the bar and the position of its centre of gravity.



Figs. 3 and 4.—A problem of weight and distance.

The Comment.—Here again are two contrivances whereby moments (rotating forces) about a fulcrum are balanced, the moments being measured by the force multiplied by the distance from its point of application. These moments are sometimes called *torques* (twisters). The first contrivance is shown in Fig. 3. The second contrivance is as shown in Fig. 4.

We are therefore able to state two equations from which we can find the two quantities required—the weight and the distance.

The Answer.—Suppose x to be the weight in pounds and y to be the distance in feet of the centre of gravity from the middle.

Then: $4 \times 5 = xy$

$\therefore x = \frac{20}{y}$

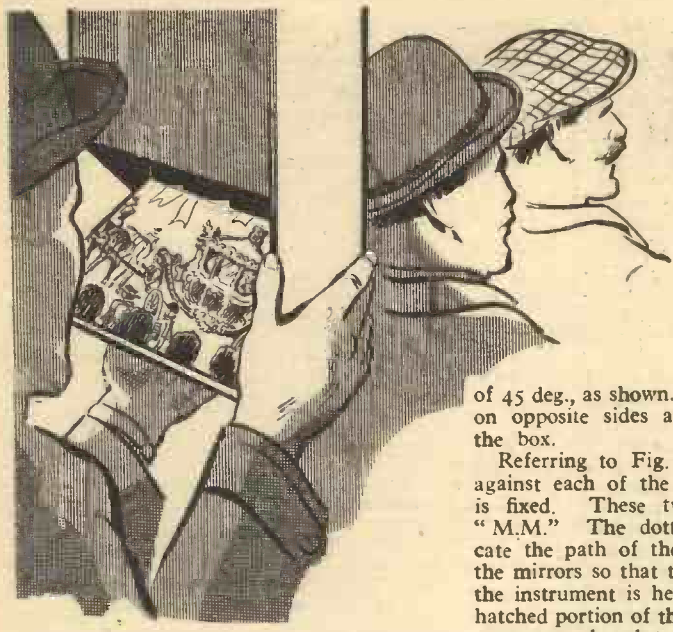
And: $12 \times 4 = x(y + 1) = xy + x$

$\therefore 48 = 20 + x$

That is: $x = 28$

$\therefore$ since $x = \frac{20}{y}$, then $28 = \frac{20}{y}$, or $28y = 20$, or $y = \frac{20}{28} = \frac{5}{7}$

The weight therefore is 28lb. and the distance of the centre of gravity from the middle is $\frac{5}{7}$ of a foot.



PERISCOPES

Their Uses and How to Construct Them from Easily-obtainable Materials

By E. W. TWINING

FOR civilian peace-time use, its chief purpose is to enable a person to see over an obstruction which is too high for normal direct vision. Such an obstruction can be a wall, a hedge, or a crowd of people. In the last everyone knows how annoying it is, when there is anything interesting to see, to have a number of people, taller than oneself, in front, completely blocking the view. Children, particularly, often see little, or nothing, of what is passing.

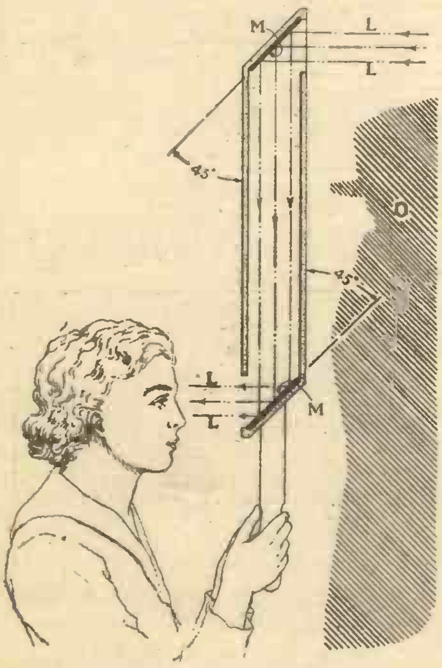


Fig. 1.—The principle of the periscope in use.

At the Coronation of our Gracious Queen Elizabeth the Second, in June, there will be hundreds, perhaps thousands, of people, who, though they go to see the procession, will never see it, unless they provide themselves beforehand with some optical aid.

The Principles

The diagram, Fig. 1, will explain both the use of the periscope and what it consists of. Briefly: it is a long box of rectangular cross-section with ends each fixed at angles of 45 deg., as shown. There are two openings on opposite sides and at opposite ends of the box.

Referring to Fig. 1, it will be seen that against each of the diagonal ends a mirror is fixed. These two mirrors are marked "M.M." The dotted lines, "L.L.," indicate the path of the light rays reflected off the mirrors so that they become visible when the instrument is held vertically. The cross-hatched portion of the drawing, lettered "O," represents the obstruction over which what is happening will be seen by the child looking into the periscope.

The writer has never seen a periscope fitted with handles for holding when the instrument is in use, but such handles would be found a very great convenience in avoiding aching arms if observation were very prolonged and details are included in the drawings, which are given in Fig. 2. As may be seen, the handles are arranged to swivel around and lie along the case, so as to avoid an overhang and thereby shorten the overall length for convenience in carrying. To lock the handles in both the closed and open positions the inside of the case is fitted, one on each side, with leaf springs, which can be either cut from hard-rolled sheet brass or strips of spring steel. Each spring has a stud riveted into it, which, passing through holes in the case, will drop into corresponding holes in the handle. Each handle has two stud-holes; one for the open and the other for the closed position. Each spring has, just beyond the stud, a little cranked lug, under which the finger tip can be placed to lift the stud by flexing the spring, so releasing the handle from either closed or open position.

The Case

For the case, either straight grained wood or three-ply can be used, about 3/16in. thick. In the drawing I have shown the front and the back made of strong, stiff cardboard or strawboard; this, especially the latter, if it is about 1/16in. thick, will be sufficiently strong and will be lighter than wood, but if wood or three-ply is preferred it can, of course, be used and a leather strip, not shown, can be screwed on as a handle for carrying. If wood is used instead of cardboard the four small battens shown in the drawing, crossing the card, will not be needed.

The two mirrors, both 4in. square, should be cut from looking glass, not plate glass, which would be too heavy, but from ordinary mercury-coated, or silver-coated sheet, the thickness being that of either 15oz. or 21oz. per foot and of first quality.

In putting the case together, all parts should be both glued and pinned and the mirrors secured with little strips of wood to retain them in place. For the finish the inside of the case can be painted dull black and the outside either sized and varnished or French polished to show the grain of the wood, or it can be enamelled any colour, or black.

Fig. 3 shows a periscope of entirely different design and construction although the principle is, of course, the same.

The instrument, as may be gathered from the drawings, is made entirely of metal, with the exception of the two mirrors, which are of the same high quality as in the first periscope. Each of these mirrors is carried in a plate, preferably of sheet brass, of about

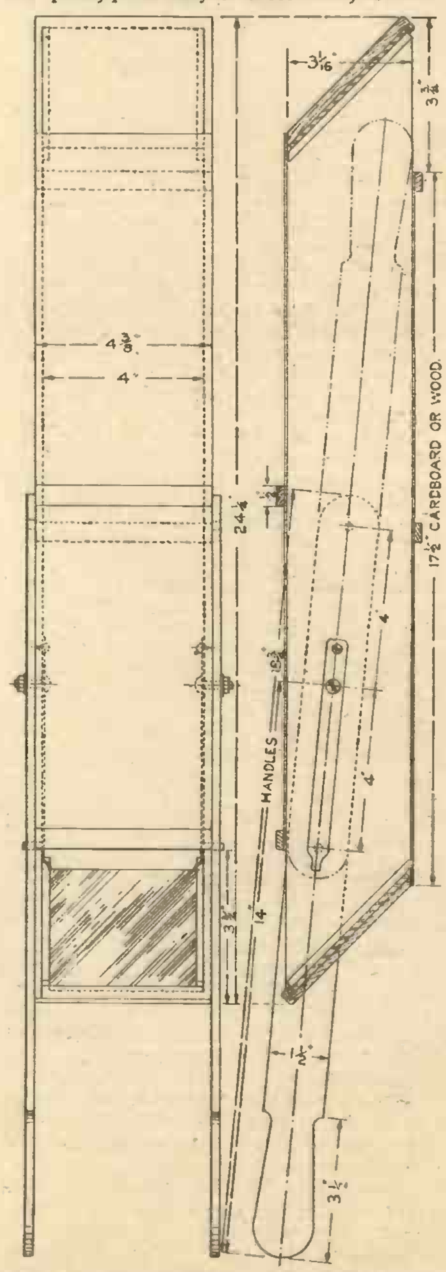


Fig. 2.—Details of a wooden periscope with folding handles.

No. 20 s.w.g., cut and filed to the outline shown in Fig. 4, with holes drilled in the four semi-circular lugs, to take 3/32in. dia. rivets. All four sides of the square are then bent upwards at the dotted lines; 1/16in. being allowed as a radius for bending. The 3/16in. square lugs will then be standing upwards. These lugs are again bent over to secure the mirrors, but it will, I think, be best to put in the mirrors last cf all.

"Lazy Tongs" Construction

The crossed levers of the "lazy tongs," as I have known this arrangement of bars to be called, are of strip brass or steel, as may be preferred. On each side there are six whole bars and two half-bars, all ⅜in. wide by 1/16in. thick. Each whole bar is drilled with three holes and the half-bars with two holes, all of 3/32in. dia., say, a No. 38 drill, all at exactly 2⅜in. centres and all on scribed centre-lines. If the marking out, the centre punching or the drilling is

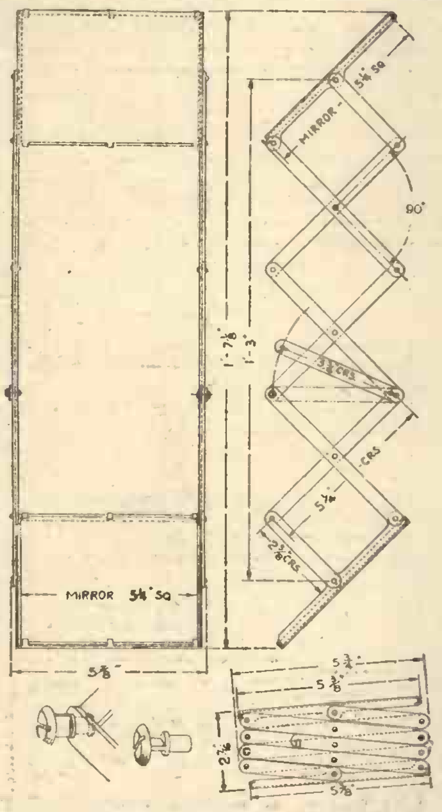


Fig. 3.—General arrangement of a collapsible periscope.

n_t dead accurate the periscope will not fold correctly.

Drilling Jig

The proper way to do a job such as this is to make an accurate drilling jig, into which the bars can be slipped and firmly held, and that I would recommend the periscope maker to do. No marking out or centre-punching of each individual bar would then be necessary. Such a jig is sketched in Fig. 5 and in this the bars are shown, held by little steel wedges, which may be 1½in. long with a taper on one edge amounting to 1/32in. The rounded ends of the bars had better be filed to shape after drilling so that they can be nicely true and symmetrical.

The whole of the bars could then be connected together and to the plates by 3/32in. rivets, but in order that the periscope shall be retained, when open, with the mirrors making the necessary angle of 45 deg. with the horizontal, and also to prevent it from collapsing by its own weight, a tie-bar, shown in Fig. 3, will be required. This bar is drilled at one end and at the other a slot is sawn and filed out; the slot is to fit over a special pin which will take the place of an ordinary rivet. This pin is sketched at the left-hand lower corner of Fig. 3; it could be filed up from a brass, round-headed wood screw. Where, on the opposite side to the special pin, the tie-bar is pivoted, a longer rivet will be used in order to include this bar.

Before riveting all the parts together it would be advisable to see that the rivets are an easy fit in the holes, and before putting in the rivets to smear grease over the ends of all the bars, where they will rub together, so that after closing over the rivets the joints will all slide easily. Closing over should be done by many light taps with the rounded end of a ball-peen hammer, rather than with few heavy blows; for the closing over is necessary chiefly to prevent the rivet from coming out again.

The whole periscope can be finished in dead-black lacquer and, finally, the mirrors dropped into the end plates and the small lugs bent over to secure them.

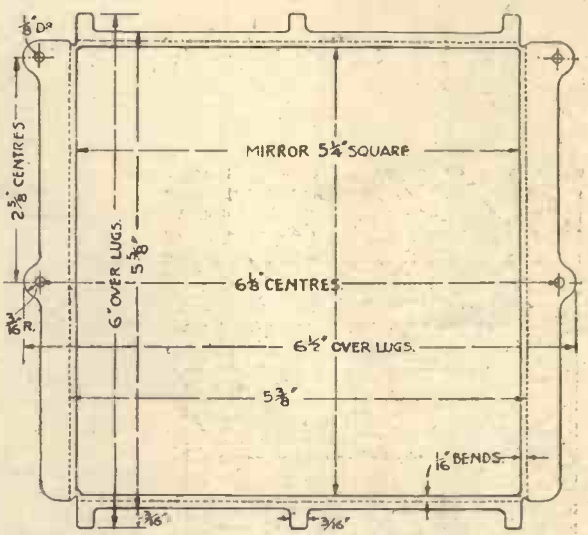


Fig. 4.—Outline of one of the mirror plates, before bending.

In the drawings of both of the periscopes the figured dimensions are arbitrary: they can be departed from and the instruments made larger, especially as regards length, if it is thought advisable; the wooden instrument, however, is tall enough to enable a child of ten to twelve years to see over the heads of adults of average height, and the all-metal one would be somewhat heavy and unwieldy if it were made bigger.

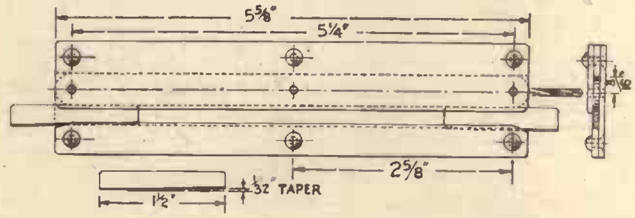
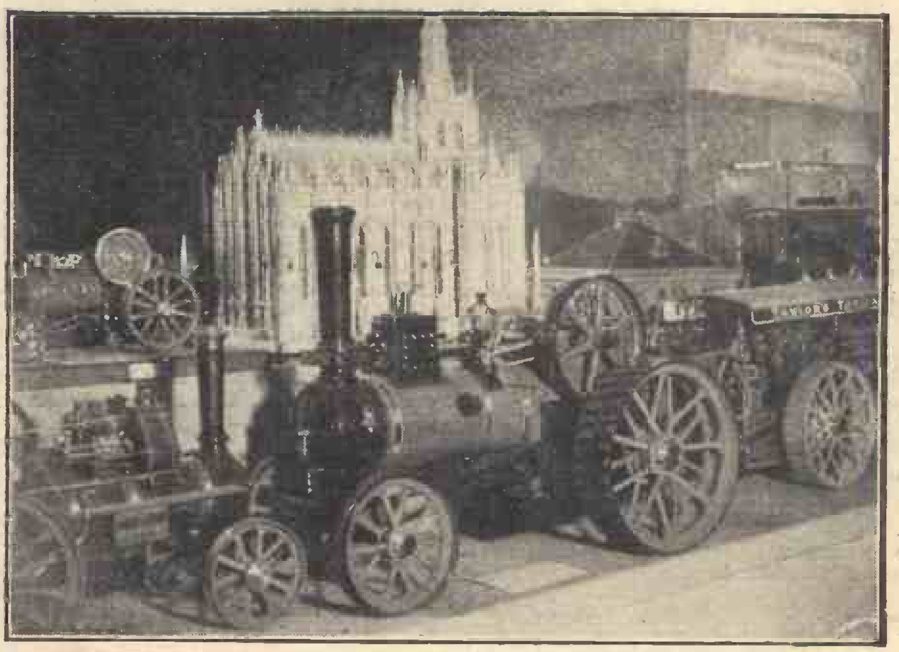


Fig. 5.—A drilling jig for the bars of the "lazy tongs" for the collapsible periscope.

Excellence in Model Making



This fine display of scale model traction engines was seen at the Model Engineer Exhibition, held at the Horticultural Hall, Westminster, last October. In the background is a model of Milan Cathedral, made from matches.

Using Sump Oil as Fuel

The "Oil and Water Method" With Details of a Suitable Burner for Use With Domestic Stoves

By F. EVANS, M.A. (Cantab.)

A burner using sump oil, fitted to a domestic boiler. Note. The water drip is not shown.

FOLLOWING on the method described in the January issue of PRACTICAL MECHANICS for using old engine sump oil as a fuel for a heating stove, another way of doing so may interest readers. It is a method perfected in the Army during the last war, and burners improvised in the manner described below were successfully used in the field for a variety of purposes; with heating plant, for raising steam in the small boilers of disinfectors, for heating water, and for cooking. The oil, in this method, instead of being vaporised by previous heating, is atomised by the addition of water in the correct proportion, well distributed throughout the oil.

Preparing the Sump Oil

Although of higher flashpoint than the fuel oils, used lubricating oils can, in this way, be employed for heating purposes in suitably designed burners. And burners can be made up in any metal workshop to measurements that will enable them to be fitted into existing stoves normally used for burning solid fuel.

No alteration of the usual types of solid fuel stoves in use is necessary as long as these are designed to have a rectangular opening at the bottom into which the burner can be fitted. If there are gratings above this opening they should, of course, be removed when the stove is burning sump oil.

Baffles of firebrick arranged inside the stove, as described in the previous article, will add to the efficiency of the fire.

The burner described in this article will permit either oil, with the burner in position, or, when the burner is removed, solid fuel alone to be used in the stove.

Before discussing the principle of the simple burner illustrated, it is necessary to say how the used oil should be prepared for use as a fuel. It is likely to contain solid particles and also a proportion of water. Fig. 1 shows how the oil should be strained through a gauze sieve at the top of the storage tank, which should preferably be tall in shape rather than squat.

Two taps should be inserted in this tank, one at the very bottom, and one about 6in. above it. This bottom tap is to enable the water which, after an hour or two, will accumulate at the bottom of the storage tank, to be drawn off occasionally. From the upper tap, therefore, oil free from both solid particles and water can be drawn as required, the accumulated water being drained off periodically.

The Burner

The burner is a simple rectangular venturi which, at its narrowest point (where the oil burns) is about ¾in. above the bottom of the burner, and as wide and tall as the particular burner concerned, which has been made to fit the stove.

There are two methods of making this venturi. One is shown in Fig. 2, where a V-shaped plate is fitted inside the burner casing, this having a row of 1/10in. or ⅛in. holes drilled along the bottom, and a row of similar holes on each side of the apex of the V, and about ½in. above it. A row of 1in. holes is drilled along the middle of the inner side of this plate; this is to enable any flame or gases generated inside the V-shaped piece to escape into the stove.

A simpler and equally effective method is to place a venturi plate or diaphragm across the burner, as shown in Fig. 3, this having a ¾in. vent at the bottom and the holes drilled as shown.

To provide an extra air supply when the burner is going well and very hot, between the oil and water feed pipe and the stove, a row of ⅜in. holes is drilled across the top of the burner casing, which is capable of being covered or uncovered at will by a sliding collar of sheet iron slotted to pass the vertical feed pipe. These holes should be kept covered when the fire is being lighted. When the fire is going strong they can then be uncovered, to supply the extra air.

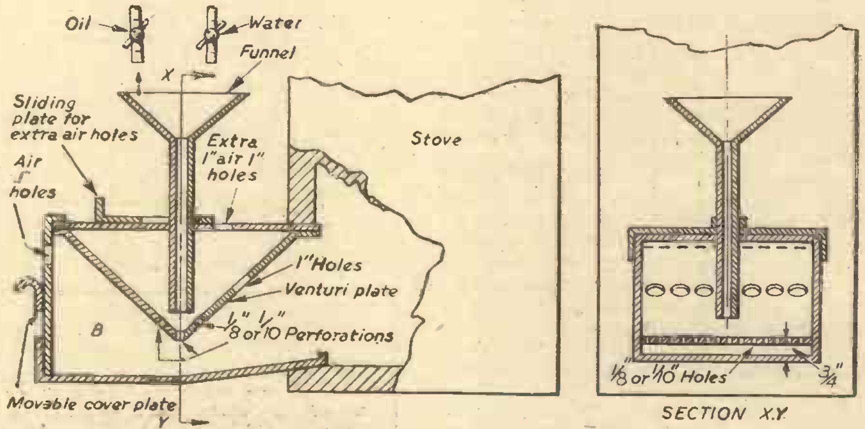


Fig. 2.—Sectional views of a venturi burner for using waste engine sump oil by the oil and water method.

Oil and Water Feed

Tanks with taps to hold the cleansed oil and the water are necessary, and must be arranged to give drip feeds, which are to be visible for ease of supervision and control. The proportion of oil to water is about 3 to 1, and the idea is that the water is dripped on to the oil as it flows into the burner, so that the globules of water are *evenly distributed* over the oil and carried upon it by surface tension into the burner. This can be done by dripping the oil and water directly into a funnel, or by an arrangement shown in Fig 4 whereby a sloping ½in. pipe, cut horizontally in half, forms a trough into which oil is dripped at the top end and the water lower down. A good method of distributing the water very evenly throughout the oil is to plug a piece of string into the end of the water tap and lay the other end in the stream of oil, the

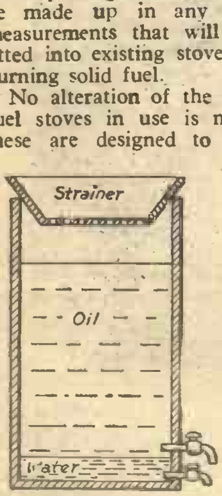


Fig. 1.—Section of an oil cleanser.

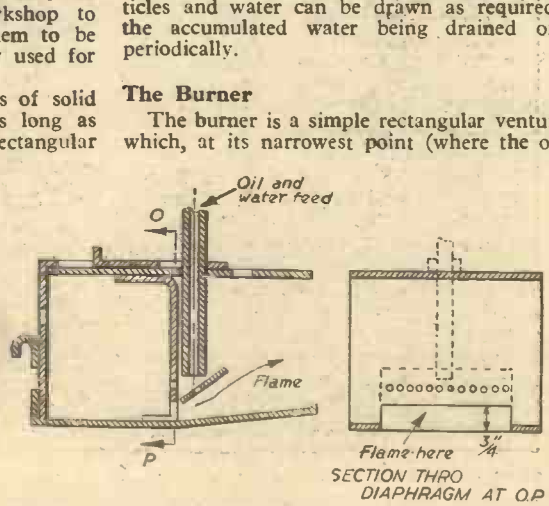


Fig. 3.—Sectional side view and cross-section of a venturi burner.

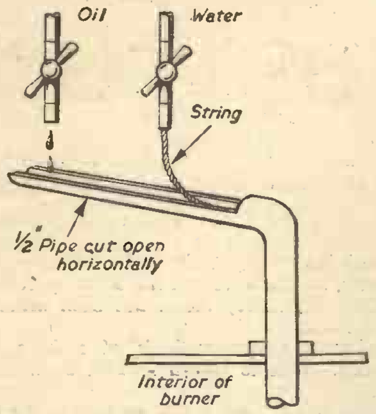


Fig. 4.—Details of oil and water feed.

drops of water soaking down along the string by capillary attraction.

With the feed taps shown in Fig. 2, the flow of oil from a particular setting of the tap will progressively be reduced in volume as the level of the oil or water falls in the tanks. That is obvious, but in practice, under supervision, this defect is not of crucial importance. However, it is quite easy to make a supply tank to have a continuous rate of flow. The "chicken feed" method (Fig. 5) shows how this can be done. The pipe should obviously be a soldered airtight fit in the tank. It is important, however, that such a tank should have a completely airtight filler cap at the top, so that atmospheric balance is maintained.

Lighting the Oil Fire

To light the burner, a piece of oily cotton waste or paraffin soaked rag is placed in chamber "B" (shown in Fig. 2) and set alight. The flame from this will heat the venturi plate and the metal of the shallow oil trough. After a minute or so the metal ought to be hot enough to "flash" the oil, and then the tap is turned to allow a thin stream of oil to run visibly into the burner. If the oil does not flash at once, it should be turned off and some more oil-soaked rags or cotton waste burned at "B." Wool rags are not so suitable as cotton as they tend to cake.

Once the burner is hot enough, the oil, distributed through the row of perforations into the narrow space over the shallow trough, will burn freely, and the venturic shape of the air intake will cause the flame to roar into the stove beyond.

At this stage, a trace of water (one part water to three of oil) should be added. This can be done when all the metal parts are extremely hot and the oil is already burning freely on its own. The effect of the water is that in contact with the hot metal it changes violently into steam which, in its "explosion," atomises the oil around even more completely than before. The result is an extremely hot and bright smokeless flame. The difficulty is getting metal that can stand up to such temperatures for a fair period of time.

This oil and water mixture is a little tricky to handle, but it is a very efficient method of using sump oil as a fuel. It is essential that all flues and chimneys are swept clear of soot before the oil and water burner is installed and lit, otherwise there is danger of the soot being set alight since the flame is very hot.

Further Points on Construction and Use

Though cast iron would be the ideal, the burner could be constructed of ⅛in. mild steel welded into place, the whole being made to fit rather tightly on a taper into the bottom opening of the particular stove for which it is intended. The whole burner should tilt slightly towards the stove. Metal of ⅛in. gauge, however, tends to burn out after a time and to pucker in the great heat that is generated. A sturdier burner would be desirable, but, as a prototype, ⅛in. welded sheet mild steel would do. Note should be taken that the venturi plate is bolted or otherwise fixed into position fore and aft, to enable easy replacement. It is an advantage to pack the burner on the outer sides with bricks, so as to protect it from violent draughts and conserve the heat. The venturi plates should be easily removable, to permit of cleaning the burner, and for clearing the holes in the venturi plates.

The rate of oil consumption depends on the size of flame maintained, but it cannot be reduced below an optimum, otherwise the cooling effect of the air current would cause the burner not to be hot enough to flash the oil. One gallon an hour—an oil stream about as thick as a large pin head—will give a first-rate fire, but a consumption much below about three-quarters of a gallon per hour is not, in the writer's experience, practicable. But that was for out-of-door installations.

A loose iron plate covering the whole of the air intake of the burner is an advantage. This should be made so that the air enters through a narrow slot or row of holes *at the top* of the venturi air intake.

Points to remember are:—

(1) Oil should be absolutely free from water and solid impurities.

(2) An absolutely hot burner and trough should be ensured *before* the oil is gently run in.

WARNING

A final warning hint is necessary. It is highly inadvisable to doctor the high flash-point sump oil with oils of lower flash-point like fuel and diesel oils. The reason is that with a hot stove and burner, even when not hot enough to flash these oils, vapour may collect inside the stove and, when the burner is heated up again, this may explode and cause a back-blow.

For the same reason, paraffin and petrol, especially, should *not* be used to thin the oil. Fuel oils can be burned in this kind of installation, but they have the danger, with careless use, of causing accumulations of explosive vapours.

In cold weather, sump oil may thicken so as to reduce the rate of flow, and so tanks should be kept in a reasonably warm situation or insulated from the cold. The oil will soon thin down once the stove is going well.

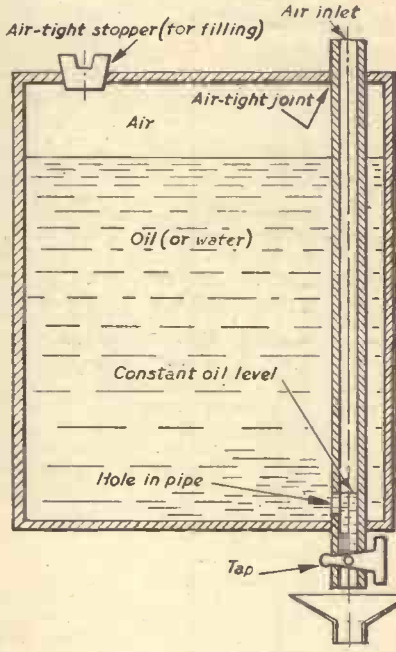


Fig. 5.—Section of tank for giving a continuous rate of flow for oil or water.

New Sea-crash Rescue Launch

The latest sea-crash rescue launch, a number of which are being built for the Royal Air Force—the fastest and most up-to-date craft of its type in the world—was demonstrated at Portsmouth recently. Our illustration shows one of the new launches putting out a fire on an object representing a crashed plane.

Further Notes on Electro-forming

Patterns, Conducting Coating, and Throwing Power of Plating Solutions

By E. R. H.

SINCE the article on "Metal Forming by Electro-deposition" was published in the December, 1952, edition of PRACTICAL MECHANICS, a number of letters have been received from readers raising queries regarding certain aspects of the process. Most of these seem to be concerned with the difficulty of obtaining a conducting surface on the master pattern. It is with a view to clarifying some of the points raised and explaining a little more fully how a conducting surface is obtained that the following has been written.

The Pattern or Master

It was stated that this could be of any suitable material which could be conveniently shaped to the desired form. In the case of a design which will not allow the former to be easily removed when the process is complete, for example where there are undercuts, it must obviously be capable of being melted out. Wax was suggested for this purpose, being cheap and easily obtained, but the pattern could be made of solder or Woods Metal. Solder would require the aid of a blow lamp to melt it, but Woods Metal will melt in hot water. Unfortunately, however, this material which is a mixture of 50 per cent. bismuth, 25 per cent. lead, 12.5 per cent. tin and 12.5 per cent. cadmium is somewhat expensive, but it may be considered for small objects. The main advantage of either solder or Woods Metal is that they are themselves conductors and do not, therefore, require to have a conducting surface to be formed on them. Immediate covering takes place when they are immersed in the plating bath.

Other suitable materials from which the pattern could be made are wood, plastics and plaster of Paris. With plastic materials it is important that they should be rigid and have a smooth, dry, non-oily surface. Vinyl based hot-melt compounds which are sold for moulding purposes are not suitable for electroforming.

Wood and plaster are, of course, porous materials and these must be rendered non-porous before they can be plated. This is best done after shaping, by immersing them in molten wax. The temperature of the wax should be just above the boiling point of water so that when immersed the water is driven from the pores and is replaced by the wax. The pattern should be left in the molten wax until all bubbling has ceased.

Forming the Conducting Coating

In the first article on electroforming it was stated that a conducting surface should be formed on a non-conducting pattern by brushing on graphite. It can be stated quite definitely that this is the most satisfactory method. It has been suggested by some that copper paint could be used. This belief that a metallic paint is conducting is a misconception which exists even in technical circles. In point of fact, it is not conducting at all due to the necessity for a paint to have a binder. Even if the metal content of the paint be high each particle of metal is separated from its neighbour by the binder, usually an oxidising oil. However, while grate polish was suggested as an easily obtainable graphite there are more suitable forms available which give a better conducting surface. These are marketed under the registered name of "dag" dispersions by Messrs. Acheson Colloids, Limited, of 18, Pall Mall, London, S.W.1, the most suitable being dispersion No. 574. Whatever form of graphite is used, however, it should be realised that the conducting coating still has a high resistance and immediate covering will not take place as soon as the article is placed in the plating bath. It grows instead slowly from the point of contact which must itself be immersed in the electrolyte. On a large article it may take all night for the pattern to become completely covered. If time is an important factor it can be speeded up by methods which, although given, are not really recommended as being worthwhile. One is to increase the volts across the plating bath to 2 or 3 volts, but this should be returned to the normal value of 1-1½ volts when the initial covering has taken place or a rough deposit will result. Another method is dusting the graphited pattern with iron powder, tapping gently to remove the superfluous powder, and pouring slowly some of the copper plating solution over the surface. The iron powder causes the copper plating solution to deposit a thin film of copper on the graphite and after careful washing in water the pattern can then be placed in the plating bath where the deposit will immediately commence to build up.

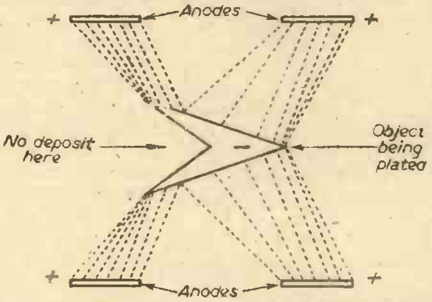


Fig. 1.—Showing how the current tends to concentrate at projections and leaving depressions with little or no deposit. (Dotted lines represent current flow.)

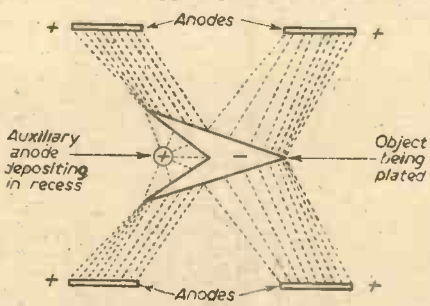


Fig. 2.—Showing how an auxiliary anode, suitably placed, enables a deposit to be produced in the depression.

Making Contact

Making contact with the graphited surface is a little difficult and is best done either where the wire marks will not show or else on a portion of the pattern where the deposit is not finally required. When the article is something with an open end such as a cover or housing, a brass rod can be screwed to this portion in the case of a wood pattern, or warmed and pushed in when a wax former is used. The graphite coating is then continued in the form of a strip right up to the brass rod. This can then form the connecting point as well as serving as a means of suspending the object in the plating bath. It should be remembered, however, that to enable the deposit to grow, the point where the graphite joins the brass rod must be covered by the plating solution.

Throwing Power of Plating Solutions

Whatever material the pattern is made from it should have an external form of the internal shape of the required object. This means, of course, that the pattern is always male. Female formations are to be avoided because of a difficulty met with in electroplating known as throwing power. By throwing power is meant the ability of the plating solution to deposit metal in cavities and right-angle bends, etc.

Fig. 1 shows what happens when an object containing points and depressions is placed in a plating bath. The points represent areas of increased current density and receive the deposit in preference to the depressions which receive little, if any, deposit. Different plating solutions exhibit this tendency to a greater or lesser degree. Nickel is one of the best metals for depositing into corners, and chromium is the most difficult. It is this very factor which makes chromium plating so troublesome to carry out commercially. Copper, however, is generally not too difficult to plate into recesses providing these are not too deep. To some extent this drawback can be minimised by means of what are called auxiliary anodes. These are separate small anodes suitably shaped and placed opposite the depressions. This is illustrated in Fig. 2.

It may be thought that a female mould could be plated by pouring the electrolyte into it and hanging an anode in the centre. This is true if we only require a flash covering such as in plating for decorative purposes, but this is not suitable for the thick deposits required when electroforming. This is due to the fact that the area of cathode surface will then far exceed that of the anode, and thick deposits will not be obtained under these conditions.

Due to this tendency for more metal to deposit on points, etc., a male pattern will obviously tend to receive a thicker deposit at sharp corners and projections. This can be overcome if desired by the use of "burners." These are auxiliary cathodes hung in the plating bath near the corners and projections. These have the effect of taking up the excessive current and help to produce a more even deposit. For convenience, they may be of the same metal as the anodes so that at some other time they may themselves be used as anodes and no metal is wasted.

Conclusion

Finally, it should be mentioned that although at the present time electroplating is a very specialised subject, and in commercial undertakings is controlled by qualified chemists, this was not always so. Most of the developments in electroplating were made by practical men who discovered the best methods by experience. Even to-day in spite of all the technical knowledge the best results are still obtained by the man who has learnt the subject by trial and error.

A LIGHT-WEIGHT CADDIE-CART

Constructional Details of an Inexpensive Accessory for the Golfer

By G. M. WHITE

This photograph of the caddie-cart in use gives a good idea of its simple construction.

IN the years following the last war caddies demanded such high wages that people looked around for other means of transporting golf clubs, and the caddie-cart came into being and, in spite of the scorn which was heaped upon the early models, it has now come into popular use by a large percentage of golfers, and the numbers are growing.

A practical caddie-cart demands the following: light weight combined with strength, wide track, some shock absorbing device, when fitted with clubs must be balanced, free running and weather protected.

There are two groups, i.e., permanently fixed models and either dismantable or folding models. The former naturally are much simpler and ideal for amateur construction, and the latter are more complicated and need extremely careful design and manufacture to be able to withstand strains imposed during progress on the golf course, so much so that very few of the commercial types are entirely successful.

The caddie-cart described below is a fixed, tubular type, which fulfils all the above demands and is simple, having only a few easily made components.

Main Casting

The first part required is item No. 3, an aluminium bracket which clamps the main body, item No. 1 to item No. 2. This may be cast in aluminium alloy at your local foundry. A wooden pattern split on the centre line (see Fig. 1) will be required, allowing 1/16in. all over for shrinkage, and having a slight draft so that the pattern may be withdrawn from the sand.

With the casting to hand, we now require two 1in. dia. holes bored as indicated; the second hole must be bored square with the first one. Alternatively, the holes could be produced by pilot drilling and counter-boring, with an inserted bit counter-bore; a good push fit is required.

The four ¼in. clearance holes are now drilled, clearing the bore by about 1/16in. and spotfaced at both sides so that the bolt head and nuts and washer sit flat; all that now remains is to split the casting into the bores, as shown. The writer used a power hacksaw blade to give a ⅛in. gap.

Bending the Tube

We now require some method of bending the 1in. duralumin tubing. If the reader is on good terms with the plumber he will, perhaps, let you use his "bender." The writer made up a simple "bender" as follows: a piece of oak, 15in. x 6in. x 3in., was obtained and a 4in. radius was formed on one end. A ⅝in. hole was drilled at the centre of radius, being careful to keep this square with sides. Next, a 1in. dia. half-circular groove was produced along the top and round radius, by first sawing and chiselling and finishing with a router; care must be taken to keep the groove to 1in. wide and no more, otherwise the tube will be squashed oval when bent. A 3in. dia. by 3in. long cast iron roller was drilled ⅝in. dia. through centre, and a 1in. dia. half-round groove was machined round the circumference. Two 1½in. x 1in. x 48in. steel arms were clamped together and drilled ⅝in. dia. 1in. from each end and again up from one end to give 5½in. centres from the end hole, with arms parted and placed either side of the oak block, and with ⅝in. bolts in all three sets of holes. The bottom bolt passes through the oak block, the next through the C.I. roller, and the top one through the distance piece, held between arms to act as a handle. Another oak block, 3in. x 3in. x 12in., with a similar 1in. dia. half-round groove acts as a top clamp

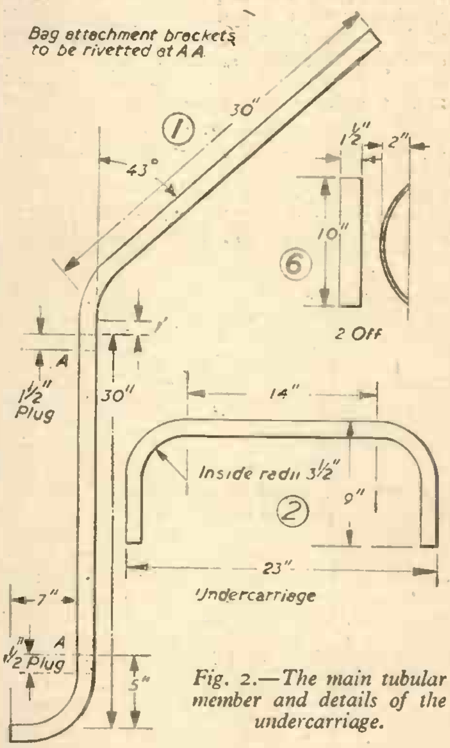


Fig. 2.—The main tubular member and details of the undercarriage.

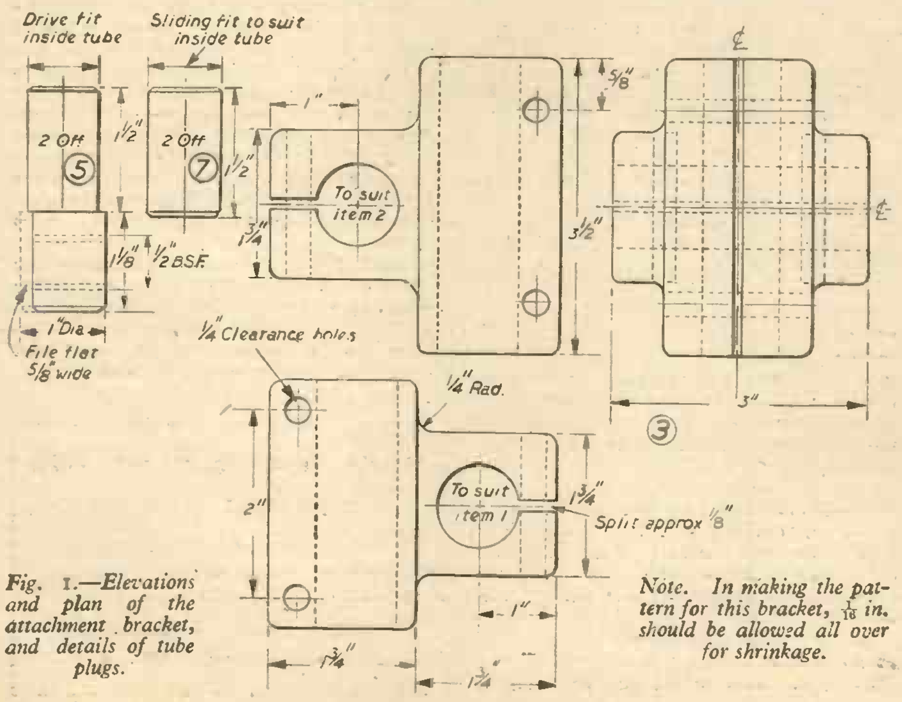


Fig. 1.—Elevations and plan of the attachment bracket, and details of tube plugs.

Note. In making the pattern for this bracket, 1/16 in. should be allowed all over for shrinkage.

MATERIALS REQUIRED

Item	Amount or No. required	Material	Use
No. 1	5ft. 6in. x 16 s.w.g.	1in. duralumin tube	Main body
No. 2	3ft. 0in. x 16 s.w.g.	1in. duralumin tube	Undercarriage
No. 3	1	Aluminium alloy casting	Attachment bracket
No. 4	2 off	1½in. x ⅛in. x 10in. duralumin	Bag attachment clip
No. 5	2 off	1in. duralumin bar x 2⅝in.	Axle tube plugs
No. 6	2 off	⅛in. x 1½in. x 10in. duralumin	Bag attachment plate
No. 7	2 off	⅞in. duralumin bar x 1½in.	Main tube plugs
No. 8	2 off	12in. x 1½in. wheels with B/B hubs, fitting Holomatic 1¼in. tyres and ⅝in. axles with 1¼in. blank arms	

Item Nos. 1, 2, 4, 5, 6, 7 may be obtained from S. C. & Metal Sales Co., 4-6, Token Yard, Putney High Street, London, S.W.15.
Item No. 3 from local foundry.
Item No. 8 Geo. Hughes, Ltd., Edgemont Avenue, Birmingham, 24.
Handle grip and bottom rubber Halford Stores.

block. The whole contraption now needs clamping to a solid bench, or long batten, or anything that will stand up to a good "pull"; this will easily bend the 1in. duralumin tubing.

A start should be made on the 90 deg. bend on item No. 1, but before any duralumin may be bent or formed it must be "normalised." A rough and ready method which will serve in this case is to coat the metal with washing soap, and apply heat by gas or blow-lamp till the soap turns brown and then black; when this stage is reached quench in cold water; the duralumin will stay "normalised" for about 15 minutes only.

After "normalising" the tube, plug one end with a hardwood plug and fill and ram hard with dry sand, and insert another plug

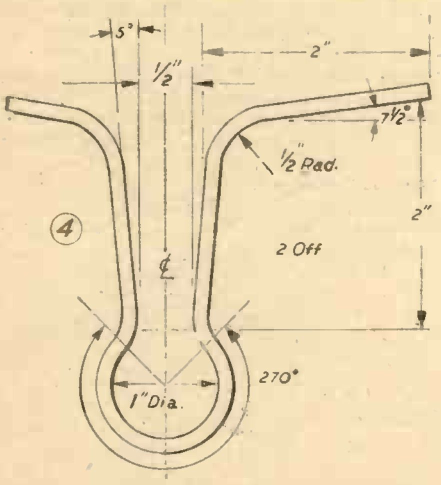


Fig. 3.—Details of the duralumin clamping strip.

in the top. A pencil mark 9in. from the end is placed at exactly the beginning of the radius, i.e., up vertically from ⅜in. pivot hole on bender, and the top clamped and handle pulled down till tube assumes a 90 deg. bend.

Item No. 2, one end only, is done similarly, except that the pencil mark is made 11in. from the end. At this stage slide the alloy bracket (item No. 3) with the longest bore on to item No. 2 and push right up to 90 deg. bend. Make another pencil mark 14in. from the first one and complete the second bend, watching that the two legs will line up. The aluminium bracket may now be centralised. Two 1½in. long plugs turned to a push fit inside the tube (item No. 1) are now required, and also one sub-assembly of items 4 and 6; the plugs are to prevent the tube collapsing when riveting the sub-assembly on.

Assembling

Push one plug down tube No. 1 till its top reaches 5in. from top of 90 deg. bend, as shown in Fig. 1, then the sub-assembly for the golf bag holder can be slid on and riveted with two ¼in. duralumin rivets. The long tube is now slid into the bracket (item No. 3), and pushed through until the bracket reaches approximately 9in. from the 90 deg. bend. The second plug can now be inserted and pushed down till its top comes 25in. from the top of first plug, and a slight indentation with a blunt punch made on each side plug to prevent it moving whilst the next bend is being made. Now slip on the second sub-assembly.

Put the long tube in the bender (after normalising) with 90 deg. bend, pointing upwards and with pencil mark 1in. above the top plug a bend is made till an angle of 43 deg. is reached (Fig. 2). A cardboard template helps here. The second sub-assembly may now be fitted over the top plug and riveted as before.

This sub-assembly consists of item No. 4 and item No. 6. To produce item 4 (Fig. 3) we require ⅛in. duralumin, 1½in. wide and 10in. long. After normalising, form round a 1in. mandrel into the shape of a long-legged U, and, while still held in the vice, drop in between the legs and on to the mandrel a ½in. steel plate and clamp tight with a G clamp. Now with a cross-peen hammer force the material still farther round the mandrel till it is in contact for 270 deg. This ¾ encirclement serves a definite purpose so it must be attained. The legs of the U must now be formed round the 1in. bar to form the wings, set at approximately 7½ deg.

Item No. 6 is formed from ⅛in. x 1½in. x 10in. duralumin and may be pulled round in the vice till a 2in. deep curve, or chord, is obtained.

Attachment to item 4 follows. First clamp the ½in. plate between legs of 4 again, and place item 6 equidistant about the centre line and rivet one wing only with 2 aluminium 3/16in. x ⅜in. round-head rivets. Predrilling of two other holes in wing of item 4 only follows.

On assembly to main tube the cramp is used on the legs, but without the ½in. plate, and held thus while riveting to the tube and plate; this tightness and 270 deg. grip on tube gives the strength required for bag holders.

Rubber Straps

The straps with which the golf bag is retained are of rubber, and were obtained from the local garage. The material is scrap flap, taken from the well of a lorry rim; it will be about 5in. wide and may be split down the middle, thus giving two straps, both being fixed to faces of item 6 (thick edge of flap just overlapping top edge of plates), with strips of 18 s.w.g. by ½in. wide aluminium at each end, one flat-headed copper rivet going through the strip, rubber, duralumin plate, and strip at the back, fitted with washer and hammered over. Where the rubber leaves the duralumin plate at each end, the rubber will have to be tapered down to 1in. wide, 9in. on the buckle side and 16in. on the other side. The buckle is attached with a dab of Bostic and a bifurcated rivet. A leather punch will make the holes.

Item No. 5 is made from 1in. duralumin bar, turned

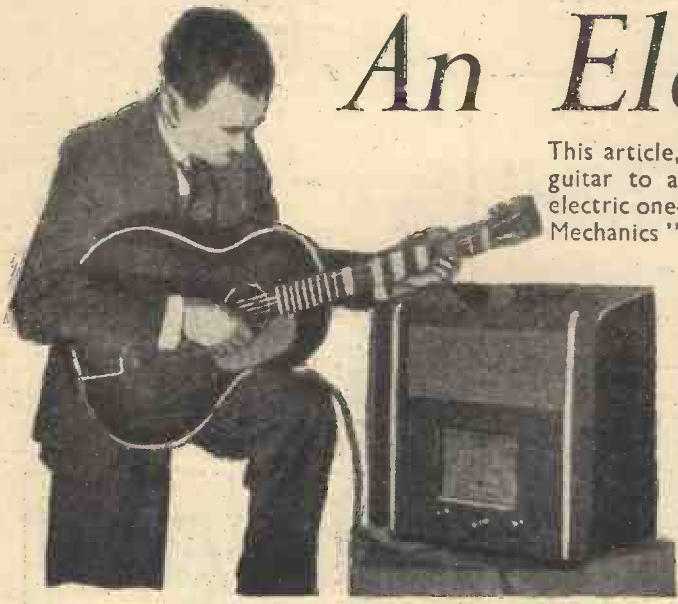
The completed caddie-cart.

down for 1⅝in. to suit the bore of tubular undercarriage; a flat is filed on the 1⅛in. portion, ⅜in. wide to give seating for axles, and tapped ¼in. B.S.F., as shown in Fig. 1.

When ordering wheels ask for axles with ⅝in. x 1¼in. blank arms; these are turned down for 1in. to ¼in. dia. and screwcut ¼in. B.S.F. Screw into item 5 and peg with ⅛in. stainless rod. Insert item 5 into ends of undercarriage so that they line up with each other sticking outwards, then rivet through the tube with 3/16in. duralumin rivets.

A rubber cycle handle bar grip is pushed on bottom of main tube to protect the bag, and a motor-cycle twist grip rubber is fitted to handle.

To complete, put the golf bag in place and strap on, and position tube attachment bracket 9½in. above bottom bag holder, so that only the slightest weight is felt when held in towing position. Finally, insert four ¼in. x 2in. Whitworth bolts and nut up tightly.



An Electric Guitar

This article, dealing with the conversion of an ordinary guitar to an electric one and the construction of an electric one-string fiddle, was first published in "Practical Mechanics" in March, 1943, and is reprinted here in response to readers' requests.

PRIOR to the introduction of electric guitars to this country by, I believe, the popular American exponent of the guitar, Ken Harvey, several systems had been developed for the production of musical tones by electrical or electro-magnetic means, but none of them appears to have had any lasting success.

It was with the full understanding of the thermionic valve that came the inventions of the Trautonium by Dr. Trautwein, the Hellertion by B. Helberger and P. Lerts, the Sphærophone by J. Mager who, incidentally, was one of the first scientists to investigate the subject, and, as far back as 1929, the noteworthy work by an Englishman, J. Compton. The latter applied for patents connected with what is best described as an "electro-mechanical" system for the production of musical sounds, as against the general use of the properties of a valve as an oscillator by the other investigators. It is the electro-mechanical system which is now widely used in conjunction with stringed instruments and certain electric organs.

All of the early valve arrangements suffered from the inability to produce chords or a series of tones at a given instant; they were purely "single note" instruments, and a good example in this class, and one which has been heard a great deal in this country, is the Theremin—invented by Professor Theremin—which makes use of two oscillators to produce an L.F. oscillation equal to the difference between the frequency of the two oscillators; the range of musical tones being governed by varying the capacity of one of the circuits by movement of the player's hand with relation to a small rod which projects from the instrument.

In all the purely electrical arrangements, the thermionic valve was not used only as a generator of musical frequencies; it was also employed to amplify such oscillations to the desired audible volume reproduced via loudspeakers.

Electro-mechanical Methods

If a coil of insulated wire is placed around a pole-piece of a permanent magnet, and if by some means the magnetic field about the pole-piece is disturbed, an electric current will be created in the coil. The strength of the current will depend on various factors; briefly, the number of turns of wire forming the coil, the strength of the magnetic field and the intensity of its disturbance. The frequency of the current will have a direct relationship with the frequency of the disturbance.

A Simple Example

One of the simplest applications of string instruments is shown in Fig. 1, which depicts an "electric" one-string fiddle, which, incidentally, is ideal for demonstrating the basic principle of the electro-magnetic system.

The body "d" is a strip of hardwood approximately 3ft. x $1\frac{1}{2}$in. x 1in., the two points "a" and "b" form the anchoring posts for the steel string "s," which passes over the small bridge "c." To allow the tension of the string to be adjusted, "a" is peg-shaped, and can be rotated in a similar manner to those used on many stringed instruments.

The assembly is a skeleton one-string fiddle; if it is played with a bow the volume of sound produced would be on the low side as no sounding board, box or horn is fitted. By using the electro-magnetic system these normally essential features can be ignored, as one is not concerned with the production of sound but with the conversion of the vibrations of the string "s" into electrical currents of identical frequency. The conversion is obtained by utilising the simple electro-magnetic assembly shown in Fig. 2, which for simplicity we will call the "unit"; its position, with relation to the string "s" and the bridge "c" is indicated by "u" on Fig. 1. Reference to Fig. 2 will make clear the construction of the unit; "u" is a permanent magnet of the "U" pattern, its approximate dimensions being 2in. in length, $1\frac{1}{2}$in. in width, and a cross-section of $\frac{3}{8}$in. x $\frac{3}{8}$in.

To provide a concentrated magnetic field in the area of the string, and a means of mounting the coils "e" and "f," two extension pieces have to be made. These are cut from transformer laminations, or $\frac{1}{2}$in. x 3/16in. soft iron strip, the latter being bent to form the "L" shaped pieces as shown in Fig. 2. After filing the horizontal portions to fit the coil bobbins, a tight push fit being required, the pole-pieces are secured to the ends of the magnet by means of $\frac{1}{4}$in. square brass rod and two—one each side of the magnet—brass bolts. This method of fixing was necessary for the experimental model owing to the fact that the magnet used did not have any holes drilled in it at convenient positions.

The gap "g" is approximately $\frac{1}{8}$in., and the units must be fixed to the body of the fiddle so that the string passes along the centre of the gap and parallel to the faces of soft iron pole-pieces.

Fixing the Unit

There are two methods of fixing, depending on the shape and size of the body. If a plain strip of wood is used it is best to shape it so that it is a tight fit between the arms of the "U" magnet and brings the string in the correct position. If over-size holes are then drilled through the wood, the clamping bolts can pass straight through, provided short lengths of metal tube are cut to act as distance pieces between the inner faces of the brass clamping pieces and the outer surfaces of the wooden body, and slipped over the clamping bolts. The over-size holes allow final adjustment to be made.

An alternative and, I think, a better method, is that which was used for the second model I made. For this a commercially produced one-string fiddle of a well-known make was used, which had a much deeper body at the bridge end to allow for the fixing of the horn and knee grips (Fig. 1).

This permitted a slot being cut in the

Note:—For experiments a strip of wood may be used for the one-string fiddle.

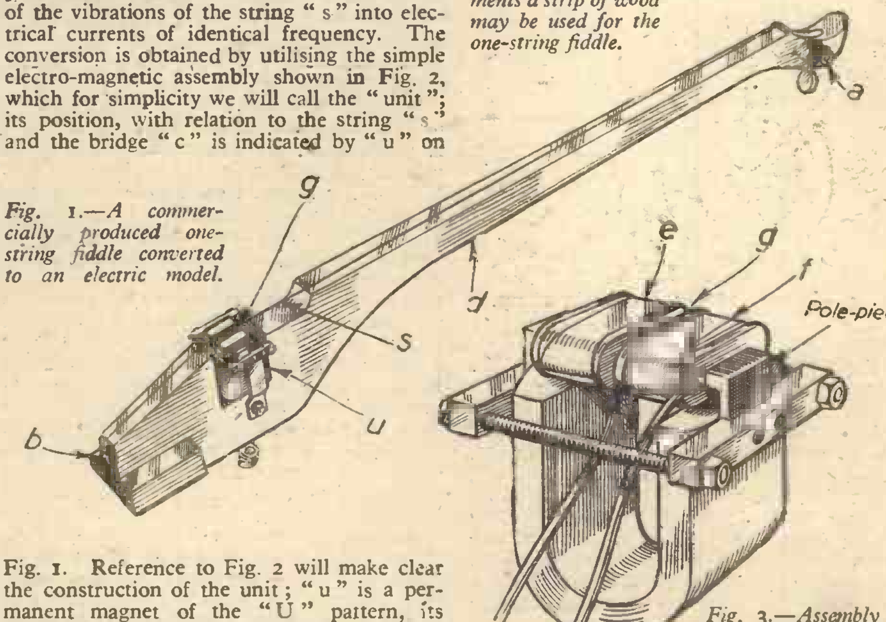


Fig. 1.—A commercially produced one-string fiddle converted to an electric model.

Fig. 3.—Assembly of the electro-magnetic unit, showing how pole-pieces are clamped to the magnet.

body to accommodate the "U"-shaped magnet and bring the horizontal pole-pieces in their correct position for the string. The unit was securely held on each side by means of two strips of brass which were fastened to the brass clamping pieces and screwed to the wooden body. See Fig. 2.

The two coils "e" and "f" were taken out of an old moving-iron loud-speaker having a resistance of 4,000 ohms., i.e., 2,000 ohms for each coil; they were connected in series on the unit and one wire from each was taken to the input terminals of an amplifier.

The Guitar

After completing the electric fiddles, which, incidentally, originated from an assembly made solely to provide a wide range of L.F. frequencies for amplifier and speaker testing, I decided to make an electric guitar. As tonal response and volume of sound did not matter, I secured a cheap Spanish type of guitar and set about converting it to an electric model. Unlike the one-string fiddle, the electro-magnetic system had to embrace six strings and this presented quite a problem as a uniform magnetic field around each string was really essential for best results. Experiments revealed that it was possible to use one magnet and one large coil or two magnets and one or two coils, but I was not satisfied with the response obtained from all the six strings individually and collectively. Eventually I devised the system shown in Fig. 4, which provides a pole-piece and coil for each string, thus ensuring a much more faithful response and uniform output during all styles of playing.

The completed instrument was very satisfactory, so much so that I decided to invest in a hand-made 20-fret, Hawaiian-Spanish guitar made by John Grey. The fitting of the unit entailed cutting the belly of the instrument, and I admit I was a little apprehensive about touching the beautifully finished woodwork. However, I need not have worried as the appearance of the guitar was in no way marred by the fitting. The orginal electro-magnetic system was used in principle but modified and improved in detail.

The Magnetic System

The permanent magnet was again of the "U" pattern, its dimensions being 3 3/16in. in length, $2\frac{1}{4}$in. in width, and a cross-section of $\frac{3}{4}$in. x $\frac{5}{8}$in. It was produced by Darwins, Ltd., Fitzwilliam Works, Tinsley, Sheffield, and I understand it was then a stock shape. Near the top of each arm of the "U" was a 3/16in. hole which simplified matters considerably as regards fixing the additional pole-pieces, as it is impossible for an amateur to drill the magnets.

The six pole-pieces were made in two sets of three, and were designed to fit on top of the extremities of the "U" of the permanent magnet as indicated by Fig. 4. the original sets were cut from the solid, the material being mild steel, and then riveted to their bed-plates "C," which were cut from a piece of 1in. x 1in. angle-iron, each being 2in. in length. Accurate marking off is essential, otherwise the pole-pieces will not line up with the strings of the guitar and/or it will be found impossible to slide on the coil bobbins. The distance between pole-pieces shown in the diagram seems unversal, but it would be as well to check the string spacing of the guitar under consideration, before marking off the metal work. An alternative system of construction is shown in Fig. 5. The points for the pole-pieces are marked off on a small iron strip $1\frac{1}{2}$in. x $\frac{1}{2}$in. x $\frac{1}{8}$in., and the small slots "D" cut. The pieces for the pole-pieces which, incidentally, can be made out of the waste cut from the angle-iron during its shaping, are provided with a tongue "E," so dimensioned that it forms the male fitting for the slot. When located, the tongue is riveted over, care being taken to see that the pole-pieces are at right angles to the strip. The completed parts are then riveted to the bed-plates as in the other method.

The fixing of the completed assemblies to the magnet is by means of the portion "A" and the hole "h" which lines up with the hole in each arm of the magnet, a suitable bolt being used to secure the parts. The hole "B" in the bed-plate is tapped, say, 4 B.A., and takes a $\frac{1}{2}$in. round-headed nickel-plated bolt, which, in conjunction with the top plate (see Fig. 6), secures the complete unit to the belly of the guitar, but more about that later.

One important item to watch when fixing the pole-piece sections to the magnet is the need for the bed-plate to bed right down on the surface of the magnet. No gap or unevenness must exist between the two faces otherwise the flux density at the tips of the six pole-pieces will be reduced considerably.

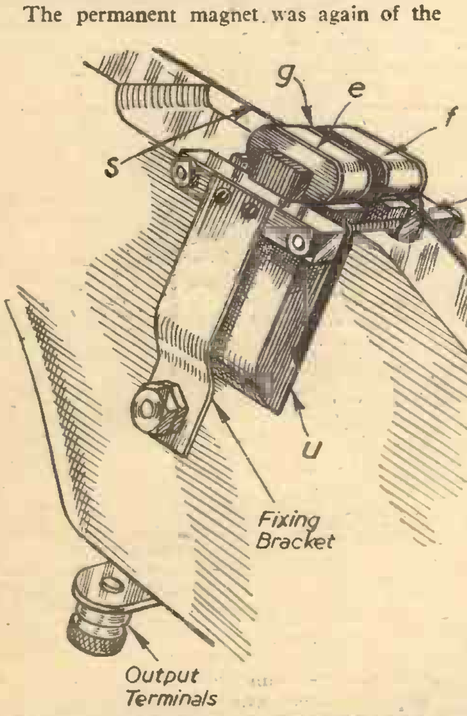


Fig. 2.—An enlarged view of the unit fitted to the one-string fiddle. Note the method of fixing.

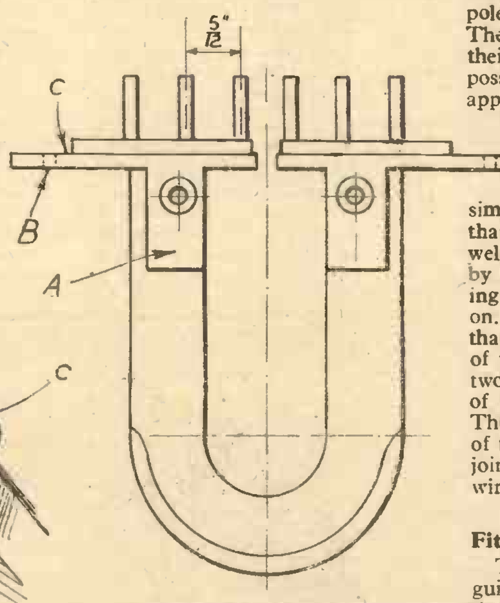


Fig. 4.—The magnetic unit for the six-string guitar. The additional pole-pieces are assembled and then bolted to the magnet.

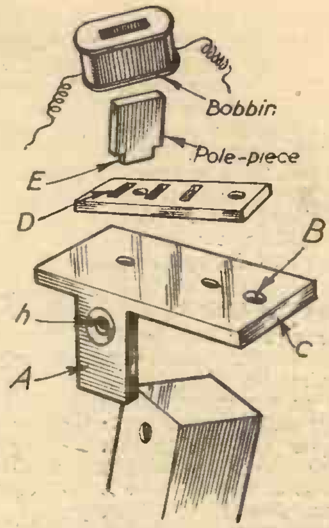


Fig. 5.—An alternative method of constructing the sets of three pole-pieces.

The Electrical Section

A coil is needed for each pole-piece and the more turns of wire used in its construction the better. The limiting factor, however, is the small space between each pole, but the writer was able to secure a number of moving-iron L.S. bobbins of the 1,000 ohm type, which satisfied requirements as regards width and efficiency.

The pole-pieces have, of course, to be made to suit the bobbin hole or slot; therefore, before shaping these parts it is advisable to secure the bobbins first, otherwise the pole-pieces might be too large or too small. The cheeks of some bobbins project beyond their coils; in such instances it is often possible to utilise what at first sight might appear to be oversize bobbins, by carefully rubbing down the cheeks, provided the winding is not damaged.

Before and after placing the bobbins on the pole-piece, apply simple continuity test to make quite sure that the windings are intact. If all is well, they are then connected in series by neatly soldering the end of one winding to the start of its neighbour and so on. See that all joints are insulated so that they cannot short-circuit through any of the metal work. When this is completed, two wires will remain unconnected—the start of the first, and the end of the last bobbin. These form the connections for the output of the unit, and they should be lengthened by joining on about 18in. of flexible instrument wire or even fine twin twisted flex.

Fitting to Guitar

The following figures are given only as a guide, as many of them will be governed by the size of the bobbins used and individual construction. With the assembly described, the aperture shown in Fig. 6 was cut in the belly of the guitar, about a centre line parallel with and $\frac{7}{8}$in. in front of the bridge of the instrument. All the strings were removed and, after lightly scribing the required outline, the wood was cut out by drilling a series of $\frac{1}{8}$in. holes around the inside of the outline. To avoid possible splintering of the polished surface, it is a good plan to go over the scribing lines before drilling with a fine, sharp cutting edge, just to sever the top surface and the grain of the wood. With a sharp chisel, it is then possible gradually and carefully to cut through material between the holes and, eventually, square up the opening thus formed. Do not exert undue pressure during any of the above operations, otherwise there is danger of cracking the belly.

The top-plate can be cut out of $\frac{1}{8}$in. aluminium, or, if nickel-plating can be done, brass. Bevel the outside edges and drill the fixing holes to line up with those "B" on the bed-plates "C." The top-plate can, of course, be used as a template for marking out the opening and locating drilling holes on the belly. Make the holes slightly oversize, to allow final line-up adjustments to be made.

Getting the Unit In

The circular hole in the belly of the guitar is, approximately, 3$\frac{3}{8}$in. in diameter on my model, but it did not allow any too much room for the unit to pass through. This is a point to be watched, as if the hole is smaller, then it would be advisable to use a shorter magnet.

Before fitting the unit, the twin leads from the bobbin assembly are soldered to a single-circuit jack and this is fitted into a suitable hole drilled in the foot or side of the instrument.

With a little manipulation the unit is fitted into the interior of the instrument. Bring the pole-pieces and bobbins up through the aperture and, with the other hand, place the top-plate over the bobbins and pass one of the round-head nickel-plated bolts through one hole in the plate, the belly and, after locating it, one of the holes, "B," in the bed-plate. Do not screw it right home; just a thread or two will be sufficient until you get the other screw through the other end. Tighten both gradually, making sure that the unit comes into the required position.

The strings and bridge are then refitted and, if all is well, the tips of the pole-pieces will be exactly underneath their respective strings and approximately $\frac{1}{8}$in. below them. After tuning, the electric guitar is ready for connection to an amplifier.

Amplification

To obtain the true advantages offered by the electro-magnetic system it is essential to use a first-rate amplifier and loudspeaker, otherwise tonal qualities and faithful reproduction will be far from satisfactory.

What wattage output is required from the amplifier? This is a question which must be answered by the player according to his requirements. For example, for solo and normal playing in a room of average size one would require far less output than the player in a dance band performing in a large hall. I have obtained ample output for home use from an amplifier having a rated output of three

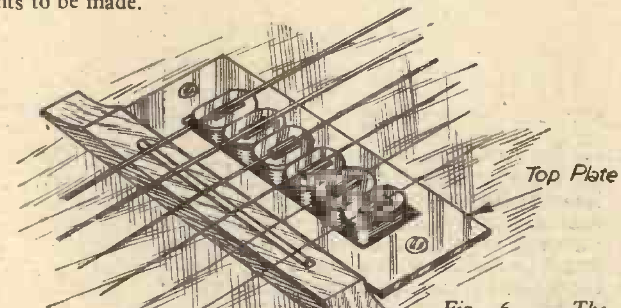


Fig. 6. — The completed electro-magnetic unit fitted to the guitar.

watts; on the other hand, I have had my guitar played in a super-cinema (by a musician) with only a 5-watt amplifier and the volume was quite sufficient. Something around these figures, therefore, appears to be the required value, although, of course, for dance band work one must bear in mind the background noise of the dancers, etc., and the size and acoustic properties of the hall.

I would recommend resistance-capacity coupling with two triodes in push-pull (class A) in the output stage, two stages of voltage amplification preceding the P.P. arrangement. A good make of permanent magnet speaker is advisable as it dispenses with energising leads and gives greater latitude as regards its location.

A 0.5-megohm volume control can be connected across the output from the unit and, if so desired, mounted on the guitar within easy reach of the right hand. An alternative arrangement is to make the volume control foot-operated and with this method it is not difficult to arrange the operating device in such a manner that the tremolo effect, normally associated with organs, can be obtained by a slight motion of the foot. Similarly, a tone-control can be incorporated, but this, I think, calls for careful consideration, otherwise the true beauty and range of the instrument can be ruined by false, unbalanced coloration. In my opinion it is far better to concentrate on the amplifier and loudspeaker to ensure that they are good, and get all the effects by playing accordingly.

Owing to the use of the electro-magnetic system of reproduction one need not be concerned with the quality of the guitar; in fact, the six strings could be mounted on a piece of board and, provided the magnetic system was arranged as already described, highly satisfactory results would be obtained. Quite a number of American models were constructed without any resonating body or belly. As long as the amplifier responded all was well, but if the latter broke down (this is a possibility one has to contend with, though, of course, it is not usual) the performer was in an awkward position. With the model I have described one can play it with or without an amplifier, as the normal sound-reproducing qualities of the instrument are not impaired in any way by the fitting of the electro-magnetic unit.

A.C./D.C. Circuit

If the guitar is to be used for band work or professional engagments it would be advisable to use an amplifier designed for operation on A.C./D.C. supplies, as it is not always certain that A.C. will be available. One advantage offered by this type of circuit is that it can usually be more compact and much lighter than an A.C. operated amplifier, especially if an energised speaker is used.

Owing to the fact that the chassis or common negative line of A.C./D.C. equipment is common with one side of the mains, it is necessary to take certain precautions to protect the player from the possibility of shocks at the mains voltage. Provided the first valve in the amplifier has across its grid-cathode circuit its grid-leak or potentiometer (volume control), the two leads from the guitar unit can be connected to the grid and earth line via mica dielectric condensers, having capacities of .001 mfd. to .01 mfd.

An alternative method is to use a suitably designed transformer between unit and input to valve, and the component can have a ratio of 1 : 1 or higher according to the characteristics of the unit.

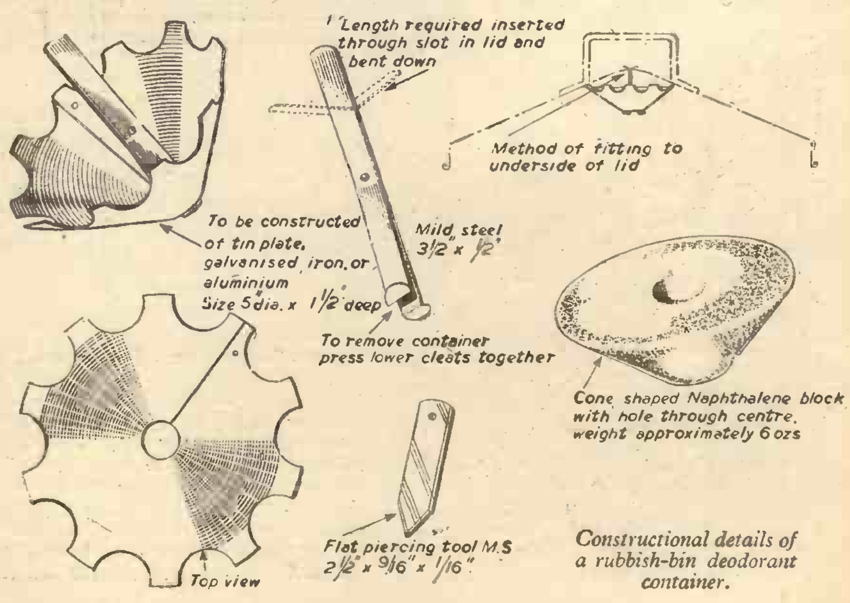
A Deodorant Container

By D. S. NOBLE

THIS rubbish-bin deodorant container consists of a shallow, inverted, cone-shaped container in which a block of naphthalene or similar material is placed. Details of the various parts are given in the diagrams.

The container can be attached to the interior of the rubbish-bin lid in a couple of minutes, a small slot being pierced just underneath the handle with a small flat piercing tool. The Y-shaped clip is inserted through the hole in the base of the cone, through the deodorant block and the slot in the lid, the tabs being bent down flat on top of the lid. To remove, the two lower cleats are simply pressed together and the container will drop off.

The deodorant block is made with a $\frac{3}{8}$in. hole through the centre to enable the clip to be attached. The effective life of the block is many months, and judging by a container already in use it is most effective, being at its best in the hot weather, the bin being entirely free of flies and ants as well as any unpleasant smells.



Constructional details of a rubbish-bin deodorant container.

Helicopters for the Royal Australian Navy

A view of the carrier's flight deck as one of the Bristol Sycamore Mark 50 helicopters was struck down into the carrier's hangar. The other two aircraft, with blades folded, stand by ready to be stowed below decks.

THREE Bristol Sycamore Mark 50 helicopters, which are going into service with the Royal Australian Navy, landed together on the flight deck of H.M.A.S. *Vengeance*, as the carrier lay at anchor off Weymouth, on Friday, January 16th.

Later in the day the carrier sailed for Glasgow en route to Australia, where the helicopters will be engaged on air/sea rescue and general communications duties.

The aircraft were ordered by the Australian naval authorities for these specialised roles after a Sycamore had successfully completed take-off and landing trials on board the aircraft carrier *Triumph*.

These trials, which lasted two days, firmly established the suitability of the machine for use as a carrier-borne aircraft. Conditions varied considerably during the trials period and wind speeds over the flight deck rose at times to nearly 40 knots.

PRINCIPAL CHARACTERISTICS

ENGINE	
Make	Alvis
Model	Leonides L.E. 23 H.M.V. Mk. 73
Weak mixture cruising ...	340 b.h.p. at 2,700 r.p.m. at 11,500ft.
MAJOR DIMENSIONS	
Overall length (folded) (Min.) ...	43ft. 8.5in.
Overall width (folded)	11ft. 4.2in.
Overall height (static; one tail rotor blade downwards)	12ft. 2in.
Distance between rotor centres ...	32ft. 0in.
MAIN ROTOR	
Diameter	48ft. 6.7in.
Disc area	1,860 sq. ft.
Max. rotor r.p.m.	287
Max. w-m cruising rotor r.p.m. ...	242
WEIGHTS	
Payload	900lb.
All-up weight	5,400 lb.

Winds of this velocity impose a particularly severe test on a helicopter at take-off or on landing, and it is the aircraft's performance under these conditions which largely determines its suitability for operation from a carrier.

The trials proved that the Sycamore can be struck down into the hangar in a remarkably short space of time. To simulate operational conditions, the aircraft was recalled to the flight deck from guard duties on the *Triumph's* starboard quarter, the rotor blades were folded, and the machine was lowered to the hangar. The operation was completed in six minutes.

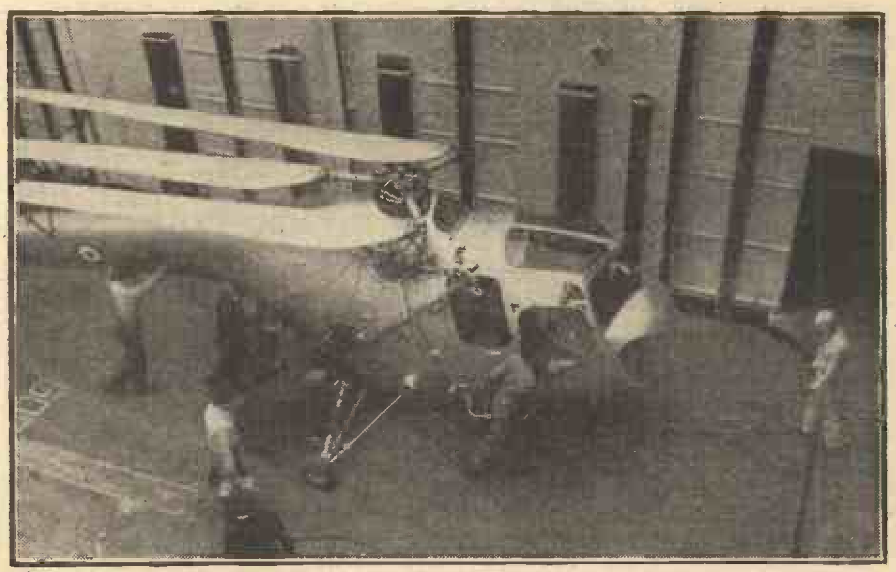
Hydraulic Winch

To meet the requirements of naval operation, a number of modifications had been introduced. Air/sea rescue work will be the Sycamore's most important duty in service with the R.A.N., and for this purpose a hydraulically operated winch is mounted abaft an open doorway on the starboard side of the fuselage, power being provided by a pump driven from the main rotor gearbox.

The rescuer, who is lowered in a special harness, secures the rescued man by passing a sling under his armpits, and throughout the operation keeps in touch with the cabin by means of an intercom extension. Extensive trials carried out by The Bristol Aeroplane Company have shown that the aircraft remains unusually steady in the hovering position while casualty and rescuer are raised by winch and taken aboard.

A new type of undercarriage gives the aircraft an additional nine inches ground clearance, enabling it to land on rough and uneven surfaces, and raising the height of the main rotor disc during ground running. A side exhaust is fitted to avoid burning or scorching when landing in scrub, or on a deck.

Rescue work with the R.A.N. will not necessarily be confined to operations at sea. The Sycamore may be summoned to the aid of crews whose aircraft have made forced landings in bush country, and although in these cases the aircraft may occasionally be able to land in order to take personnel on board, rescue by means of the winch will frequently be necessary.



One of the three Bristol Sycamore Mark 50 helicopters, which were embarked on board H.M.A.S. Vengeance *off Weymouth on January 16th, being struck below in the carrier's hangar. The aircraft is seen still on the carrier's lift platform.*

By removing the winch and covering the starboard doorway aperture by a metal panel containing a "knock-out" Perspex escape-hatch, the Sycamore can quickly be converted for operation as a communications aircraft.

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

TELESCOPE OPTICS

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

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

THERE are two philosophical instruments which stand head and shoulders above all others, the telescope and the microscope. By their aid man has acquired a pictorial view of the wonders in the macro- and micro-cosmos. This article will deal mainly with telescope optics and, to justify the opening statement, it is of value to consider the words of Prof. Robert Grant written in his monumental work[1] of 1852, "The telescope is justly considered to be one of the noblest inventions which the annals of human ingenuity can boast of. By its means the distant regions of space have been unveiled, and the views of the material universe obtained. Its penetrating power has revealed to us the astonishing fact that, far beyond the visible confines of the starry firmament, there exist countless myriads of suns and systems of suns, each of these glorious luminaries being in all probability the centre of a numerous *cortége* of revolving worlds. The planets, whose structure seemed to be equally mysterious with their movements, have been transformed from so many insignificant specks of light to an assemblage of magnificent worlds, presenting numerous points of analogy to the earth, and affording thereby irrefragable evidence in favour of the Pythagorean system of the universe."

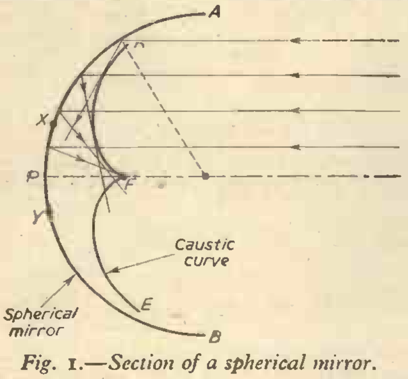


Fig. 1.—Section of a spherical mirror.

Leading Philosophers

If we study the history of the telescope we are conducted to the researches of the world's leading philosophers. Lipperhey of Middleburg, who (*circa*) 1608 is credited with the invention of the refracting instrument, was no ordinary artisan; at the request of the Assembly of the States General he used his knowledge to construct a *binoculus* so that that body may have an instrument suitable for the use of both eyes. From this period the development of the telescope was taken up by Galileo, Kepler, Gascoigne, Huyghens, Divini, Compani, and others. In 1663, however, James Gregory published in his *Optica Promota* an explanation of the reflecting telescope which was to use, in place of the lens, a concave parabolic speculum. Robt. Hooke succeeded in making a Gregorian instrument in 1674, but not before the illustrious Newton had executed a reflecting instrument of his own design—the second one having been sent to the Royal Society in 1671. Much has been written about the respective merits of the refracting and reflecting telescopes, and here suffice it to say that large object glasses for refractors require the figuring of many surfaces to accurate curves,

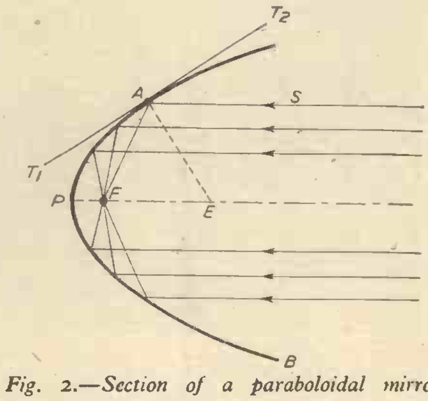


Fig. 2.—Section of a paraboloidal mirror.

and distortion due to the weight of a large glass would vitiate the optical work expended on the glass. The largest refractor is at Yerkes Observatory, and it has a 40in. dia. object glass. In the reflector a mirror is utilised and this has only one optical surface to be figured; also it can be supported underneath to prevent distortion and thus lends itself to great diameters. The largest reflector is the 200in. telescope at Palomar Mountain, U.S.A.

Refinements to the large reflectors have not made any really radical changes from the early days, except in technique of mechanical construction and the use of glass as the matrix upon which the reflective coating of silver or aluminium is deposited for the modern mirror, as compared with the speculum.

Bernard Schmidt

It is here that we come to the work of Schmidt, who surprised the astronomical world in 1930 with his optical system which has provided astronomers with their finest reflecting telescopic cameras. Before we investigate the invention Schmidt gave to mankind, some facts of the man *per se* may not be amiss.[2 3]

Bernhard Schmidt was born in 1879 on the island of Nargen off the coast of Estonia. Bernhard when eleven years old had a serious baptism in the sciences "on a certain Sunday morning ... young Bernhard, though dressed in his Sunday suit, was not in church, but instead he was out in the fields trying out a batch of gun-powder of his own manufacture. He packed it into a piece of metal pipe to assure a good bang and the explosion was so severe it cost him his right hand and forearm. The boy was tough, however, and resourceful. He washed the stump in a brook, improvised a tourniquet and made home unaided, apprehensive principally of anticipated parental wrath over a blood-drenched Sunday suit."

Schmidt's love of science, however, was undiminished; he studied at the Institute of Technology at Gothenburg and later spent many years making astronomical mirrors at

Fig. 3.

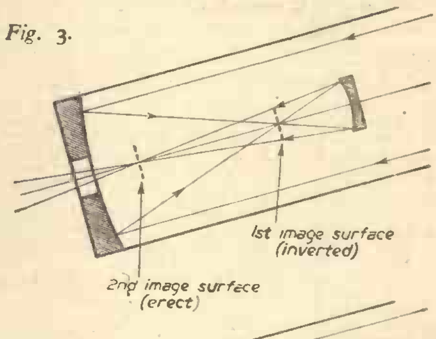
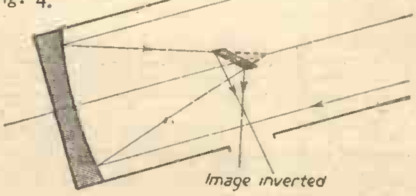


Fig. 4.



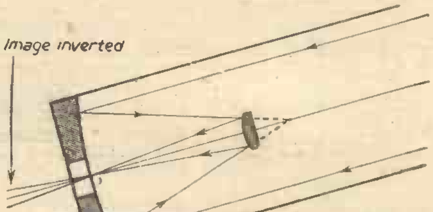


Fig. 5.

Fig. 3.—Gregory's reflector. Fig. 4.—Newton's reflector. Fig. 5.—Cassegrain's reflector.

Mittweida, near Jena. In 1926 Schorr invited him to the Hamburg Observatory in Bergedorf, and here he tackled the problems of wide-angle fast cameras. His views gradually crystallised and he disclosed his ideas to Prof. Baade in the Indian Ocean when travelling to the eclipse observation point on the Philippines in 1929.

Reflector Optics

To understand Schmidt's invention we must trace the fundamentals of reflector optics.

A spherical mirror APB, Fig. 1, receives a parallel beam of light, then every ray will be reflected according to the laws of reflection, i.e.:—

1. The incident ray, the reflected ray, and the perpendicular to the surface lie in one plane.

2. The angle of incidence is equal to the angle of reflection.

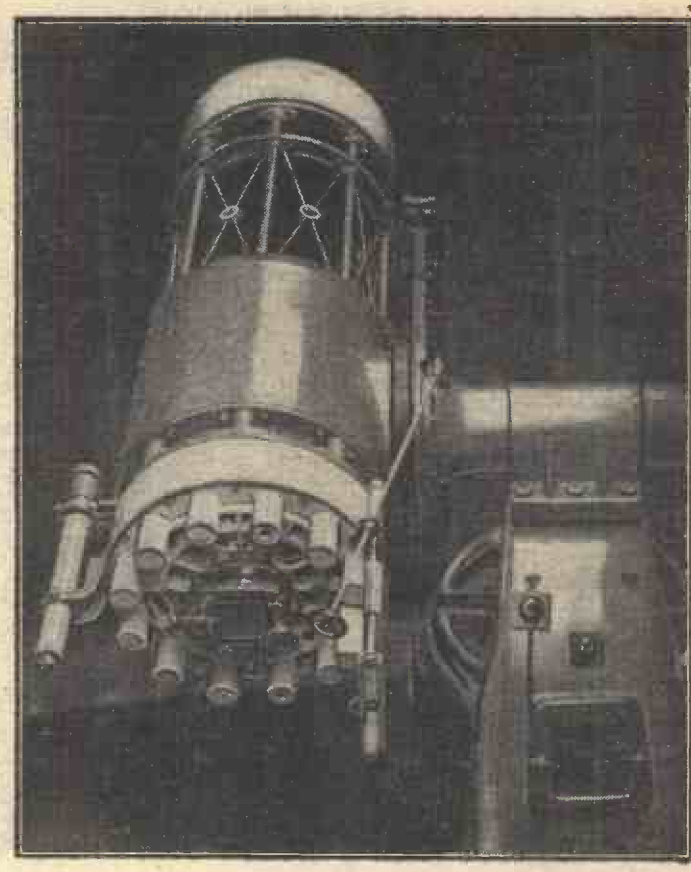
The reflected rays all touch the curve DFE which is the well-known caustic seen frequently on the surface of tea in a tea cup. Spherical mirrors for astronomical work use the portion between XY and the caustic is then reduced to a bright part near F, the focus. The rays do not come to a point focus but make an area of confusion due to spherical aberration.

To bring a large beam to a *point* focus it is necessary to utilise the paraboloidal mirror. The section of such a mirror (a parabola) is shown in Fig. 2 by the curve APB. The characteristic of such a curve is that a line FA through the focus F, and a line AS parallel to the axis of the paraboloid, make equal angles with the tangent T_1AT_2 at A, and thus with the normal AE. It follows that all rays, such as AS, parallel to the axis, pass after reflection through the focus F, and the entire beam comes to a point focus there.

Reflector Technique

It was a consideration of the image-forming qualities of the spherical mirror and the paraboloidal mirror which led Gregory Newton and Cassegrain to the elegant instruments which bear their names. Gregory used a concave spherical primary mirror with a central aperture followed by a concave ellipsoidal secondary to give an erect image behind the main mirror, as in Fig. 3. Newton used a spherical mirror and a flat mirror tilted at 45 deg. to the axis of the tube, thereby reflecting the rays to the outside of the tube, as in Fig. 4. Newton was aware of the advantage of the paraboloidal mirror but possibly found its construction too arduous. The Cassegrain technique, Fig. 5, is to use a concave primary mirror with a central aperture, the figure of the primary being paraboloidal. The secondary mirror was made hyperboloidal and arranged to intercept the rays inside the focus—reflecting the beam through the aperture in the primary to give an image behind the main mirror.

The Newtonian and Cassegrain types have served astronomers well over the years, but they have their defects. If a photograph is taken with a paraboloidal mirror, star images off the axis become "pear shaped" due to *coma*. Modern reflecting telescopes are arranged to have a narrow field of view with great penetrating power; this narrow field of view gives good definition and isolates the troubles to be found farther from the axis.



The Schmidt-Cassegrain telescope of the University Observatory, St. Andrews.

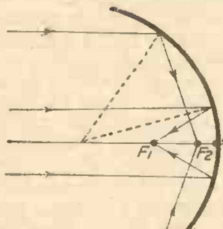
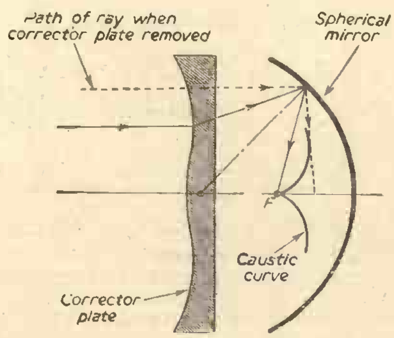


Fig. 6 (Left).—Diagram showing spherical aberration.

Fig. 7 (Right).—Schmidt's idea for correction of spherical aberration.



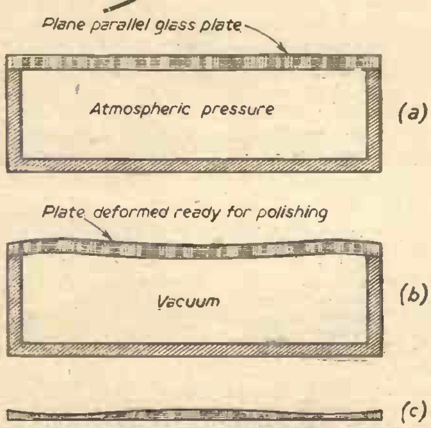


Fig. 8.—Schmidt's method for construction of corrector plate.

Corrector Plates

A solution of the troubles associated with off-axis aberrations was badly needed so that a *wide* aperture telescope camera might be made giving a photograph of *wide* fields with near perfect definition over the entire field. Schmidt solved the problem by a revolutionary idea: he *abolished the axis*, and with it the off-axis aberrations. To do this he used the spherical mirror but altered the path of the incoming rays by a corrector plate ahead of the spherical mirror. If the spherical mirror of Fig. 6 is examined it will be seen that spherical aberration causes rays near the centre to be brought to a focus F_1 at a distance from the mirror surface equal to half the radius of curvature of the mirror, while marginal rays come to a focus F_2 nearer the mirror surface at A. Schmidt arranged his corrector plate to be convex near the centre and concave for the marginal rays, as in Fig. 7. Such a corrector plate causes marginal rays to be divergent and rays near the centre to be convergent. The actual profile of the corrector plate is much exaggerated in Fig. 7. If we now consider off-axis pencils of light entering the system these form images in the outer parts of the field and the advantages of the aspheric corrector plate will be clear, for when the corrector plate is placed at the centre of curvature of the spherical mirror then an off-axis pencil will be focused very nearly as sharply as the on-axis pencil. If the corrector plate could be tilted to be square on to the off-axis pencil then it would give accurate focus. However, the corrector plate is almost plane parallel and the lack of squareness to the off-axis pencil negligible. In more precise language any coma is produced

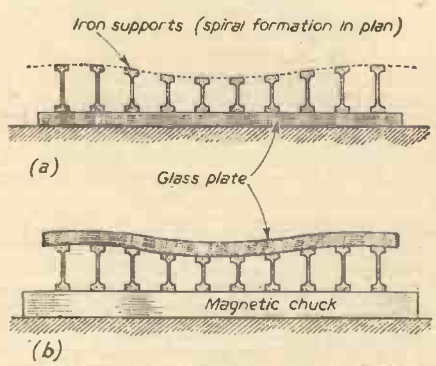
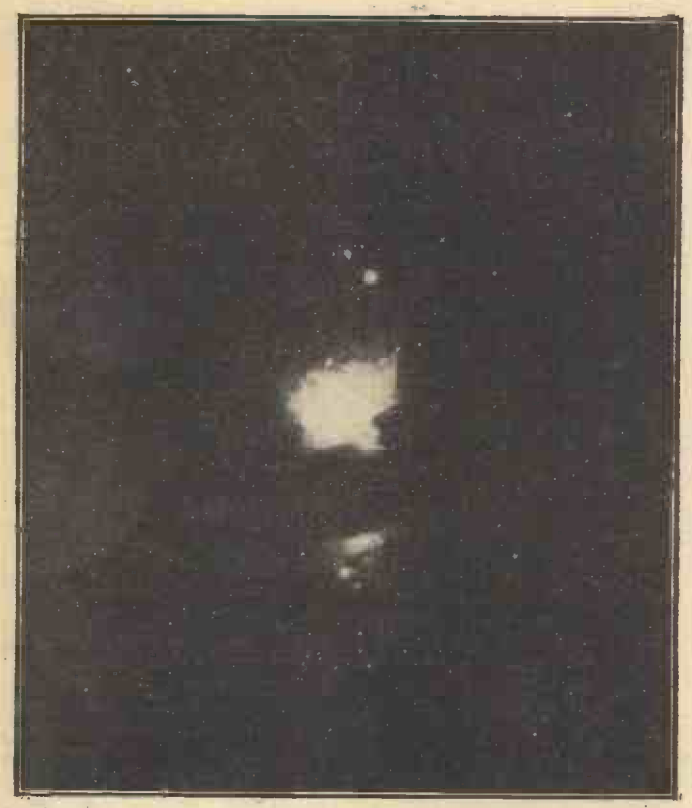


Fig. 9.—Beavan-Wojciechowski method.

Fig. 10.—Philips' technique.



Orion, Nebula and Field. Photographed with the 15-18in. Schmidt-Cassegrain telescope of the University Observatory, St. Andrews, December 20th, 1951. Exposure 30 minutes. Extent of field of this print 3°×4° (approx.). Total area of photographic field of the telescope is 5°×5°.

by the tilt of the corrector plate to rays not parallel to its own axis, and is very minute. It will be appreciated that the image surface is spherical and concentric with the primary mirror, and of approximately one half the radius of curvature. This necessitates a spherical figure to the photographic film or plate, one of the minor drawbacks of the Schmidt system. To clarify the point made above, that the corrector plate is substantially plane parallel and the plate in Fig. 7 much exaggerated, it will interest readers to know that it has been stated that a 24in. dia. corrector plate made by the Warner and Swasey Company was 0.3in. thick and the maximum departure from the plane was 0.0005in.

Here, readers of PRACTICAL MECHANICS will probably enquire regarding the manufacture of such a difficult optical component. Schmidt and other "classical" opticians kept his method secret. After his death it was learnt[4] that he had deformed a plane-parallel plate of glass by evacuating a vessel over which the plate was seated, the evacuation and distortion being gauged by an interference method. The deformed plate was then polished plane on its outer surface and the vacuum broken to release the plate and allow it to take up its correct figure (Fig. 8).

Corrector Plate Manufacture

Two other methods are disclosed in the erudite work of Twyman's,[5] and a detailed analysis of corrector plate manufacture has been given by Philips Research Laboratories,[6] with a new method used at Eindhoven. Briefly the methods are as follows:

1. A plane-parallel plate of glass is mounted in a rotating holder and ground with successively finer grades of carborundum by means of a flexible lap. The working surface of the lap is built up of lead facets cemented with gold size to a disc of sponge rubber about $\frac{3}{8}$in. thick. The facets are made petal shaped.

2. The second method is ingenious and called after its inventors the Beaven-Wojciechowski method. A plane-parallel glass disc has cemented to it a series of concentric iron rings. These rings differ slightly in their heights so that the locus of their upper surfaces form a reverse of the Schmidt surface. This assembly, Fig. 9_a, is inverted and the iron placed on a magnetic chuck. The glass plate is then deformed and its upper surface, Fig. 9_b, ground and polished flat. The plate when removed from the iron is found to be figured to the Schmidt form.

3. The Philips' method would seem to be the only one of use in small corrector plates for mass production. It comprises the following steps: A metal mould is made, the surface of which forms the negative of the shape of the corrector plate required. The mould is heated to 40 deg. C. and a 20 per cent. gelatine solution run in and a glass plate placed on the gelatine surface. The figure of the mould is made five times the thickness dimension of the corrector plate, and this is reduced in the gelatine by drying (when 80 per cent. of the water evaporates) leaving a surface of gelatine which is a five-fold reduction of the mould. The finished corrector plate is thus composed of a glass plane-parallel plate with a figured gelatine surface (Fig. 10).

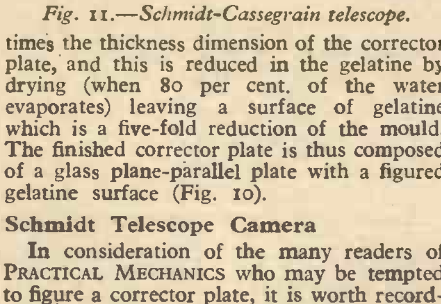


Fig. 11.—Schmidt-Cassegrain telescope.

Schmidt Telescope Camera

In consideration of the many readers of PRACTICAL MECHANICS who may be tempted to figure a corrector plate, it is worth recording that amateurs were the first to work in this field after Schmidt, and the construction of a Schmidt camera f/1 is to be found in that vade-mecum of telescope making—"Amateur Telescope Making Advanced: Scientific American," p. 410, the article being by H. A. Lower.

The advantage of the Schmidt photographic telescope camera is to be appreciated from the following data[7]: The 200in. telescope on Palomar Mountain, as in other large telescopes, is restricted in its field of view. The field is about 2 minutes of arc which may be increased to about 15 minutes of arc with a suitable Ross lens near the focus. In contrast to this performance, the large Schmidt camera on Palomar, which has a 72in. primary mirror and a 48in. correcting plate, gives a field of about 44 square degrees in one exposure. The plate used is 14in. square, and the instrument so fast that with 103a-o emulsion it reaches its limiting magnitude of 20.3 in 12 minutes of time. This 20.3 limiting magnitude corresponds to the brightness of a galaxy at a distance of 300 million light years, a distance one-third of that explorable by the 200in. giant. On account of this wide field and the perfection of the star images the "Big Schmidt," as it is fondly styled, has been engaged upon a project financed by the National Geographic Society, viz., a survey of the *entire* sky visible from Palomar. This survey was inaugurated in July, 1949, one plate being taken in red light and another in blue light of each field. The entire sky contains 41,253 square degrees, and three-quarters of this is visible from Palomar Mountain. Since the "Big Schmidt" can in one plate cover approximately 40 square degrees, the project can be accomplished with less than 1,000 plates. To conclude this description of the "Big Schmidt" it is worth recording that the weight of the instrument is 12 tons, and the drive effected through a $^1/_{25}$ h.p. synchronous motor.

Schmidt-Cassegrain

Two deviations in optical design from the classical Schmidt are of interest. First, the Schmidt-Cassegrain, which, as the name implies, includes something of both the work of Schmidt and Cassegrain. The schematic arrangement is shown in Fig. 11. This instrument eliminates one of the drawbacks of the classical Schmidt—viz., the image surface and photographic plate being inside the telescope tube. With an aperture in the primary mirror and a convex secondary mirror inside the focus of the primary the image surface is now made to appear outside the telescope tube. The photographic plate has to be made concave to agree with the concave image surface. Tremendous interest has been focused on this type of instrument, and the St. Andrew's Observatory of Fife has covered itself with honour in constructing a Schmidt-Cassegrain instrument on site having a main mirror diameter of 20in. From the experience gained, the workers there are building a 40in. Schmidt-Cassegrain at a cost of £25,000. The large instrument will be able to "see" and record star clusters at immense distances, and may be used to study the globular star clusters and the part they play in the structure of the universe. The design of the instruments is under Professor Finlay-Freundlich, with Mr. Robert Walland as chief technician.[8]

The accompanying photographs show the Schmidt-Cassegrain telescope of St. Andrew's Observatory, and an exposure taken with the instrument of the well known Orion nebula. Note the perfection of the star images at the edges of the plate. These photographs are reproduced by courtesy of Prof. Finlay Freundlich.

REFERENCES

1. "History of Physical Astronomy." R. Grant, F.R.A.S.
2. "American Journal Roentgenology & Radium Therapy" (Jan., 1948).
3. "Journal British Astronomical Association," 59, p. 111.
4. "Zeitschrift Für Instrumentkunde," 56, 336-338, (1936).
5. "Prism & Lens Making" (1952). Hilger & Watts.
6. "Philips Technical Review" 9, No. 12, p. 349-356 (1947/8).
7. "The Observatory," 72, No. 869, Aug., 1952. p. 135. "The Scientific American." Dec., 1950.
8. "Weekly Scotsman," March 6th, 1952.

(To be concluded)

Making a Demagnetiser

Theoretical Considerations and Constructional Details

By N. J. WADSWORTH, B.Sc.

A DEMAGNETISER is an instrument which many workshops do not possess, but which can be easily built for a cost of only a few shillings. With such an instrument small tools such as screwdrivers and pliers may be demagnetised, thus preventing their collecting iron filings and sticking to steel screws. Also the springs of clocks and watches which tend to become magnetised if placed near magnets may be demagnetised, resulting in better timekeeping. Many books on workshop practice or clock repairing mention the construction of a demagnetiser but give no idea of the theory behind it, and the reader is left not knowing how to calculate the effect of varying the dimensions of the coil, the size of the wire, the supply voltage, etc.

In this article, therefore, we will start with an outline of the theory behind demagnetisers, and then describe the construction of one, pointing out how the design may be varied to allow the use of different voltages, different currents, or the demagnetisation of larger objects.

Theory

To understand the operation of a demagnetiser it is essential to understand the magnetic properties of the material to be demagnetised. If a piece of iron or steel is placed in a magnetic field it becomes magnetised and will, for instance, pick up iron filings at its ends. As the field is increased the amount of magnetisation increases to begin with, but eventually can be increased no further. When the field is removed it is found that some of the magnetism remains, but that there is less than there was when the field was present. If the field is reversed, the magnetism gets less, and, as the field is increased, the iron becomes magnetised in the reverse direction. We can plot the intensity of magnetisation against the field applied and get a curve as in Fig. 1. In the beginning, with no field, the intensity is zero. This is represented by the point A. The increase in intensity due to increasing the field is represented by the line AB. As the field is increased past the value at B the iron does not get magnetised any further, represented by the line BC. If the field is now reduced, the magnetisation reduces slowly along the line CD, so with the field completely removed the iron is still magnetised an amount AD. A reverse field of increasing amount causes the magnetisation to follow the line DEF. Thus in a reverse field of amount AE the material is completely demagnetised. At F it is completely magnetised in the reverse direction, and on reversing the field again the line FGHBC is traced out. From this it is obvious that one way to demagnetise some iron is to place it in a reverse field of magnitude AE, which will reduce its magnetisation to zero. When the field is removed the iron will be completely demagnetised. The difficulty with this method is that the field needed varies with the amount the material was magnetised previously, and what sort of material it is. Thus for some alloys a tenth of an œrsted would be sufficient, whereas others would need fifty or more. It will be noted that the curve at E is steep, and a small inaccuracy in the field will result in a large intensity of magnetisation. Also the direction of this field must be exactly opposite to the direction of magnetisation of the iron and it will be difficult to determine this accurately. In practice this method is too complicated to be useful.

Another method which has been suggested, and can be used in some cases, is to heat the material. This has the effect of removing all the magnetisation, but the temperature required is a bright red heat and any tempering which the material may have had will be lost. This makes the method unsuitable for tools and springs of any sort. Also, if iron is heated to this temperature it becomes covered with a layer of oxide (scale) which prohibits the use of the method for accurately machined parts.

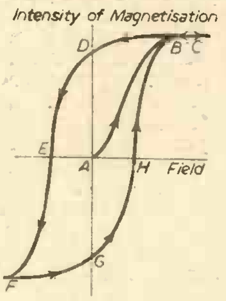


Fig. 1.—Plotting the Intensity of magnetisation curve.

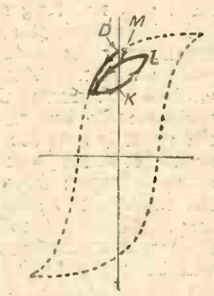


Fig. 2.—Curve indicating the effect of an alternating field.

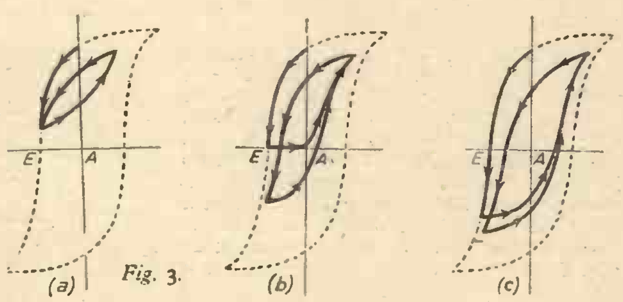
Alternating Field

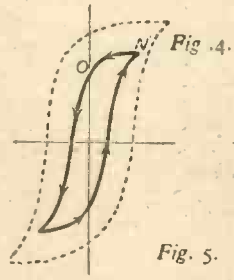
We will now consider the effect of an alternating field on a piece of magnetised iron. Before the application of a field the iron is at a state corresponding to D in Fig. 2. If a small reversed field is applied, the intensity of magnetisation is reduced to that represented by J. A removal of the field brings it to point K, an increase in the reverse direction to point L, and a removal to M. Thus one cycle results in a slight decrease in the intensity of magnetisation. However, further reversals just move the iron round the loop MJKLM without reducing the magnetisation further. Larger reversed fields move it round the various loops in Fig. 3, from which it will be seen that if the maximum or peak value of the field is less than AE the material has a mean magnetisation left superimposed on the varying one. If, however, the maximum field is AE or greater, the average magnetisation is zero. One is tempted to think that the job is now done and all one has to do is to switch off. A moment's thought, however, shows that this is not so. If we happen to switch the current off just as the field reaches its maximum value at N in Fig. 4, the material is left at O, considerably magnetised. The only way to be sure of leaving it completely demagnetised is to reduce the peak value of the field slowly, so the magnetisation loop becomes a spiral as shown in Fig. 5. If this is done slowly, taking many tens of cycles, the material will be left completely demagnetised. This, then, is the practical method of demagnetising. The material is placed in an alternating magnetic field whose peak value is at least the AE value for that material. Since we cannot be sure of applying the field in the direction the material is magnetised the peak value should be somewhat greater than AE. The field is then slowly reduced to zero. In practice the method of doing this is to place the material in a coil of wire carrying an alternating current, and to withdraw it slowly. This is an easy way of reducing the field at the material slowly and evenly.

Practical Design

The first thing to find is the "AE value" of the materials to be dealt with. This may be taken as equal to the "coercivity" of the material, for all materials one is likely to want to demagnetise. In the case of the best modern permanent magnet alloys, the only exceptions, it is still less than one-and-a-half times the coercivity. The accompanying table gives the coercivity of a number of common magnetic materials. It will be seen that a peak field of about 100 œrsted will be sufficient to demagnetise all but the best permanent magnet materials, whilst a field of 1,000 œrsteds will demagnetise even them. A convenient way of obtaining this field is by a short coil of wire of the shape shown in section in Fig. 6. The object to be demagnetised is passed slowly through it. Since the object is not

Metal	Coercivity (œrsted)
Mu-metal...	0.03
Transformer stampings ...	0.7
1% silicon iron ...	1.5
Mild steel ...	2.0
Cast iron ...	4.5
Hardened carbon steel ...	50
Tungsten steel ...	75
Cobalt magnet steel ...	250
Alnico magnet steel ...	510





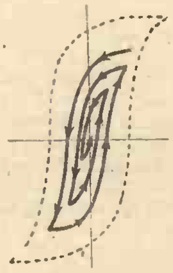


Fig. 5.

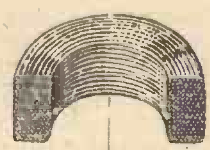


Fig. 6. ← r →

Fig. 3 (a, b and c).—Effects of reversed fields. Figs. 4 and 5.—Demagnetisation effects. Fig. 6.—Section through coil.

all in the field at once, the effect of the outer part must be considered. The effect is to necessitate a larger maximum field. If this is made twice that calculated above it should be sufficient.

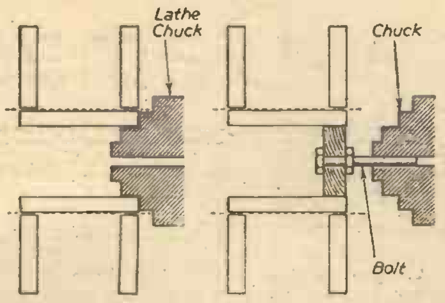
The field, H, at the centre of a coil such as is shown in Fig. 6 is given by—

$$H = \frac{nI}{4r} \qquad (1)$$

where n is the total number of turns, I is the current flowing and r is the mean radius of the coil in inches. The field near the windings is larger than at the centre, so only the latter need be considered. Thus to produce a field H = 200 œrsteds—about 560 ampere turns are required if the coil is 1½in. in diameter or ¾in. in radius. We now have to decide what source of A.C. we intend to energise the coil. If the coil has sufficiently high resistance or inductance it may be connected direct across the A.C. mains. If not, a transformer may be used to reduce the voltage or the coil may be run from the mains in series with a resistance.

Using Lamp as Resistance

The last method is the cheapest, as normal mains filament lamps may be used for the resistance and are considerably cheaper than suitable transformers. As the coil is only switched on for short periods the power wastage does not matter. The number of turns required prevent the use of the first method for small coils. If we decide what size lamp we will use that fixes the current and hence, from equation 1 the number of turns. Let us use a 60-watt 230-volt lamp. This passes a rms current of 60/230 = 0.26 amps which has a peak value of 1.4 times as much, i.e., 0.36 amps. Therefore, about 1,060 turns are needed. We now must decide on the gauge of wire to use. If we use very thick wire the coil will be heavy and the wire expensive owing to its weight. Also the mean radius of the coil will be increased, thus necessitating more turns. If very thin wire is used it will get hot very quickly and may burn out. The rate of heating should be worked out for a number of wire gauges. A length of about 230 yards of wire is needed. This could be provided by 2oz. of 36 SWG wire, 4oz. of 32 SWG wire or 8oz. of 28 SWG wire. The resistance of the wire may be looked up in the wire tables and is found to be 120 ohm, 60 ohm and 30 ohm respectively for the three coils. The heating is given by $W = I^2R$ where W is the watts produced in the coil, I is the rms current in amps and R is the resistance of the coil in ohms. This gives 8, 4 and 2 watts for the three coils. 10 watts will heat one ounce of copper about 1°C. in one second. It should not be necessary to have the coil on for more than about 10 seconds at a time, but even so the first coil, wound with 36 SWG wire will become warm and might overheat if use many times in quick succession. The second coil warms at a rate of 0.1°C. per second, which is satisfactory. The third coil warms even more slowly but is more bulky and expensive. The second coil is a good practical compromise. Double silk-covered wire of 32 SWG winds at 5,600 turns per square inch, so the 1,600 turns will take up 0.3 square inches and the coil can be made 0.75in. long and



Figs. 7 and 8.—Methods of using a chuck for holding the coil former.

0.4in. thick. Double cotton-covered wire of 32 SWG winds at 2,300 turns per square inch, so the cross section would be 0.7 square inch, say, 1in. long and 0.7in. thick.

If it is decided to run the coil from a transformer its inductance must be taken into account. The inductance may be worked out from the formulæ given in various radio books. For coils of this size the effect is that the voltage which must be applied is about 50 per cent. greater than that calculated from Ohms law, V = IR. V is the voltage, I the current and R the resistance. When the coil is run from a transformer, or direct from the mains, the current will be reduced when magnetic material is placed in it. The coil should therefore be designed for a larger field than that actually needed. If a series lamp is used this complication is avoided. If the reader wishes to design a coil of a different size or to run off a different supply it is only necessary to put the new figures in the above calculation to find the size of wire, number of turns, etc., needed. If no A.C. mains are available the coil may be run off the secondary of a vibrator-transformer set of the type used in radios.

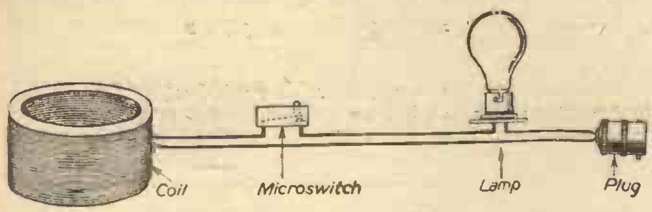


Fig. 9.—Showing the coil ready for use, in series with a lamp.

Construction

To wind the coil it is necessary to construct a former to wind on. A simple former may be made from a coardboard postal or similar tube of the appropriate size. Two circles of thick cardboard are cut out to be a tight fit on the tube and pushed on as shown in Fig. 7. If the former is to be permanent they should be stuck on, if not five or six layers of paper should be placed between them and the tube in the position of the dotted lines, to facilitate slipping them off when the coil is wound. If the constructor has access to a coil-winding machine the former is mounted on it. If not a lathe should be used, if possible. The nose of a chuck can probably be fitted inside the tube as shown in Fig. 7. If it cannot a piece of thick wood should be cut to be a tight fit inside the tube and a hole drilled at the centre. A bolt is passed through the hole and a nut tightened up on the outer side. The extension of the bolt is then held in the lathe chuck as shown in Fig. 8. If a lathe is not available the bolt may be held in the jaws of a hand drill held in a vice.

Free Ends of Wire

A piece of plastic-covered flex about three feet long is soldered to the end of the wire to be wound on and the joint covered by a piece of insulated sleeving. The plastic wire should now be wound about 1½ times round the former and the end brought out. If the former is permanent it can come out through a hole in one of the side walls. If not it must come over the top. The loose end is then tucked inside the centre of the former to prevent it getting tangled up as the former rotates. The reel of wire is placed over a loose-fitting spindle so that it is able to rotate easily and the coil former turned, winding the wire on. Care should be taken to feed the wire on so that it builds up evenly along the length of the former. When all the wire is on another 3ft. piece of plastic-covered wire should be attached, one and a half turns wound on, and the end anchored. If the former is permanent the coil can be covered with a protective layer of insulating tape or empire cloth, and is then ready for use. If it is intended to take the coil out of the former the inner tube is slipped out. Provided enough layers of paper have been placed between it and the coil this should be easy. The side walls and paper are now removed and the coil immediately tied with a few turns of cotton. The two plastic-covered leads are brought together and tied to each other and to the coil. The whole is then covered by a layer of tape (either plastic or "insulating") for protection. If the coil is well wound and tied it will be quite firm. It is essential that the leads be well anchored to it. It now only remains to connect the coil to the source of supply. To prevent it being left on by mistake it is advisable to use a spring-loaded switch which must be kept pressed to stay on. Many microswitches of this type are available cheaply on the surplus market.

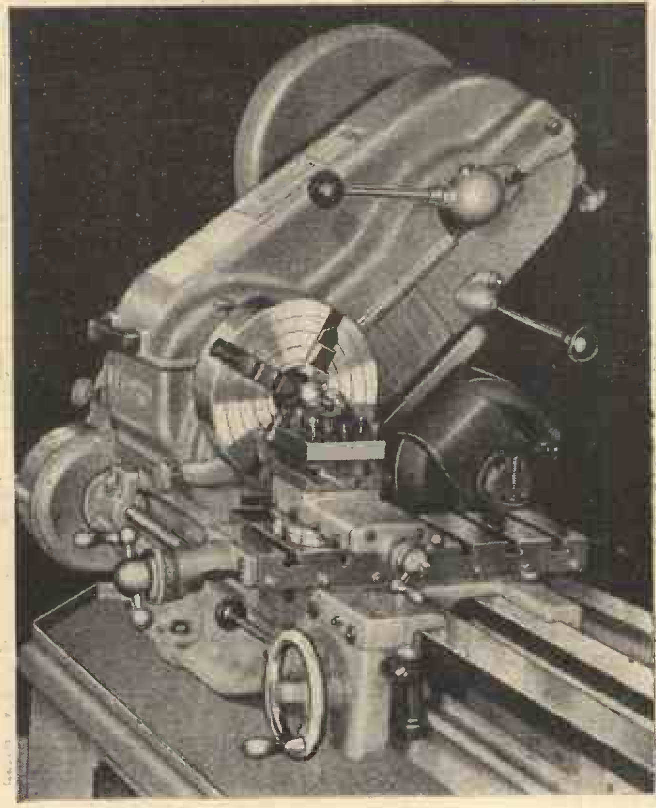
Operation

The final circuit using a series lamp is shown in Fig. 9. In use the plug is plugged into the mains and the object to be demagnetised placed in the coil. The microswitch is then pressed, switching the coil on, and the object passed through the coil and withdrawn. The microswitch is then released and the object is demagnetised. If it is found that the field is not strong enough for a particularly difficult object all that is necessary is to use a lamp of higher wattage.

It should be emphasised again that this sort of demagnetiser will only work off alternating current and that DC mains are useless for this purpose.

A demagnetiser of the design outlined here has been in use for six months and has proved very effective. No difficulties have been encountered and the coil has not overheated.

—A HIGH SPEED LATHE—



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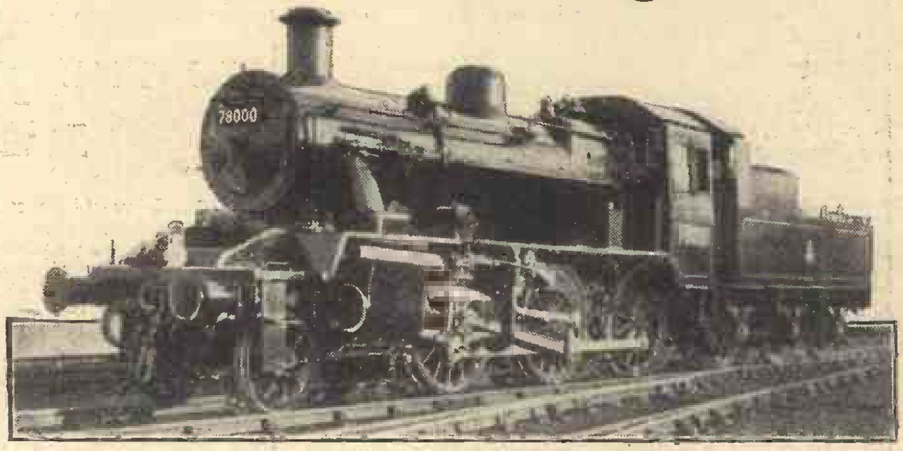
B.R. New Tender Engines

Brief Description of the Chief Constructional Features



The new B.R. mixed traffic tender engine.

THE first of this new class of mixed traffic tender engine, No. 78000, has been completed at the Darlington works of the East and North-east Regions. There are 10 locomotives to be built to this order and they are to work on the Western Region of British Railways on similar duties to the "2251" Class and "2301" Class and can replace various 0-6-0 Classes of similar power.

The locomotive has been designed and built under the direction of Mr. R. A. Riddles, Member for Mechanical and Electrical Engineering, Railway Executive. The parent office for the design is Derby, although certain parts were designed at Swindon, Brighton and Doncaster.

Although this is the smallest tender engine to be built in the range of 12 types for British Railways, it nevertheless incorporates, where suitable, the modern developments which have been found successful on the larger designs.

Apart from mixed traffic work they are particularly suitable for light main line and cross-country passenger working throughout Britain. The leading dimensions are as follows:

Cylinders, number, diameter, and stroke:	Two 16½in. by 24in. stroke.
Wheels, coupled, dia. ...	5ft. 0in.
pony truck, dia. ...	3ft. 0in.
tender, dia.	3ft. 3½in.
Wheelbase: coupled	13ft. 9in.
engine	22ft. 3in.
engine and tender	44ft. 1in.
Heating Surface:	
Tubes	924 sq. ft.
Firebox	101 sq. ft.
Total, evaporative	1,025 sq. ft.
Superheater	134 sq. ft.
Grate Area	17.5 sq. ft.
Boiler Pressure	200lb./sq. in.
Tractive Effort	18,513 lb.
Adhesive Factor	4.9
Weight of Engine in Working Order:	49 tons 5 cwts.
Weight of Tender in Working Order:	36 tons 17 cwts.

Boiler

The principal dimensions of the boiler are identical with the L.M. design of 2-6-0 Class 2. The barrel consists of two rings, made of carbon steel plate, the second being tapered equally at top and bottom, the outside diameter at the front end being 4ft. 3in. and at the firebox end 4ft. 8in.

The front ring is ½in. thick and the back ring is 17/32in. thick. The smokebox tubeplate is of the drumhead type, in which are expanded 12 flue tubes, 5⅛in. outside dia. and 7 s.w.g. thick and 162 small tubes, 1⅜in. outside dia. and 12 s.w.g. thick. The length between tubeplates is 10ft. 10½in.

The Belpaire type firebox is 5ft. 11in. long outside and 4ft. 7/16in. wide, giving a grate area of 17.5 sq. ft. The steel wrapper plate is 17/32in. thick, and the inner copper firebox wrapper is 9/16in. thick.

The relatively large dome provided contains a vertical grid-type regulator, which is operated from the cab by an external pull rod connected to a transverse shaft, which enters the second barrel through a stuffing box. All the firebox water stays are made of monel metal fitted with steel nuts inside the firebox, while the roof, longitudinal and transverse stays are of steel.

The boiler fittings are standard with the other B.R. locomotive types where this is possible and economical. The main steam manifold is placed on the top of the firebox outside the cab on which is mounted all the separate shut-off cocks to each steam supply pipe, a main shut-off valve operated from inside the cab being also provided.

Frames and Axleboxes

The carbon steel main frames are 1in. thick plates, on which are mounted the hornblocks at the driving wheel stations and the guides at the leading and trailing wheel stations; the surfaces of these are fitted with manganese steel liners and strips welded to a backing plate and finally bolted to the guide.

The axleboxes on the engine are all plain bearing type, the coupled axleboxes with pressed-in horse-shoe brass being mechanically lubricated by engine oil fed to the underkeeps in which a worsted trimmed pad feeds the oil on to the journal. The axleboxes on the tender are roller bearings of the outside journal type with dual roller race.

Cylinders and Motion

The two outside cylinders are 16½in. bore and have a 24in. stroke, the steam distribution being controlled by piston valves of 8in. nominal diameter driven by an outside Walschaert's gear, giving a valve travel of approximately 6in., with 1 5/16in. steam lap and ¼in. lead. The valves are lubricated by atomised oil delivered through atomisers from the cylinder mechanical lubricator and the pins of the valve gear are grease lubricated, except the expansion link and radius rod die pins, dies and die paths, which are oil lubricated. The bearing of the return crank rod big-end is of the self-aligning ball type.

The cross-heads are of the two-bar type; the top bar is mechanically lubricated, being the load carrying bar when the engine is working forward.

The connecting rod big-end and coupling rod bearings are lined with white metal and the oil is distributed over the bearing by a felt pad which is lubricated by splash feed from an oil box integral with the rod above the bearing.

Pony Truck

The leading pony truck has helical bearing springs, two pairs to each axlebox, each pair acting on either end of a yoke which transmits the load to the axlebox. Double helical springs are also used for the side control of the truck and two spring-loaded friction retarders are employed fore and aft of the truck centre to further control the freedom or side play of the truck.

Brakes and Cab

The steam and vacuum brake equipment is identical with the other B.R. locomotives, being gradual in operation, and applying steam brakes on engine and tender and vacuum brakes on the train when working fitted stock. The steam brakes can also be operated separately if so desired.

Tender

The tender has a capacity of 3,000 gallons of water and four tons of coal, and is fitted internally for water pick-up apparatus, and, therefore, can be equipped externally as required.

The tender brake shaft bearings and tender water pick-up pins and shafts (where fitted) are grease lubricated. The front plate of the tender is specially designed to provide adequate cover to the footplate staff, with good visibility when working the engine tender-first.

LETTERS TO THE EDITOR

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

Organ Notes and Temperature

SIR,—In reply to a query in the November issue it was stated that the frequency of the note from an organ pipe would be reduced if the temperature was raised. This, however, is not so. It is well known that the velocity of sound in a gas varies directly as the square root of the absolute temperature i.e., $V \propto \sqrt{T}$ (*This is open to question.—Ed.*)

In an organ pipe the wavelength of the note depends mainly upon the length of the pipe, i.e., $\lambda = 2 \times \text{length}$ (for an open pipe).

$$\text{Since frequency} = \frac{\text{velocity}}{\text{wavelength}} \therefore F \propto \sqrt{T}$$

Suppose an open pipe of length 100 cm. at 0° C., i.e., 273° A.

$$F = \frac{V}{\lambda} = \frac{33{,}000}{200} = 165 \text{ cycles/sec.}$$

If the temperature is now raised to 20° C., i.e., 293° A

$$\therefore F \propto \sqrt{T} \therefore F = 165 \times \sqrt{\frac{293}{273}}$$

= 171 cycles/sec.

Now suppose the pipe to be made of a metal of coefficient of expansion 0.00002 $\text{deg.}^{-1}\text{C.}$ (a probable value).

On being raised to 20° C., the pipe would expand:

$$l \times c \times t = 100 \times 20 \times .00002 = 0.04 \text{ cms.}$$

$$F = \frac{V}{\lambda} = \frac{330}{200.08} \times \sqrt{\frac{293}{273}} = 171 \text{ cycles/sec.}$$

Thus it can be seen that the lowering of the frequency due to the expansion of the pipe is quite negligible in comparison with raising of the frequency due to the increase of velocity of sound in the air.

Thus the frequency of the note emitted by an organ pipe is raised if the temperature is raised and lowered if the temperature is lowered.—W. R. C. ROWLEY (Corbridge-on-Tyne).

SIR,—In the November issue of PRACTICAL MECHANICS, in answer to a query on variation in frequency or pitch of an organ pipe, it is stated that this is caused by variations of temperature. I would like to make some comment on this.

A stretched string varies in pitch with length, and also varies greatly with tension of string, and with vibrating mass. Rise of temperature makes the pitch lower, as stated. However, with an organ pipe, rise of temperature makes the pipe note of higher pitch. I know, because I have tried it. I do not *know* the correct explanation. The coefficient of expansion of the pipe metal, usually lead compound, is very small, about .00003 per degree Centigrade at temperature of 20° would make very little difference to the comparative length, or the pitch.

I believe the explanation lies in the fact that the speed of sound in air increases by about 2 feet per second per °C. An increase of 20° now would make 1,100ft. per second, approximately 1,140ft. per second. As the column of air causes the note, this *should* make a very appreciable difference to the pitch, a rise of temperature making the pipe of higher pitch.—W. SOUTHWARD (Glasgow).

Deep Well Pump

SIR,—I am of the opinion that your correspondent, Mr. J. Gibson, may be mistaken in some of his observations on the deep well pump (PRACTICAL MECHANICS, December, 1952, page 122).

He says, ". . . The rod reaching to the piston may be solid steel, light conduit in screwed sections, or rods of pitch pine connected by fish plates. The wooden rods are supposed to be best for easy pumping on account of the buoyancy floating in water gives them, with metal rods a counterweight has to be used on the end of the handle to give balance." The last 18 words indicate that he accepts the preceding proposition. In my view, when wooden rods are used any buoyancy on the upward stroke of the rods, piston and water column is cancelled out because the water which gives the buoyancy is carried by the piston which is in turn carried by the rods. On the down stroke the water column is carried by the foot valve, and the buoyancy of the rods during this stroke is in direct opposition to the motive power. Therefore any buoyancy of wooden rods detracts rather than adds to the efficiency of the pump.

Obviously, if the piston and rods are counterbalanced energy applied to the lever is mostly expended in the desired activity of raising water.

I have for some years used a lift and force pump of this nature in a 250ft. well. A rising main of 3in. was used with pump bore of 2½in., and this was satisfactory. The cost of a 6in. rising main would have been prohibitive.—M. L. COKER (Tunbridge Wells).

Time Lag in the Cinema

SIR,—The following experience may be of interest to some of your readers.

Over a long period I have visited a cinema and, apart from the entertainment, I am interested in the technical side. Almost without exception I have noticed, during the run of the film, a definite delay or "time lag" in the sound and film; ordinarily it pointed to faulty projection, but I thought that highly improbable in a modern cinema. However, one evening I saw the manager and the circuit engineer, who happened to be paying a routine call at the cinema.

On voicing my complaint he took me up to the projection room to check up for myself—the projector, the film on the screen, and the monitor speaker adjacent to the projector; I found the performance 100 per cent. I then took the engineer with me to the back of the "circle," where my complaint was immediately justified by the resultant effect—strange to say no one had complained before.

Is it just a question of acoustics? The "throw" of the picture is 140ft., but a cinema at which the engineer worked some time previously had a "throw" of 180ft. with perfect reception. The puzzling feature is that during the run of a film it often "comes over" perfectly and within a few moments will develop a lag, sometimes pronounced, at other times less noticeable.

One theory I have is that the variation is caused by the difference in speed of the sound wave through warm or cold air, which occurs during the times the doors are open to admit patrons. Does sound travel faster or slower through warm or cold air? Can its speed be so effected as to cause sufficient delay for one to notice in 140ft.?

The answer in this cinema is the fitting of extension speakers at the back of the stalls or at the back of the circle or, perhaps, the front of the circle. The air in the upper regions in this case is warmer, therefore causing more trouble by the upward surge of cold air from the doors, due to the pull of the air-conditioning exits. — R. H. BARHAM (Reigate).

Interplanetary Space Travel

SIR,—*Re* the recent correspondence on interplanetary space travel in your paper. A consideration has occurred to me which has apparently escaped the scientists and which to my unscientific mind would make space travel impossible, even if a means is found of driving the ship through space.

The consideration is this: Take an ordinary vacuum flask and fill it with a hot liquid. It stops near boiling point for at least 24 hours because the heat cannot escape through a vacuum. The heat is slowly leaking away through the neck and cork.

A space ship would be flying in a perfect vacuum with no leakage. Every person in the ship is creating natural heat all the time; there is the effect of the sun's rays, untempered by atmosphere, plus the great heat of the jet motors. At first sight the ship would get hotter and hotter until all were cremated alive!

This raises another problem: how does the heat of the sun reach the earth through a perfect vacuum? Is it because the glowing surface of the sun acts as a hot cathode surrounded by a field of electrons and emitting cathode rays like an oscilloscope tube, creating a conducting path.

(*Continued on page* 301).

LETTERS TO THE EDITOR

(*Continued from page* 298)

Apply a high-tension potential to the anode of a radio valve and no current flows through the vacuum till a conducting path is made by heating the filament which emits free electrons. Anything which conducts electricity conducts heat equally.

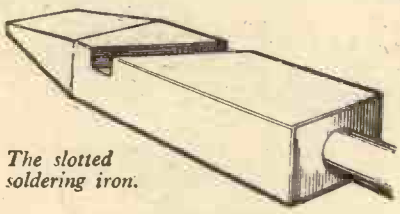
Therefore, an ordinary vacuum metal filament lamp gets hot on the outside because the filament is metal or some material which emits free electrons. A vacuum flask has static heat which has no escape path.

How long would it take a space ship to get red hot in free space?

Are meteorites red hot from the rays of the sun and, if so, does that not explain why the many millions of them which reach the earth's atmosphere are instantly burnt up when they come in contact with the oxygen of the air? I always doubted the theory that the speed of these iron and nickel missiles is so great that they get red hot and vaporise in the few seconds that they are travelling through the earth's atmosphere. They must be a red hot glowing mass before they reach the earth's atmosphere, and catch fire and burn away with their speed of travel through air on arrival.—W. J. LAND (Ealing, W.5).

A Soldering Tip

SIR,—Recently, I wished to move a switch-plug and, after fifty-five years of occasional dabbling in soldering joints, I could see that the job would be made easier by using a slotted soldering iron. I tried unsuccessfully to borrow one and eventually



The slotted soldering iron.

obtained a large copper soldering iron and had a 3/16in. x 3/16in. groove cut across it. I tinned the groove and made a good job of the joints. To my surprise solder did not run out of the ends of the groove, but was retained and formed a bath of solder into which each joint was placed. The sides of the iron were not tinned and were blackened in the fire.—H. K. WHITEHORN (Inverness).

Spontaneous Glass Fracture

SIR,—In the January, 1953, issue of your magazine, under the "Queries and Enquiries" section, there is a query dealing with spontaneous glass fracture. In the published reply we feel that there are several inaccuracies. For instance, in the fifth paragraph it is stated that occasionally a sheet of glass or other article escapes the annealing process, or else is not properly annealed. Speaking as the largest manufacturers of flat glass in this country, it is quite impossible for a glass sheet to escape the annealing process, because whether polished plate or ordinary sheet glass, it is made in a continuous strip, and going a stage further, if for any reason the annealing conditions do go wrong that glass cannot pass out into use, because obviously it has got to be cut in our works, and if the annealing were such that spontaneous breakage could occur, then it could not possibly be cut.

In order to understand the spontaneous fracture mentioned by your queriist, it is first of all necessary to understand the fundamental properties of "armourplate" glass. Toughened glass, of which "armourplate" is a type, is produced by subjecting fully annealed and processed glass to a supplementary heat treatment, which induces in the glass the stresses to which you refer. These stresses are deliberately induced and take the form of very high compression in the surface zone and compensating high tension in the centre perfectly balanced and stable.

In the sixth paragraph a number of suggested happenings are mentioned which might cause a local strain to release itself. We can assure you that with a piece of properly toughened glass, which the trolley top in question appears to have been, something much more drastic is required. We would suggest that the probable explanation of the break was that at some period prior to the spontaneous fracture the edge of the glass had received a blow causing material shelling. This was obviously not sufficiently severe to cause immediate disruption, but weakened the glass locally at the edge, so that when a sudden change of temperature occurred or some other form of additional stress imposed, the fracture was able to occur. What we would stress, however, is that the last sentence of the reply contains the exact opposite of the facts. The glass has had induced in it deliberately by a supplementary process the internal strains which you suggest it should be free from in order to do its job. These stresses are induced in the glass for the express purpose of giving it a high degree of resistance to thermal shock and also an ability to carry greatly increased loads. — PILKINGTON BROTHERS LIMITED (St. Helens, Lancs).

Westminster Door Chimes Modification

SIR,—During the last few years I have made several of the excellent articles described in your magazine, among them the Battery Operated Clock, Strip Projector, and also the Westminster Door Chimes, which I constructed when they first appeared in PRACTICAL MECHANICS, in July, 1949.

I made a few minor alterations to the latter, one of which is that I do not use two weights but only one. The cord from this is wound on a screwed drum fitted with a ratchet and re-wound with a detachable handle when the cord has run out. Also, I wired the push-button through the camshaft so that only when the stop is engaged with the trigger mechanism is the electrical circuit completed. This means that current to the coil is cut off immediately the chiming cycle is started and contact is re-made on its completion. If the button is still being pressed, the whole operation is, of course, restarted. This means a saving of battery consumption. The chimes are worked by an Ever Ready No. 996 battery; the original one is still in use.

Lastly, I fitted a double stop after a few weeks of operation. This causes the bells to stop after four notes only have been struck. I did this as I found that callers were a bit startled at having such a long peal loosed off at them by the simple action of pressing a button, as was the case when eight notes sounded.

May I take this opportunity of expressing my appreciation of PRACTICAL MECHANICS and wishing you every success in the future?—GEORGE P. ROBB (Edinburgh, 9).

Conservation of Energy

SIR,—Your readers may be interested in the following, and those with facilities may like to make the experiment, being thus able to obtain accurate data which may throw light on my final query. The apparatus required for this is a non-ferrous wheel, mounted to revolve in the horizontal plane, and powered to revolve quite slowly, about 1 r.p.m. This wheel is fitted with an outer annular strip or platform, also non-ferrous. Wrought iron blocks, say, 1in. in height and each weighing 1lb. are distributed evenly over the strip, say 25 blocks.

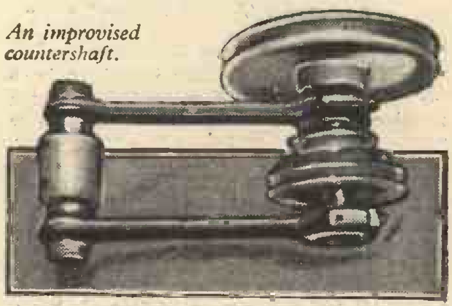
A permanent magnet is secured over the strip, but independent of it or the wheel, at a clearance of 2in. and of sufficient strength to lift the blocks which will be passing beneath.

Now set the wheel in motion, and as each block is lifted strip it from the magnet and replace it in its original position on the moving strip.

It will be seen that with each lift the magnet does 1lb./inch of work. The additional work in reaction against stripping we shall neglect, but its existence should be obvious. Thus in 12 revs. of the wheel the magnet does at least 25ft./lb. of work. Let us now consider the original energising current used in the manufacture of the magnet. Suppose it was equivalent to 1 h.p. applied over ten seconds. I assume this to be adequate, not being conversant with modern magnet manufacturing methods. In such a case the actual input work would amount to 5,500ft./lb., ignoring the losses caused by limits of permeability. This in output work is equivalent to 20 revs. of the wheel. Would the magnet, before that time, have lost so much of its power as to be unable to lift more of the weights, or would it continue to pick up after the 220 revs? From experience of modern magnets I suspect the latter and, should this be the case, is it not a direct contravention of the Law of Conservation of Energy? If the law is not contravened, where does the extra input energy, which must be at least equal to the output, come from? The act of stripping is obviously work done *against* the field, or there would be no resistance from it, and the only work done by the wheel powering mechanism is against friction which, by lightening the load, the magnet tends to lessen. I would welcome your readers' comments.—E. T. BAILEY (Darton).

A Lathe Countershaft

SIR,—In converting my treadle lathe into a motorised job, my only major difficulty was the purchasing of a countershaft, which



An improvised countershaft.

I found was fairly expensive to buy, so I set about making my own.

It had to be simple but strong and able to be made on existing treadle lathe.

I have enclosed a photograph of finished countershaft, the main parts of which are the connecting rods from an old car.

I am sure that there are a number of people in the same position as I was, so I am passing on my idea.—GEOFFREY THORNE (Glamorgan).

Trade Notes

V.P.I. Coated Papers for Rust Prevention

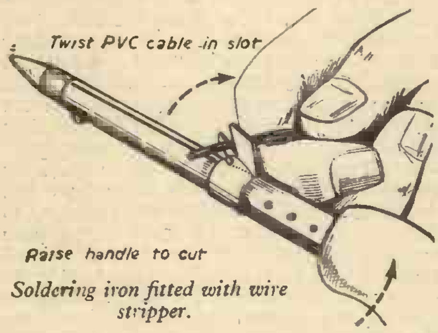
THIS paper, a product of the Royal Dutch-Shell group of companies, is a new form of rust prevention. The letters V.P.I. stand for Vapour Phase Inhibitor, the unique feature of which is that it prevents corrosion when a combination of moisture and oxygen (the prime cause of rust) is present. It is slightly volatile and, in a package, vaporises slowly from the coating on the paper, permeates the air and forms a non-corrosive local atmosphere; any water inside the package absorbs the V.P.I. and becomes incapable of causing rust. V.P.I. does away with the necessity of using oil or grease coatings, and the metal parts of components which are packed by the V.P.I. method arrive at their destination ready for use; for protecting the internal precision parts of instruments such as timing mechanisms, V.P.I. is invaluable. These papers are being used for wrapping a great range of products, ranging from car bodies to hairpins. Full details of these papers and instructions for use are contained in a special booklet issued by the makers—Leonard Stace, Ltd., Cheltenham, England.

Coronet Lathes

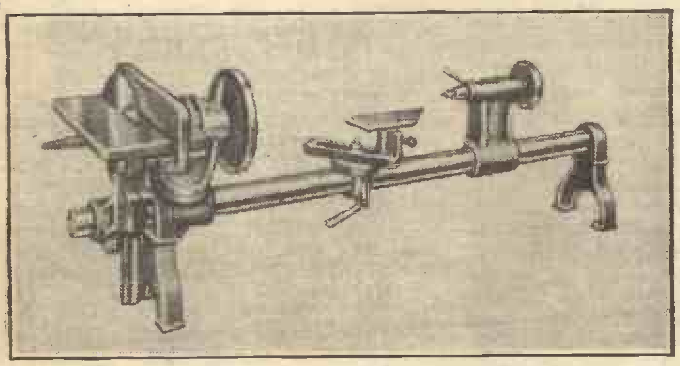
THE Home Cabinet-maker is being used extensively in many varied spheres, including educational and handicraft centres and building departments and sites, where the machine is taken to the job for floor block and panel cutting, etc. All the attachments are separate and distinct and the purchaser may use any combination of accessories he chooses for the lathe, which is made in three lengths and is suitable for use in the small workshop or as an auxiliary in a large workshop. Features include a swivelling headstock which allows large work to be done on the faceplate, work which is outside the scope of most lathes limited to the height of their centres. It is also provided with zero indication line for each position, i.e., plain turning and circular sawing, bandsaw and extra large work on the faceplate. Other features include an adjustable large bronze main bearing, totally enclosed back ball bearing and ball thrust, screw feed to tailstock with brass pad locking device, two-speed cone pulley for vee drive, and a large faceplate.

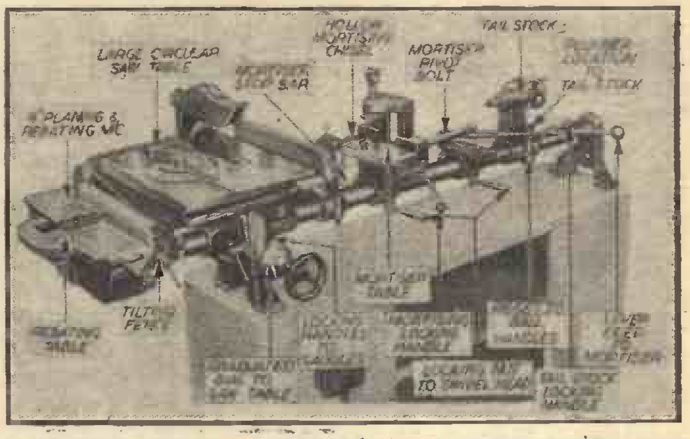
The Coronet "Major" is a combination woodworking, metal turning and spinning lathe with height of centres 4½in. and length of bed 4ft. It can be supplied complete with attachments for the following operations: turning to over 2ft. in diameter; circular sawing, using 8in. blade; band sawing; band sanding; disc sanding; buffing; planing and rebating; tool sharpening; side and end mortising. It is adaptable for flexible drive equipment and everything is driven by the one self-contained motor. It is fitted with a swivelling-type head and the headstock may be swivelled to any angle, even while the circular saw or planer is in use, enabling the user to saw or plane any length of material in the most confined space. It is fitted with large, adjustable bronze bearing and ball thrust. The spindle is of extra heavy and unique design and has a screwed nose, and is bored No. 1 Morse taper to receive centre and all standard drills, etc. The tailstock is fitted with a large sliding barrel, bored No. 1 Morse taper and operated by a machined handwheel; the whole unit is plunger located and can be locked in any position of the bed by a ballhandle. The unit may be thrown out of position to give the operator freedom when doing faceplate work. The tool rests are mounted on two separate carriages, may be used together or independently, and are also plunger operated. The circular saw has many valuable features incorporated. With the "Major," a battery of three attachments may be kept mounted at one time, thus saving changing time although this operation is only a matter of seconds. The circular saw attachment need never be dismantled.

The address of the Coronet Tool Co., is 8, Mansfield Road, Derby.



Soldering iron fitted with wire stripper.





Above—The Coronet Home Cabinet-maker.
Right—The Coronet "Major" with its many attachments.

"Construct Your Own Refrigerator"

THE above titled booklet is written by a refrigeration engineer and is intended to give guidance to those enthusiasts who would like to construct their own refrigerator. The different systems and the equipment required are dealt with and insulation lining, layout and interior fittings are gone into; there is also a chapter on converting the larder. The booklet is profusely illustrated and many satisfactorily-operating amateur built refrigerators are shown. This book is published by the author Robert C. Scutt, 52, Hadley Way, Winchmore Hill, London, N.21.

Wolf Electric Soldering Iron Attachment

WOLF Electric Tools, Ltd., announce that Wolf Solderguns type numbers 31 and 41, and Soldering Irons numbers 32 and 42, will in future be fitted with a patent wire stripper for stripping plastic-covered wires prior to soldering. The stripper is conveniently fitted to the barrel of the tool.

It can be used on all sizes of plastic insulated wires—single or stranded—without damage to the internal wire or stranded conductors. This innovation will be of great assistance to the operator and, as shown in the illustration, the stripping can be done with ease and simplicity and, particularly on repetition work, will save much time and reduce fatigue. The attachment is not suitable for stripping rubber insulation.

BOOKS REVIEWED

Motor-Cycle Repair. By A. St. J. Masters. Published by C. Arthur Pearson, Ltd. 192 pages. Price 6s. net.

THIS book is a practical guide for motor-cycle dealers, repairers and owners, and anyone who is contemplating opening up a repair business. The private owner who carries out his own repairs will find in this book much useful information on all phases of repair and maintenance work. There are thirteen chapters and the subjects covered include : Repair Shop Layout ; Engines ; Brakes, Wheels and Chains ; Spray Painting ; Soldering ; Measuring and Timing ; Carburation ; Two-stroke Motor Cycles ; Lucas Electrical Equipment and Final Tuning. The appendix includes several tables of technical data, and there is also a very full index. The book is profusely illustrated with line diagrams and half tones.

Modern Applied Photography. By G. A. Jones, M.A., F.R.P.S. Published by Temple Press, Ltd., 162 pages. Price 9s. 6d. net.

IN this book the author draws upon his wide experience to survey the scope of applied photography in most major branches of industry, emphasising its value in research and investigation, as well as in simple recording. All the chief modern techniques are clearly explained, with the reasons underlying their uses broadly analysed in terms of the fundamental properties of light-sensitive photographic material. The book contains many examples of applied photography in a wide variety of industries. In addition to many fine half-tone illustrations, the book includes a useful bibliography.

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.

OPPORTUNITIES in Radio and Television Servicing.—Full-time theoretical and practical 1-year courses at E.M.I. Institutes in London. Job assured on successful completion. Next course commences April 14th. Early enrolment is advised. Free brochures giving details of these and other courses from E.M.I. Institutes, Dept. PM36, 10, Pembridge Square, London, W.2. (Tel.: BAYswater 5131/2.) (Backed by H.M.V., Marconiphone, etc.)

COLLECTORS

AIR LINE LABELS: 100 different, 7/-. Cormack, 75, Overstrand Mansions, London, S.W.11.

MATCHBOX LABEL APPROVALS ! Stamped envelope, please. "Mekalabels," 3, Alpha Road, London, S.E.14.

EDUCATIONAL

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

BECOME A TEACHER of Woodwork or Metalwork. Interesting well-paid work with pensionable security. Long holidays. No previous experience required. Expert rapid postal coaching, low fees. Books provided free. Send now for free prospectus, Dept. 24, Chambers College, 148, Holborn, London, E.C.1.

RADIO AND ELECTRONICS Correspondence School. Easy postal courses in radio and electronics, specially prepared for the amateur and beginner. Complete courses from £2. Syllabus free. Write, The Secretary, Radio and Electronics Correspondence School, 27, Belmont Road, Wallington, Surrey.

A.M.I.Mech.E., B.Sc., CITY & GUILDS, Etc. Guaranteed postal courses for all Exams. and Technical Divisions from Elementary to Degree standard. Approximately 95% successes. 144-page prospectus free on request. B.I.E.T. (Dept. 967), 17, Stratford Place, London, W.1.

FREE ! Brochure giving details of courses in Mechanical and Production Engineering, Draughtsmanship, etc., for the A.M.I.Mech.E., A.M.I.P.E., City and Guilds, and other Professional examinations. Train with the Postal Training College operated by an industrial Organisation ; moderate fees. E.M.I. Institutes, Postal Division, Dept. PM30, 43, Grove Park Road, London, W.4. (Associate of H.M.V.)

I.P.R.E. TECHNICAL PUBLICATIONS. 5,500 Alignment Peaks for superheterodynes, 5/9 ; Data for constructing TV aerial strength meter, 7/6 ; sample copy "The Practical Radio Engineer," quarterly publication of the Institute, 2/- ; membership and examination data, 1/-. Syllabus of 7 postal courses free and post free. Sec., I.P.R.E., 20, Fairfield Road, London, N.8.

FOR SALE

BRIGHT MILD STEEL, over 40 sections in stock; s.a.e. for list. B. J. Harris, The Cottage, Corngreaves Hall, Cradley Heath, Staffs.

REJUVENATE your water softener; new Zeolite, 2/3 lb.; 10lb. post paid. C. G. Nelson, 118, Anchorway Road, Coventry.

FOR SALE, 4ft. S.C. Treadle Lathe, in perfect condition, 5in. bed, 18in. centres, hollow mandril, accessories and tools; best offer over £25. Parsons, 24, Barbara Close, Rochford, Essex.

HOUSE SERVICE METERS, credit and prepayment ; available from stock. Universal Electrical, 221, City Road, London, E.C.1.

A FOOT MOTOR will drive your lathe, etc. ; make your own, easily, for 5/-; proved Drawings and Instructions, 2/6. Sinclair, Buss-Craig Road, Eyemouth, Berwickshire.

COMPRESSOR EQUIPMENT, Miscellaneous Items; catalogue, 1½d. Pryce, 157, Malden Road, Cheam.

GYRO COMPASS, 24 volt, comprising master unit, setting corrector, auto and pilots repeaters, azimuth circle, switches, diagrams; full instructions; perfect order; ex-R.A.F. ; cost hundreds of pounds; £12. Abbott, Rothesay, Stourport-on-Severn, Worcs.

HIGH-SPEED TWIST DRILLS, 1 set, in sizes 3/64in., 1/16in., 5/64in., 3/32in., 7/64in., ⅛in., 9/64in., 5/32in., 11/64in., 3/16in. and 7/32in., for 10/-, post free; 11 drills in set; all new and clean and guaranteed 18% Tungsten; cash returned if not completely satisfied. R. Coleman, 170, Brookscroft Rd., London, E.17.

ELECTRIC MOTORS, B.T.H. 230/240, ¼ h.p., 1,425 r.p.m.; new and unused; £5/5/- each. Miniature 12 or 24v. Motors, A.C./D.C.; ideal for models, etc.; size 2½in. long x 2in. x 1½in. New Twin 40w. Ballast Units, no starter required; all voltages, 200/250 supplied ; 25/-; requires holders and lamps only to complete ; Single 40w. Units, S/H, 17/6 ; Holders, 2/6 each ; Starters, 2/6 each ; 24v. Vent Axia Fans, new, 45/- each Crompton Parkinson Chlorinator Pumps, 220v., 230v., A.C., ¼ h.p. ; little used ; £10. Harringy Photographic and Electrical Supplies, Ltd., 423, Green Lanes, N.4. (Tel.: MOU 2054.)

COMPRESSORS, twin cylinder, large XWD, professional type ; full details and list; s.a.e. Rogers, 2, Matlock Avenue, Southport.

COMPRESSORS for sale, 3 CFM, 180lbs. sq. in., on metal base, with driving wheel and receiver, price £3. ¼ h.p. Heavy Duty Motors, price £3 ; carriage forward. Wheelhouse, 1, The Grove, Isleworth. (Phone : Hounslow 7558.)

TRANSFORMERS, for trains, welding, low voltage lighting, battery chargers, etc. ; all transformers fitted with "earth protection" screen, "play safe." Write or phone your requirements to F. W. Whitworth, A.M.Brit.I.R.E., Model Dept., Express Winding Co., 333, London Road, Mitcham. (MIT. 2128.)

SYNCHRONOUS CLOCK MOTORS, 230v. A.C. S/Ph 50c., 12/6 each, plus 1/-. Postage Universal Electrical, 217, City Road, London, E.C.1.

FLUORESCENT 80w. brick Choke, 220/230v., with circuit for 5ft. tube, 17/6. 6 and 12v. Car Battery Chargers at 2-amps., complete, guaranteed, 45/-. Metal Rectifiers, 6 and 12v. at 2 amps., 8/9. Rotary Converters, 12v. or 24v., D.C. input, giving 250v. at 60m/a and 6.3v. at 2.5 amps., 8/6. Malden Transformer Supplies, 200, Cambridge Road, Kingston, Surrey. (KIN. 5501.)

NUTS, BOLTS, SCREWS, Rivets, Washers and hundreds of other items for model engineers and handymen. Send now for free list. Whiston, New Mills, Stockport.

THE "E.W." CONVERTIBLE, 2½in. x 8in. lathe, fully convertible from plain lathe to hand traverse, brack-gear and screwcutting ; price from £13/4/-. Ideal for beginner or expert ; immediate delivery—credit terms. Send 2½d. stamp for fully illustrated leaflet. Wanstead Tool Supplies, 48, High Street, London, E.11.

LENS WORKERS : Supplies of Abrasives. Lists available. Mason & Gantlett Limited, 3, Orford Place, Norwich.

DUPLEX Decorative Transfers, Coronation Transfers, Trademarking Transfers. List and samples, 6d. "P.M.," Axon Harrison, Jersey.

STAINLESS STEEL CYLINDERS, 24in. x 12in., tapped ½in. gas both ends, tested to 400 p.s.d., 35/- each, carriage 5/-. Propellers, 4-bladed, 3ft. dia., suitable for wind chargers, 37/6, carr. 2/6. 10 x 80 Zeiss Naval Binoculars, with stand, offers. W. Humphries, Podghill, Bude, Cornwall.

SAW BENCHES, 7in. £4/15/-, 8in. £5/10/- ; Combination Lathes £10 ; Planers, £9/10/- ; Motors. Spindles. Send 4d. stamp for complete illustrated booklet. H.P. available. James Inns (Engineers), Marshall Street, Nottingham.

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(Continued on next page)

(Continued from previous page)

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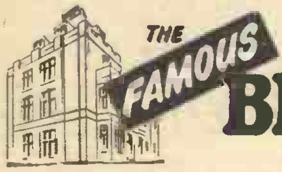

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QUERIES and ENQUIRIES

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

Testing for Carbon Monoxide

I HAVE an anthracite stove which I suspect may be allowing carbon monoxide fumes to escape into the room. Is there any simple, inexpensive way to test for carbon monoxide ?—T. A. D. (Cheshire).

WHAT you think is carbon monoxide escaping from your stove may be mainly carbon dioxide, air and the sulphurous fumes accompanying incomplete combustion. Carbon monoxide is quite odourless and, of course, virulently poisonous. If there is a good red fire in the stove there is unlikely to be carbon monoxide in any quantity. If there is a blue lazy flame on top of the anthracite, that would indicate carbon monoxide being formed, which, anyway, is formed in most slow-combustion stoves when the draught is cut down. There is no simple, reliable test for this gas, and if you feel that there is an escape of flue gases into the room you should have the stove examined by a competent stove man. There are chemical tests for the gas, but even in mines they rely on canaries for safety. The gas causes drowsiness before unconsciousness, and it is therefore very insidious.

"P.M." Telescope Query

I HAVE made the telescope described in "Practical Mechanics," June, 1952. On trying out same, star images are good, although faint. Looking at the moon, a good image is obtained, but appears to be out of focus, which I cannot correct by eyepiece draw tube.

Please could you tell me the formula for finding the position of the stop in the eyepiece—W. MacKenzie (Beckenham).

IT is difficult to say just what is wrong with the telescope, but the error is probably in the amount of separation between the eyepiece lenses. In the articles, particularly the one in the September issue, enough has been said to enable you to get the spacing correct, but it may be worth while to take the lenses out, check up on their foci and see that the separation agrees with the formula.

It is most important that all the lens surfaces be spotlessly clean, and this applies to the object glass as well. There must be no trace of glue on any polished surface and the O.G. must be mounted dead square in the tube, as, indeed, must all the lenses.

In the eyepiece the larger lens is the field and should be farthest from the eye; both this and the eye lens should have the convexed sides toward the object glass. There is no fixed formula for placing the stop. With Broadhurst, Clarkson's lenses it can be approximately midway between the field and the eye.

Suitable Metals for Electrodeposition

CAN you please answer the following queries on metal forming by electrodeposition ?

How does the strength of the deposited metal or alloy compare with that of the anode for such metals and alloys as aluminium and aluminium alloys, copper, stainless steels and bronze ? How can I make salts for these metals and alloys ?—R. Hayes (Newcastle-on-Tyne, 7).

MOST metals deposit in the hard condition, for example nickel as cast has a Brinell hardness number of between 70 and 90, but when deposited this becomes 155 to 429 according to the composition of the plating bath.

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.

Of the metals listed in your letter, however, only copper is capable of being electrodeposited with any degree of success.

The deposition of aluminium is still in the laboratory stage and even then only microscopically thin deposits can be obtained.

Stainless steel cannot be electrodeposited at all and bronze, while it has been suggested as a possible undercoat for chromium on steel, as an alternative to nickel has not reached a very advanced stage of development.

Generally, the metals most suitable for electrodeposition are copper, nickel, silver, tin, cadmium, zinc, lead and chromium.

Cistern Fault

I HAVE a lavatory cistern which, after being out of use for a month or two and with previously perfect performance, now fails to cut off after flushing. It is of the syphon type with cast-iron bell and operates straight off the high-pressure main water supply. The flush is satisfactory, but on release of the chain (whether immediately or delayed) it continues to syphon out indefinitely with a fairly slow trickle. This can only be overcome by raising the bell again immediately the flush is completed. Hence to flush requires two pulls on the chain. I have tried reducing the mains pressure, but this fails to cure the trouble. Can you please suggest the cause and a cure ?—H. W. Fensom (Romford).

THE trouble sounds like a faulty inlet valve. Sometimes the valve becomes worn or corroded, and fails to seat. This means that the water flows over the syphon continuously. The trouble is not due to the bell, although you should clean out the scale and rust that sometimes accumulates at the bottom of the cistern.

Ths only remedy for a leaky inlet water valve is to buy a new valve and ball arm, which are sold complete. You can easily screw this into place. You should, however, first check the ball to see that it is not leaking. Unscrew it and shake it; if you hear water inside it should be renewed before buying valve.

Electric Furnace Materials Suppliers

I HAVE commenced to make a small electric furnace as described in the December issue of "Practical Mechanics," but have been trying for three weeks to obtain some of the necessary materials, namely :—

"Sindanyo" heat resisting board.
"Newtempheit" fibre lagging.
"Sillimanite" Alumina cement.
"Kanthal" 32 S.W.G. resistance wire.
"Varnoflex" three-core 23/.0076 flexible cable.

Could you tell me where they may be obtained ?

Would it be possible to incorporate a potentiometer in the circuit to permit a fine control of the temperature, plus a pyrometer to give visible indication of the exact temperature ?—D. B. Arden (Kent).

WE suggest that you try the following suppliers :—

Sindanyo.—Turners Asbestos Cement Co., Ltd., Trafford Park, Manchester, 17.

Newtempheit.—Newalls Insulation Co., Broxbournbury, Broxbourne.

Aluminous Cement.—Lafarge Aluminous Cement Co., Ltd., The Kilns, Ripley, Surrey.

Refractory Cement.—Thomas Bishop, Ltd., 39, Arthur Rd., Wimbledon Park, S.W.19.

We suggest that you use 80/20 nickel-chrome resistance wire as obtained from Vactite Wire Co., Ltd., 75, St. Simon St., Salford 3, Lancs.

Asbestos Covered Wire.—General Electric Co., Ltd., Magnet House, Kingsway, London, W.C.2. E. & E. Kaye, Ltd., Queensway, Ponders End, Middlesex.

Either a variable series resistor (having a value of about 300 ohms) or a potentiometer could be used to control the heating, but we think the furnace is rather small for use with a pyrometer.

Oil-burning Unit Modification

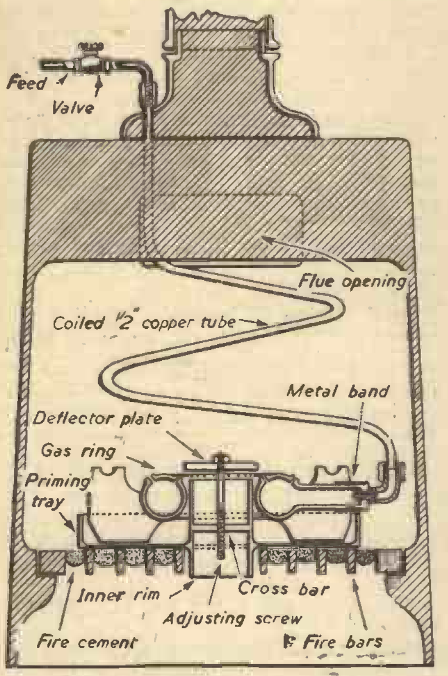
I HAVE an Ideal Neo-Classic hot water boiler which I should like to convert to burn diesel oil, but have not the clear-

ance at the front of the boiler to adapt the unit designed by W. A. in "Practical Mechanics," January issue.

I have heard that the same results can be had by using a common domestic gas-ring fitted inside the present fire, with only slight alterations.

Would you let me know what alterations would be required to the fire-bars, gas-ring and draught regulator ; also what design should the well plate be for the first flashing up ? I believe that the design of this plate has a lot to do with the size of the draught aperture 6in. x 3in.—C. Mather (Grimsby).

THE principle of the adapted gas-ring as the basis of an oil burner suitable for use in a small boiler is outlined below but, as its application does not obviate the need for a vaporising tube and, as this would require to be fitted entirely inside the stove along with the burner, the unit may prove somewhat inconvenient to service. The general



The oil-burning unit using a gas-ring.

layout is shown in the accompanying figure.

With a chimney outlet of only 18 sq. in., the volume of air it can pass will be rather restricted and so the smallest obtainable gas-ring should be used. This has its jet removed, the Bunsen regulator closed by a gas-tight metal band, and a suitable angle-joint and union fitted in place of the nipple. Since air must mix with the gas *after* it has issued from the ring, this is supplied via the centre of the priming-tray, the central extension of which passes through a hole cut in the fire-bars, the remainder of the bars being closed with fire-cement.

The priming-tray is ring-shaped with an outside diameter sufficiently large to accommodate the feet of the gas-ring, the inner diameter being such that its rim will just pass inside the centre of the ring. The height of the outer rim must be such that the inlet pipe of the ring will clear. The inside rim extends below the tray to the depth of the fire-bars and the top edge should come to within a ¼in. of the top of the ring. Half-way down the inside of this inner rim is secured a narrow cross piece, ¼in. thick, and drilled and tapped in its centre ¼in. Whit. A circular deflector plate with a diameter ½in. greater than the outer edge of the inner rim is drilled and tapped ¼in. Whit., screwed to one end of a short ¼in. rod and secured with a lock-nut. The other end of the rod is also threaded and screws into the cross piece inside the centre rim. As this plate is intended to be adjustable so as to enable the best height to be found (usually between ¼in. and ½in. above the rim), a few notches filed round the perimeter would enable it to be screwed up or down with ease by means of a rod, even though the burner were lit. It would be necessary to have the various parts of the priming-tray welded together, and sheet steel of not less than ⅛in. thick would be suitable for all except the deflector plate, which should be ¼in. thick.

A coil of ½in. copper tube would make a suitable vaporiser, it having one end attached to the ring and the other passing out of the stove as near to the top as possible, where it is coupled to the feed pipe, the flow of fuel being controlled by a small valve.

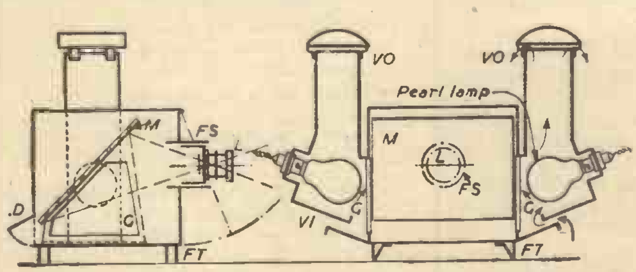
In operation the burner is primed with paraffin and a little waste and the fuel turned on when the coil and ring are judged to be sufficiently hot to vaporise the oil. The fire door must be kept closed except when adjusting the deflector plate, and the damper must always be fully open, the heat being regulated by the feed.

By substituting diesel oil for waste sump oil, vaporisation will be effected at a lower temperature, but even so, these burners do not work well if starved, as the gradual loss of heat due to radiation and absorption by the water in the boiler will eventually so cool the tube that wet oil will be fed to the burner, running over into the tray and, of course, if neglected, out of the bottom of the stove. In this connection it should be mentioned that, for insurance purposes, such an oil installation is classed as being "manually operated," and it would be inadvisable to leave it unattended for a prolonged period.

Episcope Construction

I WISH to make an episcope, using an 8in. f2.9 Pentac lens, and should be glad if you could give me the layout of the mirror, lamp, etc. I should like to insert the original picture horizontally at the base of the unit.—J. W. Pass (nr. Leeds).

THE mirror must make an angle of 45 deg. since the axis of the lens and the plane of the picture, or object, are at right-angles one with the other. Vertical illumination, by the lamp, is neither possible nor desirable. It is not possible because the mirror prevents this and it is not desirable because with a bright object or glossy picture the lamp would be reflected into the picture. Your best plan is to arrange for two lamps, one on each side, and let the lights from these shine into the box through glass sides. By this means the heat is kept away from the object.



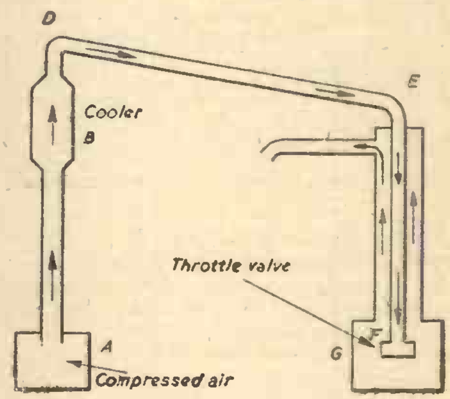
The episcope in longitudinal and cross section. L lens, FS focusing slide ; M mirror at 45 deg. ; G glass panels ; D door for changing picture or object ; VI ventilation incoming ; VO ventilation outgoing ; FT feet.

The lamps must be encased in metal and well ventilated. For the purpose of displaying objects in strong relief it would be advisable to have separate switches on the lamps, so that illumination can be, when desired, on one side only. *The sketch* shows the episcope in both longitudinal and cross section.

INFORMATION SOUGHT

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

Mr. E. J. Crocker, of Penzance, asks : How can I lower the temperature of air by taking advantage of the cooling that occurs when a gas is compressed and expanded adiabatically



Arrangement for lowering air temperature.

or approximately so ? My apparatus is shown in my *sketch*. Air, compressed in a chamber A, is delivered into a cooler B, where its temperature, which has risen during compression, is lowered. The air passes along DE and on to a throttling valve at F, by means of which the air experiences a drop in pressure and expands into a box G. The air passes upwards through a pipe which encloses the pipe to the throttling valve and abstracts some heat from the air.

(a) Could you give me a rough idea of the construction of the throttling valve ?

(b) Is this valve a venturi ?

(c) Would the box G be an ordinary enclosed chamber ?

Mr. C. J. Blamire, of Gloucester, writes : I would appreciate help or information in the making of a torch that will last for half an hour and will be safe in operation.

Mr. C. Micallef, of Malta, lists the following queries : (a) What is the process of making pearl powder out of fish scales which is being used as a polish for painted plaster figurines ? I believe that pearl powder can be made into a paint, when varnish is added and well mixed.

(b) What is the process of making artificial pearl paint ?

(c) The following formula is for fusing glassware and silver nitrate for decorative purposes. It is complete except for weight percentages. I wondered if you could suggest any alterations :

Precipitate of lead (lead borate), silver nitrate, borax, gum arabic, distilled water. Boil lead borate until crystals form, dry crystals, pulverise with silver nitrate and borax, added, then add gum.

Can I obtain colours such as gold, red, etc. ?

Mr. T. O. Edwards, of London, S.W.9, requires : Full details of how to transfer a photographic image on to an aluminium plate. It is to be used in a rotary printing machine, and except for the image it should resist all chemicals to be found in printing inks.