Make your own Thermometers!

26

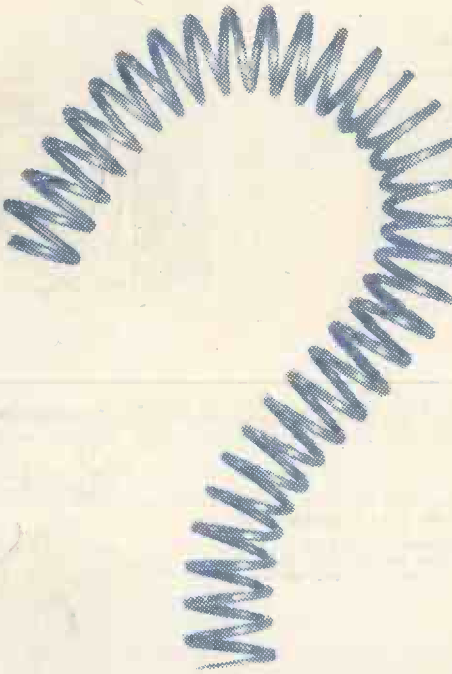
1'3

PRACTICAL MECHANICS

EDITOR : F. J. CAMM

MARCH : 1958

Contents



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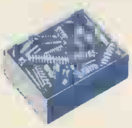

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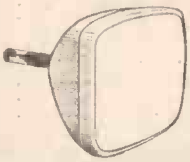

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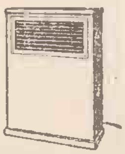

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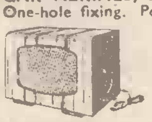

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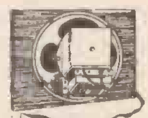

3 and 4 waveband turret tuned. Superhet. A.C. chassis, with 6" or 8" speaker. Size 8½" x 10½" x 12". Valve line up: CCH35, EF39, EBC33, CL33 and CY31. (C1C or dropper.) Ins., carr., 7/6.

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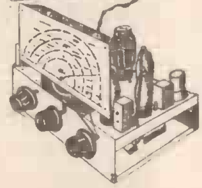

5 valve superhet chassis including an 8" speaker, 4 control knobs (Tone, Volume, Tuning, W.C. Switch); 4 waveband with position for gram., P.U. and for extension speaker. A.C. P. & P., 5/6.

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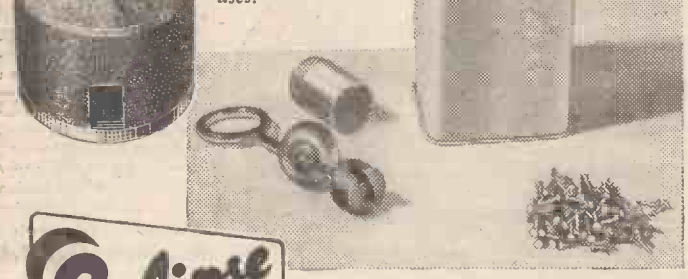

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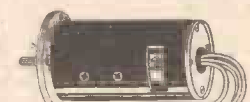

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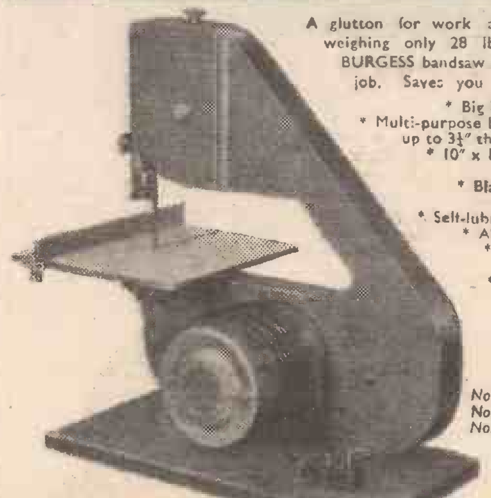

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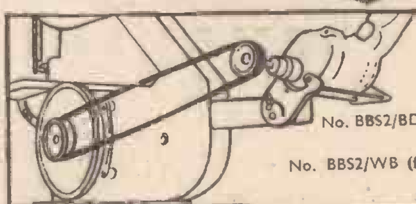

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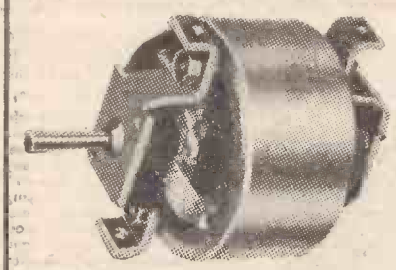

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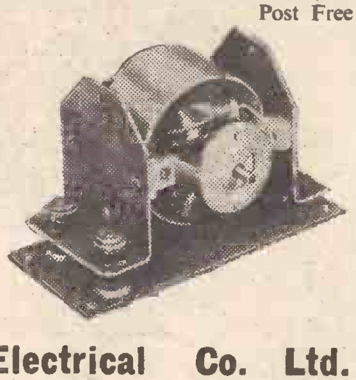

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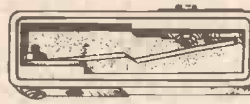

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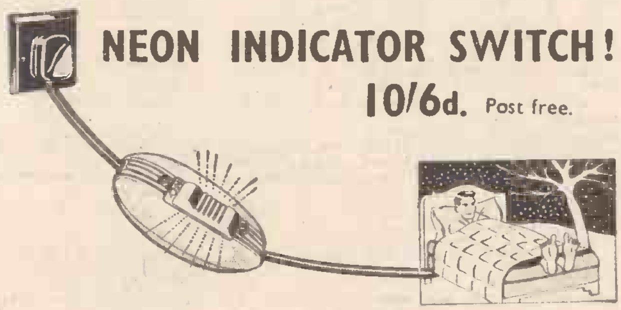

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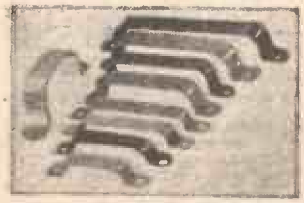

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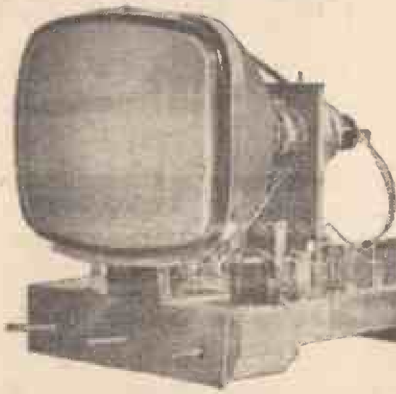

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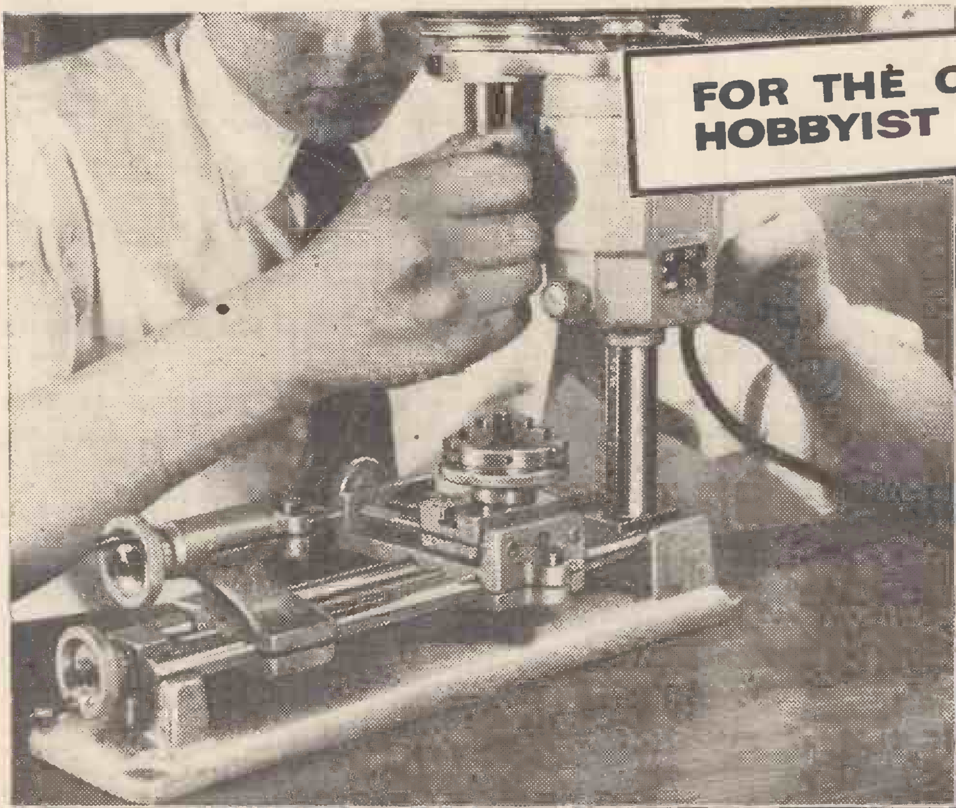

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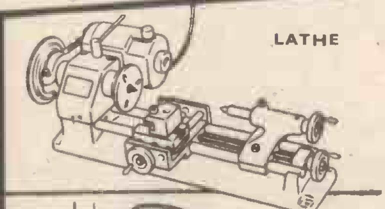

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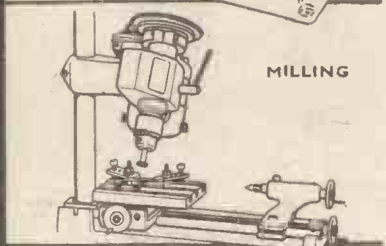

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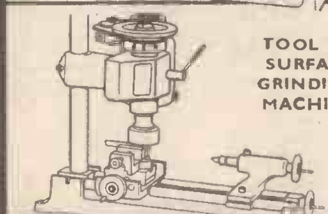

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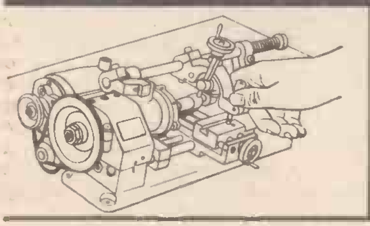

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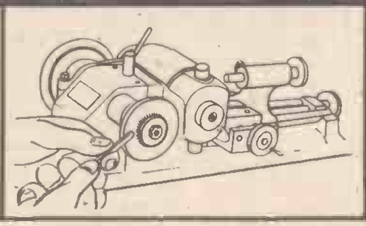

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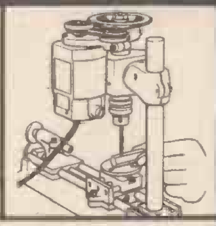

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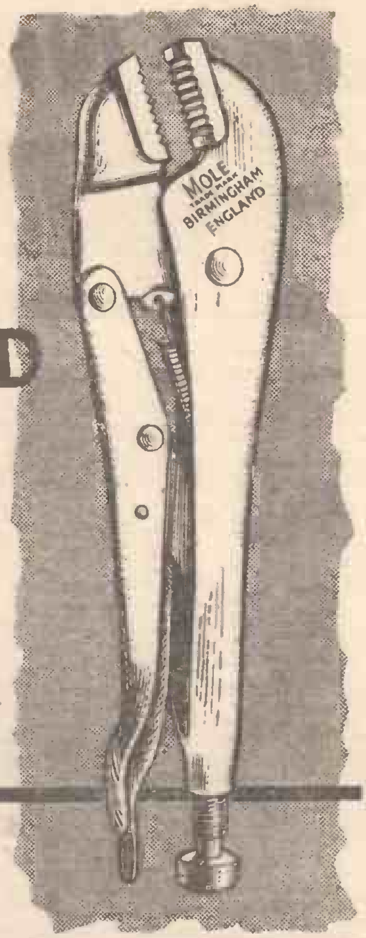

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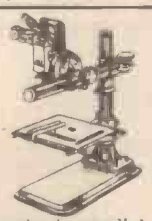

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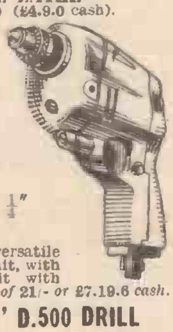

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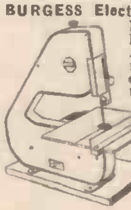

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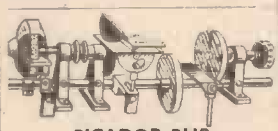

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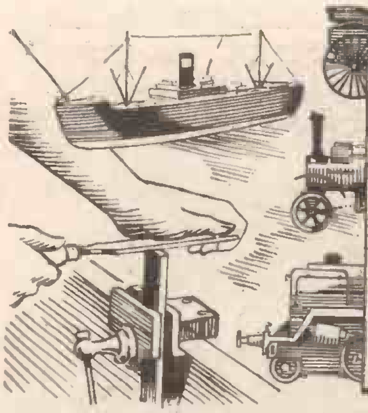

Practical Mechanics

Vol. XXV. No. 289 MARCH, 1958

"The Cyclist" and "Home Movies" are temporarily incorporated

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CONTRIBUTIONS

The Editor will be pleased to consider articles of a practical nature suitable for publication in "Practical Mechanics." Such articles should be written on one side of the paper only, and should include the name and address of the sender. Whilst the Editor does not hold himself responsible for manuscripts, every effort will be made to return them if a stamped and addressed envelope is enclosed. All correspondence intended for the Editor should be addressed: The Editor, "Practical Mechanics," George Newnes, Ltd., Tower House, Southampton Street, Strand, London, W.C.2.

FAIR COMMENT

EXTRA NEXT MONTH!—"THE PRACTICAL PHOTOGRAPHER" 16-PAGE PULL-OUT SUPPLEMENT

STARTING next month, each issue of this journal will contain as an extra, THE PRACTICAL PHOTOGRAPHER pull-out supplement. It will, indeed, be a free photographic journal, containing each month articles on camera selection and adjustment, colour photography, developing, printing, the dark room and its equipment, camera accessories, enlarging, touching up, taking photographs, mounting, selling photographs and, in fact, every aspect of photography both practical and theoretical.

The decision to issue this supplement has been brought about by the greatly increased interest by our readers in photography, an interest which has been increasing year by year since the last war. It was obvious that the occasional articles which were published herein were insufficient to satisfy the demand for more photographic material, and it was felt that the subject is now of such wide national interest that it deserves a supplement all to itself. It will have its own free enquiry bureau and the articles will be contributed by experts in the various spheres of photography. This supplement will, of course, be *in addition to the regular contents.* Make sure of your copy now, by ordering the April issue of PRACTICAL MECHANICS with the extra 16-page Pull-out PRACTICAL PHOTOGRAPHER supplement.

THE AMERICAN SATELLITE

THE successful launching in America of another artificial satellite provided further indication of the great advances which are being made towards the ultimate—namely, space travel. The American satellite is orbited at a higher altitude than Russian Sputnik 2, but this is undoubtedly due to its somewhat lighter weight. The Explorer, as the American satellite is named, weighs 30.8 lbs., including 12.67 lbs. of final stage rocket. The maximum height of its orbit is 1,736 miles at a speed of 18,000 miles an hour, and its time of making one orbit round the world, is from 106 to 114 minutes. It is 80in. long, 6in. in diameter, and was launched on January 31st. Sputnik 1, however, weighed 184 lbs., took 96.2 minutes for an orbit at an altitude of 560 miles, speed 18,000 m.p.h. and was 23in. in diameter. It was launched on October 4th, 1957. The more ambitious Sputnik 2 weighs 1,126 lbs., has a maximum altitude of 1,056 miles at a speed of 18,000 m.p.h., takes 103.7 minutes for an orbit and is 15ft. in diameter. This was launched on November 3rd, 1957. It is perhaps unfortunate that these great achievements have been somewhat clouded by the importance attached to their political significance in relation to war. The real scientific developments have received very little publicity indeed, for although neither Russia nor America has released very much technical information a great deal can be learned from deduction. From the British point of view, it is unfortunate that finance prevented us from being first. We are ahead of other nations in many aspects of this new science and our scientists are now ready to launch an artificial satellite as soon as the money is made available.

We should not forget the great pioneer work done by the British Interplanetary Society who, over 20 years ago, forecast with almost uncanny accuracy the design for stage rockets. The delicate machinery and instruments installed in these satellites is a miracle of design and the world awaits, after due lapse of time, release of details.—F. J. C.

The April issue will be published on Friday, March 28th. Order it NOW!

Exploring the Deep Ocean Floor

A Paper by A. S. Laughton, M.A., Ph.D., of the National Institute of Oceanography, read to the Royal Society of Arts on Wednesday, 20th November, 1957, with Sir Ernest Goodale, C.B.E., M.C., a Vice-president of the Society, in the Chair

IT was Aristotle who supposed the world to be made of four basic elements: earth, water, air and fire. Although this idea has long since been superseded, we can, nevertheless, usefully divide the surface of our world into these four constituents, rejecting, however, the last, since it forms so minute a part of the whole. If we consider the remaining three, earth, water and air, we can see that they are present, not intimately mixed, but on the whole separated by well-defined boundaries, each of which is a domain requiring special study and presenting its own problems.

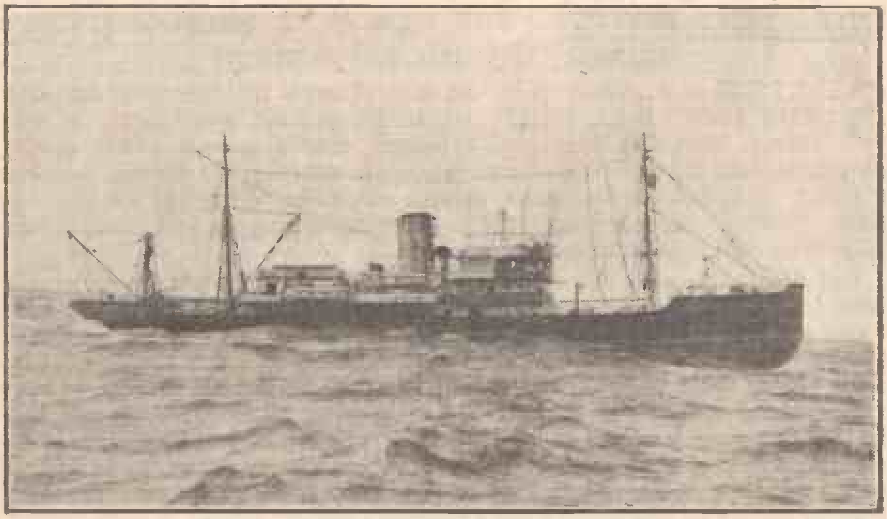


Fig. 1.—The Royal Research Ship " Discovery II."

The boundary between earth and air is the best known of all. Man has lived for many tens of thousands of years on the surface of the land and has studied and explored a great many aspects of it, and to-day we are justified in saying that we know a great deal about it. We cannot claim complete knowledge, for there are great areas such as the polar regions as yet unexplored and many problems yet unanswered, but in comparison with the other two domains our knowledge of the land surface is very extensive.

The surface between air and water presents a different kind of problem. Here we are faced with a mobile surface acted upon by the forces of tide and wind and one which man has been forced to study in order to be able to travel safely over it. But in spite of the thousands of years of practical experience in dealing with its moods it still represents a potential enemy to all who venture on to it, or who live on its borders.

It is the third domain, however, with which I wish to deal here, the ocean floor, where the earth and water meet to exclude all air and where man has seldom been. The deep oceans cover over two-thirds of the surface of the world, and yet more is known about the shape of the surface of the Moon than is known about that of the bottom of the ocean. The dark abysses of the deep sea have always stirred man's imagination, but it was not until the end of the eighteenth century that the first successful steps of deep-sea exploration were made by sounding, using a weighted line. During the next hundred years an increasing number of expeditions took soundings and sampled the bottom in increasing depths of water. In 1840 Sir James Clark Ross made a sounding of 2,425 fathoms in the South Atlantic, this being the first truly deep sounding. It was made by allowing a weighted line to run freely from a large reel on one of the ship's boats and timing each 100 fathoms, a change of speed indicating the bottom. The small boat was necessary to minimise drift and thus to keep the line as nearly vertical as possible. The line had to be reeled in by hand, making such soundings extremely arduous. In 1871 the Royal Society and the Admiralty collaborated in organising a circumnavigatory expedition in H.M.S. *Challenger*, to extend the scientific investigations of the deep sea to the more remote parts of the world. This expedition, which lasted from 1872 to 1876, resulted in a vast amount of information, which now forms the foundation of nearly all aspects of modern oceanography. The cruise reports, contained in thirty volumes and occupying an entire shelf in the library, took twenty years to work up and publish.

Although the *Challenger* was equipped with a steam winch, a deep sounding still took several hours and consequently only the bare outlines of the shape of the bottom were obtained. To-day, such a sounding is taken automatically every few seconds, using acoustic signals, as the ship steams along. On the other hand, the techniques for dredging samples from the bottom have changed very little from the early *Challenger* ones. We still have to haul a heavy steel and wire basket over the bottom and we still run the risk of losing everything if the dredge gets caught up. And to-day the operation still takes just as long. The remarkable thing is that in the eighty years since the *Challenger* expedition the number of species discovered on the deep-sea bed has not greatly increased in spite of the numerous expeditions which have been made.

Aims of Exploration

Before I go on to talk about our modern techniques of deep-sea exploration, I should like to consider what it is that we are trying to find out. In its aim, sea floor exploration is like continental exploration. The first thing we want to know is the lie of the land. Are there mountains and valleys, plains and canyons? And, if so, what is their shape, how big are they and where are they? Topographic surveying is extremely important and forms the framework on which the rest of the studies will be built. In this way we can divide up the sea floor into various regions, each with its own characteristic features and its own problems. All our results will then be correlated with these regions.

Fig. 2.—Profile of the sea floor at 1,800 fathoms as recorded by an echo sounder (vertical exaggeration 7 : 1).

The topographic surveys result finally in contoured charts and sections, but these cannot be detailed enough to give us an idea of what the bottom actually looks like. The second phase of exploration then is concerned with the scenery of the bottom as it would appear if the water were all removed and we could wander around at will. This is equivalent to eye-witness descriptions of what the continental explorer has seen and to the photographic records he has made. It is virtually impossible to reduce to a tabular or numerical form the infinite detail that makes up the scenery and so the only records that can be made are inevitably photographic. With sea floor exploration, photography provides both the means of finding out and the record.

Geologist's Work

Important members of any exploration team are the geologist and the biologist. They can collect specimens that can be examined and analysed in the comfort of the laboratory and provide the scientific data necessary for a full appreciation of the environment. So, with the sea floor, the collection of specimens is a major part of the exploration and takes us from the stage of observation into the stage of detailed analysis. We want to know what the sea floor is made of and how it came to be as we find it now. Not only do we want to know the composition of the surface layers, but we also want to know what lies beneath them and how far they extend.

Here we come into the much more difficult region of exploration, where we have to rely on complicated and indirect means to give us the answers we want. Since it is impossible to have access to great masses of buried rock strata that form the Earth's crust beneath the ocean, we have to use sound waves as our messengers and depend on such information as the velocity of sound in the strata to give us a clue to their composition.

To describe these techniques in detail here would take too long, but in principle they depend on the use of explosions in the sea to generate the sound waves which are picked up by sensitive hydrophones and recorded after being reflected and refracted by the rock strata. These seismic methods, as they are known, are used extensively in oil exploration.

All these studies are interesting enough in themselves and in the data they provide that have immediate and direct application (such as, for instance, the possibilities of oil accumulations under the oceans), but they are also clues in the much more far-reaching problems of why the ocean basins are as they are to-day, when they were formed, how they differ from the continents they surround and whether they are changing. There have been in the past great arguments about the geological history of the oceans, and even to-day there are several opposing theories based on evidence from widely differing sources. Many people have noticed the fact that if the continents could be moved around like pieces of a jigsaw puzzle, they could be combined into a comparatively solid block by bringing America eastwards to the coast of Europe and Africa, the Antarctic and Australia up into the Indian Ocean. The theory was developed by Wegener that the continents did, in fact, start as a block together on one side of the Earth's surface and that subsequent forces (whose origin is obscure) moved them to their present positions. Wegener postulated that all this took place in the comparatively recent era of the Cretaceous—that is, only a hundred million years ago, as compared with the age of the Earth of three thousand million years. We do not believe to-day that such major movements of the Earth's crust could have taken place so late in its life. The geophysical evidence obtained from our exploration of the ocean floor suggests that the oceans of the world are much older than this and have not altered radically since the crust of the Earth cooled and solidified. Furthermore, there appears to be no major difference between the structure of the crust under the Atlantic and that under the Pacific, as one would expect on the continental drift theory. I cannot here, however, go into all the interesting theories about the history of the ocean basins, and more conflicting evidence is even now being obtained from measurements of rock magnetism. I have mentioned just one theory to illustrate how the results of geological investigations of the ocean floor are so vital in helping to solve the problems of crustal history.

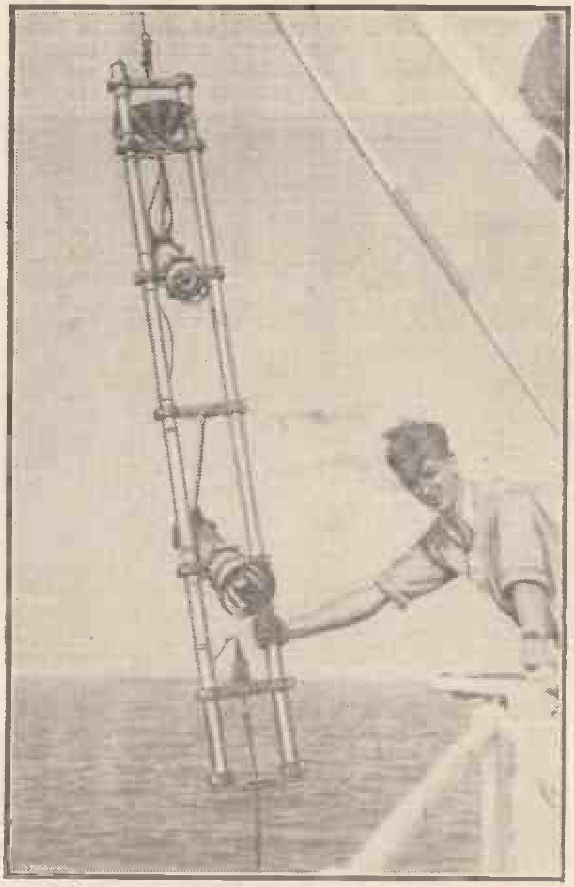


Fig. 3.—A deep-sea underwater camera.

Biologist's Work

The last field of study that I have already mentioned is the biological one. I will not say much about this, since I do not claim to be a biologist and cannot assess the problems accurately. But in my own particular field of deep-sea photography I have been faced with examining and identifying the various animals and fishes that have appeared in the pictures. Our knowledge of the bottom-living fauna of the deep sea has hitherto been limited to the results of dredge hauls in which all sorts of specimens, animals, rocks and mud, are brought up mixed together and frequently damaged. Photographic studies and direct observation (when this is at all possible) enable us to see the fauna in its own environment. We can study the way it lives, its movements and postures and the tracks and burrows that it makes, all in an undisturbed state. We may even discover new species that have escaped the dredges or which are perhaps too big and too fast to be caught by conventional trawls. There is always the fascinating possibility of observing the monsters of the deep that have captured the imagination of so many authors—the giant squid or the sea serpent.

Exploration Technique

I have said enough about what we are trying to do when we explore the deep-sea floor: I now want to examine how we go about it and what we have found. A basic requirement for any sea exploration is a suitable ship and this fact dictates the manner in which all the work is done. The economics of oceanographic work have to be related very closely with those of running and maintaining a ship and this, as you may guess, is an extremely expensive business. The ship has to be big enough to be able to cross the largest oceans and to be able to remain at sea for three weeks or so, and to provide laboratory and living facilities for both scientists and crew. Much of the preliminary examination of the results must be carried out on board. The ship must be equipped with at least one deep-sea winch that contains enough wire to lower instruments to the bottom: in fact, most research ships have two or even more.

The Royal Research Ship *Discovery II*, which is now run by the National Institute of Oceanography is, perhaps, bigger than most oceanographic research ships. She was built in 1929 for the Discovery Investigations Committee, whose aims were to study the marine biology of the waters of the South Atlantic with reference to the whaling industry. As she was going to spend so much time near the ice edge of Antarctica, her specifications were rather more stringent than those of other research ships that do not have to travel so far or in ice conditions. She has a displacement of some 2,000 tons and carries a crew of about 50, together with nine scientists. She has six laboratories on board for various aspects of the work—chemical, biological, geophysical, and so forth—and deck equipment that can handle anything that she is required to put over the side. I will not say that we never grumble at the ship, for she can roll as badly as any in rough weather and her speed is quickly reduced with a head wind. But in comparison with other ships her facilities are excellent.

In planning a cruise of geophysical exploration of the sea floor there are two approaches that can be used, and this choice is forced on us by the fact that we can never rely on the weather to be good. Most of our work has to be carried out in winds less than strong to gale, and for many purposes calm weather is necessary.

We can either decide in advance to study a particular area or feature, steam there and stay around until the weather enables us to carry out our programme, or else we can say that we will steam towards a given area and whenever a nice day occurs stop the ship and explore wherever we happen to be. So long as there are large areas about which we know nothing, then we can most usefully employ the second method, but when we know the general picture, we want to make more detailed studies and to fill in gaps in the survey, and then we have to hope for the best weather or devise experiments that can be made in bad weather.

A Typical Cruise

The cruise that I am going to describe employed both these approaches as you will see. The Department of Geodesy and

Geophysics at Cambridge and the National Institute of Oceanography planned a joint geophysical cruise for July and August in 1956 under the leadership of Dr. Maurice Hill and Sir Edward Bullard. The cruise, which lasted six weeks, was divided by a stop of three days at San Miguel in the Azores for fuel and provisions and for the recuperation of the scientists and crew.

Our target for the first half of the cruise was a valley in the mid-Atlantic ridge where we were anxious to make some measurements of the heat flowing through the ocean floor. This valley has been the subject of investigations on previous cruises and it has been suggested that it runs along the whole length of the mid-Atlantic ridge from near Greenland to the south of Africa. The heat that flows out through the Earth's crust is related to the amount of radioactivity in the rocks forming it, and it is known that certain rocks, in particular the granites which form a large part of the continental crust, have much higher radioactivity than the basic rocks such as basalt. The heat flow, then, can help us to identify the suboceanic rocks. But, although this was one of the principal objects, we also stopped whenever possible to carry out seismic work, to dredge for rocks to core into the bottom sediments and to carry out the first extensive trials of a new deep-sea underwater camera that we had designed and built at the Institute. Similarly, in the second half of the cruise, in which we went farther south, we seized the opportunity provided by the good weather to do as much work as we could where we happened to be, and we, in fact, concentrated our studies for several days on a small seamount that we discovered.

Throughout the whole cruise while we were steaming we made continuous measurements of both the depth, to give a profile of the ocean bottom, and of the intensity of the Earth's magnetic field. We wanted the magnetic field measurements because they are influenced by the presence of rock masses buried beneath the sediment, which otherwise cannot be seen. As these instruments require constant attention, all the scientists on board combined to keep a 24-hour watch on them. This is one of the more tedious duties that befall seagoing oceanographers, but it is nevertheless one of the most important, since continuous records, wherever the ship goes, steadily build up an overall picture of the vast areas of the sea bottom.

A Profile of the Ocean Bed

The depth profile is obtained with an echo-sounder. This is a machine which sends out a short, ultrasonic signal, or "ping," and listens for the echo. The time delay between the outgoing "ping" and the echo is a direct measure of the depth and this is automatically recorded on paper by a rotating pen. A "ping" is sent out every five seconds and so, as the ship moves on, the shape of the bottom is gradually built up on the record. For the sake of convenience and for accuracy of depth measurement the record is made so that the vertical scale is exaggerated to seven times that of the horizontal scale and all features appear much steeper than they really are. Fig. 2 shows a section of the sea bed at a depth of 1,800 fathoms (or nearly two miles) just south of Madeira Island, where the bottom is fairly rough and probably consists of banks of unconsolidated and semi-consolidated sediments. The appearance of the record is often most useful in interpreting the nature of the bottom. For instance, an area where there are a lot of large rocks strewn around gives a much longer echo than an area of uniform sediment, just as in a cave you get reverberations from your voice echoing all around, whereas from a cliff face the echo is sharp and distinct. A hard bottom gives a much stronger echo than a soft bottom, as you would expect.

What have our echo-sounding surveys given us? We have prepared a contoured chart of the ocean bottom of part of the north-eastern Atlantic, based on some 12,000 miles of steaming by *Discovery II* and by ships of the Admiralty Hydrographic Department. We can see that the continents are bordered by a shelf of shallow water, usually less than 100 fathoms in depth, that extends out about 50 miles or so from the coast. Then, going farther seaward, the bottom plunges quite steeply to the great oceanic depths of several thousand fathoms. Compared with typical slopes on the land, the continental slope is fairly gentle (for instance you could quite easily ride a bicycle up the continental slope), but extending for a great many miles. The ocean basin of the eastern Atlantic is bounded on the west side by the mid-Atlantic ridge, which rises to the surface in some places, such as Azores Islands. On the whole the bottom is fairly flat, comparable, perhaps, with the Home Counties, but in some places it is exceptionally flat. These exceptionally flat areas are the abyssal plains and extend for many hundreds of miles with gradients of less than one in a thousand. They are to be found on the continental side of the ocean basins, and the way in which they acquire such extreme flatness is still an unsolved problem.

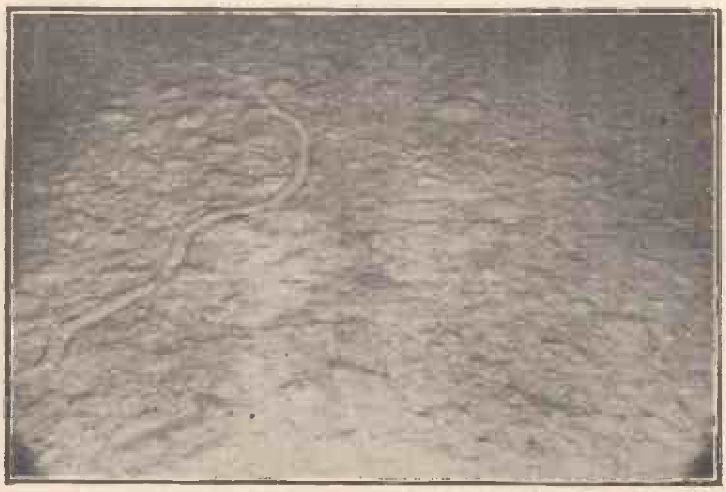


Fig. 4.—Typical view of the deep ocean floor at 2,550 fathoms. The ooze has been disturbed by the burrows and tracks of bottom-living fauna. The track on the left, which is 4 in. wide, has probably been made by a holothurian or "sea cucumber."

Superimposed on the basic pattern of a broad basin confined on one side by the continents and on the other by the mid-Atlantic ridge, we find a number of smaller features such as seamounts, which are usually volcanic in origin, and submarine canyons, cut in the continental shelf or even, in one or two rare cases, cut across the flat floor of the basin. In the region of the eastern Atlantic off the mouth of the Mediterranean there is a great concentration of seamounts, some of which rise out of depths of several miles to within a few fathoms of the surface, where it is possible to anchor the ship.

Underwater Photography

It is in the vicinity of these seamounts that we have taken most of the underwater photographs shown here.

First I want to describe the camera and what is involved in using it. Photographically, the problem is not difficult, since the water near the bottom is extremely clear and all that is necessary is to place a window between the camera and the water. It is true that the water imposes some limitations on the distance we can see and also affects the focal distances but the chief problems of design are concerned with keeping everything waterproof against the high pressures of the deep ocean (up to three tons per square inch) and making the whole unit self-contained and automatic, so that the only control necessary from the ship is that of the wire on which it is lowered.

The camera (Fig. 3) consists of three units, each of which is contained in its own pressure-proof case, together with its own batteries. The lowest unit is the light source, which is an electronic flash similar to those used for indoor photography. No daylight penetrates below a few hundred feet from the surface and so the photographs need artificial illumination. For the same reason the camera needs no shutter since it is always dark. The camera is above the light, so that we can see the shadows behind the objects to judge their height. The spools of the camera hold 15ft. of 35 millimetre film, and this enables us to take up to a hundred pictures in a sequence without raising the camera to the surface. There is a small motor inside to wind the film on to the next frame whenever a picture has been taken. The third unit is the acoustic signalling device or "pinger" which signals to us at the surface, maybe three miles away, that the camera has reached the bottom.

When we want to do a camera station, then, we first examine the bottom by echo-sounding to find out the depth and to place the ship over the feature we want to look at. Then, with the ship stopped and heading into the wind, we lower the camera over the side on our 4 millimetre hydrographic wire. As it goes down we can hear the regular "ping" every five seconds on the hydrophones that we have in the water. These regular "pings" enable us to keep in contact with the camera as the signals get weaker. In deep water it may take half an hour to reach the bottom, and everything must be kept quiet to hear the signals at all. When the camera touches the bottom a fast group of "pings" is transmitted, and the winch operator stops and reverses the winch as soon as possible. The camera is lifted a few fathoms off the bottom and a minute later is lowered to take another picture. By that time the flashlight has recharged and a new film is in position. This process is repeated for as long as we can afford, giving us a series of pictures while the ship drifts, and then we bring the camera up. The whole station in deep water may take three hours. We like to develop and print all the pictures on board and use these as the basis for further experiments such as dredging or coring.

Composition of the Ocean Floor

In the deep ocean basins the bottom is composed of sediments, a mixture of clay particles and the remains of millions of small creatures—the foraminifera—that live in the surface water and sink when they die. It is

(*Continued on page* 306)

MAKING & USING Archery Equipment

No. 1 of a Series Describing How the Equipment for This Ancient Sport May be Made at Home

By F. HOOK

WHEN the bow and arrow became obsolete in warfare, archery continued to be practised as a sport, and, at the present time, it is a sport which is growing in popularity. In most districts there is an archery club where the beginner is always assured of a welcome and where

Fig. 1.—Sections of the two types of bow.

he or she may learn the ancient art and join in the various competitions.

Little equipment is needed in order to follow the sport. In fact, most of it may be made by the prospective archer for an outlay of about £2. The following notes will deal with such topics as making the bow, making strings and arrows together with the making of such accessories as shooting tabs, arm guards, targets, etc. Any person with average carpentry experience and a few of the more common woodworking tools may easily make all the equipment needed for this sport.

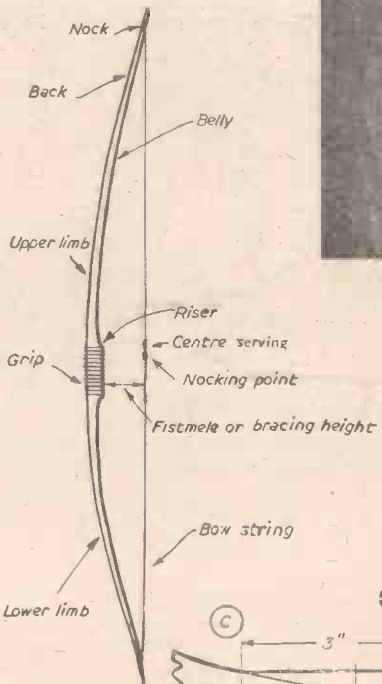


Fig. 2. — The parts of the bow.

The Bow

The traditional timber for bow making is yew, but, unfortunately, this wood is difficult for the amateur to work, and suitable wood is not always easy to obtain. But there is an excellent substitute available known as Degame or Lemonwood. The grain of this timber is so fine that it may almost be ignored when working it. Well-seasoned staves of this timber may be obtained from Irvin and Sellers Ltd., Forge Street, Derby Road, Liverpool, 20. The average cost per stave, already fine sawn to the size required, is £1.

Fig. 3.—Archery is a sport for the ladies too.

There are two kinds of bows, the traditional long bow and the more modern flat bow. The long bow is very smooth in action, but it will not cast an arrow as far as the flat bow. Nevertheless, it is very good for a range up to sixty yards. The main difference between these two bows is in the cross-sections (Fig. 1).

Before proceeding with the constructional notes it will be as well to describe the various parts of the bow. These are shown in Fig. 2. Normally the bow is held in the left hand and the stave is perpendicular to the ground. The part of the bow above the hand is the upper limb, and it is a little longer than the lower limb below the hand.

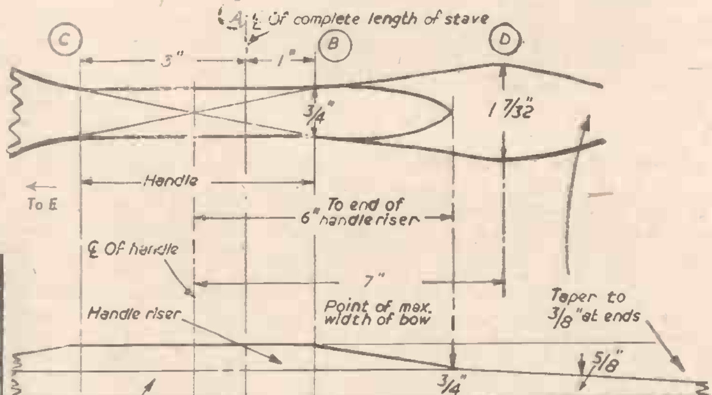


Fig. 4.—Details of the centre part of a flat bow.

At the extreme ends of the limbs are two small grooves filed around the stave known as the upper and lower nocks. It is into these nocks that the bow string is placed. The side of the bow facing away from the archer is the "back" of the bow and the side towards the archer is the "belly."

The first step in the construction of the bow is to determine its length, and this is related to the length of arrow to be used, as shown in the table on the next page.

ARROW LENGTH TO BOW LENGTH
Flat Bow

Arrow	Bow
25 in.	5ft. 0in.
26 in.	5ft. 4in.
27 in.	5ft. 7in.
28 in.	5ft. 9in.

The length of the arrow is a personal factor and measured off from the anatomy of the bowman. To do this, stand with your arm and fingers extended. Place the end of a yardstick against your armpit, extend your fingers along the stick and get someone to read off the length to the second joint of the index finger. This length is the correct arrow length. It is important as it renders the overdrawing of the bow impossible if the bow is held and drawn properly. More will be said of this later.

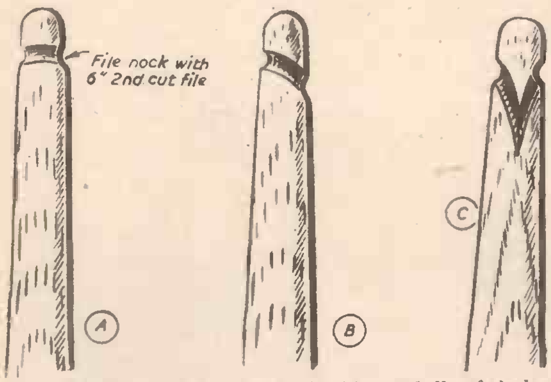


Fig. 5.—Nocks as viewed on back, side and belly of the bow.

Making a Flat Bow

Having determined the correct length for the bow, it is advisable to order a stave from the timber merchant a foot longer than this dimension. This extra foot will serve to make the handle riser.

When the stave is delivered, saw off to the correct length and then lightly smooth down with a finely-set smoothing plane. Be careful to remove only enough material to take away any sign of saw marks or other surface defects.

Make a mark A (Fig. 4) midway in the length of the stave. Make a mark B 1in. above A and a mark C 3in. below A. The space between B and C is the handle. The limb on the side of B will be the upper limb and that on the side of C the lower limb of the bow. From this it will be seen that the upper limb will be 2in. longer than the lower limb. This enables the arrow to be shot from approximately the centre of the bow.

Now 7in. from the centre of the handle mark off a line at D and E. These are the points of greatest width in the bow. i.e., 1 7/32in. From these points the bow tapers off to a width of ⅜in. at either end.

The width of the handle is ¾in. between points B and C. From these points to D and E a smooth curve is drawn.

At this juncture the tapers from D and E to the ends of the stave may be planed. The shaping of the handle must be left until later.

Next the thickness of the limbs is planed down. At 6in. from the handle centre the full ¾in. thickness is kept. At 8in. from the centre of the handle the thickness is ⅝in., half-way to the end of each limb the thickness is ½in., finally ending up at ⅜in. thickness at the extreme ends of the limbs. These dimensions are approximate, and at the tillering stage later on the thicknesses will probably have to be further adjusted.

The spare piece of wood, 12in. in length, may now be planed up and glued in place, 6in. either side of the handle centre. The handle riser should be glued on with one of the resin glues such as Aerolite which is immensely strong and also waterproof. When the glue is properly dry, the shape between lines D and E may now be worked. A bow saw and spokeshave will be useful tools for this task.

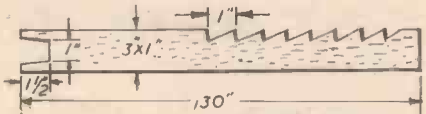
Finally, from points B and C, the handle riser is smoothed off in a regular slope towards its extremities.

Tillering the Bow

At this stage the bow has been shaped and the handle riser fixed. The edges of the upper and lower limbs have been left square, and so they must be left until the bow is tillered.

Before tillering can be commenced, a nock must be filed at the end of each limb. This is shown in Fig. 5. The bow may then be strung. At this stage the bow is very stiff and it may help to hold the bow in a vice by the handle. The handle must be wrapped in some soft leather to prevent damage to the wood by the vice jaws.

A tillering board is needed and consists of a piece of wood 30in. × 1in. × 3in. shaped according to Fig. 6. The bow rests in V-shaped end of the board and the string is drawn back into one of the nearer notches at first when the bow is still stiff. With the string thus drawn back observe the curves of each limb. They should correspond. If there is a noticeable difference, make a mark on the stave where there appears to be stiffness. Gradually release the string and work in the stiff area with a finely set plane or a scraper. Remove a little at a time and repeatedly test the bow on the board.



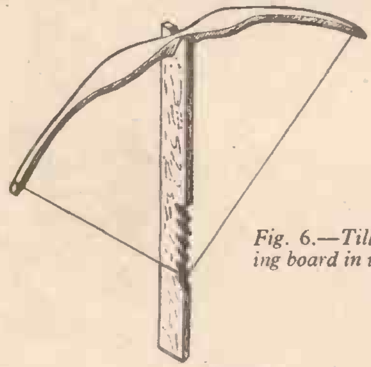


Fig. 6.—Tillering board in use.

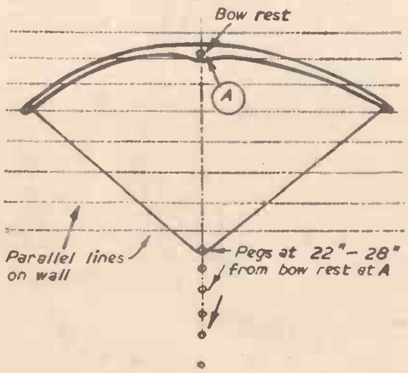


Fig. 7.—Tillering by means of pegs and a wall.

When symmetry of the two curves has been obtained, the bow may by now be less stiff than at first, and the string can be drawn back to the full length of 26in. At this juncture the weight of the pull must be tested with a spring balance. That is to say the hook of the spring balance is hooked over the centre of the bow string and it is noted how many pounds is required to pull back the string to the 26in. mark.

Beginners should use a lighter pull rather than a heavier one. Heavier pulls will of course make for a longer cast of the arrow. But the newcomer to the sport is not immediately concerned with a long cast but rather with learning a good shooting position and shooting for accuracy. It is suggested that a 35lb. pull is suitable for the novice.

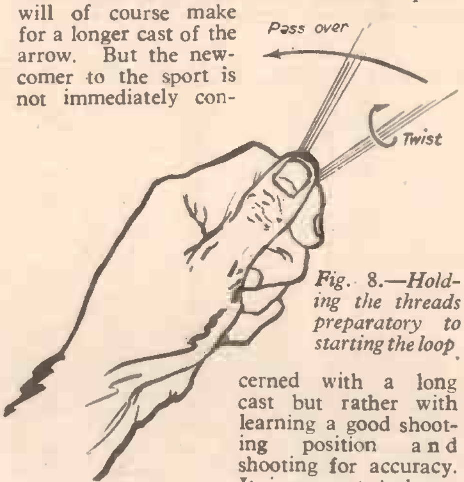


Fig. 8.—Holding the threads preparatory to starting the loop.

If, therefore, the pull on the spring balance exceeds 35lb., more material will have to be removed from the thickness of the bow on the belly side (not the back). No fixed rule can be given as to how much wood will have to be removed: experiment alone will decide. Proceed with care, using the plane or scraper and still keeping an eye on the contour of the drawn bow, as with the first stage of tillering. Do not remove any material from the handle during this tillering process. The handle does not bend and to remove material from this point is to weaken the bow.

Another method of tillering is to fix a number of pegs into a smooth wall as shown in Fig. 7. A number of horizontal parallel lines are drawn so that one may more easily judge the comparison of the two limbs.

When the tillering is completed the bow is finished off by rounding the edges of the stave with a file and glasspaper. The nocks are finished and the tips of the limbs are also rounded.

The handle may be finished by binding with leather or cord, whichever is preferred.

After the final sanding is completed, apply a coat of yacht varnish, diluted equally with turps. Allow this to dry out for 48 hours. Lightly rub down with fine steel wool. Apply a second coat of undiluted varnish. Allow to dry, rub down and then apply a last coat of varnish.

Some archers like to finish the bow by using boiled linseed oil repeatedly rubbed in with a soft cloth. The aim of either finish is to exclude moisture from the wood of the bow. In this connection it may be advisable, therefore, to complete the varnishing of the bow before applying the leather grip to the handle.

Making Bow Strings

Bow strings can be purchased quite cheaply but the reader having made the bow himself, may also like to make the strings.

Usually the bow string is made of linen thread but these days there are other possibilities in the use of synthetic threads. Barbour's No. 40 linen thread is the one most used but bootmaker's thread No. 12 is also suitable. Before commencing to make strings, the breaking strain of the thread must be known in order to arrive at the number of threads per string to use. The linen thread mentioned above has a breaking strain of about 7lb. per thread.

There are two types of bow string. The most usual, and the one recommended to the beginner, has a permanent loop at one end, and at the other end the loop is formed with a timber hitch. Thus one may adjust the total length of the string by altering the hitch. The other type of string has a permanent loop at both ends. The little adjustment possible with this string, about ½in., is made by twisting or untwisting the string as required.

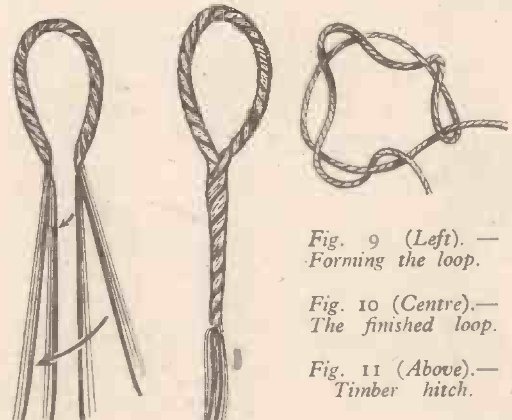


Fig. 9 (Left).—Forming the loop.

Fig. 10 (Centre).—The finished loop.

Fig. 11 (Above).—Timber hitch.

Materials Required

In addition to the linen thread already mentioned, a piece of board about 2ft. longer than the length of the bow, two ⅜in. dowel pegs to fix into the board, or two stout nails, a lump of beeswax and a sharp knife will be required.

The pegs or nails are fixed into the board at a distance equal to the length of the bow plus 18in.

Tie one end of the thread to one of the pegs. Now wind the thread round and round the pegs to make a skein. The number of threads to be put on is determined by the breaking strain of the thread. For example, if each thread had a breaking strain of 10lb., 20 threads would be needed to give a total breaking strain of 200lb. which is about the strength needed. That is to say the thread must be wound round the two pegs ten times. The beginning and end of the thread must now be tied. In this winding process keep the tension on each thread the same as far as possible.

Forming the Loop

When the ends are tied off, the two groups of threads, one on each side of the pegs, are thoroughly waxed by rubbing up and down their length with the beeswax. Rub well in with a piece of soft leather.

Cut the skein of threads at each peg and keep the threads in two groups. Hold the two groups of threads in the left hand as shown in Fig. 8, at a distance of about 10in. from their ends. With the right hand twist one group of threads tightly to the right and lay it over the other group towards the left. Continue this action with the other group of threads and repeat, using each group of threads alternately. Repeat these processes until about 3in. of rope-like string has been formed.

The remaining ends of the threads are now carefully pared down with the knife to a taper. Then the ends are bent round to form a loop, Fig. 9, and a tapered group is laid against each long group of the string.

Now hold the loop in the left hand with the thumb at the ends of the twisted parts already made. The previous process of twisting a group of strings to the right and laying over to the left is again carried out, the two new groups of threads being made up of some long threads and some short tapered ones. Gradually the short ends will disappear in the main threads of the bow string.

When the loop has been formed (Fig. 10), draw out the threads so that an even tension is in each thread. Wax the string again. Now twist the whole group of threads about 35 times and then rub well with the leather cloth to soften the wax and bind the whole string together.

The looped end of the string goes round the nock at the upper end of the bow.

The free end of the string may be strengthened for the last 12in. of length by twisting in some tapered threads about half in number of the threads in the bow string in the same way that the upper loop was finished. The end of the completed string must be whipped to prevent unravelling.

The string is formed in a timber hitch (see Fig. 11), to secure it to the lower nock of the bow.

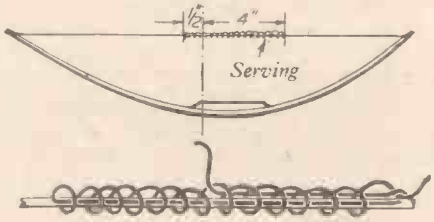


Fig. 12.—Serving the string.

Fig. 13.—Stringing the bow.

Bracing the Bow

The distance between the loop and the timber hitch is a matter of experiment. At first adjust the length to be a little less than the length between nocks on the bow. Slip the loop over the upper end of the bow and let it slide down towards the handle. Secure the timber hitch to the lower limb around the nock.

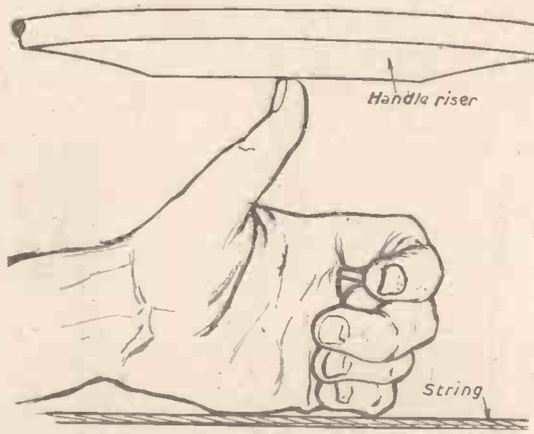


Fig. 14.—Adjusting bracing height of fistmele.

Now place the lower end of the bow against the inside of the left foot, back of the bow towards you, Fig. 13. Hold the handle of the bow with the left hand. With the right hand pressing on the back of the top limb of the bow and pulling with the left hand, slide the loop of the string with the fingers of the right hand towards the end of the bow until it slips into place in the upper nock.

The distance between the handle riser and the string is called the bracing height or fistmele (see Fig. 14). This distance is tested traditionally with the clenched fist and extended thumb.

Serving the String

Before the bow can be used the string must be served. The disposition of the serving and method of doing it is shown in Fig. 12. The diagram shows only the method of serving, needless to say the turns are all pulled in close together as tightly as possible.

The serving is done with some fine thread and sufficient layers are wound on so that the served string will push into the nock at the end of the arrow with sufficient friction to prevent the arrow falling off the string under its own weight.

Constant shooting will wear down the serving to a loose fit into the nock after which a new serving must be made.

The reader will understand that the number of threads in a bow string will affect its weight and so will have an influence upon the distance the arrow can be cast. A different weight string will upset the sighting of a bow. Therefore it is advisable to keep a note of the exact number of threads which are put into the string for reference when making a new string. Always have one or two spare strings to hand in case of breakage when at a shoot.

A warning must be given at this juncture! Resist the temptation to draw the bow and let it go with no arrow. The action might well fracture the bow.

(To be continued)

REPAIRING POTTERY

No. 2.—Hints on the Materials and Methods Used

(Concluded from page 221, February issue)

SOMETHING can be done to clean up crazed crockery by placing it in water which is very slowly brought up to the boil (there is a risk here of the pot disintegrating), or by soaking it in a hypochlorite solution or in a solution of chloride of lime, followed by immersion in a dilute solution of hydrochloric or sulphuric acid. This, of course, is properly a bleaching process, and generally, except in the case of valuable articles, it is perhaps hardly worth the trouble—and risk—of applying.

Often enough a dish or a jug gets a piece knocked out of its side, the piece being so hopelessly fragmented that cementing it back is quite out of the question. In this event the piece of crockery is either immediately discarded, or, at least, used in the secret hope that it will quickly become smashed up altogether.

There is, however, quite a good repairing technique for this sort of trouble. Here, indeed, is pottery surgery proper, the idea being to fill up the offending gap in the vessel's side in something like the manner in which a patient dentist slowly fills up a defective molar or a careful surgeon delicately implants a new fragment of bone substance.

The actual technique of this pottery surgery must naturally vary a good deal, each case having to be considered and treated according to its individual circumstances, but the following description of an actual piece of work will enable the reader to put the method into practice.

A valuable antique Italian spouted jug happened, by accident, to get a piece knocked out of its upper rim. The piece was shattered and was quite incapable of being replaced. Patiently cutting and grinding another piece of pottery to fit the gap and cementing and/or riveting it was impossible owing to the difficulty in matching the shade of the material and, also, in getting the peculiar rim-curvature of the jug. The only feasible repair method was an actual moulding operation.

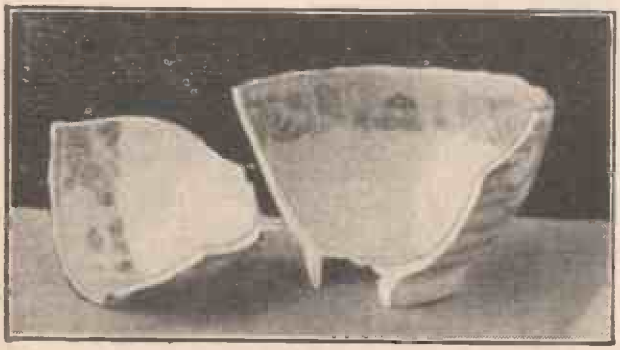


Fig. 7.—An early china handleless cup broken in two pieces.

First of all, a couple of very fine holes were drilled about ½in. down into the broken edge of the jug. In these were inserted steel pins—fine gramophone needles, as a matter of fact—the purpose of these being to reinforce the moulding material which was to be laid over them, and thus to provide an additional "key" for the inserted material.

It was now necessary to obtain the correct curvature of the outer and inner sides of the jug. This was effected by taking a quantity of children's play-wax, a material which becomes plastic when rolled between the hands. This was rolled into a flat sheet and pressed on to the inner and undamaged side of the upper edge of the jug so that a correct replica of the inner surface and curvature was obtained. The same was carried out with another piece of the moulding wax on the outer jug side. The two moulded pieces of wax—outer and inner sides—were then slid round on the upper edge of the jug until they covered the gap, thereby providing "walls" for the latter. Between these moulded wax walls the moulding material was carefuly poured, being gently prodded and compacted down with a blunt stick, particular care also being taken to see that the material was compressed evenly around the two reinforcing pins which had been previously fitted into the broken edge of the jug. The level of the moulding material was raised slightly above the level of the jug edge.

Fig. 8.—The cup repaired.

After the moulding material had set and hardened the wax "walls" were pulled away and the upper edge levelled down to the height of the remainder of the jug rim, this being done by gentle sandpaper treatment. The hardened "inset" was then very carefully smoothed off with fine glasspaper and given a couple of coats of cream cellulose paint to match the rest of the jug at that area.

Now this technique can be adapted to a host of different pottery repairs. Holes in the side of valuable jugs, dishes and other ceramic articles can be filled in and built up neatly, making the repair only visible on the very closest examination. The repaired parts, particularly if reinforced, have considerable strength and will usually withstand normal wear.

Moulding Materials

The moulding materials which can be used for this purpose may comprise any type of fine-grained waterproof luting or cement. Plaster of paris may be used, but it is very brittle, even when a little powdered asbestos is incorporated with it to give it additional strength.

A good cement is magnesium oxychloride, which is similar to dental cement. Such stuff is readily made by slaking finely powdered calcined magnesia with a 40 per cent solution of magnesium chloride (made by dissolving 40 parts of magnesium chloride in 60 parts of water). This cement hardens in two days. It expands very slightly on setting and therefore exerts a good grip.

Silicate Moulding

The latest cements of this nature are those which are based on an alcoholic solution of ethyl silicate containing a trace of acid. Ethyl silicate is now obtainable from most chemical suppliers. It is a clear liquid water-white. When treated with acid it gradually sets to a jelly and then to a hard mass of pure white silica, which is waterproof and inert.

The mode of preparation of the ethyl silicate is to take 19 parts of it and add 8 parts of alcohol (surgical spirit will do) and 3 parts of very dilute hydrochloric acid (0.06 per cent HCl). This mixture is shaken or stirred until the liquid does not separate into two layers. One hour after this stage a further 15 parts of ethyl silicate are added to the mixture. In this "hydrolysed solution" form it will keep for several weeks but will, in time, set to a jelly. Now, if sand, three parts; fine silica powder, one part; and (optionally) asbestos powder, one part, are slaked with the hydrolysed ethyl silicate solution as above prepared, the resulting white mass will set hard within about 24 hours. The incorporation within the mass of 1 per cent of calcined magnesia will considerably decrease the setting time of the mixture.

For pottery-repairing purposes, particularly in the case of high-grade work, this modern ethyl silicate method has many possibilities.

Incidentally, of course, any of these moulding mixtures can be used for filling-in small intervening gaps which may exist when pottery pieces are riveted and/or cemented together. Figs. 7 and 8 show an early china handleless cup before and after repair by this method.

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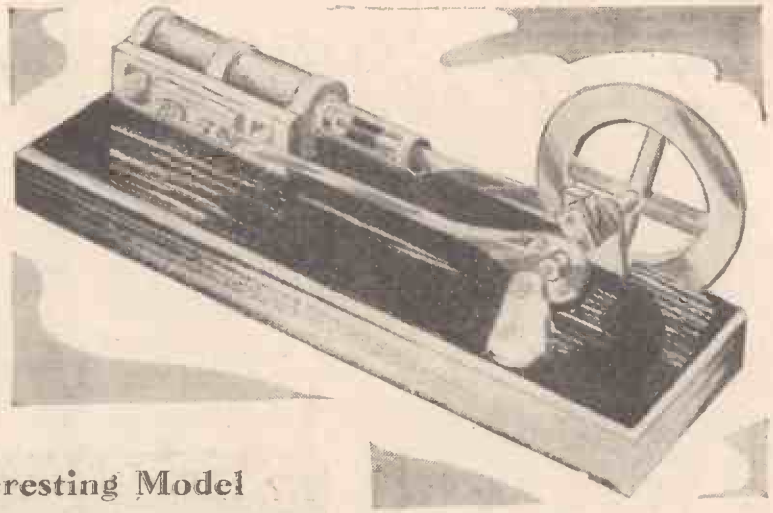
An Electric Slide Valve Engine



By S. J. GARRATT

Constructional Details of an Interesting Model

THIS engine is in reality a form of electric motor in which an iron plunger takes the place of a piston, the iron plunger being pulled to and fro by means of solenoids which act like magnets while the current is "on," but cease to attract the iron when the current is "off." There are two solenoids placed end to end so that the engine is double acting, and the electrical contacts are operated by means of an eccentric and sliding contact arrangement. The complete model, therefore, looks very much like a real steam engine. Although not so powerful, it will run at a high speed from a six-volt accumulator, and is free from smoke and smell.

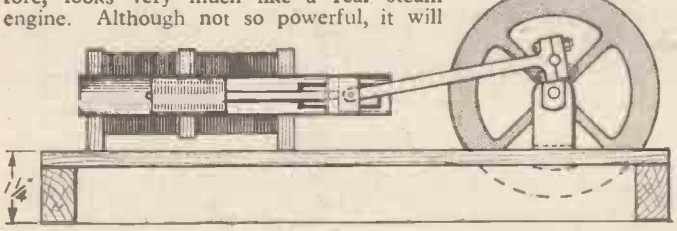


Fig. 1 (Left).—A sectional view.

Figs. 1 and 2 show a sectional view and plan of the complete engine, and Fig. 1 will make the principle clear.

The Base

First make the base, which is in the form of an inverted wooden tray of the dimensions given in Fig. 2. The top may conveniently be made from a piece of ¼in. ply wood and the sides of 1in. × ½in. material. This may be either tacked or screwed together.

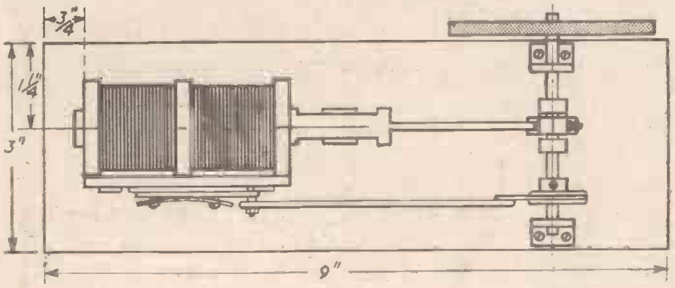


Fig. 2 (Left). — A plan view.

Fig. 3 shows the construction of the double bobbin which takes the place of the cylinder and crosshead guide. The central portion is a piece of thin brass tube ½in. internal dia. and 4½in. long. The slots in the side can be cut out with a file, and two rings of brass wire about 1/16in. dia. are soldered on in the position indicated. These are to keep the wooden end cheeks in position. These end cheeks are made to the dimensions given in Fig. 3. Two of the shaped pieces are required and one circular one; they should all be a tight fit on the tube and must, of course, all be threaded on to the tube before soldering on the wire rings.

The winding of the solenoids may now be tackled, and for this purpose it is well worth while making a simple winder, as shown in Fig. 4.

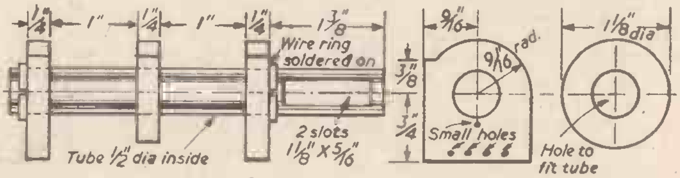


Fig. 3 (Above).—Construction of the double bobbin.

Winding the Bobbin

Buy a 4oz. reel of No. 24 gauge enamelled copper wire from an electrical dealer's. Fix the bobbin on the winder and wrap a piece of writing paper round the central tube between the cheeks. The paper should be cut about 1/16in. wider than the distance between the cheeks and nicked with scissors about every ¼in., as shown in Fig. 6. This will allow the paper to splay out slightly (see Fig. 4) at the ends of the bobbin and prevent the wire touching the brass tube. Bind the paper on with a couple of turns of thin sewing cotton.

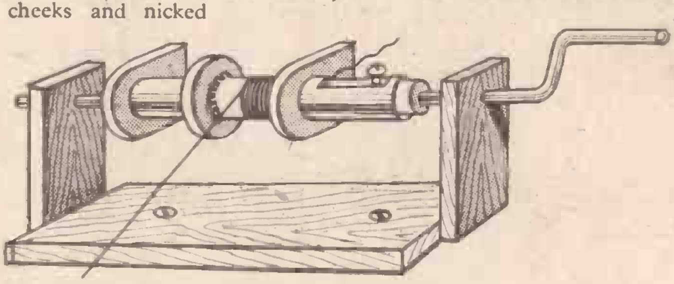


Fig. 4 (Above).—Details of the winder.

The end of the wire will probably be bent or kinked for a few inches, so cut this part off and thread (from the inside) the new end through the small hole near the centre of the bobbin, allowing about 4in. to protrude, as shown in Fig. 4, then wind on a layer of wire. Keep the turns quite close together and fill up the space right up to the central cheek, the wire should be wound fairly tightly but not nearly tight enough to risk breaking it.

When the first layer is completed, wrap on another layer of writing paper exactly as before, then continue with the second layer. An assistant will probably be required when fixing the paper. Put on eight layers of wire altogether, with a paper between each layer, and be careful to see that the wire does not sink below its proper layer, particularly at the ends of the bobbin, otherwise there might be a short circuit and the model will not work. Careful fitting of the paper layers together with careful and close winding of the wire will avoid this. At the end of the eighth layer cut off the wire, allowing about 6in. to spare, then thread this end to and fro through the four small holes, as shown in Fig. 5; this will effectually hold the end of the coil and remove all danger of the wire becoming unwound.

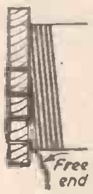


Fig. 5.—Securing the end.

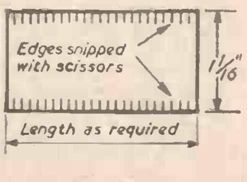


Fig. 6.—How the paper is cut.

The other half of the bobbin should then be wound in exactly the same manner. The

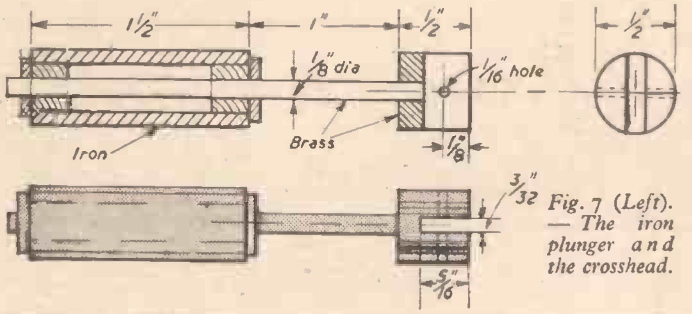


Fig. 7 (*Left*). — *The iron plunger and the crosshead.*

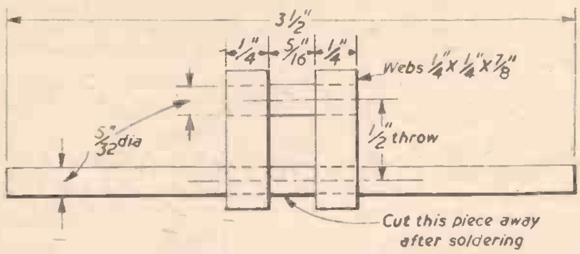


Fig. 8.—The crankshaft.

direction of winding does not matter, though, of course, once winding has commenced it must continue in the same direction until that particular bobbin is filled.

Screw the solenoids down to the base by putting in small screws from underneath; the position is indicated in Figs. 1 and 2.

The Iron Plunger

Fig. 7 shows the iron plunger and the crosshead. The plunger is just a piece of iron tube 1½in. long and about 1/16in. thick. The outside diameter should be ½in. or rather less, so that it will slide freely inside the central tube of the solenoids; if necessary, the plunger should be eased a bit with a file or emery cloth. It should move quite freely in the tube, and a little shake will not matter, but it should not be smaller than is necessary to allow free movement. Plug up the ends of the plunger with hard wood and drill a central hole for the brass "piston rod." Solder two brass washers on to the ⅛in. brass rod to prevent the rod from pulling out of the plunger (Fig. 7). The crosshead is a short length of ½in. brass rod, slotted with a file, as shown in Fig. 7. This is drilled with a ¼in. hole for the piston rod, which should be soldered in place. The 1/16in. hole is for a hinge pin.

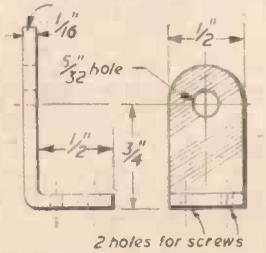


Fig. 9.—The bearings for the crankshaft.

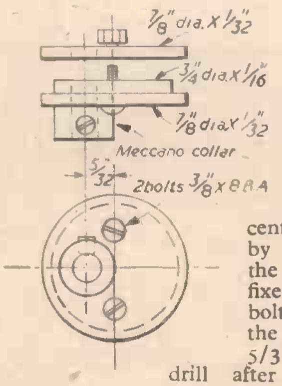


Fig. 10 (Right).—The eccentric.

The connecting rod is illustrated in Fig. 7. The big-end bearing is made from ¼in. thick brass filed to shape; it should be split and the small bolts fitted before the central 5/32in. hole is drilled. The rod itself is a separate piece of brass soldered into a slot in the big-end bearing. The crankshaft is made from a piece of 5/32in. steel, but the webs are of brass ¼in. square in section. Both webs should be drilled together, so as to keep the holes in line. Later on, when being assembled, the two webs are soldered together and cut out in the centre of the shaft after soldering is completed, as shown in Fig. 8.

The bearings are made of brass 1/16in. thick two, of course, being required, as shown in Fig. 9.

A suitable flywheel can be bought at a model engineers' store for a few pence. It should be 3in. in diameter and bored to fit a 5/32in. shaft, the boss being tapped for a grub-screw. Choose a well-finished flywheel which will greatly add to the appearance of the model. If the reader wishes to make his own flywheel he can do so without the use of a lathe by cutting one out of 1/16in. sheet brass with a fretsaw. The boss should be made from a brass collar soldered on to the centre. These collars can be obtained from toy shops complete with grub-screw.

Extra weight should be added to the rim by cutting out two rings of 1/16in. sheet brass (3in. outside diameter and 2in. inside) and soldering a ring on each side of the wheel already cut out. The flywheel in the heading sketch was made in this way.

Next make the eccentric shown in Fig. 10. The central disc should be ¾in. diameter by 1/16in. thick, but the two discs forming the flanges may be much thinner and ⅞in. diameter. A farthing will do admirably for the centre disc, while the boss is another collar as recommended for the flywheel boss. Fix the collar, one flange and the centre disc all together by soldering, but leave the other flange to be fixed by the two small bolts. The centre of the collar should be 5/32in. from the centre, drill after the eccentric is completed.

The Eccentric Strap

This is quite a simple affair: see Fig. 11. It should be a free fit on the eccentric when assembled, but should not have any considerable amount of slack. The eccentric rod should not be soldered on to the strap until the model is assembled.

The last piece to be made is the sliding contact arrangement illustrated in Fig. 12. There is nothing very difficult about this, but it requires to be carefully made, as the parts are rather small. The whole thing should be fitted up on its little baseboard and screwed on to the side of the solenoids, by means of a screw into each wooden end check, when complete. The contacts, both fixed and sliding, are of brass 1/16in. thick. Screw the fixed contacts into place and drill the two holes in the centre contact for the long screws to hold the spring; then file all three contacts at once to bring them exactly to the same level. The sliding contact may be bent very slightly between the fingers so as to make sure that the ends make contact; the small bolt at the extreme end is for the eccentric rod. The little spring should be of very thin brass, bent to a curve as shown at the top of Fig. 12; its pressure can be adjusted by means of the two screws.

Assembling the Model

The model may now be completely assembled. The solenoid is fixed as already described and in the position indicated in Fig. 1. Next screw down the crankshaft bearings in such a position that the plunger moves freely to and fro, and is central in the solenoid when the crank is upright as shown in Fig. 1. To prevent sideways movement of the crankshaft, thread a small piece of brass tubing on the shaft between the crank web and the bearing on the fly-

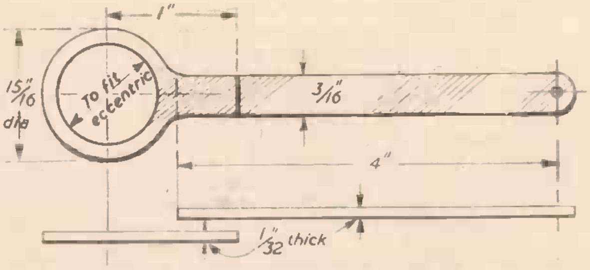


Fig. 11.—The eccentric strap.

wheel side, and another piece of tube between the bearing and the flywheel itself.

To adjust the eccentric, turn the flywheel until the plunger is at the inward end of its stroke, then fix the eccentric so that it is as high above the shaft as possible; move the sliding contact exactly to its middle position (as shown at the top of Fig. 12), fit the eccentric rod and solder it to the eccentric strap.

(*Concluded on page 284*)

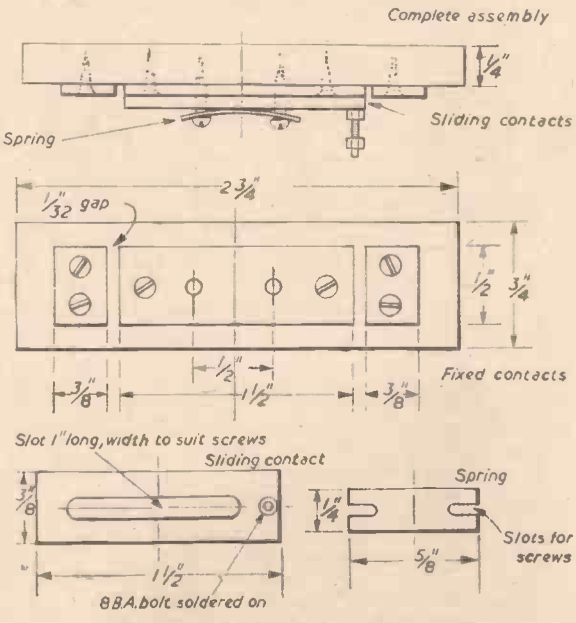
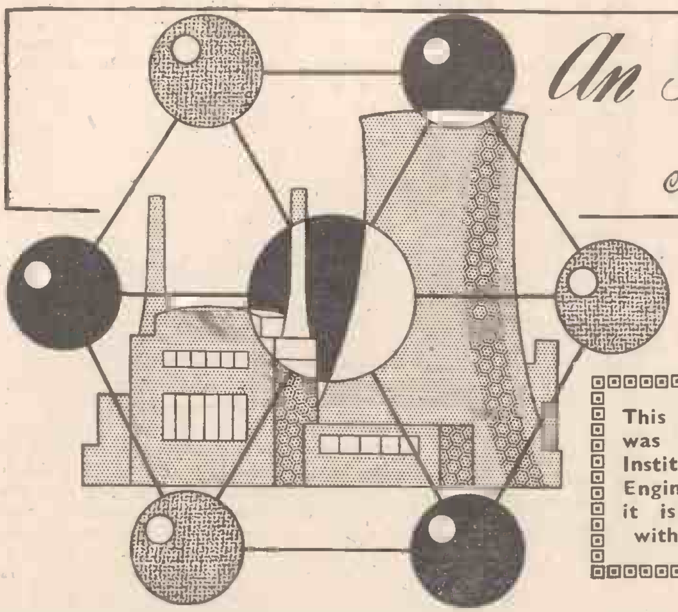


Fig. 12.—The sliding contact arrangement.



An Introduction to Nuclear Power

By P. T. FLETCHER, B.Sc.(Eng.), M.I.C.E., M.I.Mech.E., M.I.E.E.

This is a paper which was presented to the Institute of Marine Engineers recently and it is reproduced here with their permission

THE bigger the core the smaller is the chance of a neutron escaping from it. As the size of the core is increased, a point is reached at which the rate of escape of neutrons, added to their rate of capture, is just equal to the rate at which they are generated by fission. At this point the core is said to have achieved "criticality," or the capacity for a chain reaction, and has reached what is known as its "critical" size.

The important point thus emerges that the size of a natural uranium reactor is determined mainly by nuclear considerations of criticality and not by the power output. The power output is limited only by the permissible rate of heat release, and this in turn is governed only by matters of engineering design, such as the cooling system and materials of construction.

It has been shown that the use of a moderator in a suitable size of core enables criticality to be achieved with a natural uranium fuel. It has not been emphasised, however, that the achievement of criticality demands that every source of non-fission capture of neutrons must be ruthlessly eliminated from the system. The materials used in the construction of the core must be chosen not only to withstand the high heat release rates that a compact power producer demands but to cut down to the minimum the waste of neutrons. But when the best has been done, the critical size of a graphite-moderated thermal reactor, fuelled with natural uranium, remains relatively large.

Enrichment

Fortunately, there are ways of cutting down the critical size. It was mentioned earlier that the two isotopes of uranium, 235 and 238, cannot be separated by chemical processes but that they can be separated by physical means. Physical separation of the two isotopes is actually being carried out in this country today, so that it is possible to increase the uranium 235 content of fuel, which then becomes "enriched" uranium.

With enriched uranium as the fuel, the battle for criticality no longer limits design possibilities. Not only can the core size now be reduced but coolants and materials of construction can be used which will permit higher rates of heat release, thus higher specific power outputs. The range of possible types of reactor is thus broadened.

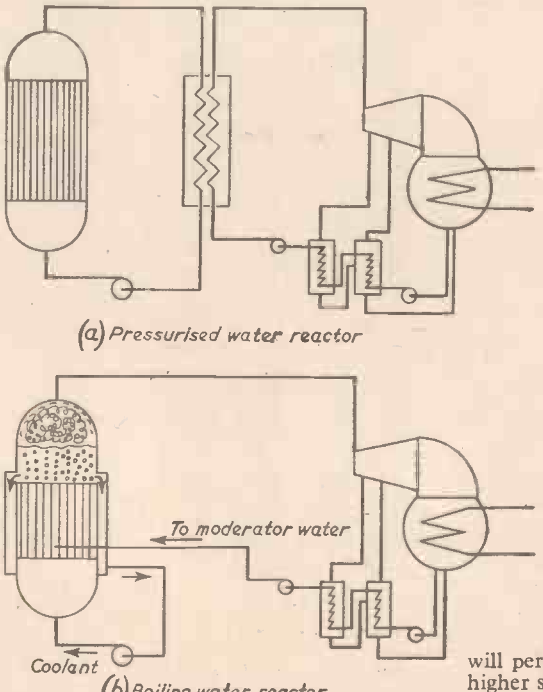


Fig. 10 (Left).—Pressurised and boiling water reactors.

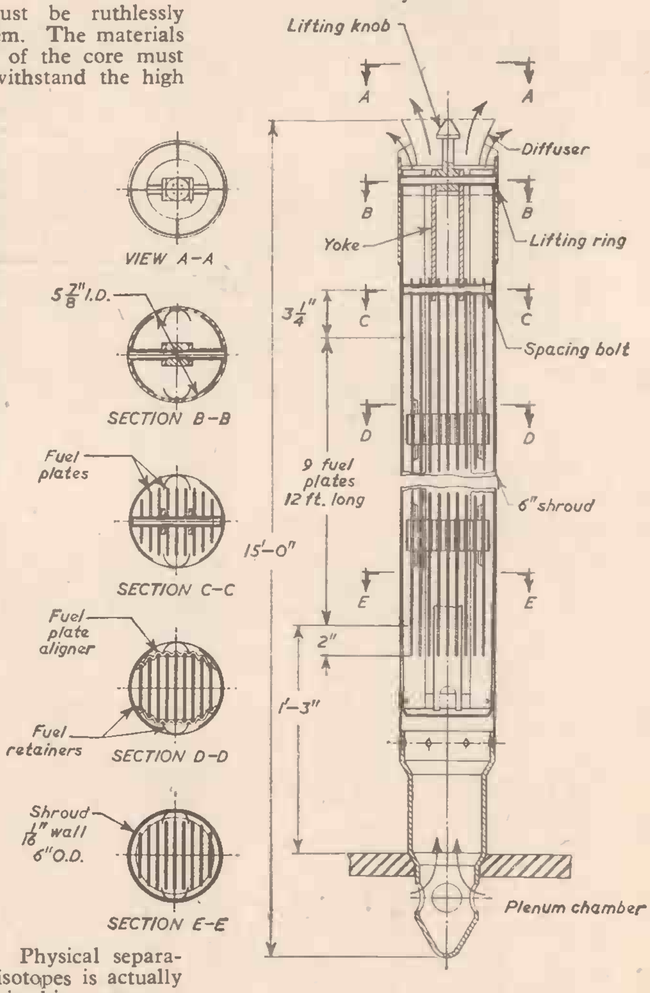


Fig. 11 (Right).—Fuel assembly for 1,000 M.W. D_2O boiling reactors.

(*Continued from page 229, February issue*)

Types of Nuclear Reactor

Moderators and Coolants

Possible moderators of practical interest are:

Heavy water
Light water
Graphite
Beryllium

In conjunction with these materials it is possible to use any of the following coolants:

Heavy water
Light water
Gas
Liquid metal

For the industrial type of reactor, a beryllium moderator can probably be ruled out on account of cost as compared with the alternative solid in the form of graphite, despite the smaller size of core to which the use of beryllium leads. Heavy water, on the other hand, though expensive, appears able to compete with its rivals as a moderator, but due to its great cost, a high specific heat rating of the reactor is imperative. Heavy water as a coolant in conjunction with any other material as moderator cannot be justified on any grounds.

Of the liquid metal coolants, sodium appears best able to meet the requirements of low neutron absorption, low vapour pressure, good thermal conductivity, and chemical compatibility with constructional materials. It reacts violently with water and for this reason will not be considered for use with a heavy or light water moderator. The only moderator available for use with this coolant is therefore graphite.

Light Water

A characteristic feature of light water as a moderator is the low ratio of volume of moderator to that of uranium. The value of this ratio lies in the region 2 to 3. Use of a gaseous coolant with such a moderator would require the fuel rods to lie coaxially with pressure-resisting tubular gas passages, the space between the tubes being available for the moderator. It readily follows that the low ratio of moderator to uranium volume will only permit extremely small areas for gas flow and therewith too low a heat rating for a power producing reactor. A disadvantage of water as a coolant is its inability to achieve the high temperatures required on thermodynamic grounds without subjection to very high pressures.

A graphite moderator bears a ratio by volume to that of uranium of about 45 : 1. Consequently, as has already been seen, the core size will generally be large. With water cooling this disadvantage is allied to that of low thermodynamic efficiency.

This process of elimination leaves the six types of reactor lis.ed below for more detailed study.

Moderator	*Coolant*
Heavy water	Heavy water
Heavy water	Light water
Heavy water	Gas
Light water	Light water
Graphite	Gas
Graphite	Sodium

Pressurised and Boiling Water Reactors

In the case of any reactor employing water as a coolant, there is a choice between two systems:

(a) Pressurised.
(b) Boiling

In the pressurised system, shown diagrammatically in Fig. 10, the coolant is maintained at high pressure below the corresponding saturation temperature so that boiling at any point in the system is suppressed. American sources quote pressures as high as 2 000 lb. per sq. in. abs., the corresponding saturation temperature being 636 deg. F. After leaving the reactor vessel, the coolant is passed through a heat exchanger, where it transfers heat to the water and steam used in a steam power cycle. It is then returned to the reactor vessel to pick up further heat from the core. The pressure in the secondary (power cycle) side of the heat exchangers would be about 600 lb. per sq. in. abs. corresponding to a saturation temperature of 486 deg. F.

In the boiling system, shown diagrammatically in Fig. 10, the coolant enters the lower end of a vertically disposed core at a temperature just below its boiling point, boils on its way through, and leaves the core containing a large proportion of steam. Above the core the coolant forms a free surface. The space between this surface and the top of the reactor vessel is filled with steam which is fed to the steam power plant direct.

The lower pressure in the reactor vessel in the case of the boiling system implies a reduction in capital cost or the possibility of an increase in size. Pumping power is also reduced and the necessity of a heat exchanger between the reactor coolant and the working fluid is dispensed with. On the other hand, special precautions must be taken in the power plant to ensure against leakage of the somewhat radioactive steam. Also, the consequences of a burst fuel element are more serious since contamination of the entire steam plant is involved.

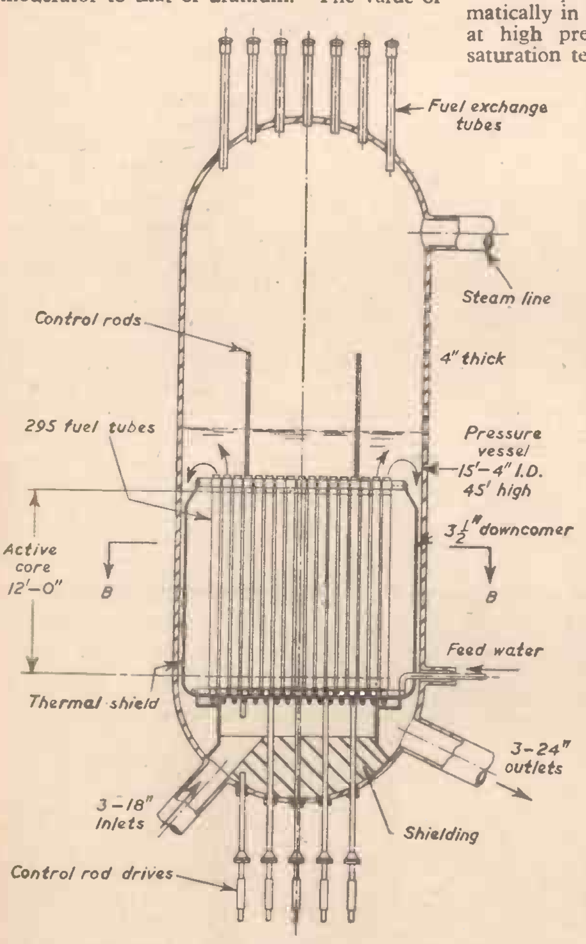


Fig. 12.—Vertical section through 1,000 M.W. D_2O boiling reactor.

Heavy Water Reactor—Water Cooled

Turning now to a more detailed consideration of the heavy water reactor, an outstanding advantage is its ability to use solely natural uranium as its fuel.

Against this advantage must be set the disadvantage of the high cost of heavy water. Although it is claimed in the U.S.A. that the current quotation of $28 per lb. can lead to an economic design, the use of heavy water in this country would either have to be preceded by the construction of an extremely expensive heavy water plant or imply reliance on foreign sources of supply.

The ratio by volume of moderator to fuel is around 20 to 1, thus easing the problem of disposing the fuel within the core. On the other hand, this high volume ratio leads to a fairly large diameter for the reactor vessel, of the order of 13ft. or so if natural uranium is to be used.

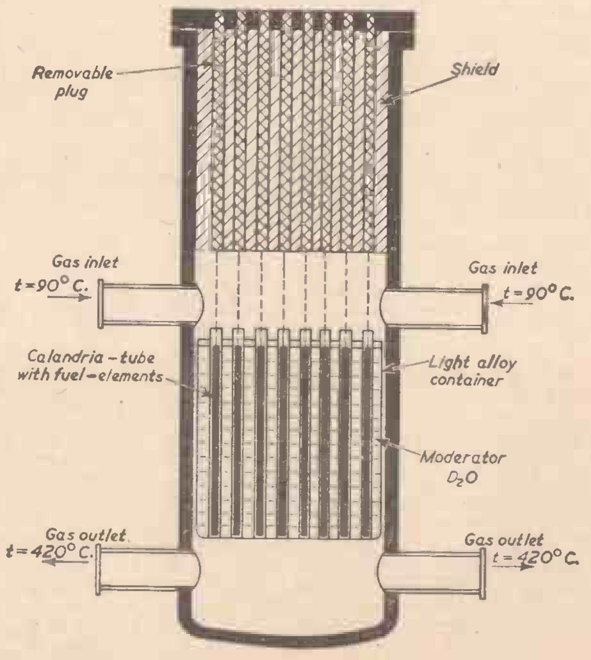
Such a size of reactor vessel encourages the adoption of the lower pressure provided by the boiling system. Taking this pressure as 600lb. per sq. in. abs., the thickness of the vessel wall would be about 4in. An additional advantage of the boiling system in this case is to be found in the very small amount of heavy water outside the reactor vessel in the form of steam and condensate as compared with the larger quantity in liquid form in the external piping and heat exchanger of the pressurised system.

An example of a heavy water boiling reactor developing 1,000 MW heat was described by members of the Argonne National Laboratory at Geneva. The design of fuel element employed is shown in Fig. 11. The fuel is subdivided into a large number of closely spaced plates to provide a large amount of wetted surface for heat transfer purposes.

Each plate is of natural uranium clad with a .04in. thickness of zirconium alloy called Zircaloy, the overall thickness being .15in. The water passage between adjacent plates is .35in., and the plate assembly is housed in a 6in. diameter Zircaloy tube, the active length of which is 12ft. The tubes number 295 in all and are pitched at 8in. on a triangular lattice to form a core about 12ft. in diameter. The core is surrounded by a heavy water reflector having a thickness of 1ft. 3in. at the sides and base and 3ft. at the top.

Fig. 12 shows the general arrangement within the reactor vessel. Cooling water slightly below boiling point is pumped into

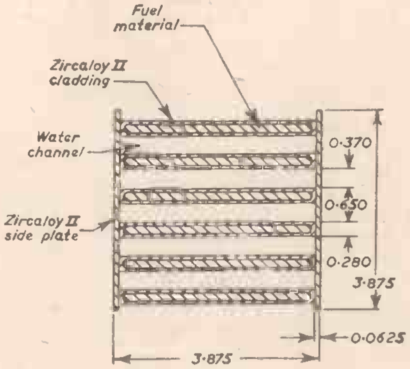
Fig. 13 (Right).—Gas cooled D_2O reactor.



the vessel through the three 18in. inlets at its lower end. It passes up within the fuel tubes at the top of which it contains 80 per cent. steam by volume. Feedwater from the power plant condenser enters the vessel through a separate pipe and is distributed by a heater system in the spaces between the fuel tubes just above the grid on which they stand. In rising up between the fuel tubes, this water keeps the average temperature of moderator and reflector down to about 200 deg. F. The upflowing streams of water within and between the fuel tubes mix above the core. This slightly subcooled water is then returned through the annular downcomer and the three 24in. outlets to the circulating pumps.

The pressure within the reactor vessel is 600lb. per sq. in. abs. resulting in the generation of dry saturated steam at 486 deg. F.

The total weight of moderator in such a reactor is given as 89 tons, the corresponding figure for the uranium being 38.75 tons.



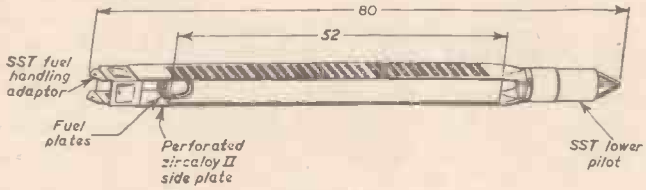


Fig. 15.—*EBWR fuel element.*

A light water coolant has been used in conjunction with a heavy water moderator in the Canadian NRX reactor. This, however, is not a power producing reactor and no published work on a power producing reactor of this type appears to exist.

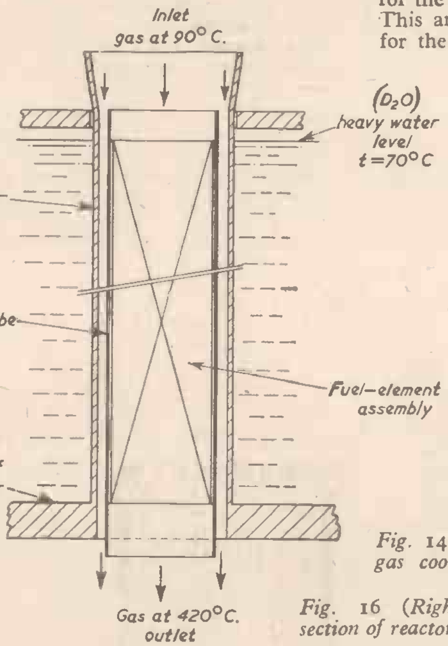


Fig. 14 (*Left*).—*Fuel channel of gas cooled D_2O reactor.*

Gas Cooled Heavy Water Reactor

The introduction of gas cooling enables higher steam temperatures to be attained in the power plant without resort to very high pressures. It also permits an appreciable reduction in the quantity of heavy water.

A design for a reactor of this type has recently been proposed in the U.S.S.R. The general arrangement of the reactor is shown in Fig. 13, whilst Fig. 14 illustrates the form of fuel channel. The reactor is enclosed in a steel pressure shell. Within the shell is a light alloy tank pierced though with calandria tubes. Between the tubes the tank is filled with heavy water. The fuel elements are suspended in the calandria tubes from removable plugs in the upper seal. The space above the heavy water level communicates with the body of the steel shell so that equal pressures are maintained in both regions.

The fuel elements consist of rods or plates of natural uranium clad in a light metal which withstands a maximum temperature of 550 deg. C., and are enclosed in a light alloy baffle tube. Between the baffle tube and the calandria tube there is a narrow gap for the passage of gas cooling the baffle tube. This arrangement ensures a low temperature for the calandria tube.

The coolant is carbon dioxide gas under a pressure of 590lb. to 880lb. per sq. in. The power required to circulate the gas is about 15 per cent. of the electrical output. The gas enters the reactor at 90 deg. C. and leaves at 420 deg. C. The steam conditions are 750 deg. F. and 425lb. per sq. in. abs. in conjunction with a dual pressure system. Saturated steam at 30lb. per sq. in. is used in the low pressure stage, providing about 20 per cent. of the total power. The net electrical output from a nuclear power station of this type is anticipated to be upwards of 100 M.W.

Light Water Reactor

In the case of the light water reactor, as has already been mentioned, the volume of moderator to fuel is two or three to one, so that the core lattice pitch is highly contracted. In consequence, the diameter of the reactor vessel can be reduced to about two-thirds of that required by the heavy water boiling reactor fuelled with natural uranium. Against this reduction in size must be set the necessity to use fuel of some 30 per cent. to 50 per cent. enrichment in a light water reactor. The reduction in size leads to a wall thickness of 8in. or so at a pressure of 2,000lb. per sq. in. abs. so that a pressurised reactor becomes a more practicable possibility when using light instead of heavy water. Furthermore, the hold-up of light water in liquid form in the external piping and heat exchanger does not represent the high capital investment as is the case with heavy water. Nevertheless, the light water boiling reactor can still offer the attraction of dispensing with this piping and heat exchanger, added to which is a reduction in cost of the reactor vessel itself, consequent on the lower coolant pressure. The boiling and pressurised light water systems are thus more highly competitive.

The fuel element in the light water reactor is conveniently of the plate type or bundle-of-rods type. An example of a plate type fuel element as used in the American Experimental Boiling Water Reactor (EBWR) is shown in Fig. 15. In the American pressurised water reactor (PWR) now under construction at Shippingport, this type of construction is used for a number of highly enriched fuel, or "seed" elements. The remaining "blanket" elements are of the bundle-of-rods type.

Fig. 16 shows a sectional view of the Shippingport reactor. The reactor is designed for a heat rate of 340 MW.

(*To be continued*)

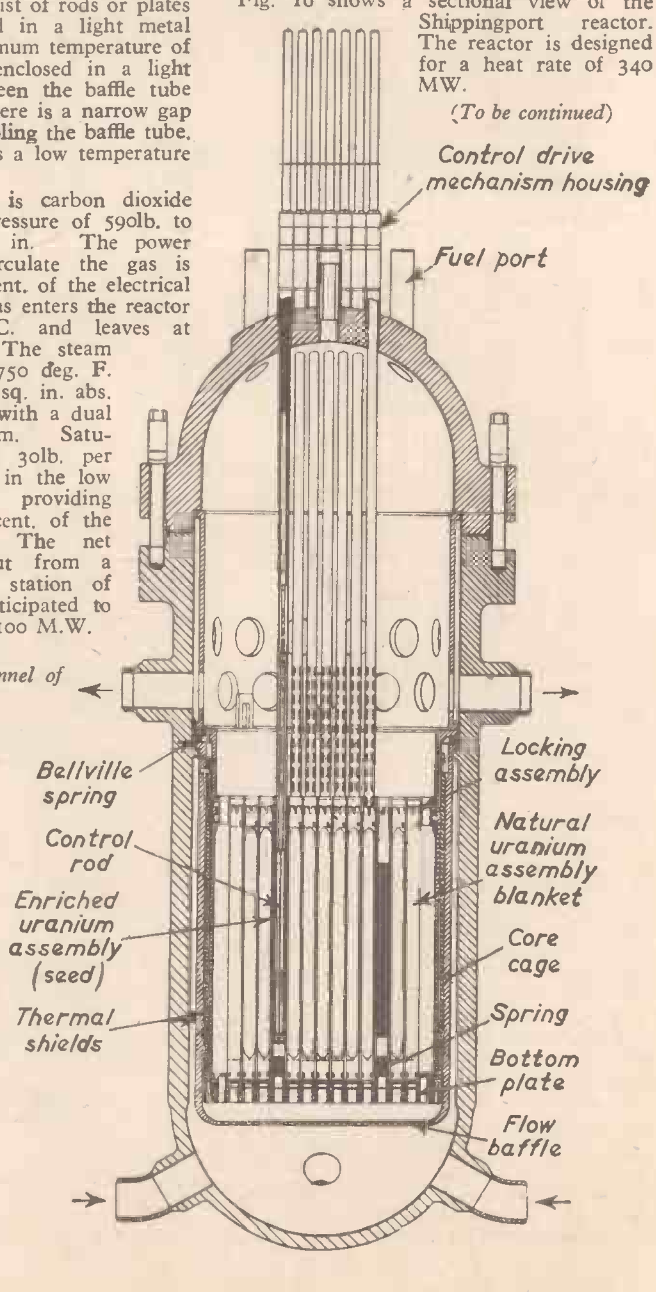


Fig. 16 (*Right*).—*Longitudinal section of reactor vessel of P.W.R.*

Why be an Apprentice?

This Serious Modern Problem is Discussed by A. W. FERRIER

"HE is as good with his hands as any other man in this shop and he has not 'served his time'." This sentence is often found on the lips of certain men on the shop floor and causes us to stop and ask ourselves the question: "Why be an apprentice?"

Many a parent and son have given this question hours of thought and it is a question of real seriousness. In these days when semi-skilled labour and female labour is being used abundantly in engineering, the anxious parent wonders if serving an apprenticeship at comparatively low wages is worth the sacrifice. Why should an apprentice have lower wages than a labourer of the same age? This is a question which immediately comes into the mind of the parent.

Here are the answers to some of the queries which may arise in the mind of a parent with no knowledge of, or connection with, the engineering industry.

Over the last number of years a vast number of firms have introduced apprenticeship schemes, and the value of apprenticeship training is now coming into its own. The skilled tradesman must be able to excel in all phases of his craft while the semi-skilled person need only be able to satisfactorily carry out a series of usually repetitive operations. The tradesman requires, therefore, a longer period in which he must receive instruction and training in his craft. This training and the provision of training facilities are costly and during a part of the training period the apprentice is non-productive. He is non-productive for a longer period than the semi-skilled person who is given training limited to the necessary operations to perform the job.

The shortage of skilled craftsmen, technicians and professional engineers in Great Britain is causing numerous firms great concern and the school leaver is now in a position where he can make a choice of craft, firm, conditions, etc. The wise pre-apprentice will be guided by his teachers, schoolmasters and careers masters, while the Youth Employment Service and other advisory bodies will endeavour to advise the placing best suited to his technical ability and practical aptitude. There are opportunities in the engineering industry for boys of various standards, and in most apprenticeship schemes the parent is assured that the apprentice will be given every opportunity to reach the level of his inherent ability or aptitude.

Table A gives an indication of the types of apprenticeship, namely, Craft, Student and Graduate, and some idea of the age at which a person would take up such training.

TABLE A

Age	Type of Apprenticeship	Usual Duration
16	Craft	5 years
17-18	Student	2-4 years
20-Upwards	Graduate	2-3 years

In the case of a boy leaving school at 15 it will be understood that in most industries he is unable to commence his apprenticeship until he is 16, but most education authorities make provision for this by providing a pre-apprenticeship course of one year's duration with expenses paid.

The entry qualifications vary with the type of apprenticeship, but Table B shows some of the qualifications which may be necessary. These can vary also with the supply and demand, type of firm, number of applicants, etc.

The practical training varies, of course, with the type of apprenticeship. It takes the form of training for the job and is graded according to the amount of theoretical training undertaken by the apprentice. The main difference is that the craft apprentice concentrates on being able to do the job while the other types of apprentices are concerned with obtaining knowledge of how the job is done.

Having outlined the types of apprenticeship we shall now see that an apprenticeship is a training for the future. It is an investment. This training will obtain for him a post commensurate with his ability and enable him to hold down the post with confidence. Why serve an apprenticeship? The answer of every good tradesman is, "It pays big dividends in the long run, I need not be out of work so long as I am trained for the job."

TABLE B

Type of Apprenticeship	Qualification
(a) Craft	(a) Pre-apprenticeship certificate (b) Practical aptitude test (c) Oral test (d) Firm's own selection test (e) Written test
(b) Student Apprenticeship	1. School Leaving Certificate e.g. (a) Scottish Higher Leaving Certificate (b) Oxford and Cambridge Certificate. (c) General Certificate of Education. 2. Ordinary National Certificate.
(c) Graduate Apprenticeship	1. University Degree. 2. Higher National Diploma or Certificate. 3. Associate or diploma of a technical college or institute.

Publishers' Publicity Circle Silver Trophy

A SPECIAL silver book designed and actually made by Mr. F. J. Camm, Editor of this journal, for annual award by the Publishers Publicity Circle here rests on the top table at their annual Christmas Lunch in London.

Mr. Alan Delafons, Editor of the Penrose Annual, announces the award on behalf of the panel judges. Left to right : Mr. F. J. Camm, Mr. Clark Ramsay (Sales and Publicity Manager, George Newnes, Ltd., and Vice-Chairman Publishers' Publicity Circle), Mr. David Patrick (Pitmans, Chairman of the Publishers' Publicity Circle).

A PORTABLE RECORD CASE

A Smart Cabinet to Carry Your Gramophone Records

By C. J. J.

GRAMOPHONE records are expensive and few people are willing to take risks when carrying them about. The ideal solution is a carrying case and the one shown in Fig. 3 can be made for less than 15s.

Construction

The front and back of the case are made from 3/16in. plywood and two pieces are required 14in. square. Cut from one of the pieces a strip 2½in. wide and put it aside to form the front of the lid later on. The sides and bottom of the box are formed from 3in. × ½in. (finished ⅜in.) ramin and all the dimensions can be seen in Fig. 1. The box is assembled as shown in Fig. 2, using ½in. csk screws, making sure that the screw heads are flush with the surface of the wood. Check that all the parts are a perfect fit, take the case to pieces again, and then finally glue and screw into place. A reinforcing strip of 3/16in. plywood must be glued and screwed into position on the inside of the back of the case at the top as shown in Fig. 1 to provide a firm fixing for the hinges.

The Lid

A piece of approximately 2½in. wide × ½in. ramin is cut to form an easy fit inside the top of the case and the 2½in. wide strip of plywood saved from the front glued and screwed to the front edge as shown in Fig. 1. A further piece of plywood is cut to measure 2 11/16in. × 14in. and glued and screwed to the ramin. This is the top of the lid.

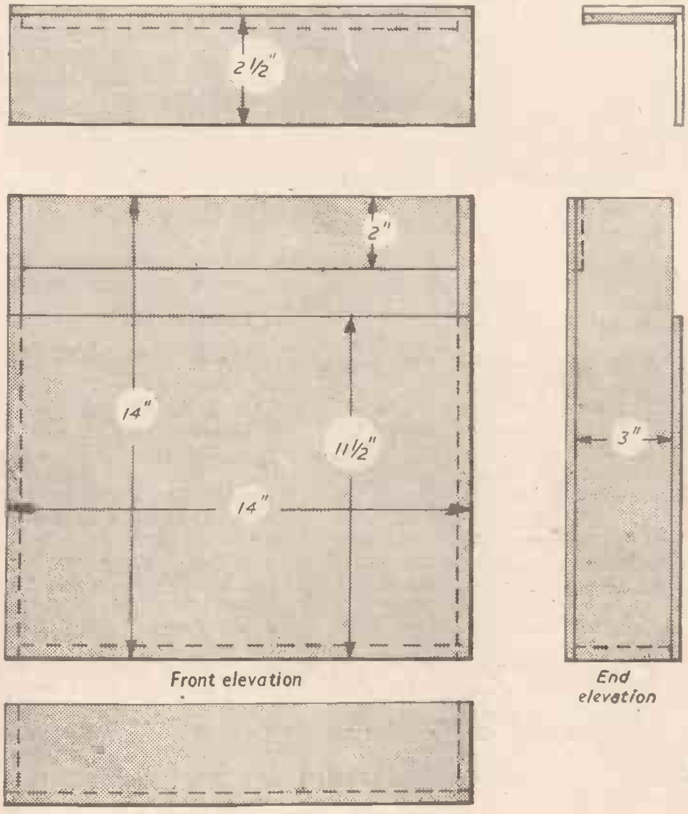


Fig. 1.—Front, end and plan elevations of the case and lid.

The hinges should be fitted next and these are recessed into the wood of the case. In the original all the recessing was carried out in the lid and the other hinge plate screwed straight on to the back, but it is equally feasible to recess both plates. Adjust the position of the hinges until you are satisfied that the lid opens and closes easily and fits accurately into position, then remove the hinges prior to covering the case.

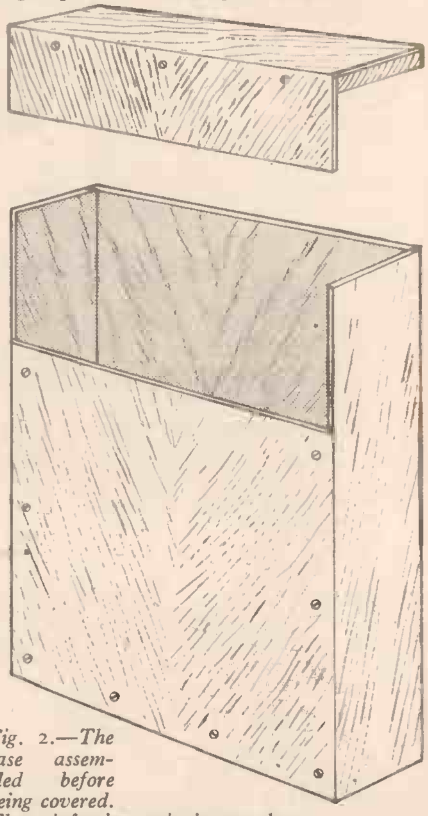


Fig. 2.—The case assembled before being covered. The reinforcing strip is not shown.

Fig. 3.—The completed record case

Covering the Case

Leatherette paper was used for this and from the wide range of colours and finishes available a grey imitation snake skin paper was chosen. Ordinary office glue of the type available from any stationers was used as the adhesive.

The method of covering will possibly vary according to the size of the sheets of leatherette paper available, but the method shown in Fig. 4 is the one used by the author. The reader will have to use his own ingenuity to make sure that the case is completely covered in the corners, but the inset sketch shows how the author tackled the problem. The job may be made easier by gluing small pieces of the leatherette paper over the corners, and then covering over the top with the large sheet. It is better to cut away the spare folds of paper at the corners rather than fold them underneath as several folds of paper will make the covering too thick. It was found advisable to cover over the hinge recesses too and then screw through the paper when fitting them, this eliminated the white edge of wood which would have been visible along the butt of the hinge. The basic shape only is shown in Fig. 4 for covering the lid. Allowance will have to be made for the edge of the wood.

LIST OF MATERIALS

2 pieces 3/16in. plywood 14in. sq. 4ft. 6in. ramin 3in. x ½in.	5/6
Attache-case handle	2/9
" " " plates " " fasteners	1/6
2 sheets leatherette paper	1/8
2 1in. hinges	7d.
4 gliding castors	7d.

In addition, two pieces of plywood 14in. x 2in. and 14in. x 3in., 4 dozen ½in. screws, round-headed screws for the fasteners and some paper for covering the inside will be required These items will probably be already on hand. Suitcase fittings are available from Frank Bolwell, 23, Goodge Street, London, W.1.

The Fittings

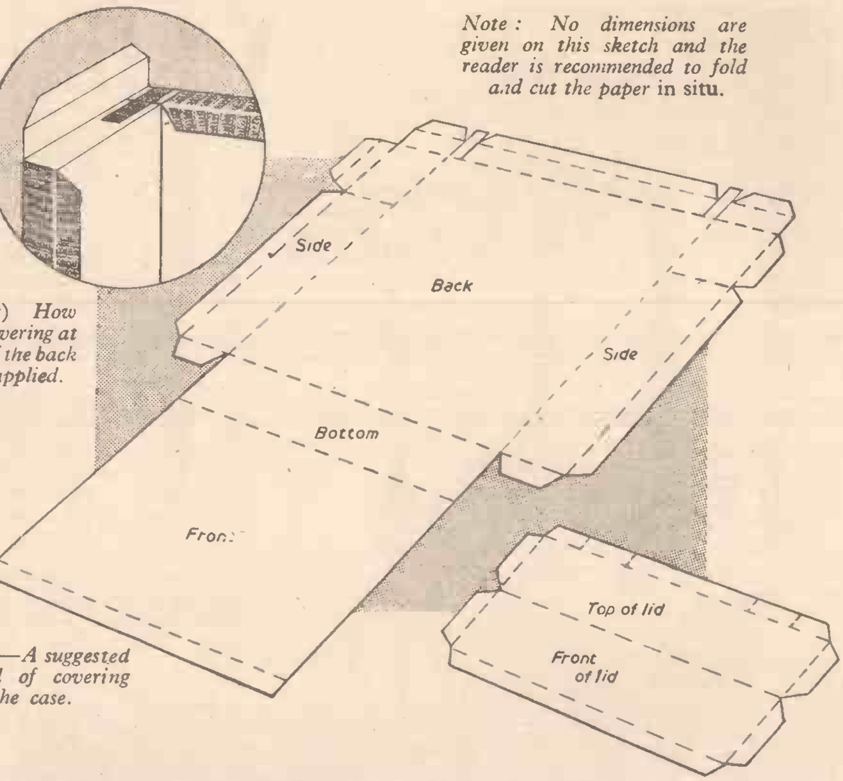
The best method of fitting the catches is to screw one half in position on the body of the case, close the lid, fit the top half of the catch and put in the locked position, then mark through the rivet holes on to the wood. Small chromium plated round head screws are used to secure both parts of the catches.

Positioning the Handle

Care must be taken to position the handle in the centre of the lid. This can be done by placing the handle and fitting approximately in position and then checking with a rule and finally marking through the screw-holes in the fitting when in the correct position. An alternative method is to cut a piece of paper the exact size of the top of the lid, mark out the position of the screws on it and then place it on the lid and mark through it with an awl. Four gliding castors are fitted on the bottom of the case to protect the covering material when the case is stood down.

Finally, the inside of the lid and as far down the inside of the case as can be conveniently reached may be neatly covered with white paper or marbled paper of the type used in bookbinding.

Note: No dimensions are given on this sketch and the reader is recommended to fold and cut the paper in situ.



(Inset) How the covering at top of the back is applied.

Fig. 4.—A suggested method of covering the case.

BOOKS Received

Van Nostrand's Practical Formulary, Edited by W. R. Minrath. 336 pages. Price 45s. net. Published by D. Van Nostrand Co., Ltd.

OVER 800 formulae that can be made up at home are contained in this book, together with information to enable them to be applied. Selection has been made with an eye to ease of preparation and only the minimum of equipment and technical skill is required. Chapters include: How to Use this Book; Surface Treatment—Wood; Lacquers, Paints, Enamels, etc.; Formulae for Metal Surfaces; Cements, Plaster, Glass and Related Substances; Household Cleaning, Polishing and Related Products; Photographic Formulae; Cosmetics, Hand Cleaners and Related Products; Food Products and Farm and Garden Products. Several useful appendices and a comprehensive index are included.

Space Flight and Satellite Vehicles, by R. B. Beard and A. C. Rotherham. 150 pages. 15s. net. Published by George Newnes Limited.

THIS is a review of the history of space flight development, an assessment of present knowledge and a survey of future prospects. The interested reader with some basic scientific knowledge will gain from this book a wide appreciation of the principles and problems involved. Interest has been stimulated all over the world by the launching of the Russian satellites and here will be found the answers to many of the questions which will occur to the thinking man.

The subject is fully dealt with, starting from basic principles. The methods of achieving space flight, the uses of satellite vehicles, the "why" and "when" of space-flight are all comprehensively discussed. Illustration is both by sketches and photographs and a bibliography and index are included.

Radioisotope Laboratory Techniques. By R. A. Faires and B. H. Parks. 243 pages. 25s. net. Published by George Newnes, Ltd.

THE aim of this book is to tell the scientist and technologist how radioisotopes may be used safely and effectively. The need for this information has been growing ever since the use of radioisotopes began to increase several years ago and now this comprehensive volume gives detailed information to aid the scientist and technologist as well as the newcomer. The authors' own experience in the Isotope School at Harwell and elsewhere has enabled them to deal with the subject in a practical way. Chapters on the elements of nuclear physics, radiation and radioisotope production are followed by Laboratory design, hazard control and waste disposal. There are further chapters on laboratory equipment, detection and measurement, one on assessing the feasibility of isotope usage, and others on applications and techniques. Several valuable appendices conclude the book. There are over 90 diagrams and four half-tone plates.

An Electric Slide Valve Engine

(Concluded from page 278)

The only thing now is to wire up the connections. To make the engine look as much like a steam engine as possible the terminals—of which two are required—should be fixed out of sight underneath the base. Run a wire from one terminal through the baseboard and solder it to the edge of the central fixed contact, taking care that the solder does not run up on to the level surface. If it does you must file the surface flat again. Now take one end (it does not matter which) of each solenoid coil and fasten or solder them both to the other terminal. Then solder the free end of the coil nearest the crank to the edge of the fixed contact nearest the crank, and lastly solder the end of the other coil to the remaining fixed contact. It is very important that the enamel should be scraped off the wire before making a connection.

An accumulator is the best source of energy for this model. If it does not work satisfactorily at first, try altering the position of the eccentric by slackening the grub screw and twisting the eccentric forward or backward a few degrees at a time until the best result is obtained. Oil all the moving parts except the contact surfaces, and adjust the pressure on the contact spring without introducing unnecessary friction.

Adding a Drawer

A Modification of Wide Application

By H. A. ROBINSON

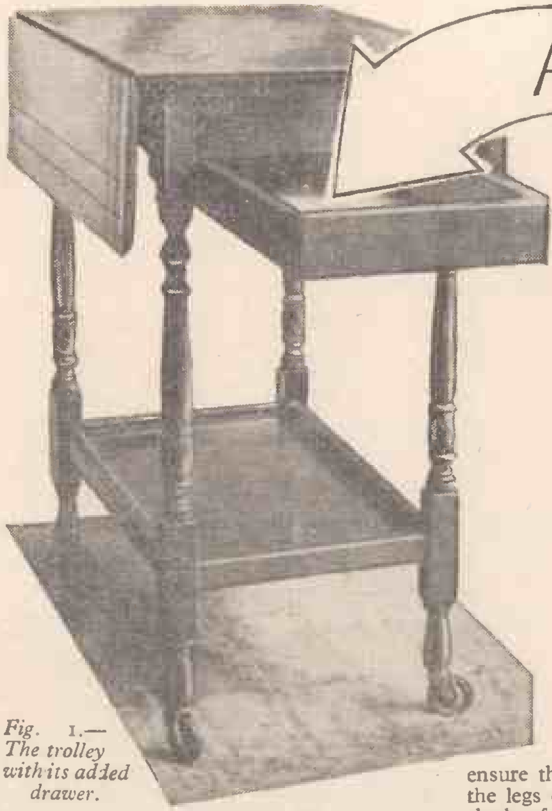


Fig. 1.—The trolley with its added drawer.

THE wheeled trolley with side leaves that can act as anything from a dumb waiter to a small-sized table for a meal would be even more convenient if it had a drawer to hold serviettes and other light table "furnishings."

Fitting such a drawer is well within the scope of the average home craftsman. As will be seen in Fig. 1, the extra feature in no way spoils the lines of a trolley; indeed, the one shown has been definitely improved by it, having gained a more solid look.

Construction

To give a cover to the "tray" and so keep out dust the inside of the trolley was first prepared, as shown in Fig. 2, with a rectangle of hard-board, ⅛in. thick, cut to fit between the ends and sides, small squares being taken out at the corners to accommodate the inner edges of the legs, which impinged a little on the under-top space. To hold this in position ½in. thick strips, ⅛in. less in depth than the ends, were screwed to the inner face of each end-piece and the hardboard secured to them. Fitted thus the underside of the hardboard and under edges of the ends were flush and a continuous surface was formed right across.

Suspension

The drawer was hung from the hardboard by the side runners, shown in Fig. 2, and shaped in each case from a single piece. They could have been built up from lengths of ½in. square and ¼in. square wood, gluing and inserting small screws at close intervals. In length the runners were cut to fit between the inner faces of the trolley legs.

The rebates of the runners were positioned a little closer together than the inner faces of the legs so as to give the biggest drawer capacity possible and yet ensure that the sides did not scrape against the legs or be in danger of doing so after a shade of wear sets in. In the writer's trolley a clearance was allowed of a trifle under ⅛in. each side, but exact measurements will have to be obtained from the trolley being dealt with.

Making the Drawer

Full dimensions are given, for the drawer as made would do quite well for trolleys near the size, or some widening could be readily effected for larger sizes, to give maximum capacity. Depth would remain the same for a whole range of widths.

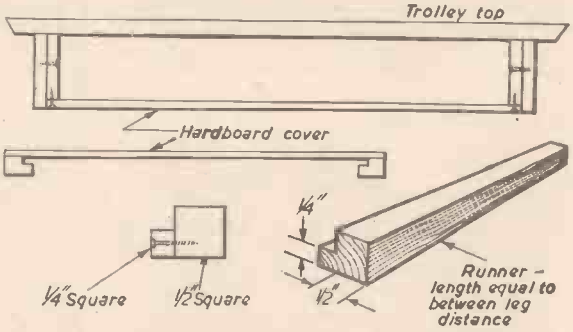


Fig. 2.—Suspending the drawer.

The external dimensions are 20in. × 9⅝in. × 2⅜in. (see Fig. 3). Component parts are two end-pieces 9⅝in. ×2⅜in. × ⅝in., two sides 19¼in. × 2⅜in. × 5/16in. and a hard-board rectangle 19in. × 9¼in. for the base.

To strengthen, the sides were let into the ends by the joint in Fig. 4, the thickness of the end-pieces allowing for this. The hardboard base was held in a channel ⅛in. deep and ⅛in. high taken out of the inner faces of the sides and ends and positioned 3/16in. up from the lower edges. The board needed careful cutting so that it fitted in the channel quite tightly.

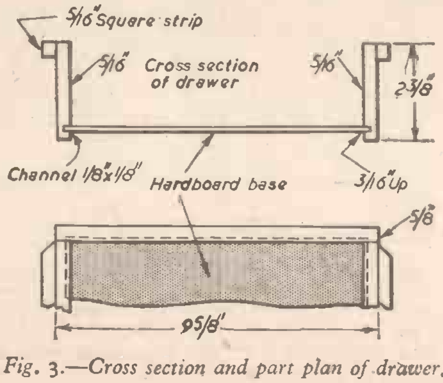


Fig. 3.—Cross section and part plan of drawer.

Before the final assembly the runners were put in position on the sides of the drawer. These were 5/16in. square strips held by small screws and glue, the ends being neatly bevelled to give a finished appearance.

All being completed, ends, sides and base were put together, glue being used at the principal joints and a panel pin at each of the four corners. There was no need to fit knobs or handles to the drawer ends as it can be pulled out readily by fingers placed beneath. Assembly is shown in Fig. 5.

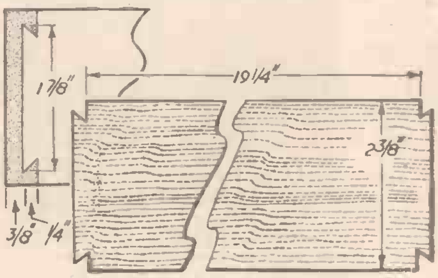


Fig. 4.—Method of jointing.

Fitting and Finishing

Drawer and runners should be finally tested for easy sliding in the rebates and when any adjustments that are necessary have been made the whole hardboard cover attached under the trolley with screws, as previously described.

The tray and runners can be finished to match up with the rest of the trolley, the end-pieces being polished. It is interesting to note that a drawer thus fitted pushes out equally well at either end of the trolley.

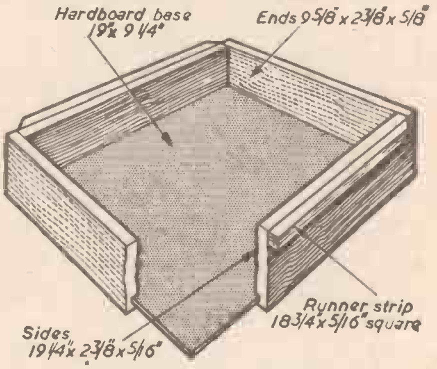


Fig. 5.—Drawer assembly.

PRACTICAL HOME MONEYMAKER

EDITED BY F. J. CAMM MARCH ISSUE NOW ON SALE

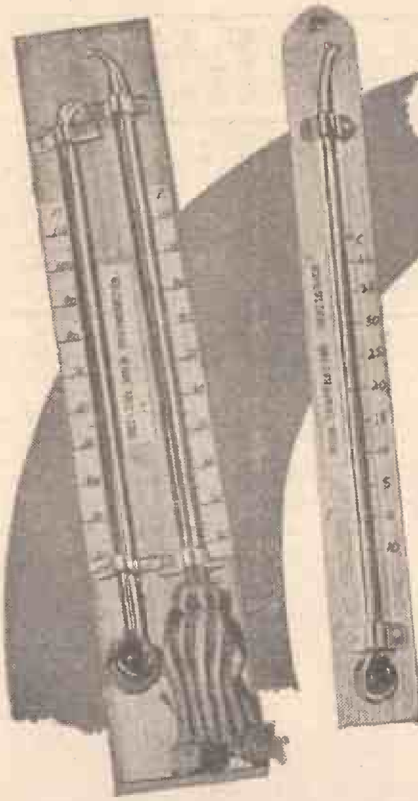
PRINCIPAL CONTENTS: Contemporary Iron Work; Designing Showcards; House Numbers in Wrought Iron; Passe Partout Binding; Home Shoe Repairing; Budgerigars for Profit; Bees for Pleasure and Profit; Tartan Scarves and Hand-woven Ties; Gesso Decoration; Finding Your Market and many other profitable articles.

Make Y
Therm

By E. V. KING

No. 1 of a Series Whic
Describe the Construc
Several Types

ORDINARY cheap thermometers are not very accurate and they can easily be made at home. Chemical thermometers of good grade cost over £1 each—largely due to labour and laboratory upkeep, etc. You can thus make yours much cheaper. They may be designed for use in a living room, the loft, the greenhouse, the sick-room, baby's bath water, motor radiators, soil, photography, chemical processes, sweet making, etc. It is not possible, nor would it be advisable, for the amateur to attempt to make a clinical thermometer for taking body temperature. For this purpose always buy a thermometer with a National Physical Laboratory Certificate.



Apparatus Required

For the most part this is quite elementary, and most of it will be found in the kitchen. The actual filling of the thermometer, however, should be done in the workshop or on a good thick covering of newspaper, as the dyes used will stain a kitchen table badly.

The capillary tubing required can be ordered at your local chemist's, from any laboratory suppliers or from Messrs. Laboratory Glass Industry (Clapton) Ltd. The dyes used are not critical; as long as they will dissolve in alcohol they will suit.

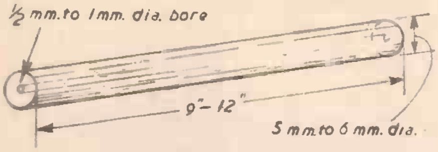


Fig. 1.—Soda capillary tubing of a suitable size.

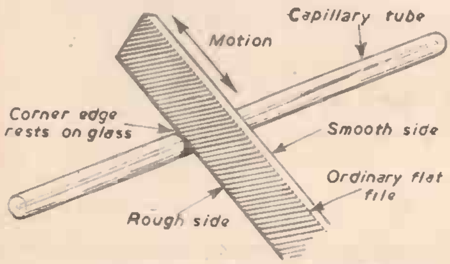


Fig. 2.—Marking the tube into lengths.

A Simple Room Thermometer

This thermometer can be mounted on a wooden stand or made to be part of a mantelpiece ornament, etc. With practice you can turn these out by the dozen for your friends or for sale.

When delivered the tubing is usually in 3ft. lengths and this will have to be cut into suitable pieces. Start by cutting them into 12in. pieces to allow for errors in blowing the bulb; later, 9in. pieces are sufficient. The tubing suggested has an internal hole of about ½mm. (do not use a hole smaller than .4 nor greater than 1mm.), this size is easily worked in all respects (see Fig. 1). Finer tubes may be used later for special jobs, but not by the beginner. Soda glass tubing should be used for cheapness and ease of working.

To cut, take a triangular or rectangular file and, using a corner of it, make a scratch across the tubing (see Fig. 2). Hold the tube in two hands close to the scratch, with scratch uppermost, and bend it gently downwards. It will then snap cleanly. If you are working in the kitchen make sure no chips could fly into open food. File off any razor-sharp edges which may remain. When using a rectangular type file do not use a corner adjacent to the flat side.

Sealing One End

It is possible to make the thermometer without a special burner. The large roaring burner fitted to most gas stoves will do the job, but the manipulation, especially for a beginner, is somewhat tricky. A large bunsen burner or a builder's blow-lamp is ideal. The job is somewhat easier using a standard bunsen burner, as the flame is smaller and can be made yellow at ease for annealing. If you are using a blow-lamp or gas stove you will have to anneal by holding the glass about a foot away from and above the flame.

Close the air holes of the bunsen burner and put the gas on full (Fig. 3A). Hold a piece of tubing at its centre in the left hand and keep it rotating with the fingers of the right hand. When you can do this continuously without thinking about it introduce the left-hand end of the tube to the yellow flame. Keep turning all the time and after about 30 seconds, still keeping the glass in the flame, open the air hole of the burner fully, the flame will then be roaring. This is the hottest flame available with the burner. Keep the glass rotating all the time and carefully locate it just above the tip of the blue cone of the flame. Only the end of the glass tube should be near the blue cone (Fig. 3B).

Soon the flame will become yellow (sodium light) as the glass begins to soften. Keep the tube turning steadily or it will take on snake-like contortions. Now the glass tip will be seen to become red-hot and the end will round over and after about a minute it will seal off. As soon as this stage is reached you must work quickly.

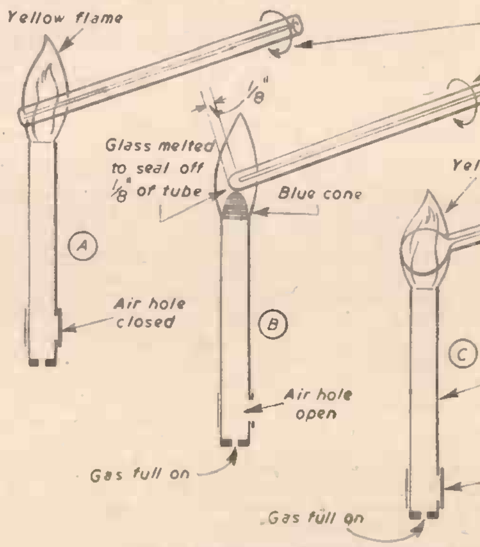
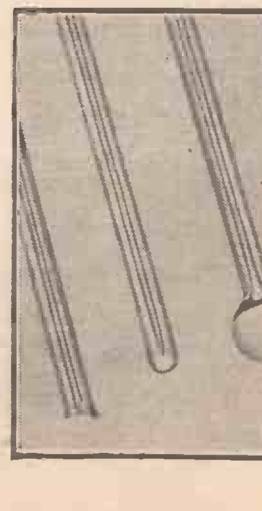


Fig. 3.—Stages in blowing a glass bulb

Making the Bulb

When just about ⅛in. of capillary hole has melted into the sealed



(Right)—Stages in the construction of a thermometer (left to right) capillary tube; end sealed; bulb blown; tube filled; top end drawn out; top cut off; end sealed.

MATERIALS REQUIRED

Capillary tubing, between ¼ and 1 mm. bore, nearest to ½ mm. is best. Soda glass. Order through any chemist, laboratory supplier or Laboratory Glass Industry, Ltd., 85, Clifden Rd., Clapton, London, E.5. Cost 6s. 6d. per pound, which will make dozens of thermometers.

DYE

I.C.I. Methasol Fast Colours. Obtainable in quantity from Messrs. Skilbeck Bros., Ltd., 203, Upper Thames St., London, E.C.4.

Methyl Violet and other colours obtainable in small quantities from British Drug Houses or via them through any retail chemist.

Hectograph Carbon Paper, Spirit Duplicator Carbons or Banda Carbons. Obtainable from any office duplicating equipment company or Messrs. Block and Anderson.

Wood, tin plate, panel pins, etc.

Methylated spirits from any ironmonger or chemist.

Minimum equipment required.

HEATING

Gas stove, bunsen burner or builders' blow-lamp.

A spirit lamp alone will not do for this work. Certain spirit type blow lamps are probably suitable.

Glass or metal funnel, 2in. or more in diameter.

Small rubber tubing to attach funnel to capillary tube.

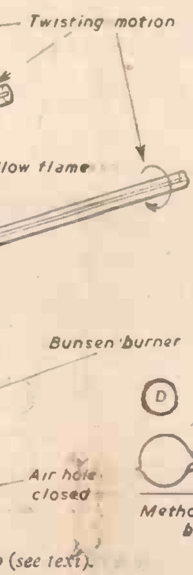
Cans or saucepans, jam jars, bottles, rags, etc.

Your Own ...ometers

...ch Will ...ction of

The photographs left and right of the heading show some thermometers which will be described later in this series.

tube withdraw quickly from the flame, keep the tube turning all the time and hold it vertically, sealed end down towards the floor. Now bend the head forward and blow strongly into the open end of the tube (you have filed away sharp edges already).



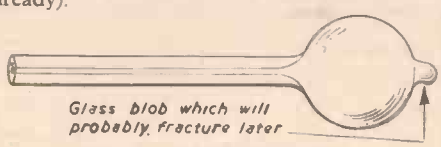
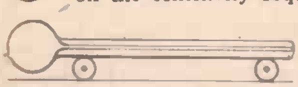
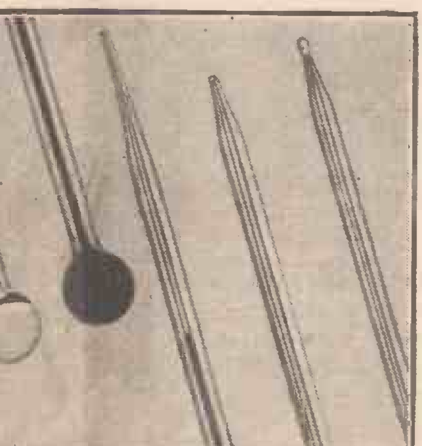


Fig. 4.—A badly-blown bulb.

Have the glass really hot before you attempt to blow. Blow very hard initially, being ready to ease off at once the moment the glass starts to stretch. Once the bulb commences to form very little air pressure is needed or the bulb will become much too large and burst. If the bulb were large the stem would have to be unduly long and the bulb itself would be very weak.

The size of bulb you require depends on the sensitivity required. For a start aim at a bulb ½in. in diameter with the ½mm. approx. tubing. The larger the bulb and the finer the tube the more travel the liquid will make for a given temperature rise. In thermometers used for purposes where one particular temperature is of great importance (i.e., photography), great sensitivity is often useful and easy to attain. Normally, where one requires a reasonable range with a thermometer of normal size, some sensitivity has to be sacrificed.





If the blowing operation is not successful the first time do not worry. Reheat the same piece of glass and try again. If you make the glass bulb too large or small, reheat (keep the glass rotating) and the bulb will melt into a glass blob again ready for blowing. Beware, however, of getting a bulb like the one in Fig. 4 for the blob is likely to crack off, especially if the annealing is not perfectly done. It looks untidy, too. If this does happen to you *just* touch the tip of the tube in a saucer of cold water and the end will crack off and you can start again. Alternatively, let the glass cool and use the file. Never use the file on hot glass as it will ruin the file even if you do not burn your fingers.

If you blow too hard after the initial "puff" the bulb will blow to a diameter of some 4in. The glass will be less than 1/1000in. thick and the slightest breath of air current will break the bulb, when the glass will float about in the air. It is dangerous to inhale this floating glass.

Annealing

If glass is allowed to cool quickly its molecular structure is such that internal stresses are formed. Then, at some future time, when some slight mechanical vibration or thermal change is applied, the glass fractures. This is overcome by the annealing process in which the glass is allowed to cool slowly over a period of about 90 seconds.

The moment the bulb has been blown, introduce it back to the flame, which has been turned yellow, and keep the glass turning (Fig. 3C). Now slowly withdraw it from the flame over the next 30 seconds. Then place it to rest on a couple of spare glass tubes, the bulb being "in air." Do not let any air draughts play on the bulb during the latter stage as it is still annealing (Fig. 3D).

Warning

Hot glass does not show up like iron or steel. A bad burn can result from careless techniques. Especially watch that a hot tube is not placed in the mouth.

The Thermometer Fluid

Although mercury is often used in commercial high grade thermometers, in many respects alcohol is more suitable and it is proposed here to use alcohol in the form of methylated spirits. This is used on economic grounds mainly, but it is also easier to fill the bulb with alcohol than with mercury.

Alcohol thermometers may be used at temperatures well below any ever experienced in this country or in any domestic refrigerator's ice box. They cannot be used where the temperature it is wished to record is above 78 deg. C. (172 deg. F.) because the alcohol would boil and blow up the bulb. Thus, although the thermometer we are making is quite suitable for taking room temperatures, it would not be suitable for sweetmaking or for chemistry work at boiling water temperature (100 deg. C., 212 deg. F.).

Although you may use methylated spirits as bought to fill your thermometer, it is best to colour it. I.C.I. Methasol Fast Red and Orange dyes are satisfactory, but the smallest quantity which can be bought is 1lb. (enough for 10,000 thermometers). An alternative, which proved reasonably successful, was the use of solid iodine crystals, obtainable from any chemist, but the cost was rather high. The best alternative the author found, and one which was easily obtainable, was the use of Banda Carbon Paper, made by Block and Anderson, and sold by all business duplicating suppliers. Hectograph carbon paper is just as good and is obtainable on order from most stationers including W. H. Smith and Son. The dye used in these papers is probably methyl violet. Two sq. in. of the paper shaken about with approximately 15 c.c. (egg cup full) alcohol will produce a dark purple coloured liquid ideal for use in these thermometers. Any alcohol soluble dye may be used, however. If the liquid produced by dissolving the dye off the special carbon papers is not perfectly clear (i.e., bits of wax are visible) it should be filtered (blotting

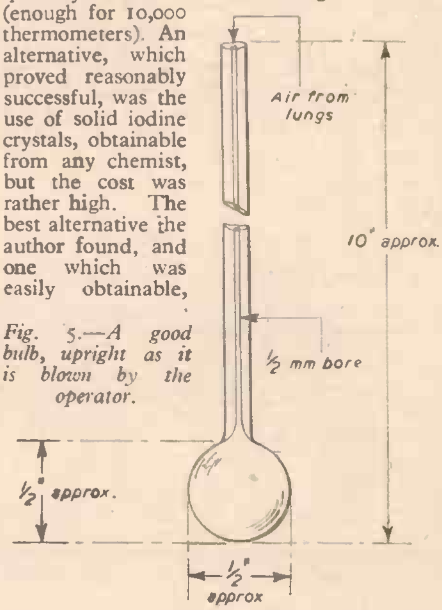


Fig. 5.—A good bulb, upright as it is blown by the operator.

Fig. 6.—Two methods of making the dye solution.

paper will do). The author found that this was not necessary unless he used a very small bore tube.

It is suggested that you make up, say, half pint of this solution (within limits the stronger it is the better) and keep it in a labelled, closely corked bottle. It is inflammable and a very strong dye indeed, so keep it well out of the way of children.

Filling the Thermometer

Three methods are available. It is suggested that the first method is followed by the beginner, as it is somewhat safer though it takes longer than the other methods.

Method No. 1

Attach a small metal or glass funnel to the capillary tube, Fig. 8. Pour in a little dye solution and lower the bulb of the thermometer into a can of boiling water. As air in the bulb becomes heated it will expand and force out air bubbles through the liquid in the funnel. Then place the bulb in a can of cold water (60 deg. F.), keeping the funnel attached all the time (Fig. 7). If the annealing has been done properly this will not cause a fracture. The air in the bulb now contracts back to its original size minus that which has been expelled. The "vacuum" left is then filled with fluid from the funnel, it being pushed in by atmospheric pressure.

Now replace the bulb, containing some dye solution, in the can of boiling water. The alcohol in the bulb will now boil (Fig. 8), driving off air with the vapour. This air will be observed bubbling through the reserve liquid in the funnel. On placing in cold water again the bulb will completely fill with alcohol. If it does not then repeat the process once more. There must be no bubble left in the bulb when this process is finished. A small bubble or two in the stem will not matter as you may remove them later by swinging the tube in a semi-circle so that centrifugal force takes the heavier liquid down to the bulb with each "swing."

Before removing the funnel of reserve liquid let the bulb cool down to room temperature. If you do not do this, the liquid will contract into the bulb leaving none in the thermometer stem.

Method No. 2

Fit a funnel of reserve fluid as for No. 1. Heat the bulb directly in a small blue flame (or use a spirit lamp). Remove the bulb after five seconds and let it cool on its own. Do not use cold water or you will crack the bulb. A few drops of alcohol will enter the bulb as it cools. Now carefully boil this in the small flame, keeping the bulb shaking all the time. When it has nearly all boiled away let the bulb cool on its own once more. If the bulb does not completely fill with fluid then repeat the process as necessary. Be careful that you do not spill the liquid from the funnel on to your hands as the spirit will most likely catch fire. Should this happen wrap the hands calmly in a towel and no harm will result.

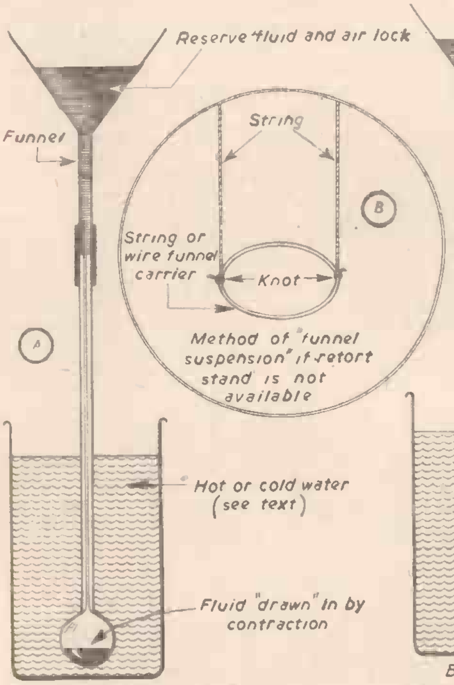


Fig. 7.—Filling by method No. 1 is shown at (a) and at (b) is shown an alternative method of suspension.

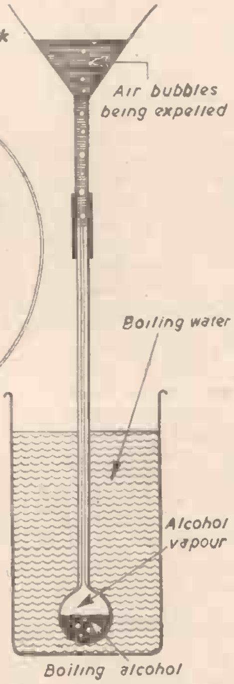


Fig. 8.—Air being forced out by method No. 1.

Method No. 3

Do not fit a funnel. Heat the empty bulb as for No. 2. Invert the tube so that the open end rests in a beaker (jam jar will do) with some fluid in the bottom. Let the bulb cool and some fluid will be drawn up into the bulb. Now boil the alcohol in the bulb as in method No. 2. Invert the tube again in the beaker. Repeat if necessary until the bulb completely fills. This last method is the quickest for "mass production" at home, but alcohol is often squirted out and will stain the wall or any other object it contacts. It will also catch fire if you are not careful. You should use method No. 1 until quite confident.

Method No. 4

This method is not used this month, but it is mentioned here as it may be of interest. This is for use with mercury. On the whole it is harder for the beginner to use mercury and unless the tube used is very fine the cost is prohibitive. Mercury should be

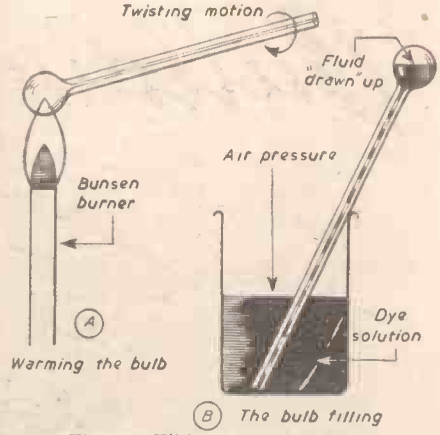


Fig. 9.—Filling by method No. 3.

heated in the gas or electric oven for a few hours (i.e., while the Sunday joint is cooking) to make sure it is dry and has not got dissolved gases in it. Method No. 2 is then used. A large tin (painted) or, better still, enamel or polythene tray must be placed under the apparatus to catch any mercury spilled. Every time the bulb is allowed to cool use the shaking method to get the stem full of mercury down into the bulb. This means taking the funnel off. To fill one bulb will probably mean heating, cooling and shaking about 15 or 20 times. If bubbles appear in the bulb around the glass itself it is most likely you have not heated the mercury properly beforehand.

The main difficulty experienced in the above is keeping the funnel upright while doing the manipulations. The author used a retort stand to hold the funnel and moved the cans of water in lieu of the thermometer bulb.

With two pairs of hands the job is easily done, one holding the funnel the other manipulating the hot and cold water, etc. A sling to suspend the funnel from a shelf, lamp or the plate rack of the gas stove is feasible. You can then easily slide the hot or cold cans of water under the bulb without spilling the liquid.

Drawing Out the Stem

Having filled the thermometer and let it cool to room temperature it needs to be sealed. There are, however, one or two things which must be attended to first.

(*To be continued*)

[*Part two of this series will tell readers how to complete the room thermometer, including adjusting the amount of liquid in the stem, sealing, mounting and calibration*].

PRACTICAL MOTORIST AND MOTOR CYCLIST

Edited by F. J. CAMM

March Issue Now On Sale

Principal Contents : Cylinder Reboring *in Situ* ; Carburetter Maintenance ; Preparing the Car for Spring ; Loss of Compression ; The Beginner's Guide to the Motor Car ; Building a Two Berth Caravan ; The Electrical System ; Overhauling the Post-war Standard Eight ; Braking Principles and Practice ; Tuning Motor Cycle Engines ; Overhauling the D and DX Type Vauxhall ; Accessory Review ; Garage Mechanic's Diary ; Many Other Interesting Articles.

Building an Outboard Motorboat

A Sturdy All-wood Craft, Ideal for the Week-end

(Concluded from page 232, February issue)

Protecting the Keel

If the boat is to have a lot of rough work on the beach, or is likely to be repeatedly dragged along the ground, this keel should be sheathed with 1/16in. × $\frac{7}{8}$in. brass strip, which can be carried right up to and round the bend of the stem, up which it may extend for 3in. This may be drilled for and secured by No. 6 ½in. brass screws at 3in. intervals.

A further means of protecting the bottom is to put on some bilge keels. These are

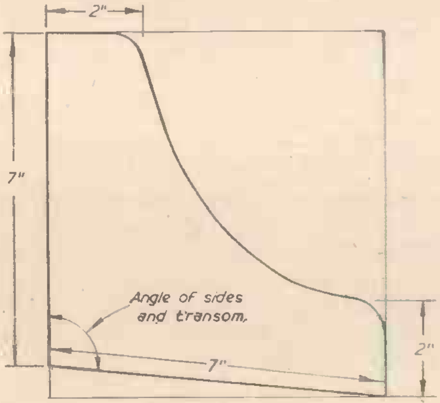


Fig. 27.—Details of the knees.

simply pieces of 1in. × 1in. oak, each 3ft. long, screwed on each side of the main keel to the boat's bottom, about midway between the keel and the sides, and in the centre of the boat, measured fore and aft.

These, too, may be metal shod, but it is not important, as they are easily renewable.

Finishing the Keel

Having completed this part of the work, turn the boat right side up, and complete the fitting of the keel by passing screws through holes in the frames, which were made earlier in the job for securing them to the setting up batten. These screws should be 3in. long No. 8 brass; you will, of course, need to counterbore for these with a long gimlet before you can drive them into the oak. The heads of these screws can be stopped over with mahogany colour plastic wood, and the ones in the false stem with natural colour plastic wood.

The Knees

There are three strengthening knees on the gunwale line and two at the bottom of the craft. The first to be considered will be the two that brace the sides to the transom and are known as "quarter knees." Fig. 28 shows the shape of them and their position. These knees are sawn out of 1in. oak, and should have sides 7in. long, so that the plank will need to be 7in. wide. There are two knees of this size, so a piece of 14in. × 7in. is required; allow waste and sag, 18in. × 7in. To make these first measure the angle which the sides of the boat make with the transom, this can be done with a bevel gauge, or a piece of stiff cardboard can be placed over the corner made by the sides and transom and the shape marked with a pencil. A third method is to use a folding rule, if the joints are not too loose, in the same way as a bevel gauge is used.

Transfer and mark this angle on to the timber and make each limb of the knee 7in. long. At the end of each line draw a line 2in. long at right angles and join them by a gentle curve. Fig. 27 shows this more clearly. Cut along these lines, the curved one with a bow saw or pad saw.

Fitting the Knees

The fitting of these knees requires patience and care. First cut out a notch to allow the knee to pass over the transom framing and set fair against the transom itself. Notice that the sides slope inwards and the transom backwards, therefore the knee will have to be bevelled to fit. This is best done by trial and error, taking a little off at a time, and trying the knee up in position.

Since this will have to be done a good many times before a perfect fit is obtained, try to get the boat near the vice. When the knees are properly shaped you can round off the corners of the curve to neaten the job up and proceed to fit them.

In professional work they are usually riveted right through with long copper rivets, but the job may be done by fitting them by means of screws passed through the boat's side and gunwale on the one side and and the transom on the other, taking care to get the knee flush with the top of the gunwale. Use No. 8 screws, 2½in. long. These knees must be well fitted and secured, as apart from their purpose of bracing the sides to the transom they take a considerable amount of the thrust of the motor in driving the boat forward.

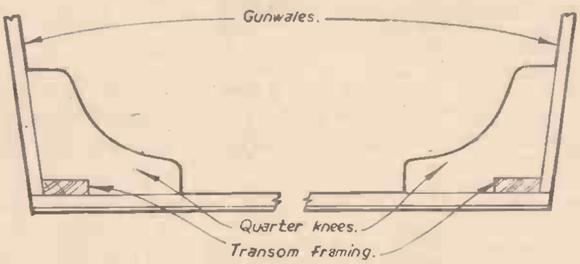


Fig. 28.—Fitting the quarter knees.

The next knee to fit is up in the bow and this braces the sides at the gunwales to the stem. Fig. 29 shows how it is fitted. The method of marking out, etc., is the same as for the quarter knees but not quite so difficult; it is secured in the same way. Great care should be taken to get graceful curves in the cut-away portion, as a well-proportioned breast hook, as this part is called, can improve the appearance of a boat. When it is fitted, either plane or rasp it up fair and smooth with the top of the main stem post, finishing off with sandpaper.

The length of the breast hook should be about 7in. but it is not critical.

The next knee will be in the forefoot of the boat and braces the bottom of the stem post and the boat's bottom, it rests on the seam batten and is secured by long screws

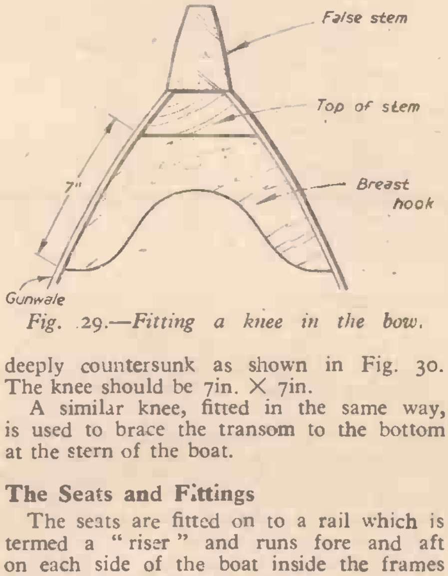


Fig. 29.—Fitting a knee in the bow.

deeply countersunk as shown in Fig. 30. The knee should be 7in. × 7in.

A similar knee, fitted in the same way, is used to brace the transom to the bottom at the stern of the boat.

The Seats and Fittings

The seats are fitted on to a rail which is termed a "riser" and runs fore and aft on each side of the boat inside the frames to which it is secured by screws, two screws at each position where it touches a frame.

The riser is made from 1½in. × $\frac{7}{8}$in. mahogany and extends from the transom framing to about 6in. forward of frame No. 1.

It is fitted 1ft. 3in. above the floor of the boat, this measurement being taken from the boat's bottom planking to the top edge of the riser, measured at the middle of the boat, and runs straight fore and aft, and does not conform to the curve or sheer of the boat.

Once these risers are fixed the fitting of the seats is simple.

The stern seat is made from mahogany 14in. wide × ¾in. thick, and is cut to the width of the risers at the transom and screwed to them.

The centre seat (8in. wide × 1in. thick), is fitted in the middle of the boat and screwed to the risers. The forward seat is 8in. × 1in. secured in a like manner, and its position is such that there is a space of 3ft. 6in. between its rear edge and the front edge of the centre seat.

The Rowing Chocks

The rowing chocks to hold the rowlocks can next be made and fitted; these are produced from oak 1½in. × 1½in. and each 6in. long. They must be shaped slightly on one side to conform with the curve of the boat's side; the other side has its corners rounded off.

A hole is bored through the centre to take the plate bearing of the rowlocks, and the size of this hole must be governed by the size of the rowlocks purchased. Fig. 31 shows how they are made up and also shows the fitting arrangement. A second piece of oak should be fitted a few inches lower to steady the rowlock. They are fixed by means of 2½in. screws passed through the planking and gunwales from the exterior of the boat.

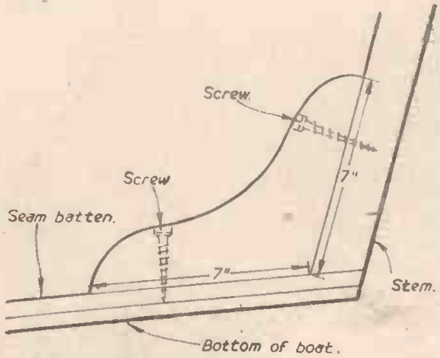


Fig. 30.—Method of fitting the fore knee.

The Rowlocks

The exact positions for these rowlocks is best determined by temporarily clamping them in position and then sitting in the boat with a pair of oars resting in them. Experiment until a comfortable position is obtained.

Remember, however, not to get ones in the front seat too far aft or it will be found that the person on the centre seat is in the way when rowing from the forward position.

Good all-round positions, however, are as follows: Fit the front seat so that the hole in the chock is 12in. aft of the centre line of the seat and the centre set 14in. aft.

The Rubbing Band

This must be fitted round the boat from stem to transom on the outside level with the gunwale. It can be made from ½in. × ½in. oak, bent round and secured every 6in. with a 1in. No. 6 wood screw. The front end should be tapered off for 3in. down to nothing, where it meets the false stem post and rounded off at the transom end.

With a finely-set sharp plane trim the edges off all along, giving the band a half-round appearance.

Floorboards

Floorboards must now be made up as it is unwise to tread or put any local weight on the bottom planking itself.

These boards need not be shaped; all that is required is some planks of good, clean deal 4in. wide, ½in. thick, and long enough to reach from just under the stern seat to just forward of the front seat.

Lay one along the centre of the boat then one on each side of it resting on the frames. Now continue to add planks until the width between the frames is made up with the exception of a few inches. As the boat narrows down towards the bow so shorter planks are fitted. Alternatively, of course, the planks can be shaped if a smarter-looking job is desired.

Having got the planks set out it is usual to fit them together in groups of two or three by fitting battens underneath.

This makes a quicker job of removing them for cleaning out, and as the groups of planks have a greater weight and area they will stay in position without any fixing.

The final item of construction will be to screw a ring bolt in the inside of the stem about half-way up, to which a rope for tying up your boat can be attached.

Finishing

Rub all the woodwork down with sandpaper preparatory to finishing.

The bottom inside should receive three good coats of paint up to the top of the chines. Black is too drab-looking; grey looks well, and is perhaps the most suitable colour.

The bottom outside may be to choice.

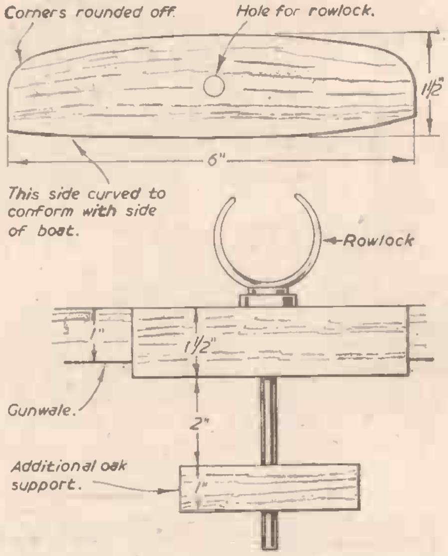


Fig. 31.—The rowing chock and fitting the rowlocks.

Standard boat colours are green, red, white and blue; any of these will look well against the varnish which is used for the rest of the job. Give three good coats, allowing each to dry well.

This also applies to the varnish, which should be good quality yacht varnish.

Flexible Pottery

METALLURGISTS in America have developed a method of treating brittle ceramic materials so that they can be bent. A combination of the desirable properties of both metals and ceramics is the aim.

Ceramics are not noticeably affected by temperatures of 3,000 deg. F., but are brittle; metals are flexible, but melt at well under the temperature mentioned. This seems to indicate that a combination of the two could result in a suitable structural material for rockets, guided missiles, etc.

Measuring the Standard Metre

THE standard metre is deposited in a cellar deep below ground at Servres, near Paris, and a new proposal has been put forward to define it as "equal to 1,650,763.73 times the wave length in a vacuum of the radiation of Krypton 86."

The present standard metre provides accurate measurement within one to two millionth parts. The new standard recommended would, it is claimed, prove accurate to within "some millionths of a millionth."

The metre was first set up as a standard during the French Revolution and was designed to be the ten millionth part of a quarter of the earth's meridian.

Rubber Crash Doors

THE rubber crash door is becoming more and more popular in industry and consists of a heavy rubber sheet hung on an angle-iron frame in such a way that the rubber at the edge farthest from the hinge is free. The doors are opened by the impact of a truck against the rubber sheet and close again automatically.

Automatic Lighting Up

MANY of the bright lights and flashing neon signs in London's West End are switched on automatically by means of a photo-electric cell which reacts to daylight intensity. When the skies darken to a preset level, they set in motion the control unit which automatically switches on the lights.

Flexible Light Bulbs

FLEXIBLE lamps which can be shaped as required and made from nylon, plastics or steel mesh have been developed. Electro-luminescent panels and murals, made by coating sheets of glass with phosphors have already been produced. They are treated to conduct electricity and when supplied with power, light up.

This process may, in several years time, lead to the production of window shades, drapes and other bendable materials that actually produce light.

World's Largest Blast Furnace

THE largest blast furnace of its kind in the world is being designed by the Stalproekt Institute in the U.S.S.R. It will have a volume of 2,286 cubic metres and a daily capacity of 4,500 tons of metal.

Rockets Gain Information

LAUNCHING earth satellites is not the only function of a rocket; it can be used to obtain information about temperatures in the upper atmosphere. The method may be by spreading chemicals in the atmosphere and it is thought that valuable information on the structure and composition of the atmosphere could be obtained.

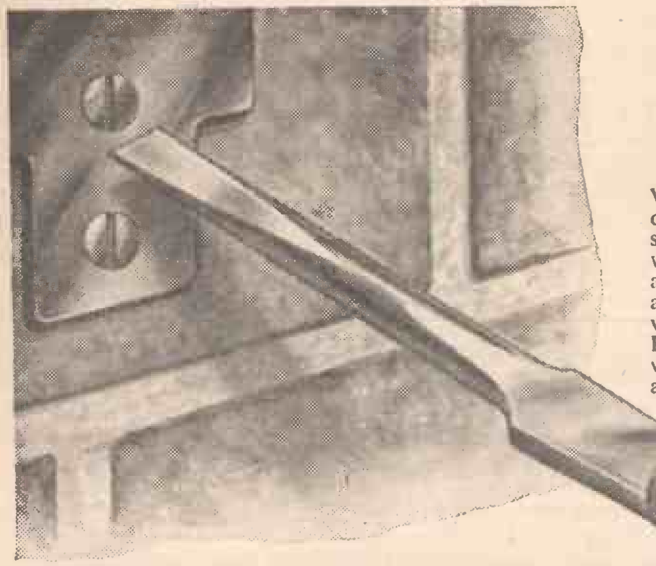
Wrong Author

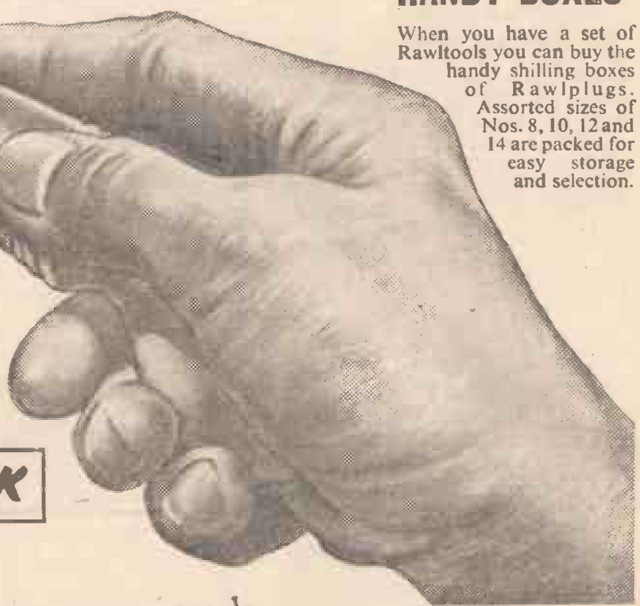
IN the article entitled "A 6in. Telescope Mirror," we regret that the author's name was wrongly given as J. Parker. The author was in fact T. J. Mulligan.

Building an Outboard Motorboat—Error

WE regret that the dimensions printed for the sloping side members of frames Nos. 2, 5 and 6 (Nov. and Jan. issues), were incorrect. They should have read as follows:

Frame No. 2 ...	1ft. 3¼in.	Sloping Measurements
„ No. 5 ...	1ft. 3in.	
„ No. 6 ...	1ft. 2⅞in.	





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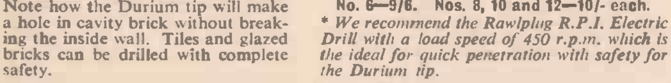

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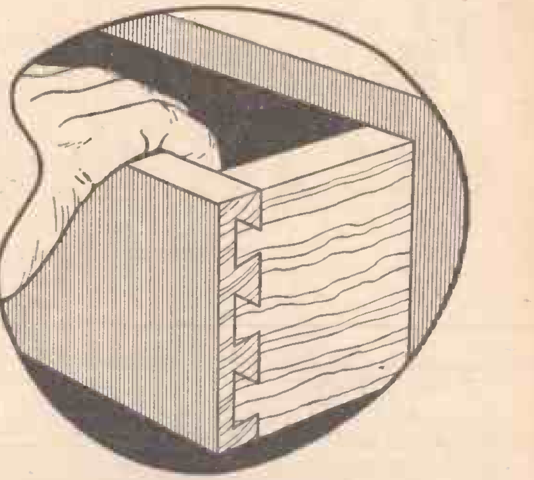


FOR the more precise jointing of timber the mortise and tenon joint is widely used. This consists of two parts, the tenon which can be described as a "tongue" cut on one piece of timber which fits into a recess cut in the other piece, which is the mortise.

There are several variations of this type of joint, but it would be impractical to cover all, so one will be dealt with in detail and the others surveyed. The method of construction is similar in all cases, and only the marking out varies.

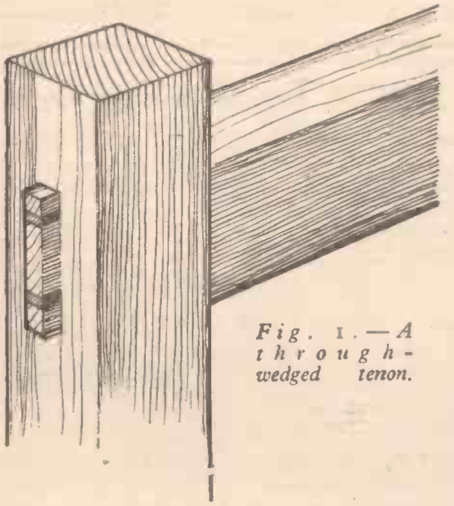


Fig. 1.—A through-wedged tenon.

Through Wedged Tenon

Fig. 1 shows a through mortise and tenon joint which is wedged in place, and this is commonly known as a "through wedged tenon." It will be noted that the tenon passes through the mortise completely and that there is some waste material. This waste is removed with the plane after the glue has set.

The first step in the marking out is seen in Fig. 2, where the try-square is being used to set out the length of the tenon. In the case of a through tenon it must be marked off longer than necessary to provide the waste material seen in Fig. 1.

A tool not previously encountered in this series is now required; namely a mortise gauge. The main difference between this and the ordinary gauge is that it has two points, one fixed and the other moving. The moving point is controlled by the screw at the end of the gauge. When setting the gauge, the chisel being used is held against the points and the moving point set so that the gap between the two is equal to the width of the chisel. This operation is followed by adjusting the fence so that the points will mark at the required distance from the edge of the timber—usually in the centre. The mortise gauge being set is shown in Fig. 3, and Fig. 4 shows it in use. The lines set out with the aid of the try-square can also be seen.

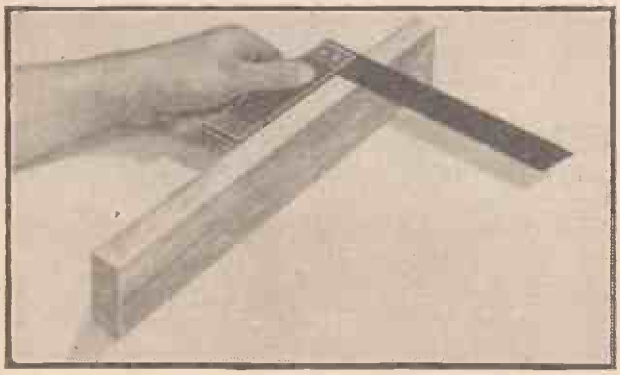


Fig. 2. (Left)—Length of tenon being marked off.

The try-square and mortise gauge are used to mark out the position of the mortise, and again the operation is similar to that of setting out the tenon, except that in this case the mortise is not at the end of the timber. The mortise and tenon, both marked out ready for cutting are shown in Fig. 5, and the shaded portions denote the timber that will be removed.

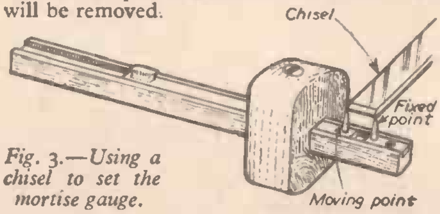


Fig. 3.—Using a chisel to set the mortise gauge.

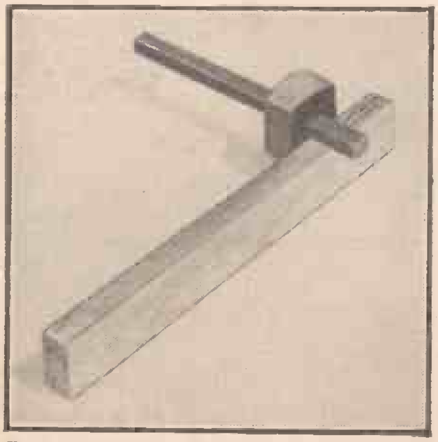


Fig. 4.—Marking off the width of the tenon.

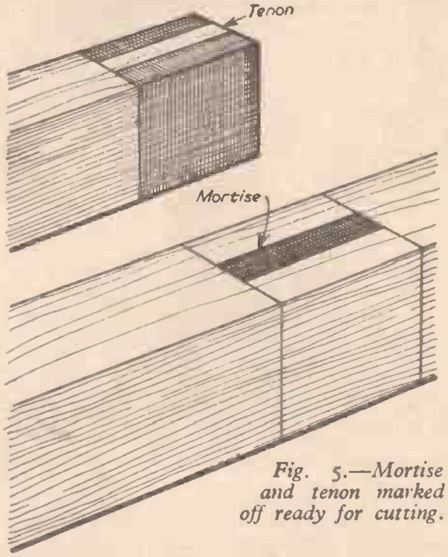


Fig. 5.—Mortise and tenon marked off ready for cutting.

Cutting the Mortise

The actual removing of this waste timber is illustrated in Fig. 6, and Fig. 7. The mortise is first cut with the aid of a brace and bit, the latter being slightly smaller than the width of the mortise. With this a series of holes is drilled, so removing the bulk of the waste material. The remaining timber between the holes and at the mortise ends is removed with a chisel as seen in Fig 7.

Cutting the Tenon

Fig. 6 deals with the cutting of the tenon. The tenon saw is used and the cut is commenced as at "A." The saw handle is steadily lowered as cutting continues until the position seen at "B" is reached, and at this stage the wood is tilted in the vice and the cut continued to the shoulder line as shown at "C." The wood is then reversed in the vice and the operation completed with the timber again upright as at "D," the saw teeth now being level with the shoulder line. Both sides of the tenon are treated

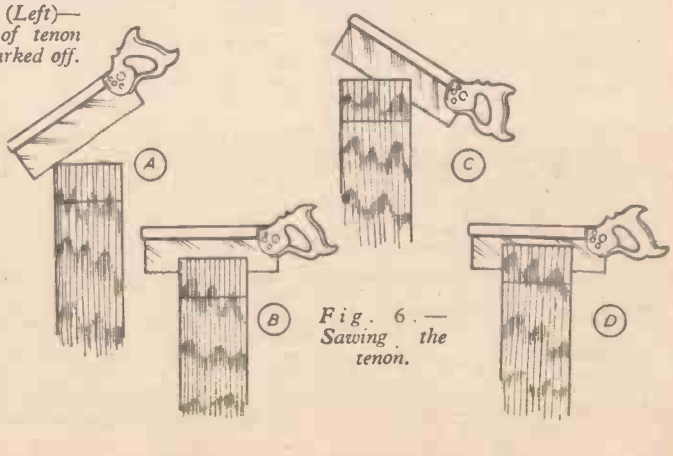


Fig. 6.—Sawing the tenon.

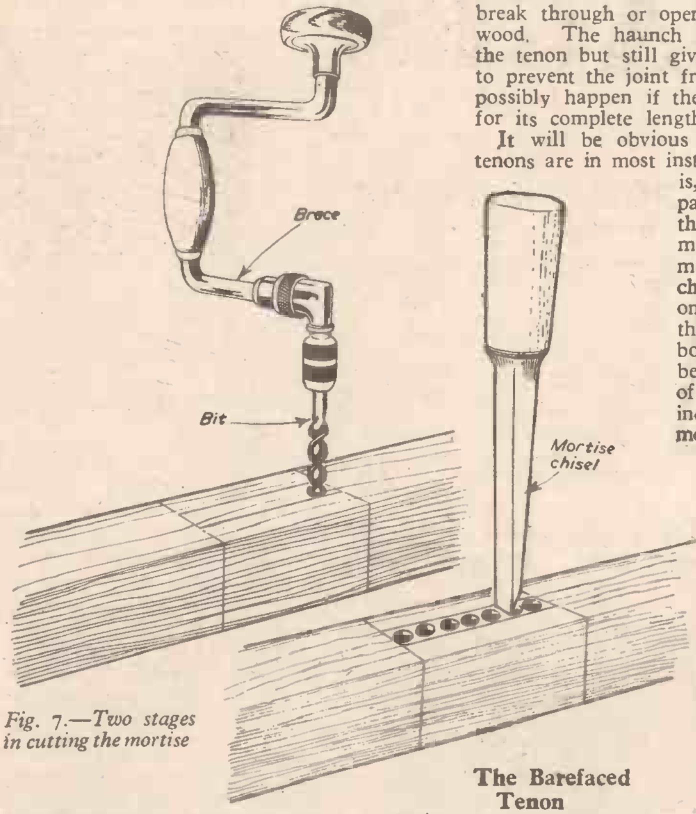


Fig. 7.—Two stages in cutting the mortise

in this manner. When sawing it is advisable to run the saw teeth on the waste side of the line so that when cutting is complete the lines are visible, but only just. This makes for a good, tight-fitting joint.

The shoulder lines can now be cut, but before using the saw, grooves must be cut with the chisel and these keep the saw running true. These grooves are depicted in Fig. 8.

To receive the wedges two saw cuts are made in the tenon before the joint is assembled.

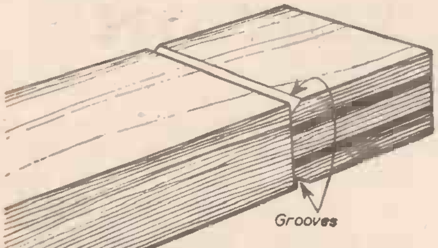


Fig. 8.—Tenon shoulders prepared for sawing.

Variations of the Joint

A tenon with a square haunch is shown in the sketch, Fig. 9, and attention is drawn to the fact that the tenon end is cut to a 45 degrees angle. This is to allow the ends of two tenons to meet as, for example, when two rails are fixed to a chair leg. A plan view of such a joint also shown. The making of this type of tenon is quite simple as it is first set out and cut as previously described, then the haunch is marked off and cut.

Below this is shown another haunched tenon, but in this instance the haunch is sloped. Such a tenon is sometimes used in table construction. In both cases the mortise must, of course, be cut to mate with the tenon in question.

Haunched tenons are used where one piece of timber must be joined to the end of another. Obviously a full-width tenon cannot be used as the mortise for this would break through or open out the end of the wood. The haunch reduces the width of the tenon but still gives additional strength to prevent the joint from twisting as would possibly happen if the tenon were reduced for its complete length.

It will be obvious that these haunched tenons are in most instances "blind"; that is, the tenon does not pass completely through the mortise. This means that the mortise must be bored and chopped from one side only, whereas with the through variety the boring and cutting can be done from each side of the timber and, indeed, this makes for more accurate work.

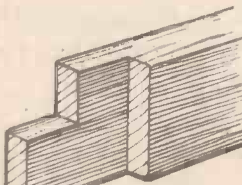
The Barefaced Tenon

This is clearly seen in Fig. 9 and, as shown, this joint has one shoulder only. Although a square haunch is shown this is by no means a strict rule, as a sloping haunch could be used if desired. The joint is used where it is necessary to fit one piece of timber lower than the face of the other and yet have two faces flush. This rather complicated statement is fully explained by glancing at Fig. 9, which also shows a completed joint where a rail is joined to an upright. It will be seen that the outer faces are flush, yet the inner face of the rail is lower than the inner face of the upright.

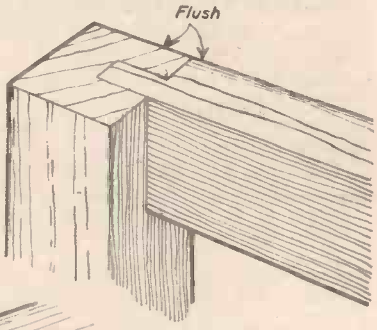
Mortise and Tenon Dimensions

In woodworking designs the exact dimensions of mortise and tenon joints are often given so no difficulty in this direction will be experienced. However, it sometimes happens that the home woodworker designs his own project and consequently must also design the joints. When this is the case it is as well to remember that the tenon must not be less than one-third the thickness of the timber, provided its mortise is not more than one-third the thickness of the timber in which it is cut. When a thin piece of wood, on which a tenon will be cut, is to be fitted to a thicker piece the tenon in this case can be greater than the stated one-third, remembering, of course, that the mortise must not exceed one-third the thickness of the wood in which it is cut.

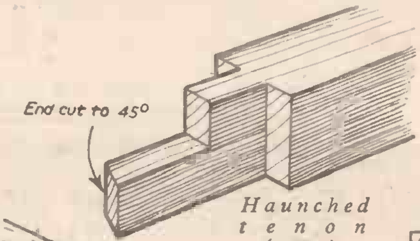
In the case of a haunch this can be one-quarter the width of the complete tenon.



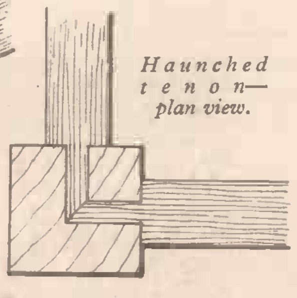
Barefaced tenon.



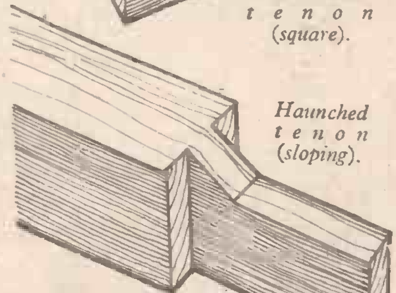
Barefaced tenon in use.



Haunched tenon (square).

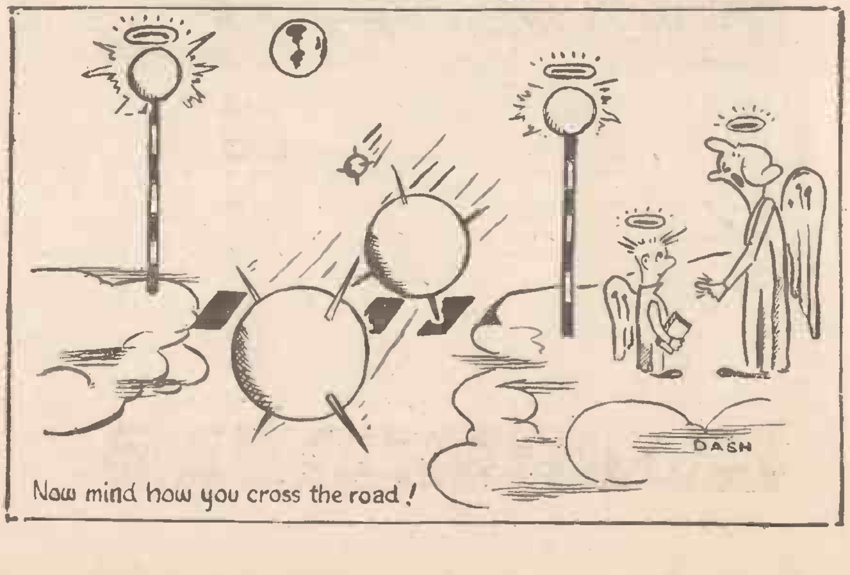


Haunched tenon—plan view.



Haunched tenon (sloping).

Fig. 9.—Some variations of the mortise and tenon joint.



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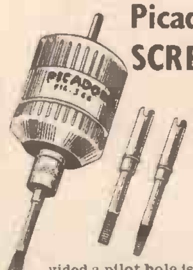

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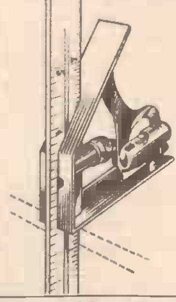

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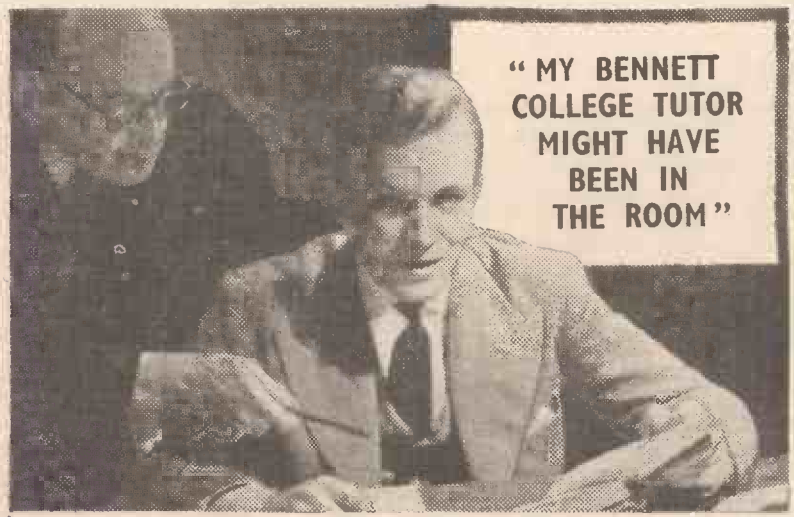

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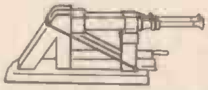

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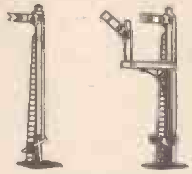

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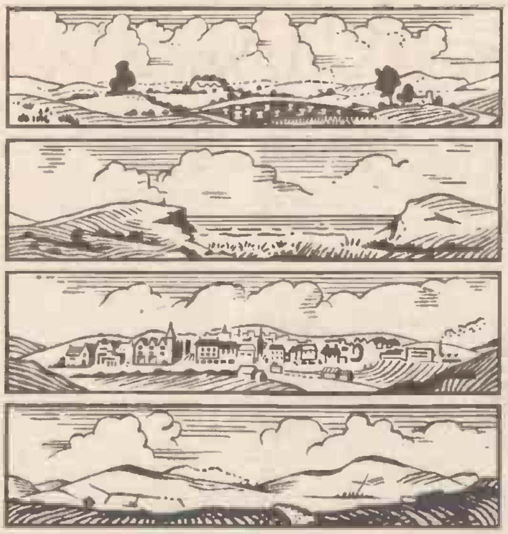

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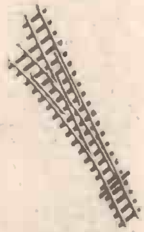

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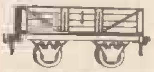

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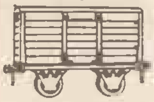

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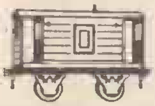

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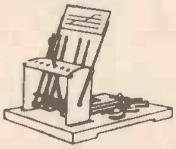

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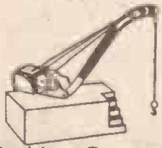

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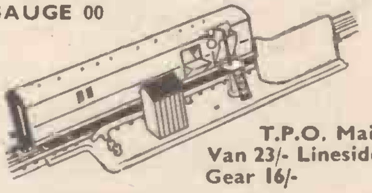

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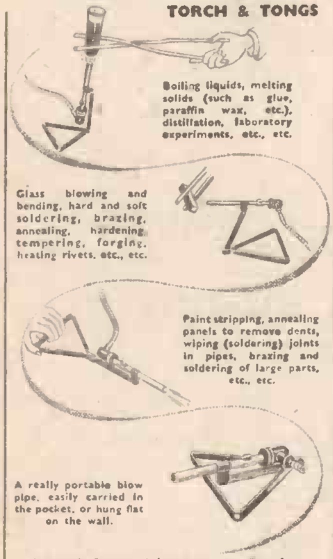

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A CHILD'S WHEELBARROW

Make This Simple Toy for Your Young Brother!

By W. HUNTER

ALL that is required is a stout box from your vanman or local store (the one used was a Guernsey tomato box, 14⅝in. long × 9in. high × 8⅞in. wide at the top and 8in. at the bottom), 10ft. 6in. of 1in. square wood, two 4in. dia. ¾in. thick hardwood wheels two No. 12 × 2in. long brass round-headed screws, six ½in. brass washers and a quantity of screws or nails.

Construction

Cut the 1in. square wood as follows:—

Piece A—1 off, approximately 8in. long to suit the inside of the box at the bottom.

Piece B—1 off, 10in. long with a 3/32in. dia. hole, 1½in. deep, drilled centrally in each end.

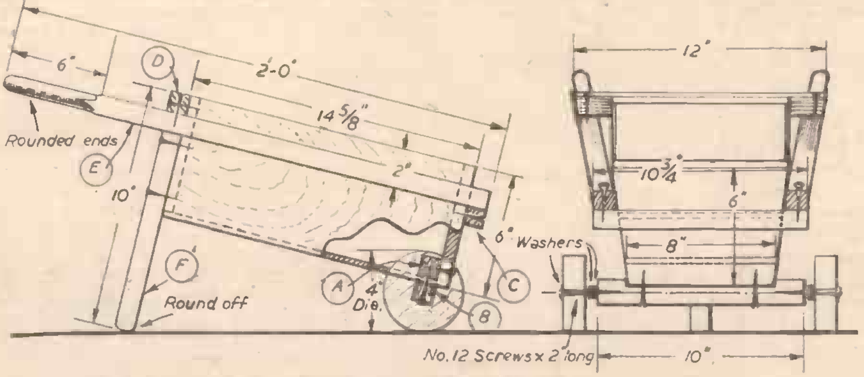
Piece C—1 off 10¾in. long.

Piece D—1 off 12in. long.

Piece E—2 off 3ft. long with one end of each piece rounded for a length of 6in.

Piece F—1 off 9in. long.

Fit piece A to the inside of box at one end, position piece B exactly underneath and central; fix to each other through the bottom of the box and then fix piece A to the end of box. Fix piece C to the outside of the same end of the box, central and 2in. below the top of the box. Fix piece D to the opposite end of the box, central and flush with top of the box. Fix handles, pieces E, on top of piece C and underneath piece D, as shown in the sketch. Spread handles on piece D to suit the child. after fixing them to piece C. Fix piece F to the handle end of the box, central and butting up to piece D. Drill a ¼in. dia. hole in the centre of the 4in. dia. hardwood wheels and fix to the ends of piece B with the No. 12 screws and two washers to the inside and one to the outside of the wheels. Ensure that none of the screw or nail points is protruding. Finally, sand and paint.



A side view of the wheelbarrow with part of one side cut away and a front view. The dimensions shown were those used by the author and can be varied to suit the size of box employed.

Running Your Own Magazine

How to Edit Your Own Class or Club Journal

THE simplest form of magazine, and one suitable for a small school or club, is the folio type. First form a committee, and proceed to appoint editor and treasurer. The editor draws up a double list. The first column is headed "Contributors," the second "Readers." Anyone who has a desire to write enters his name in the first column, the rest, who, whilst interested, cannot be active in the business, put their names in the second column. This will ascertain the amount of support likely to be forthcoming.

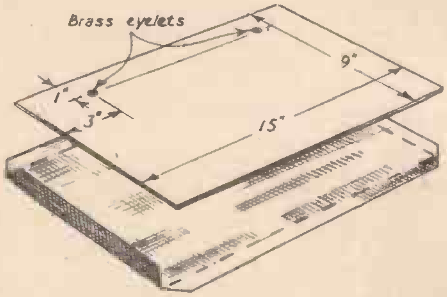


Fig. 1.—Details of the binder.

Supposing the promoter thinks he has enough support to start the magazine, he next sees about the election of a committee drawn from the list of members shown in the columns. If both columns are fairly full, then it is a good plan to have two committeemen from each, making, with a chairman, five in all.

From these names are selected an editor and a treasurer.

Next fix the subscription, and with this form of magazine a merely nominal subscription is necessary. All work will be done voluntarily, and there is just the binder and paper to be bought.

Binding the Magazine

To make the binder take two pieces of limp cardboard, 15in. × 9in. (Fig. 1), and paste on the outside of them some imitation leather or, better still, some bookbinder's canvas. Two holes are bored in each and brass eyelets inserted 3in. from the top and bottom respectively and 1in. in from the margin. Then obtain a couple of dozen tags. They consist of two brass sections 1in. long, joined by a silken cord, which varies in length according to the purpose which the purchaser has in mind. The double tags are now threaded through the eyeleted holes of the two covers of the binder, making it one (see Fig. 2). When sheets are added, the under part of the binder is slipped out of the tags, and the sheets of paper are threaded on, holes being punched or bored to correspond with those of the binder. On the front may be pasted the title of the magazine, etc., whilst on the inside of the binder, to face the first page, may be written or typed the rules and circulation list.

The editor writes his opening remarks or "editorial" on the next page, stating what he wants his contributors to do—how much he wants them to write, etc. This is followed by a sufficient number of pages for the first circulation of the magazine (about two pages per contributor). An additional page at the end is headed "Criticisms," and comments are encouraged from both contributors and readers. Photographs and sketches can be used to illustrate the various contributions.

Fig. 2.—Double tags are used to secure the magazine.

Circulation

As soon as the editorial is complete, the magazine is started on its round of contributors and then the readers, the first contributors having it again to read the contributions and criticisms which followed theirs. The same circulation rota should always be maintained and a time limit (say three days) imposed for retention of the folio.

Letters to the Editor

Address letters to The Editor, "Practical Mechanics," Tower House, Southampton Street, London, W.C.2.

The Editor Does not Necessarily Agree with the Views of his Correspondents

Puzzle Corner

SIR,—With reference to the piston problem in "Puzzle Corner" of your January issue, you offer as a solution that the piston stops when the crank changes from a vertical to a horizontal motion. It is impossible for this to occur, since except at the ends of horizontal and vertical diameters of the circle described by the crank, when the horizontal and vertical motions are respectively zero, the motion or velocities of the crank can always be split up into two component velocities in the horizontal and vertical planes.

May I offer the following solution to the problem?

Accepting the fact that the locus of any point on the crank, except the axis, is a circle, consider a circle as the path traced out by a point which simultaneously performs simple harmonic motion in two directions at right angles. The motions are of equal amplitude and periodic time but differ in phase by $\frac{T}{4}$ where T is the periodic time.

Considering these two directions to be horizontal and vertical, motion in the horizontal plane is produced directly by the piston, and motion in the vertical plane is produced by the reaction of the piston arm on the crank.

Therefore in one revolution the motions in the horizontal and vertical planes each stop twice, and each is at a maximum when the other stops.

At the point in question, when the piston reaches the end of its stroke the horizontal motion stops and the inertia of the system maintains vertical motion.

If it were not for this inertia and vertical motion, the crank would remain in direct line with the axis of the crank and the piston and no motion would occur. Hence the necessity of the flywheel.—A. H. BAXTER (Manchester).

Is the Speed of Light Fundamental?

SIR,—Re light-velocity from a moving source (December, 1957, issue).

The velocity of any wave propagated is entirely dependent upon the constants of the medium in which it travels, irrespective of the velocity of its source.

This is true for sound waves as well as light or other special radiations, but it has been my experience, in wave mechanics lectures, that though students can accept it for sound, there is some difficulty in grasping the same conditions with light.

It seems to be due to the erroneous conception that light is projected, like a bullet, whereas it is nearer truth to think of it as being *released* from its source and then swimming away at its own speed. If its velocity were not completely independent of the speed of its source, the Doppler Effect would either not exist at all or be quite invalid as a measure of source movements.

We suffer from another cause of misconception when speaking of "light travelling in straight lines." It certainly travels on direct radii, but every light-wave not interrupted or reflected by matter is a perfect sphere, becoming ever larger until it penetrates through ageless Time, all the infinity of space.

No one knows what these waves are, nor what they move in. They are called "electro-magnetic" or "photo-synthetic," or just yellow, red or violet—all from their effects, merely. They obey all known laws of wave motion and at the same time possess certain attributes which we only find in solid matter otherwise. They may even operate in a fourth dimension that we cannot perceive. —F. O. BROWNSON (Bedford).

Ocean Currents Circulate

SIR,—It is with interest that I read your paragraph "New Ocean Flow Below the Gulf Stream" in the January issue.

About 12 years ago I wrote to the Admiralty suggesting that philosophical logic assumes that there is a build-up of waters at the equator. On collapsing, the warm equatorial waters drift in north-easterly and south-easterly directions towards the poles.

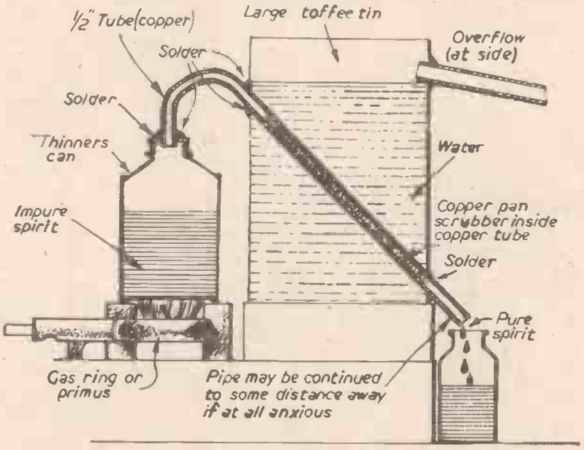
They return as "cold water" on the floor of the ocean after washing the polar ice-caps.

I had a very illuminating reply: "You show a remarkable ignorance on the subject of hydrostatics."

The common eel can (and does) find its way to the Saragosa Sea by swimming against the warm surface current and returns (at a lower depth) in a cooler current.

It has an unerring instinct that notifies it of the "direction" of its journey aided by the temperature of the water it swims in. There are "highways" in the ocean. Perhaps, soon, it will be announced that there are highways in the air obeying the same principle.—V. C. ARMSTRONG (Middx.).

RECOVERING METHYLATED SPIRIT



"Economist's" distilling apparatus.

SIR,—In reply to Mr. H. G. Radford, "Information Sought," January issue, the best way to purify contaminated methylated spirit is to distil it.

The apparatus described in the "Junior Chemist" series, PRACTICAL MECHANICS, April, 1955, can be used, but on a larger scale something bigger and more robust is needed.

The apparatus shown in the sketch will serve admirably and consists of the boiler, made from a ½ or 1 gallon paint thinners can. A hole is drilled in the cap and a ¼in. copper pipe soldered in. The pipe is bent as shown and passes through another large can. The joints are soldered and the pipe passes out near the bottom of this can. The pipe inside the can is filled with copper gauze (pan scrubber), this greatly assists the heat transfer and breaks up the stream of vapour and prevents any uncondensed vapour escaping.

The large water capacity dispenses with the need for running water and enables the outfit to perform out of doors at a safe distance from anything inflammable.

Methylated spirit, turpentine and paraffin can all be purified in this way. It seems an alarming thought to boil such liquids, but the apparatus is perfectly safe provided that the joints are airtight, that the cooling water is not allowed to overheat and that the "boiler" is not boiled dry. To prevent this last mishap the impure spirit should be carefully measured and the process stopped when three-quarters of it has been distilled.

In use the "boiler" will become coated inside with paint, etc., and may then be replaced with another can.

This same process is used for the recovery of industrial solvents, in this case waste steam is often used for heating.

The Excise Authorities *may* insist on a licence being taken out for this apparatus, but not necessarily so.—ECONOMIST (Swinton).

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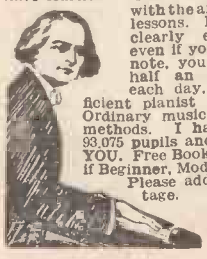

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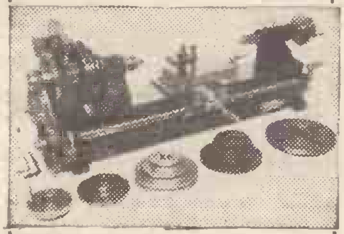

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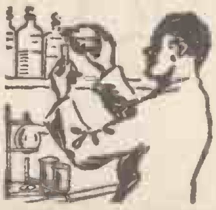

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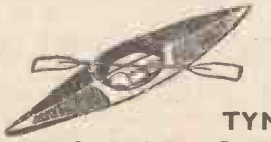

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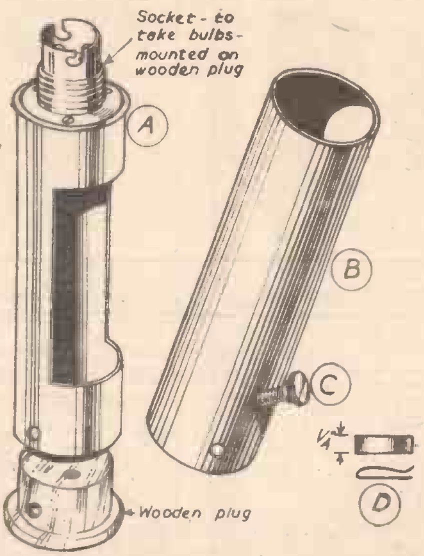
CAPACITOR FLASH GUN IMPROVEMENTS

SIR,—Last year I made the flash gun as described in your May, 1956, issue but have now made another one which I think is more efficient.

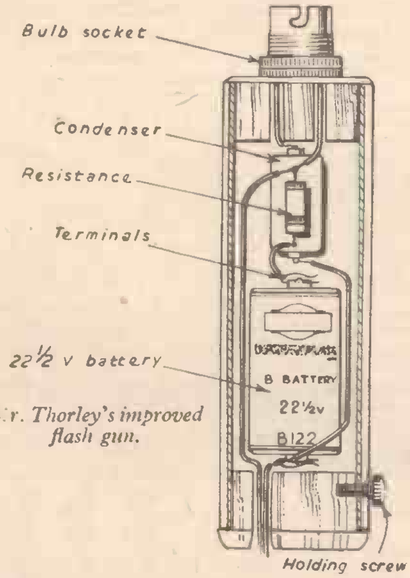
As will be seen in this arrangement, whenever the inside has to be inspected (i.e., for renewal of battery), all that is necessary is to unscrew the knurled screw "C" and slide off the outer bakelite cover, "B." This then exposes the whole of the inside of the gun.

The terminals, as suggested, will be found the best method of connecting the wires, as this type of battery is different from most others. The wires are soldered to the terminals and then the terminal clipped under the battery terminal.

The battery can be fixed inside the gun with sticky tape. No details have been given for the bulb socket or the method of fixing to the camera as readers will probably have their own ideas on the subject.—A. J. THORLEY (Manchester).



Details of the flash gun. A is a bakelite tube $1\frac{1}{8}$in. I.D., $1\frac{1}{4}$in. O.D. with centre cut out as shown and with wooden plugs in each end. It is about 6in. long. B is a bakelite tube $1\frac{1}{4}$in. I.D., $1\frac{3}{8}$in. O.D. and is a slide fit over A. C is a 2 B.A. knurled screw. D is one of the brass or phosphor bronze clips which catch under the battery terminals. Two are required.



Mr. Thorley's improved flash gun.

Silvering Solutions—Be Careful!

SIR,—I refer to your issue for January, 1958, page 188, where you give an excellent article on the process of silvering. Correct and concise as the article is, however, it contains no warning about the highly explosive nature of ammoniated silver solutions and their residues.

Whilst in general the process described is not the one which a vast previous experience has shown to be the most unstable, it is a fact that ammoniated silver solutions can give rise to the production of fulminating silver, which explodes at the slightest jar.

Whilst the quantities of silver and ammonia used in the article under discussion are relatively small and as described need not be a cause for great concern, it would be as well to inform your readers that whilst solutions A and B are perfectly safe for storing, the process of ammoniating should not be allowed to take up too much time. It should not be done at a temperature higher than 65 deg. F. and ammoniated solution B should under no circumstances be kept. Further, all unused and spent ammoniated B and A + B solutions should be swilled away with copious amounts of water, and all utensils thoroughly rinsed to avoid the retention of dried material which will almost certainly contain silver amide.

If these simple precautions are observed there will be no danger whatsoever.—S. N. GAYTHORPE (N.W.3).

CHANCE BROS.—NEW ADDRESS

READERS who are contemplating making the astronomical telescope mirror, details of which appeared in our January and February issues, will be interested to know that the makers of the glass blanks have a new address. This is the Chance-Pilkington Optical Works, St. Asaph, Flintshire.

Does "G" Force Propel FLYING SAUCERS?

SIR,—I should like to comment on Mr. V. A. Milburn's letter in the January issue.

First, I wish to compliment him on realising the propulsion method used by the "Saucers," it is, of course, the only method by which they could operate.

I do not compliment his nearsightedness in saying that they originate from this planet. Such a method of propulsion would not have remained in the hands of one country for so long and no country would want such a secret craft to fly over foreign territory.

There would be no sign of acceleration using this type of propulsion, as this is proved by the fact that none is felt by a person in "free fall" before a parachute descent.

The magnetic lines of force which encircle the earth follow much the same, but not quite the lines of longitude. If the lines can be crossed by another magnetic force then there you have your propulsion problems solved!

I have *seen* a F.S. and have very closely followed your comments in earlier publications. Please do not start talking about hallucinations, flying cobwebs, weather balloons, etc.—this was the genuine article, completely silent, orange in colour, slightly oval (probably from the angle viewed) and very, very fast.—M. H. (Herts).

SIR,—With reference to my fellow reader of PRACTICAL MECHANICS, Mr. V. A. Milburn and his letter on "The Mantell Incident" in the January issue. From the contents of the letter I fully expected his address to be at least Mars as he seems to be so conversant with "G" technology. In his last paragraph he states that "G" force may easily be reversed. I, for one, would be interested to learn of such a method, and I am quite sure I do not stand alone in that respect. We are all aware of the fact that reversal of "G" force would be of advantage, cranes would be obsolete, ships could be built far inland and later deposited in the sea. I would suggest that my learned friend should not confuse gravity which can only have one direction and magnetism which has polarity. Gravity is a fundamental attraction between particles, it exists between all bodies and will never be "neutralised." Gravitation holds the Solar system together and even holds all atomic particles, such as electrons to the nucleus.—R. DIXON (Co. Durham).

SIR,—I heartily endorse the first paragraph of Mr Milburn's letter in the January issue.

From then on Mr. Milburn is a little "twisted" on one point and demonstrably uninformed on another. The second point first. Mr Milburn claims that flying saucers (I prefer UFOs) are earth made, but factual evidence is against this being correct. UFOs have been seen over practically every country you can mention, commencing in 1945, not to mention pre-heavier than air flying machine sighting reports.

The UFOs do not all betray the same characteristics of flight and manœuvrability, nor are they all of the same appearance. The majority of those sighted are obviously powered by a means far in advance of present-day knowledge on earth. The method defies the triangle of velocities and laws of inertia.

Why are fantastically expensive liquid propellent rocket motors still being used to establish earth satellite vehicles? How would Mr. Milburn account for the *formations* of UFOs sighted in 1947, and at the same time account for the world-wide secrecy which exists? What about the millions of pounds and billions of dollars being poured into the guided and ballistic missiles industry, and what about passenger and freight air traffic? Does Mr. Milburn not think that if a revolutionary method of propulsion which had all the UFOs attributes was possessed by some world power in 1947, it would have been adapted for wider use by now?

"G" force is a force resulting from sharp acceleration or deceleration or a rapid change of direction and is not a force in itself such as gravity (whatever this may be) and electromagnetism. Many are now aware of the experiments being carried out in the field of "electro-gravitics," by which means discs of aluminium up to 3ft. in dia. have been flown in closed circuits. The results are encouraging but fall a long way short of being used as a method of propelling 30ft. to 75ft. disc-shaped machines through the atmosphere and beyond. We are also neglecting the larger UFO, the "cigar shaped" variety.

One or two ingenious theories of propulsion have been put forward and there is no doubt that in a few years time one or possibly more of these methods will be employed to achieve "G free" and inertialess flight, but certainly this had not been achieved in 1945.—D. WIGHTMAN (Chairman, Wigan and District F. S. Group).

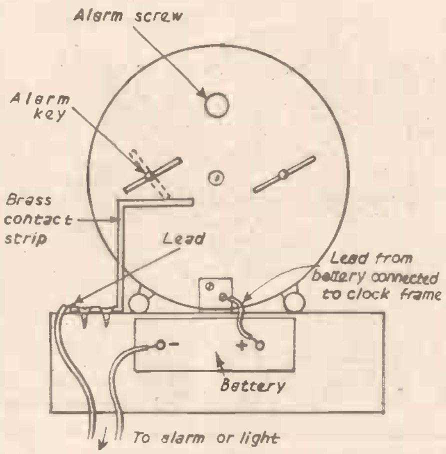
TIME SWITCH USING ALARM CLOCK

SIR,—In reply to A. Barnard (Norfolk), "Information Sought," December issue, I have used the device shown for many years.

The clock is firmly screwed down on to a box, inside which is housed the battery. A brass contact strip is bent and fixed underneath the alarm key, as shown in the sketch. As will be realised, this limits the movement of the alarm key to about a quarter to half a revolution. The alarm need only be wound a few turns as it will never be fully unwound.

When the alarm key is wound, the brass contact strip is screwed into position, underneath it. It is so arranged that when the key is wound back a little, it just misses the top of the contact strip. When, however, the alarm rings, the key turns into the position shown dotted, thereby closing the circuit and setting off the alarm.

The great advantage of this system is that once the key turns it cannot go any further, thus the alarm rings until the key is turned back into its original position. The frame of the clock will be found good enough to complete the circuit, but a wire could be attached directly to the key if wished. Also, a switch could be placed somewhere in the circuit, to switch off the alarm without having to touch the key.—A. J. THORLEY (Manchester).



Mr. A. J. Thorley's time switch.

Specific Gravity Calculations

SIR,—I refer to your issue for January, 1958, page 206, where you reply to W. T. F. (Leeds) on the matter of Specific Gravity Calculations. Watson's Physics will I think show that it is possible to calculate theoretically, and indeed practically, the specific gravity of a mixture of given proportions, and conversely from a known specific gravity of an aqueous mixture to calculate the proportion of water in the mixture.

Let S = Specific gravity of mixture
V_1 = Volume of diluent to be found
V_2 = Volume of commercially pure liquid
S_1 = Specific gravity of diluent (water)
S_2 = Specific gravity of commercially pure liquid.

From any textbook on Hydrostatics

$$S = \frac{V_1S_1+V_2S_2}{V_1+V_2}, \text{ whence} \qquad (1)$$

$$SV_1+SV_2=V_1S_1+V_2S_2 \qquad (ii)$$

W. T. F.'s (Leeds) query cannot be answered without knowing the volume of the commercially pure liquid (V_2) but if we work on a proportional basis we can take any volume and, for the purpose of this calculation, call it 100 units, be they cc.s or pints!

We thus have the following quantities.
$S=1.20$ (given by W. T. F.)
$V_2=100$ units (assumed arbitrarily)
$S_1=1$ (water)
$S_2=1.26$ (given by W. T. F.)

Substituting in (ii) we have

$$S\times V_1+S\times V_2=V_1\times S_1+V_2\times S_2$$
$$=1.2\times V_1+1.2\times 100=V_1\times 1+100\times 1.26$$
$$1.2V_1+120=V_1+126$$
$$1.2V_1-V_1=126-120$$
$$0.2V_1=6$$
$$V_1=\frac{6}{0.2}=30 \text{ units}$$

Check: Specific gravity S, of mixture $=$

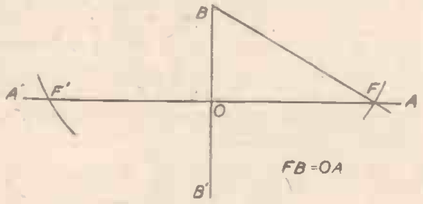
$$\frac{V_1S_1+V_2S_2}{V_1+V_2}=\frac{30\times 1+100\times 1.26}{30+100}=\frac{156}{130}=1.20 \text{ Q.E.D.}$$

Now the volume of the diluted fluid is equivalent to $V_1+V_2=30+100$ units of which 30 units are the diluent.

Therefore $\frac{30}{130}\times 100=\%$ dilution $=23\%$ in W. T. F.'s case.—S. N. GAYTHORPE (N.W.3).

Finding Ellipse Foci

SIR,—Every draughtsman knows how to draw an ellipse using two pins, a piece of cotton and a pencil, but I have often been struck by the fact that very few know the quick way of finding the foci. Accordingly I give it herewith.



Finding ellipse foci.

Let AA^1 be the major axis and BB^1 the minor axis, and O the point of intersection. With centre B and radius equal to OA describe a circle cutting AA^1 at F and F^1. Then F and F^1 are the foci.—R. M. MYERS (Birmingham).

Electric Fence Control Circuit

SIR,—We have had a number of enquiries about the article on electric fence design in the October, 1957, issue and would like to point out that this article is really not one which is suitable for anyone wanting to make one of these equipments for themselves and, in fact, when we published this in our dealer magazine "Outlook" the following cautionary statement was added:

"The present article is published as a matter of interest, and as an illustration of trigger tube circuit design. It is not intended to encourage the building or repair of fence controllers. Existing controllers must always be serviced by their makers."

The paragraph and the heading "transformer" should be emphasised. This read as follows:

"An existing transformer was used. If suitably redesigned, it could be taken via R4 to the 240v. line rather than to a 120v. tap.

Redesign of the transformer is essential in any practical controller based on this experimental circuit. The present arrangement allows the possibility of moving the 120v. tap to a much higher position on the battery, with, as a consequence, a prohibitively high output delivered to the fence."—MULLARD LTD.

[*The article concerned was printed by courtesy of Mullard Ltd.—*ED.]

Scooter Braking

SIR,—I feel that the letter published in the January issue of PRACTICAL MECHANICS, sent by Mr. J. I. George, Brighton, deserves some comment.

Although the hard application of the front brake on a pedal cycle can be dangerous due to its light weight, this is not so in the case of a motor cycle or scooter. Here the front brake is by far the most important and its hard application is quite safe due to the low centre of gravity and heavy weight of a motor cycle or scooter.

Mr. George states that in his opinion the rear brake is the most efficient as the rear of the machine carries the greater weight. Apparently Mr. George is not aware that on application of the brakes of any machine weight is transferred to the front wheel by inertia and therefore the front wheel is far less likely to skid under heavy braking than is the rear wheel.

To support the above I quote braking figures of a Model LE Mk. III Velocette Water-cooled Twin as given in a road test.

Braking figures on WET TARMACADAM SURFACE from 30 m.p.h.

Both Brakes 29½ft. Front Brake 33ft. Rear Brake 49ft.—W. R. SHAKESPEARE (Rhyl).

Silvering Solutions

SIR,—I have read with interest "Glass Silvering for the Amateur" in the January issue of your paper and find that, in the preparation of solution "A," there is a mistake in the amount of distilled water for the dissolving ingredients. As the two solutions are used in equal parts, solution "A" should contain 250 cc. (as mentioned), but for 5oz. of water it should read 9oz. This is important for the amateur who may not be conversant with working out cubic centimetres into fluid ounces. From my experience it is not easy to obtain a glass measure with both calibrations. In silvering, the correct measure is very important.

The glass sheet ready for silvering should be placed on four wedges (wood would do) absolutely level so that the glass is not resting on the bottom of the dish, so that silvering takes place only on the upper side of the glass. Rocking the dish is not recommended as the reflection might become cloudy.

I have found that 100 c.c. (equal 3½ fluid ounces) of the final mixture will cover 1 sq. ft. of glass.—M. NARTOWSKI (Cornwall).

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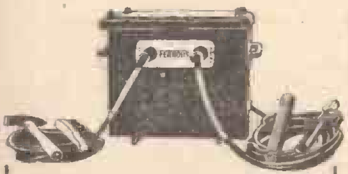

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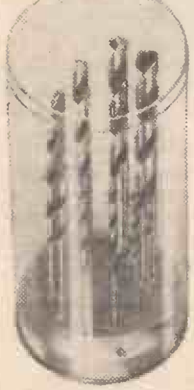

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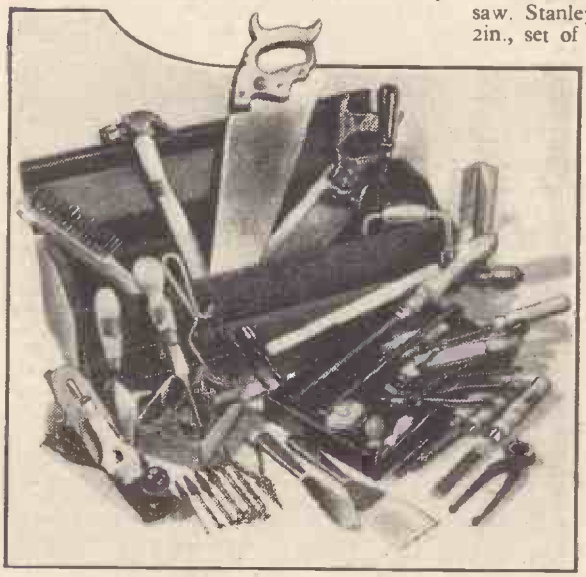
TRADE NOTES

A Review of New Tools, Equipment, etc.

"ZYTO" TOOL KIT

SPECIALLY selected for the home handyman and do-it-yourself enthusiast, the "Zyto" general-purpose tool kit comprises a complete outfit of high quality tools. They are housed in a steel carrying case, with removable tray and padlock and key. The contents include:—



The complete tool kit.

20in. handsaw, 10in. brass-back tenon saw. Stanley adjustable iron plane, 9in. × 2in., set of three handled chisels, $\frac{1}{4}$in., $\frac{1}{2}$in., $\frac{3}{4}$in., claw hammer, 6in. cabinet handled screwdriver, 4in. ratchet electrician's screwdriver, crosspene pin hammer, two handled bradawls, pr. pincers, 6in., 7in. Footprint pipe wrench, 3in. paint stripping knife, putty knife, Stanley ratchet brace, set five fast-cutting centre bits, $\frac{1}{4}$in., $\frac{3}{8}$in., $\frac{1}{2}$in., $\frac{3}{4}$in., 1in., pointing trowel, padsaw with blade, set of crampheads, pair combination pliers, wire brush, Stanley hand drill, set twist drills, soldering iron, stick solder, tin flux, mitre block, pair radio pliers, junior hack saw, six spare hacksaw blades, nail punch, 2ft. boxwood folding rule, instruction book.

The tool kit is marketed by S. Tyzack and Son, Limited, 341, Old Street, Shoreditch, London, E.C.1, at £16 10s.

Thread Measuring Comparator

THE new "Marlco" thread measuring comparator is based on the same principle as the well-known thread measuring parallels but employs a dial indicator instead of a micrometer. Male threads of up to $2\frac{1}{2}$in. dia., including Whitworth, Unified, American, Metric and B.A. may be measured. One flat and one hemispherical anvil are supplied so that the comparator may be used on plain diameter work, also a polished wood case. A stand is available. Although primarily intended for thread measurement, a wide range of anvils is available for other external forms. The price of the comparator is £12 10s., and the makers are W. H. Marley & Co. Ltd., 105, High Street, New Southgate, London, N.11.

(Left)—The new "Marlco" thread measuring comparator with dial indicator.

Salter Balances

TWO additions to the well-known range of Salter balances are now available, they are the Air Traveller's Balance and the "Weighlet" Letter Balance. The former will enable the frequent air traveller to avoid excess luggage charges. The balance is strongly made and has a brass dial which registers up to 50lb. and 23kg. Packed in the polythene pouch supplied, the balance may be carried in the pocket and costs 12s. 6d.

The two balances.

The "Weighlet" balance has a white plastic dial, graduated in $\frac{1}{4}$ oz. up to 4 oz. and in 10 g. up to 150 g. The letter is held by the wire spring clip, which is simple and effective. The balance fits into a waistcoat-pocket size leather case. The price is 8s. 9d.

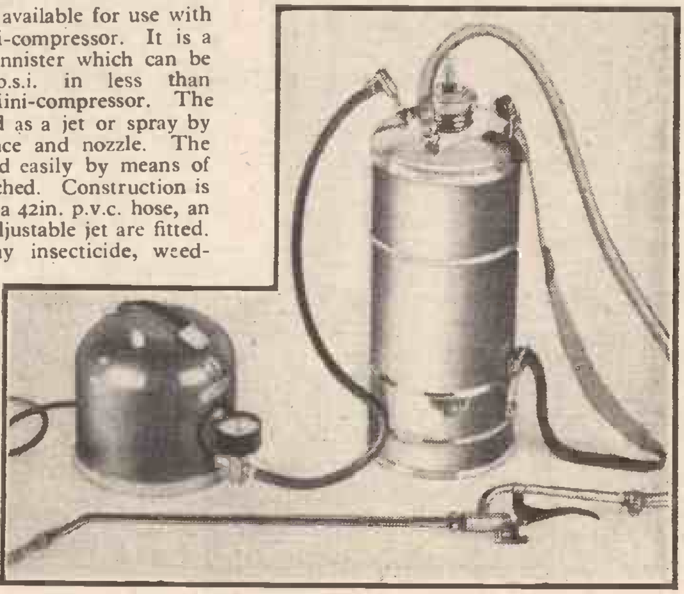
Lens Catalogue

OF special interest to users of optical equipment will be the catalogue issued by Scottish Distributors, Ltd., 62, Shirland Road, Maida Vale, London, W.9, in which some 250,000 items are listed. Included are achromatic doublets, cemented triplets, cemented four-lens elements, double convex, plano convex, and double concave lenses, filters, optical flats and windows, mirrors, graticules, prisms and other types of optical equipment. Enquiries are also welcomed regarding equipment not listed.

Slightly damaged lenses are sold at reduced prices.

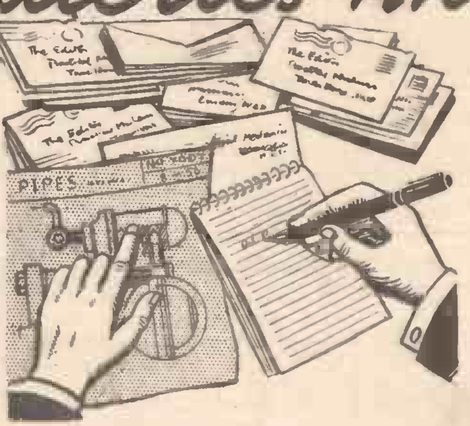
BULK LIQUID SPRAYING UNIT

A NEW accessory is available for use with the Gennar Mini-compressor. It is a 2-gallon lightweight cannister which can be pressurised to 80 p.s.i. in less than half a minute by the Mini-compressor. The contents are discharged as a jet or spray by means of an 18in. lance and nozzle. The cannister can be carried easily by means of the shoulder strap attached. Construction is of lacquered brass and a 42in. p.v.c. hose, an 18in. bent lance and adjustable jet are fitted. It is possible to spray insecticide, weedkiller, liquid fertiliser, tar oil, winter washes, creosote, whitewash, etc., and the price of the cannister is £9 9s. 6d. The makers are Gennar Engineering, Ltd., 99, Old Street, London, E.C.1.



(Right)—The compressor and cannister.

Your Queries Answered



Spirit Duplicating

I HAVE recently obtained a quantity of spirit duplicating carbon papers and wish to use these for some small-scale duplicating. Please let me have details of the process of spirit duplicating or tell me if there is any publication which would describe it fully. How many copies is it reasonable to expect from the one master copy ?—A. S. Aldis (Cardiff).

THE original master copy is done on a sheet of hard bond paper by means of the carbon paper. This sheet is then placed in contact with a moist surface of gelatine or other appropriate material and the written or typed master copy is absorbed from the paper and appears in reversed form on the gelatine surface, after being firmly impressed. Then by placing a sheet of blank dry paper on this moist surface the impression is transferred to the paper. You can improvise a gelatine pad by running the mixture given below into a biscuit tin lid. A roller, such as is used for glazing photographs, is the best way of obtaining the transfer by even pressure.

Gelatine pad formula.—Glue 100 gms., water 375 gms., glycerine 500 gms. Barium sulphate (finely ground) 25 gms.

Melt glue in water and add the glycerine and barium sulphate. 50 to 100 copies can be obtained, depending upon the intensity of the dye used in the carbon sheets.

Imitation Leaded Lights

I WISH to make some imitation coloured leaded lights. Could you please tell me the name of the transparent paint used to give the glass the coloured effect. Also the name and address of suppliers ?—R. R. Heathcote (Matlock).

THE glass to be painted upon must be ground glass, because this has a grain to hold the colour. Where smooth glass is used, the paint will flake off after a year or so. The colours are to be laid on the ground or matt side of the glass. The lead lines had better be painted in first with dark lead colour, perfectly opaque, oil colour. This can be made from a tube of artist's white lead paint, called "Flake White," and with it is mixed "Lamp Black" or "Ivory Black." The drying can be forced by the addition of Japan gold size. The width of the lines representing the leads should be ¼in.

For painting between the leads to represent the coloured glasses there is no better medium than artist's tube colours but a careful selection must be made to get only those which are transparent and which are permanent. The following are taken from Winsor and Newton's list. These will not fade.

Yellows : Aureolin, Indian yellow.
Reds: Alizarin crimson, burnt sienna.
Blues : Prussian blue, ultramarine.
Greens : All varieties of greens can be got by mixing in various quantities of the blues with the yellows.

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> A stamped, addressed envelope, a sixpenny crossed postal order, 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.

Purples and violets : All shades can be got by mixing the crimson with ultramarine.

Ruby : Mix Alizarin crimson with burnt sienna.

Pink : The crimson alone will give this.

Squeeze the colour out on to a palette (a piece of glass will do for a palette) and add Japan gold size and a few drops of turpentine. Thoroughly mix with a palette knife and apply to the glass with a soft brush. Float the colour on rather than paint, and if not dark enough give another coat when the first is dry. Floating, or flooding, the colour on will avoid leaving brush marks and streaks.

If you want to imitate the drawing and shading in draperies and faces, hands and foliage, etc., as in a stained glass window, it must be done with opaque colour : a mixture of burnt umber, or raw umber, with black. This painting is done with sable brushes for the lines and with a hog hair for the shading where the brown is stippled on.

Any glass which is required to be left uncoloured in the window must not be left as ground glass. It must be given one or two coats of Japan gold size alone.

Moulding Cement Troughs

I WISH to make two or three small cement troughs for miniature gardens, size approximately 12in × 6in. × 3in. deep but am having some difficulty The outer case of the mould I made with wood and found I could take away satisfactorily, but the inner mould, made of wood also, cannot be taken out without damage to the casting. Can you advise me how to make an inner part for these troughs ? The walls of the casting would be ¼in. to ⅜in.—R. Ackerman (Bristol).

IN order to make the former for the inside of the cement troughs easily removable it will have to be made collapsible ; that is to say, it must be made of five pieces of wood and the vertical pieces forming the sides must have mitred corners which must not make too close a joint. The bottom board of the inner mould must be bevelled underneath so as to present no vertical surface for withdrawing from the casting. No attempt should be made to collapse the mould until the casting is quite set and nearly dry. The mould should be made of ⅛in. thick board and it would be as well to paint (with white lead paint) all five pieces, all over. We recommend you to make the casts fully ⅛in. thick.

As an alternative to the collapsible mould, the cast could have tapered or sloping insides; by this means a solid, one piece mould would withdraw from the cast. The angle of slope could be about the same as a flower pot. The resulting casts would be much stronger if the thickness at the bottom were, say, ⅝in. and at the top ¼in.

Arc Welding Outfit

I WANT to build up an arc-welding outfit cheaply.

What are the sizes and capacity of components needed for general purpose welding of mild steel up to ¼in. thickness ?

Can an arc-weld be made as strong as an oxy-acetylene weld ?

If not, is it advisable to spend more on an oxy-acetylene outfit ?—B. G. Silcock (Hertford).

FOR arc welding ¼in. mild steel you could use ⅛in. electrodes in conjunction with a transformer having an open-circuit voltage of 80/100 volts, the transformer being capable of supplying a current of 90/125 amps. These should be used with a choke coil to reduce the voltage across the arc to about 25 volts after the arc has been struck. The choke coil may be adjusted for various welding currents by means of tappings on the windings, or by means of a sliding core. Alternatively an adjustable leakage bridge may be used in the transformer itself to provide an automatic volt drop on load.

The actual strength of a welded joint depends on its type, size and shape, and

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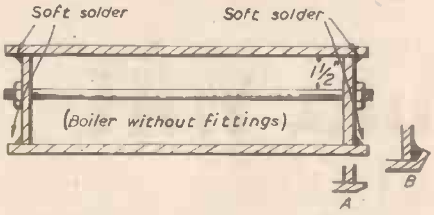
The above blue-prints are obtainable, post free, from Messrs. George Newnes, Ltd., Tower House Southampton Street, Strand, W.C.2.

*An * denotes constructional details are available free with the blue-prints.*

upon the quality and condition of the weld and parent metal, and upon the human element. These factors are really more important than the type of welding employed in most cases.

A Model Boiler

I HAVE constructed a boiler for a model steam engine. It is made of 3/16in. thick seamless copper tube and is 3in. diam. and 10in. long. The ends are 3/16in. thick brass discs with a ⅜in. stay through the centre. The brass ends are, however, soft soldered to the tube using 50/50 tin/lead solder.



Mr. G. S. Brown's Model Boiler

Would you please tell me what steam pressure such a boiler would stand?

For a pressure gauge I am using an oil pressure gauge from a car dashboard. A catalogue of pressure gauges, however, says they are for "cold" pressures and for steam a syphon must be fitted.

What is the purpose of the syphon?—G. S. Brown (North Shields).

THE boiler will, in respect to its circumferential strength, have a bursting pressure of 2,700lb.; allowing for a factor of safety of 10 the working pressure could be 270lb. But note that this is for the cylindrical part only. The ends are another matter and as you have drawn the end discs dependent upon the shear of the solder it is impossible to calculate at what pressure the ends would blow out. Obviously you cannot depend upon the solder so the central stay must be considered as taking all the stress. This it cannot do because it is 1½in. away from where the shearing of the solder will take place. Our advice is that you reduce the thickness of the 3/16in. ends of the tube to say a bare ⅛in. (A in the sketch) then beat over the projecting ends, first of all removing the fillet of solder. Do this at both ends, as shown, and then run in a new fillet of solder, as at B. The bursting pressure at the ends will then go up to probably 1,000lb., so with a safety factor of 10 you will be able to adopt a working pressure of 100lb. per sq. in. No one knows the highest pressure that solder will stand; it depends upon what the solder is made of, the shearing stress and the quantity that is put on and the exact nature of the joint.

The reason for using syphons on steam gauges is that they must be kept cool and use air, or water, in the gauge itself. If you were to connect your gauge directly to the boiler it would be filled with high temperature steam, which would render it incapable of reading correctly; the injury would be permanent. The longer the syphon tube the better.

Cleaning Horns

WITH reference to your article in the September, 1957, issue on "Modeling in Horn," I obtained horns as recommended from the local abattoir, but find they are not hollow but filled with a bony substance. Can you please give me any information with regard to removing this bone and general preparation?—C. Turmaine (Oldham).

THE horns obtained from the local abattoir were not shelled, a trouble not anticipated, as most abattoirs shell the horns, the horns then being sold for hoof and horn fertilisers, etc.

All you have to do to remove the core is to leave the horn and core for two or three weeks to decompose; the bony core can then be withdrawn. It is then wise to dip the horn in a solution of lime to burn off any surplus membrane. They can then be washed and the usual preparation, as in the article "Modeling in Horn," carried out.

Overhauling Binoculars

PLEASE tell me how to clean and overhaul a pair of binoculars, including cleaning the prisms and lenses, and also repainting the inside with matt black and the outside with black paint. Is there any special paint sold for this purpose? Also, a double image appears when observing a fast moving object such as a plane, how can this be remedied?—R. F. Thorpe (Shoreham).

YOUR binoculars should first be taken to pieces. The lenses can be cleaned if they are very dirty by washing in tepid water with a little good soap, thoroughly rinsed and dried, preferably on a new chamois leather or, failing that, on a clean handkerchief.

The inside of the case should be repainted with a matt black lacquer which you can probably obtain from an optical instrument maker or you can make it yourself with vegetable black in a weak solution of shellac (brown shellac flakes dissolved in methylated spirit). For the outside of the case you will need a glossy black celluloid lacquer. This dries very quickly and must be applied with a soft brush rapidly and deftly.

If the "double image" is only seen when observing fast moving objects we would say that it is an optical illusion or that you twist, in your excitement, the frame of the binoculars; but if the double image is always present then the two oculars are not parallel, that is to say their optical axes are not parallel. This is best remedied by an optical firm.

Electric Blanket

I HAVE the lining of an R.A.F. flying jacket, which is fitted with heating elements and wish to convert it to an electric blanket, using a transformer. Could you assist me with the choice of this. The elements, in the form of gauze ribbon, are four in number and cover practically the whole of the jacket. They appear to be connected, a pair in parallel, in series with the other pair, which are in parallel also. I would like to rearrange the elements on a rectangular heating pad if possible.—F. E. Millington (Gillingham).

WE understand these jackets have four elements, each rated at 12 volts, one element in each sleeve and one in each half of the body; one sleeve element and one body element being connected in series with each other and in parallel with the elements in the other half of the jacket for use from a 24-volt supply.

You could cut the jacket into strips, each with one element, stitching the strips on to a piece of suitable material. If you retain the series-parallel connection we suggest you feed the blanket from a transformer having an output of 3 to 4 amps at 24 to 30 volts.

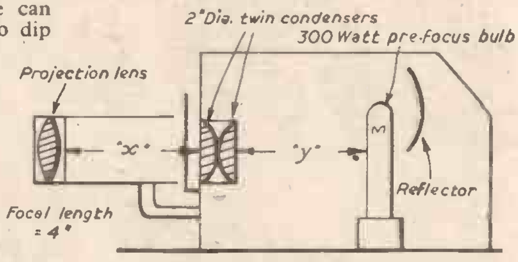
Projector Calculations

I WISH to build a home 2in. × 2in. still projector and would like details to calculate the required distances as illustrated in sketch.

x minimum distance of lens from transparency.

y minimum distance of condensers from lamp.—D. Berry (Stockton-on-Tees).

THE distance x depends upon the conjugate focus of the 4in.F projecting lens and this will be regulated by the size



Component spacing required

of the enlargement. You will have to provide a focusing arrangement for varying the distance of the lens from the film. If the enlargement were placed at infinity the value of x would be the normal focus of the lens, viz. 4in., but it will be much nearer than this, dependent on size, and x will become longer than this 4in., so it will be a matter for experiment by means of focusing for every different size of enlargement. It may become up to 5in. or 5½in.

With regard to the condensers: this again involves a test. All you have to do is to mount the condensing lenses vertically, hold a piece of tracing paper, or waxed paper, in the position the film will occupy and move the lamp backwards or forwards as required until you obtain, on the paper, an equally distributed field of light. Then measure carefully the distance between the paper and the lamp and make the enlarger accordingly.

Information Sought

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

Spin Dryer Motor

I WISH to construct a spin dryer of average size; could you please tell me the type and size of motor I need? Is the motor shaft a direct drive to the drum or is it a belt drive? What speed does the drum need to rotate?—F. HOLMES (Hayes).

Table-tennis Table

I WISH to build a table-tennis table; can you supply me with a plan or tell me where I may obtain one?—J. PAYNE (Dublin).

EXPLORING THE DEEP OCEAN FLOOR

(*Continued from page 272*)

chalky to look at and feel, and is known as globigerina ooze. It is not, however, flat and featureless, as we have supposed in the past, but is in fact covered with the burrows and workings of the animals that live on the bottom. Often we find tracks, sometimes with an animal on the end, but more often without (see Fig. 4). Because of the very small currents and the incredibly slow accumulation of sediment (about a centimetre in a thousand years), these features are preserved for a very long time. In the basins we have never yet seen exposed rocks and we do not really expect them. All we find is mile upon mile of this ooze.

(*To be concluded*)

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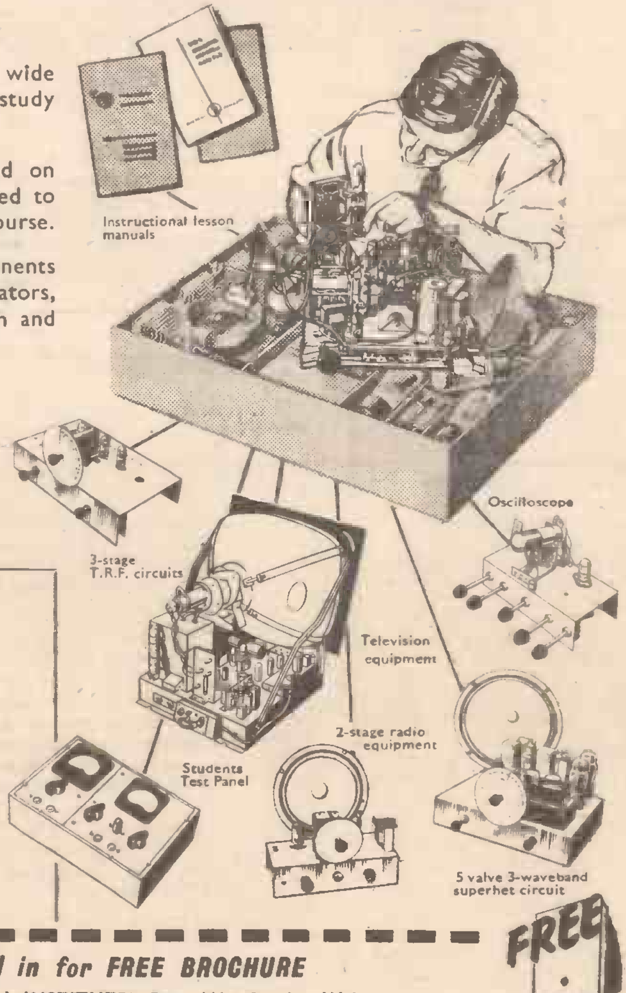

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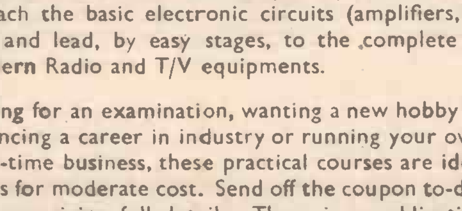

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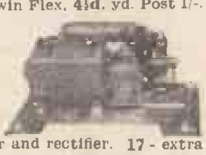

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THE Cyclist

Editor : F. J. CAMM

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WHAT I THINK By F. J. C

N.C.U. Out of the Red

AT a recent general council meeting of the N.C.U. the members were informed that for the previous nine months the Union had emerged from the red and at the end of the full financial year there would be a working profit of over £1,000, the overdraft and all outstanding debts having been paid. A year previously the balance-sheet was £12,800 on the wrong side. The sale of the offices in Doughty Street has, of course, been mainly responsible for the present credit balance, together with some official economies. If the N.C.U. can, during the next few years, increase its credit balance, and £1,000 cannot permit the Union to embark upon any expensive campaigns, it may yet reinstate itself as a power in the land of cycling. Much however has yet to be done before it can gain the full support of all the cycling clubs which alone can bring this about. It must live down the antipathy and the animosity which its disastrous policies have brought about over a long period of years. Whatever the N.C.U. recommended was considered the thing not to do. It now must face the ineluctable fact that it must work with the B.L.R.C. and not against it, and it must drop its autocratic policy if it wishes to survive. It now seeks to amalgamate with the B.L.R.C., but I suspect on the terms of controlling it. In other words, it wants to take it over, under the thin veneer of an imaginary condominium. The B.L.R.C., however, will vigorously watch points, for confidence between these two bodies has not yet been established.

Some Advice to Amateur Editors

EDITORS of club journals are amateur scribes without knowledge of journalistic procedure and the law, as it relates to privilege. They all write in a slap-happy libellous style and have the opinion that they can say what they like in a club journal. Members of these clubs do not realise that they may be sued for libel, either jointly or individually, and the plea that it is a privileged publication can be set aside. The fact that what you write is true does not make it anything less of a libel. In fact, the greater the truth the greater the libel. Very few club journals are serious and need not be taken seriously, for the writers, more often than not, are not worth powder and shot.

This paragraph has been encouraged by a perusal of the latest issue of a club rag called the "Hobbyhorse" the journal of the Redhill Cycling Club. It has a printed cover to make it look like a magazine but the inside is duplicated typewritten matter. This month there is an article entitled "The Cycling Press," which reviews most of the various journals which deal with cycling. After drawing attention to the increased costs which publishers have to face, it goes on to say that "it is revenue earned by advertising that pays for any periodical. It is this fear of loss of revenue that affects the policy of many periodicals. Cycling magazines are not exempt. Costs must be met somehow." This is so divorced from fact that experienced journalists will smile, for it ought to be well known that the basis of all periodical revenue is circulation. Without it you cannot get advertisements for an advertiser will not continue to support a periodical, the circulation of which is so poor that the advertiser does not get results. In other words, it is the aim of every publisher and editor to seek the widest possible sales in the expectation that, having provided a large market place, the advertiser will buy space in it to sell his goods. The article attacks a well-known cycling weekly because "falling circulation and advertising revenue resulted in the editorial being extended to cover the range of mopeds . . . although with brilliant journalistic tact, it undoubtedly offended the paper's most loyal readers . . . the obvious bias against the B.L.R.C. in the past is now thought wrong by a fickle leadership who have almost forgotten their differences with the rebel minority. Would it not have been safer to regard road racing as legitimate news even if not a legitimate sport?" This displays the ignorance of the writer of fundamental facts, except insofar as his reference to the B.L.R.C. is concerned. The writer of the article wants news, and the journal in question gives it, crowding its pages with six point type in order to give up-to-the-minute racing results without having to hold overmatter. The plain fact is, that in its efforts to serve cycling and keen cyclists, club cyclists did not respond by buying the journal in sufficiently large quantities and it naturally had to serve another and more modern market to maintain its circulation and, therefore, its advertisement revenue. If cyclists want cycling periodicals they should buy them. In many clubs only one copy is taken and passed round. At one time there were over 50 monthly, weekly and quarterly cycling periodicals in this country, but one by one they died for lack of support, and only the journal in question weathered the storm, having had an advertising monopoly for a long period of years until The Cyclist came along and broke it, achieving a much larger circulation within a few weeks than had ever been obtained by a cycling periodical before. Unfortunately it became an early war casualty owing to paper shortage and its title was maintained in this journal by means of this supplement. No cycling periodical could ever succeed, however, if its main editorial policy is merely directed to reporting racing news from the clubs. This only represents about 50,000 cyclists out of a total of over 10,000,000. Most cycling clubs have a membership of 25 or so. Very few of them, however, buy cycling periodicals. The club cyclist, because of his apathy, does not deserve a cycling periodical. That is why The Cyclist devoted a minimum amount of space to sport but gave the majority of its space to touring, mechanical matters, bicycle history and even bicycle fiction. H. G. Wells's "Wheels of Chance" and H. H. Griffin's famous history of the bicycle were serialised in it. It is obvious, therefore, where the market lay.

The article we have quoted goes on to comment on other cycling periodicals such as the official journal of the B.L.R.C., the N.C.U. pamphlet, which the writer describes as "trashy" and, of course, this supplement. Although small in size, during its period as a supplement this journal has had a greater effect upon the sport of cycling than all other cycling periodicals put together and but for us the B.L.R.C. would not have survived. It was the present writer who described the underhand tactics of cycling organisations including the N.C.U., the R.T.T.C. and to some extent the C.T.C., in their efforts to get massed start racing stopped. The only objections to massed starts which the Minister of Transport had received when we interviewed him on the matter were from these three bodies—mainly the N.C.U. The papers themselves were knitted together in an anti-B.L.R.C. policy. We prepared the famous memorandum putting the case for massed starts and which was presented to the Minister and caused him to abstain from threatened legislation. We have, on a number of occasions, acted as delegate for the B.L.R.C. in meetings with the M.o.T. and it is this journal alone which is responsible for all of the other cycling organisations having deferentially to genuflect to the B.L.R.C. They have won their battle, they are recognised, and had the luscious satisfaction one year of being recognised by the U.C.I. while the N.C.U. was not recognised. Like the N.C.U. the cycling press of this country, in the main, have been the apostles of lost causes. Cycle sport has become a closed shop with its members acting as proprietors of the sport. They elevated themselves by adopting high faluting titles such as "cycling legislators," when the plain fact is that like lawyers they were merely paid advocates and not in the sport as genuine amateurs. I do not agree with any of the views expressed by this obviously inexperienced writer. The cycling movement, to-day, has got the cycling press it deserves and the space in this specious publication would have been better occupied in impressing even its few readers with the importance of regularly buying a cycling periodical. I do not absolve cycle manufacturers from some responsibility. They have never really adequately supported the cycling periodicals, and in some ways indeed have endeavoured to control editorial policies and to restrict advertising to certain favoured journals. Where you find an industry lacking adequate periodical representation, you will find an impoverished, industry, and it may be that the present decline in sales is somewhat due to this lack of support. If there is a demand for periodicals, publishers are in existence to supply them. They are not, however, in business to act as propagandists to any industry which does not back them up.

EVERY CYCLIST'S POCKET BOOK
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Fitting a Hub Gear

And Some Notes on Adjustment

FOR the purpose of this article it is assumed that the hub three-speed is already built into the rear wheel and that the gear has been purchased complete. The fitting routine described applies specifically to the Sturmey Archer range but will be useful for other types.

It is possible that the range of gears obtainable on the purchased hub is not suitable for the rider's particular requirements and it is possible to vary this by changing the sprocket. A larger sprocket will lower the range of gears and a smaller one will raise it.

The sprocket on a Sturmey Archer hub has three semi-circular shaped splines which fit into three grooves on the hub. It is locked in place by means of a ring which is sprung into a groove in the driver boss (Fig 1). Correct fitting is ensured by two 1/16in. washers and by varying the position of these the chain line may be altered. The spring ring is removed by prising it off with a screwdriver.

The Chain Line

This is the distance from the centre line of the bicycle to the centre of the sprocket teeth, and before measuring this it is

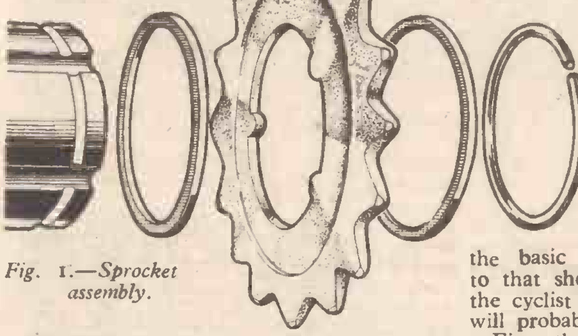

Fig. 1.—Sprocket assembly.

necessary to ensure that sufficient spacing washers and locknuts (the same number both sides) are fitted to make up the width between the fork ends. The chain line measurement should of course be the same as that on the chainring, and, as already mentioned, it may be varied to obtain any position in 1/16in. steps, between 1½in. and 1¾in., by varying the position of the two spacing washers fitted with the sprocket and by reversing the sprocket, one face of which is dished.

Fitting the Gear Change Mechanism

The usual control for the hub gear today is the trigger type which is fitted on the handlebar, but the older type consisting of a small lever in a quadrant is available for fitting to the top tube.

For the trigger control, the usual cable length is 54½in. inner wire and 17½in. outer wire, but other lengths are available. For the quadrant type fitting, cables are available in sizes 32in., 34in. and 36in. There can be no difficulty in fitting the fulcrum, pulley and control levers as this is merely a matter of positioning the clip fitting and tightening the screw into the clip nut.

The positioning of the various fittings on the two most common types of frame is shown in Fig. 2. The fittings themselves are also shown inset. When a chainguard is fitted on an open frame, an extra pulley will probably be required.

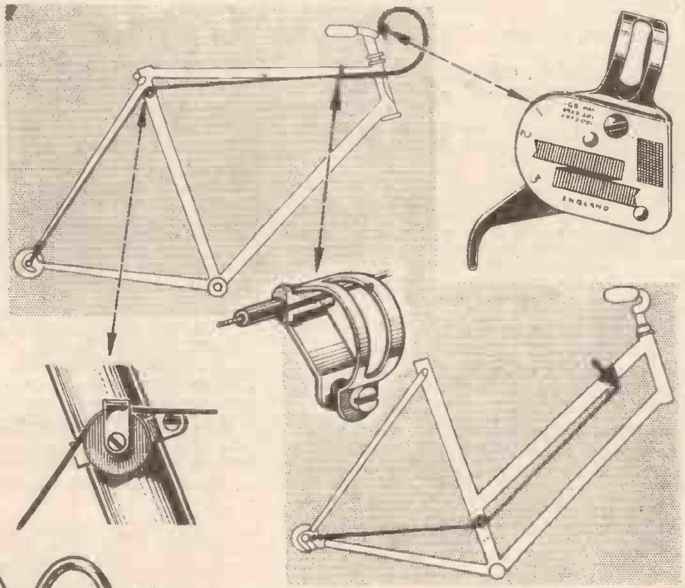

Fig. 2.—The fittings and their positions.

The Trigger Control

There have been one or two variations in the design of the trigger control in the past, but the basic design is in all cases similar to that shown in Fig. 3. The only time the cyclist will need to do any work on it will probably be when renewing cable.

First the old cable must be removed and to do this the inner wire must be detached from the indicator chain at the hub and the outer cable released from the fulcrum clip. Pull the cable ferrule upwards until the threaded end (at this time inside the trigger control) engages in the hole B, and then unscrew. Pull the lever right past the bottom gear position to the stop C and push the inner wire through to detach the nipple from the ratchet plate. The wire is pulled out of the threaded hole B after passing between the pawl and the ratchet plate at D.

Fitting a New Cable

Keep the lever in place beyond the bottom gear position and push the wire through the threaded hole, down between the pawl and ratchet plate at D until the nipple on the end of the wire fits into the notch E. Screw the cable ferrule A back into the threaded hole on top of the casing, then push the lever forward into top gear, keeping the wire taut at the same time. Finally, refit the outer cable into the fulcrum clip and reconnect to the indicator chain at the hub.

Indicator Adjustment

The hub may have either of the two types of adjustment indication, shown at A and B in Fig. 4. In either case, the locknut above the chain is slackened off and then the knurled wire connection rotated to bring the indicator rod into the correct position. With SW, S B, S G, AM, ASC and AC three-speed hubs, this position is as shown at A, i.e., the end of the indicator rod is level with the end of the hub spindle on the left-hand side of the hub. This indication also applied with FW, FM, FC and FG four-speed hubs. The indication shown at B, where the shoulder of the indicator rod is brought level with the end of the spindle on the sprocket side applies to the AW, AB, AG and TCW.

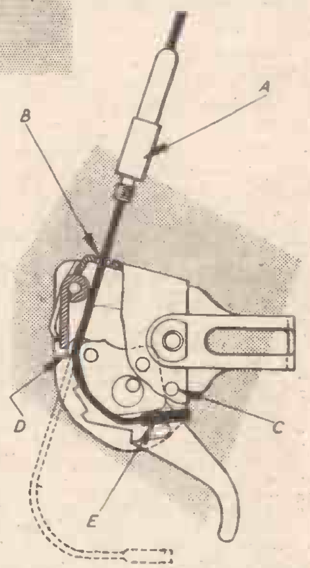

Fig. 3.—The trigger mechanism.

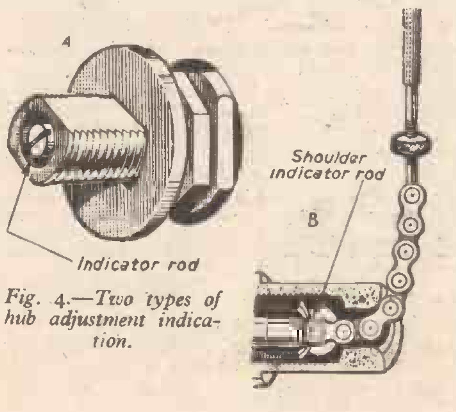

Fig. 4.—Two types of hub adjustment indication.

5,000 **High Speed Slitting Saws and Slotting Cutters**, 2 1/4" dia., 5/8" bore, 0.045", 0.051", 0.057", 0.064" thick, 3/9 each. 2 3/4" dia., 1" bore, 0.027", 0.036", 0.048", 0.051", 0.056", 0.064", 0.072", 0.090" thick, 3/9 each. 3" dia., 1" bore, 3/64", 5/64", 5/32" thick, 6/- each. 3½" dia., 1" bore, 1/32", 3/64", 9/64", 5/32", 11/64" thick, 7/6 each. 4" dia., 1" hole, 3/64", 5/64", 7/64", 7/32" thick, 8/6 each. 5" dia., 1" bore, 5/64" thick, 12/6 each.

3,000 **High Speed Toolbits**, ground finish, slightly below 3/8" square, 3" long, actual present day value 47/- per doz. A most useful bargain, 25/- per doz. 13/6 half doz., 2/6 each.

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1,000 **High Speed Side and Face Cutters**, 2 1/2" dia., 1" hole, 1/4", 3/8", 1/2" thick, 15/- each. 3" dia., 1" hole, 1/2", 5/8" thick, 20/- each. 3 1/2" dia. 1" hole, 3/8", 3/4" thick, 25/- each. 4" dia., 7/8", 1" thick, 1" hole, £2 each. 5" dia., 1" hole, 1/2", 3/4" thick, 50/- each.

1,000 **H.S. Long Straight Shank Twist Drills** approx. 1/16" and 3/32" dia., both 4 3/4" long, 2/6 pair. Approx. 3/16" and 3/" dia., 6" and 7" long, 5/- the two, 9/64" dia., 11" long, 3/6 each. Approx. 13/64" dia., 10" long, 4/6 each. Approx. 15/64" dia., 9 1/2" long, 4/6 each. 3/8" dia., 11" long, 10/- each.

200 **H.S. Spot Facing Cutters** 1 1/4" dia., 1/4" dia. detachable pilot, No. 2 M.T. shank. An essential tool for facing bolt holes on castings. Worth 45/-. Gift 12/6 each.

1,000 **H.S. Inserted Blades Expanding Reamers**, 21/32", 23/32", 16/- ; 11/16"-3 4", 17/6 ; 27/32", 15/16", 18/6 ; 7/8"-31/32", 18/6 ; 15/16"-1 1/16", 20/- ; 31/32"-1 1/8", 22/6 ; 1 1/16"-1 3/16", 27/6 ; 1 3/16"-1 11/32", 32/6 each.

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1,000 **H.S. Morse Taper Shank End Mills.** No. 1 shank 1/4" 5/-, 3/8" 6/-, 1/2" 6/6, also No. 2 shank, 9/16" 10/-, 5/8" 11/-, 3/4" 12/-, 7/8" 12/-, 1" 15/-. Also straight shank H.S. 5/16" 3/6, 3/8" 4/-, 1/2" 5/-, 3/4" 7/6, 7/8" 10/-, 1" 12/6 each.

Special Clearance, H.S. taper pin reamers, sizes 4, 5, 6, 7, 9, 17/6 the lot, worth £8.

All items brand new. £1 orders post paid, except overseas.

2,000 **Small H.S. Twist Drills**, approx. 1.32", 3/32", 4/- doz. ; approx. 1/16"-1/4", 7/6 per doz. ; approx. 9/32"-15/32", six for 10/-.

3,000 **Circular Split Dies**, 1" dia. cutting 1/4", 5/16", 3/8", 7/16", 1/8" Whit., B.S.F., also brass thread, 26 thread all sizes and American N.S. 12/- per set of 5 sizes, 2 sets 22/6, 4 sets 42/6. Taps to suit 12/6 per set, either taper or second or plug. 1" dia. stocks 6/- each.

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1,000 **High Speed Parting Off Tool Blades**, Eclipse brand : 11 16" x 3/32" x 5" long, 5/- each ; 13/16" x 1/16" x 6" long, 5/- each ; 15/16" x 3/32" x 6" long, 6/- each.

7,000 **Pratt & Whitney** circular split dies, superior quality precision ground cutting edges, 13/16" dia. suitable for machine or hand use. Sizes : 2, 4, 5, 6 B.A., 8/6 per set, 13/16" die stock, 3/6 each.

5,000 **Ball Races**, 1/8" bore, 3/8" o.d., 1/8" thick, 4/- pair ; 1/4" bore, 3/4" o.d., 7/32" thick, 4/- pair ; 6 mm. bore, 19 mm. o.d., 6 mm. thick, 4/- pair ; 9 mm. bore, 26 mm. o.d., 8 mm. thick, 4/- pair ; 3/8" bore, 7/8" o.d., 7/32" thick, 5/- pair, 3/16" bore, 1/2" o.d., 5/32" thick, 4/- pair.

2,000 **Files.** 4"-6", good assortment, 10/6 doz., also toolmakers' needle files ass., 12/6 doz.

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2,000 **Straight Shank End Mills**, size 1/8", 5 32", 3/16", 7/32", 1/4", 5/16", list price 30/- set, 15/- set, also 3/8", 7/16", 1/2" ditto, 12/6 set.

500 **H.S. 90° Countersinks**, body 1 2" dia. Gift 5/- each.

1,000 **Bevelled Wood Chisels**, handled, 1/4", 5/16", 3/8", 1/2", 5/8", 3/4", 7/8", 1". Actual value 37/6. Gift 25/- set.

200 **Cast Steel Circular Saws for Wood** 4" dia., 6/- each ; 6", 10/- ; 8", 13/6 ; 10", 18/- ; 12", 24/-.

1,000 **Semi High Speed Centre Drills**, Slocombe brand 5/16" body dia., 3/32" point. 1/6 each, 16/6 per doz.

20,000 **Small High Speed Milling Cutters**, various shapes and styles. We want to clear these quickly. 12 assorted, 15/-.

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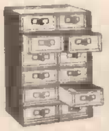

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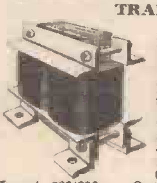

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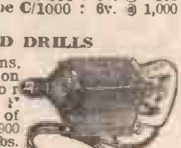

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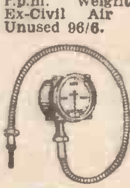

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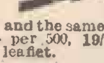

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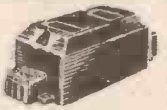

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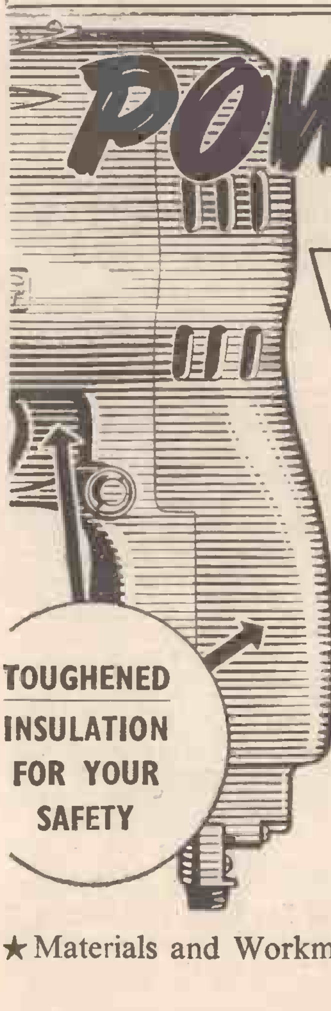

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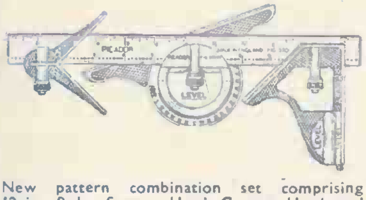

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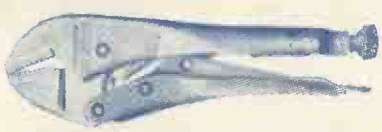

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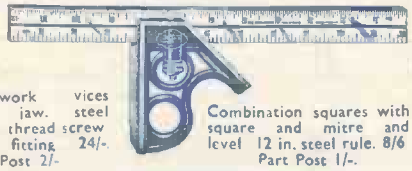

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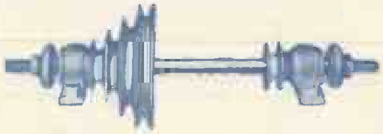

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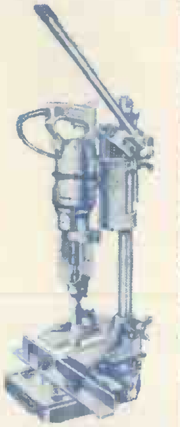

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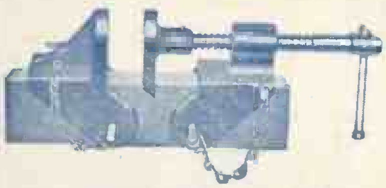

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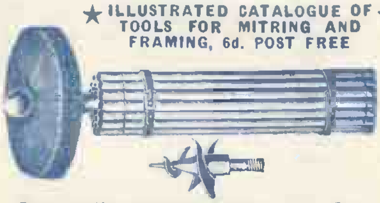

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