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EDITOR: F. J. CAMM

JUNE 1951

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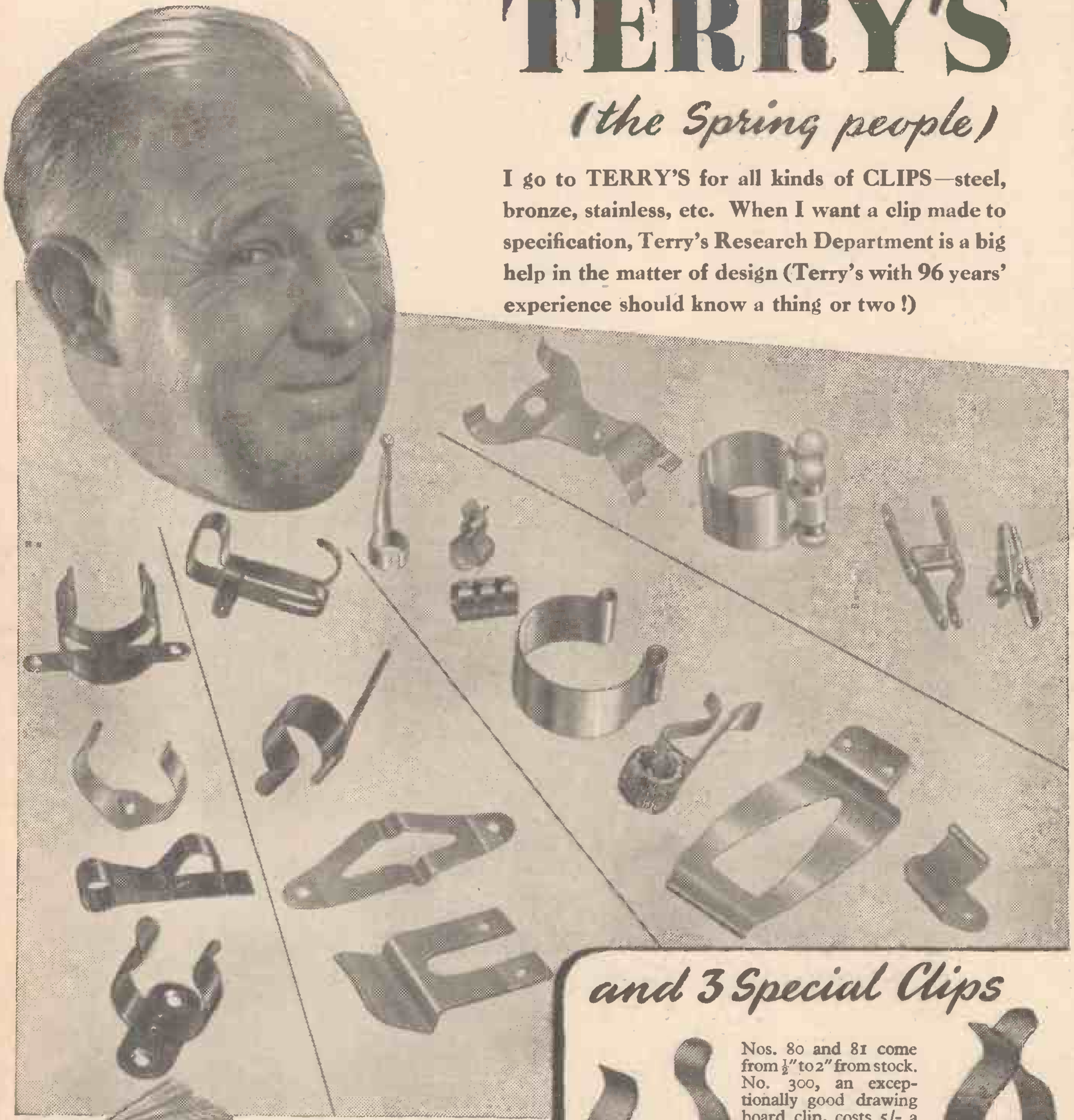

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PRACTICAL MECHANICS
EDITOR F. J. CAMM
JUNE, 1951
VOL. XVIII. No. 210
Owing to the paper shortage "The Cyclist," "Practical Motorist," and "Home Movies" are temporarily incorporated.

FAIR COMMENT

By The Editor

THE FESTIVAL OF BRITAIN

THE Festival of Britain is not only an exhibition of British Industry and ways of life but it is in celebration of the Great Exhibition of 1851 which attracted world-wide attention. Great Britain in those years was the commercial centre of the world. Its goods and its currency were the standards by which those of all other countries were judged.

Victoria was on the throne in 1851 and we were in the throes of an industrial revolution. The national ways of life were changing, and so the year 1951 enables us to compare the progress, or otherwise, which has taken place during the past very eventful century.

Until 1880 the changes were mostly in connection with improved standards of living brought about by our colonisation, the expansion of our Merchant Service, and our development as a great power. And then, for no accountable reason, the scientific world proceeded to shower upon us a number of great inventions and vital discoveries which have entirely changed our ways of life, and our methods of earning our living.

Free education has made us a more intelligent race. The pneumatic tyre was invented in 1888. The telephone and telegraph, the early motor cycle and motor car, the development of road travel, the successful demonstration of flying by those early experimenters who contributed so much to the first successful flight of the Wright Brothers, the advance of machine tools and mass-production methods, photography, the gramophone, the cinema, radio and television—these are but a few of the scientific developments which have changed, and will continue to change, the outlook of the world. The past 50 years have been the most fruitful in the world of science, invention and discovery in the whole history of the world. Within recent years nuclear energy has come to the forefront as one of the newest of sciences. The splitting of the atom, one of the dreams of scientists for centuries past, is now an accomplished fact.

Fission opens up an entirely new era in science, and it may within the next five decades radically change our scientific concepts of existing principles. Einstein has already gone a long way in that direction.

So it is fitting that in 1951 we should celebrate the planting of that seed in 1851 by the Prince Consort and Henry Cole which has laid the foundation of scientific development throughout the world. This is a fact which needs to be stressed in a manner which only a Festival such as the present makes possible. Throughout the world to-day there are insidious attempts to belittle Great Britain by countries which by now would not have existed as separate entities but for the developments, as well as the protection, which Great Britain made possible and available to the rest of the world.

It may be that we have perhaps been a little too generous, and that we have placed "rods in pickle" for our service. There may be those who, comparing 1851 with 1951, will conclude that in many ways things were better then than they are now. Such judgment, however, is based upon false reasoning.

The railways in 1851 were practically undeveloped. Road travel was uncomfortable and risky and by stage coach. One must not judge road travel by the alluring pictures of coaches arriving at old inns which decorate Christmas cards. No one to-day would like to go back to those days.

The Penny Post, introduced by Sir Rowland Hill in 1839, was a great advance, but in 1851 it was still a comparatively slow process. There were no telegrams. Letters took days to deliver which now take hours. There was always the risk of highwaymen. Medical science had not progressed very far from the process of bleeding.

The bicycle was still in the hobby-horse stage. Very few people could read. Free education was unknown, and our staple industries were coal and cotton, with pottery and engineering running close. So it is not so much a century of achievement which the Festival epitomises, but a half century of achievement, development and progress which owes little, if anything, to the preceding 50 years.

Most people in their fifties to-day have witnessed the remarkable developments mentioned earlier. They have seen them develop from the miraculous to the commonplace. In 1912 people would hurry from their homes to witness an aeroplane flying over. In 1922 radio was considered a modern miracle. Television to-day is almost a commonplace, and even school children are acquainted with the elementary principles of atomic energy.

Children of the present generation may have their outlook warped by the fact that most of them were born during a period of war and, therefore, can have no experience of life before 1939.

During the past 100 years science has, paradoxically enough, given us cheaper goods, and then made them dearer. It has made them more plentiful and then scarcer. Indeed, as science advances it produces the inevitable paradoxes because there are those who will divert the real purpose of science, which is to make the world a place worth living in, to purposes of destruction. Great Britain cannot be criticised on that score.

The Festival is a wonderful display of all that is British. It was opened on May 4th by the King and Queen, preceded the previous day by a Service of Dedication at St. Paul's Cathedral. It was exactly 100 years ago that Queen Victoria and her Prince Consort drove to Hyde Park to open the Great Exhibition, and it certainly was a memorable day not only for London but for the whole world.

There was no radio and television in those days, but the world flocked to the Exhibition, and buyers did not need to be persuaded to come and inspect and buy our goods. It was the first of the innumerable great exhibitions which have been held since. F. J. C.

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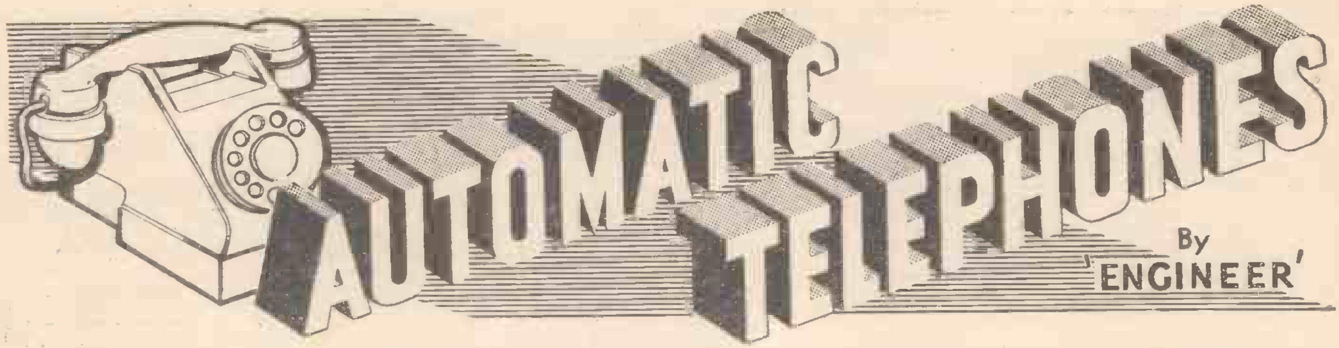


The Operation of the Modern Automatic Telephone Exchange Simply Explained

AN acquaintance of mine told me the other day that the average man in the street has not the slightest idea how the automatic telephone works, and to prove his remarkable statement my friend asked the first ten people of average appearance and interests that we met. The majority appeared interested, but had no idea what happened at the telephone exchange; the remainder had no idea, but couldn't care less, so my friend was, therefore, quite right. I am endeavouring in this article to give a picture, in non-technical language, of the mysteries of the automatic telephone exchange.

Making a Manual Call

We all know what happens in a manual exchange, so I will briefly run through each important step in the establishment of a manual call and compare it with its automatic equivalent. A subscriber wishing to make a call lifts the receiver (Fig. 1), or in

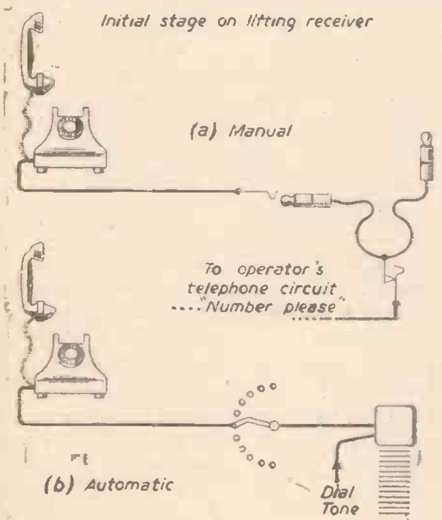


Fig. 1.—Two stages in calling a subscriber—by manual and automatic operation.

the case of a magneto telephone, winds the handle first. Whatever the instructions are, the net result is that an operator or operators at the manual exchange are made aware that a subscriber is calling. I should mention that the subscriber's line terminates at the manual exchange in a socket or "jack" as it is called, into which a plug can be inserted for extending the call to wherever it is intended to go. Associated with this "jack" there is a lamp or signal which indicates when the subscriber wants to make a call. In addition, a common visual or audible signal may be given to indicate that someone somewhere is wishing to make a call. In response to this common signal an operator will look around to see whose lamp is glowing and plug into the associated "jack." The operator will then throw a key or switch, which causes her telephone to be connected to the calling line, and say "Number, please."

Automatic Operation

Now let us look at the equivalent automatic operation so far. The subscriber wishing to make a call lifts the receiver as before. The result is that the automatic exchange is made aware that someone somewhere wishes to make a call. There are various automatic systems, and I will start with one most comparable with the manual system and which one might expect to find in a very small exchange, but not in the larger exchanges. In this system, when the automatic exchange is made aware that a subscriber is calling, a piece of apparatus known as a Line Finder searches for the line wishing to make a call (Fig. 2). The line finder is an electromagnetic mechanism having radial arms which rotate around a central spindle and wipe over contacts on the periphery. The number of such contacts depends on the size of the switch—we will consider a twenty-five point switch for the moment. A subscriber's line is terminated on each of the twenty-five peripheral contacts so that the arms can wipe over twenty-five subscribers' lines. Such a line finder is caused to step over each of these twenty-five lines in turn until it reaches the calling line. The calling line is different from the others in that one of the rotating arms of the line finder encounters an electric potential which causes the line finder to stop rotating, and to rest on the contacts of that line. Connected to this line finder there is a piece of auto-

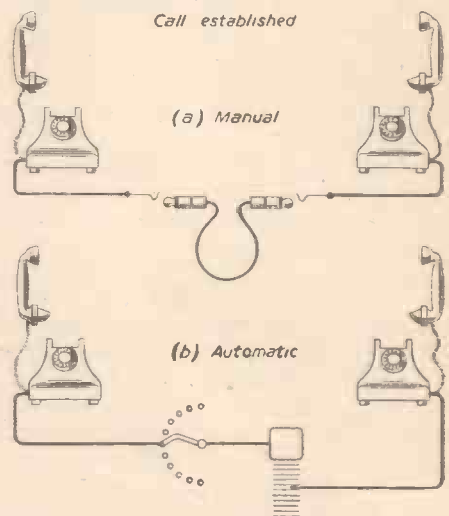


Fig. 2.—Diagrams showing how the call is established.

matic apparatus which is capable of recognising the first figure which the subscriber is about to dial. This piece of mechanism is known as a selector, and when the line finder comes to rest on the contacts of the

Selector panels in a modern automatic telephone exchange.

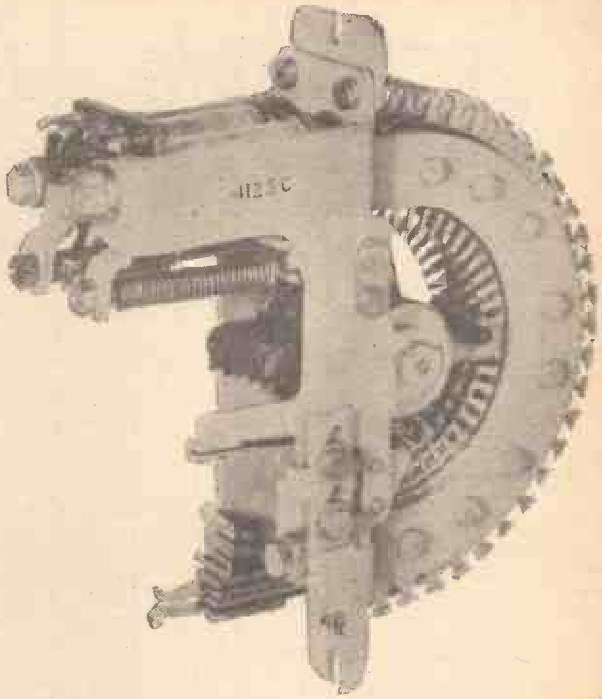
calling line, the said calling line is now connected direct to a selector which is ready to receive the first dialled digit. To indicate this, a tone known as "dial tone" is sent along the line to the calling party which indicates that the subscriber may now commence dialling. This tone is comparable with the operator's "Number, please."

In other automatic systems the line finder is turned round the other way so that instead of the selector finding the calling subscriber, the calling subscriber finds a free selector. There are also other methods by which the calling subscriber is connected to the selector. They all may sound complicated, but everything happens very quickly and, as you know, you hear dial tone in less than half a second.

You may, perhaps, ask why the selector is not permanently connected to the subscriber's line to save the complications of the line finder or equivalent. The answer is that the selector is an expensive piece of apparatus and it is, therefore, more economical to provide only as many of them as will be actually wanted simultaneously in the busiest period, and to attach them as and when required by means of the much cheaper line finders. How many calls do you make over your telephone in a day? Perhaps four, of which, say, two are made between 9 and 10 in the morning, each lasting about two minutes, so between 9 and 10 o'clock you are using a selector for four minutes. If there are fifteen of you in a group, each using a selector for four minutes between 9 and 10 o'clock, the said selector would be in use for exactly the whole sixty minutes, provided, of course, all the calls made were conveniently head-to-tail, but of course the calls occur at any time in the hour, and the mathematicians have devised a formula which will tell you how many calls are likely to occur simultaneously in these circumstances. They would probably say that four selectors would be required by the fifteen subscribers instead of fifteen if the selector were tied directly to the subscribers.

The "Speaking" Key

Let us now go back to the manual exchange. The operator has just plugged in, thrown the "speaking key" and asked the subscriber what number he wants. We will consider first a small exchange of about sixty lines —the "jacks" of which could be arranged in six rows of ten—and that the subscriber asks for No. 52. The operator takes the other plug of the connecting circuit and inserts it into jack No. 2 of the fifth row, that is, of course, if subscriber No. 52 is not already engaged. The operator can tell if the subscriber is engaged or not, either because there is already a plug in that jack, or in the case of a larger exchange where there are several appearances of the jack, the operator would hear a distinctive click in her telephone if she endeavoured to put the plug into the jack of a line which is already engaged. This click is caused by the application of a characteristic potential. The calling subscriber's line is now extended, via the calling jack, plug, cord circuit, plug, jack of the wanted party to the wanted subscriber, and all that remains to do now is to ring the wanted party's bell. In a small exchange this would be done by the operator connecting ringing current via a ringing key to the cord circuit and thus to the wanted party's line. Also associated with the cord circuit are two lamps, or signals, which indicate the switch-hook condition of the two subscribers, that is, whether or not they have hung up. This lamp, or signal, will also indicate to the operator when the wanted party responds to the ringing current. At the end of the call the operators can tell when the subscribers have hung up by these lamps, and when both subscribers have hung up the operator will pull the plugs out and everything will then be normal again.



A typical rotary line switch.

A bank of final selectors.

Impulsing Relay

In the automatic equivalent we left the calling subscriber listening to dial tone. It is necessary here to explain that there is a direct current loop from battery through an electromagnetic relay in the selector, the arm and contact on the line finder to the subscriber's premises and back again to the exchange, through a contact and arm of line finder through another winding of the electromagnetic relay in the selector to the other side of the battery. The direct current thus flowing causes the electromagnet in the selector, called the impulsing relay, to be energised. The dial tone is superimposed on this circuit. Also in series with this loop there are the interrupter springs of the dial.

(To be continued)

A Simple Magnetic Recorder

Constructional Details of an Experimental Loop Instrument

By G. R. JUDGE

MAGNETIC recording is now as firmly fixed in our lives as are radio and television, and any reader who cares to devote a few hours to the subject will get plenty of amusement apart from an insight into a very interesting scientific subject.

The simple mechanism shown in Fig. 1 will record short phrases, such as "Sorry, no cigarettes," "Keep moving, please," "Queue along here," and so on; these phrases, once recorded, could be reproduced every few seconds for days, weeks or years, until the wire or tape itself had worn away. On the other hand, any recording made can be immediately removed from the wire or tape by feeding into the head an alternating current, or by setting a small magnet alongside the loop so that, as the recording medium passes by the head, or magnet, the magnetic flux erases any previous recording, thus preparing the loop for recording again. Such a device would be a boon to a person learning public speaking or plays; one could speak a line and hear it played back immediately, thus learning the quality or otherwise of the diction. A few inches along the tape or wire from the recording head G would be placed the playback head H. The erasing head or magnet would then be placed anywhere along the line between HBCDG.

Look again at Fig. 1. You will see a board, square in this case but any other shape will do as well, in the top left-hand corner of which is fitted a small electric motor. The motor used is a gramophone motor, but this is optional. In place of the gramophone turntable is fitted a "capstan," the diameter of which must be taken into consideration when determining the speed of the tape or wire; if a gramophone motor is used which normally rotates at 78 r.p.m., by simple calculation it is possible to work out the correct diameter of the capstan. Take a 3in. capstan, for example; 3in. multiplied by 3 1/7th (the accepted multiplicant for working out the circumference of a circle) will give you the circumference of the capstan. Since the capstan will revolve 78 times per minute we multiply by 78 to get the total length travelled per minute. If we divide the result by 60 we shall then know the total length travelled per second. Following these calculations, we find that a 3in. capstan rotating at 78 r.p.m. will have a perimeter speed of roughly 12in. per second. Recorder manufacturers are satisfied with a speed of 7½in. per second for tape, and 2ft. per second for wire, so 12in. should give us a little better quality for tape, as quality improves with speed.

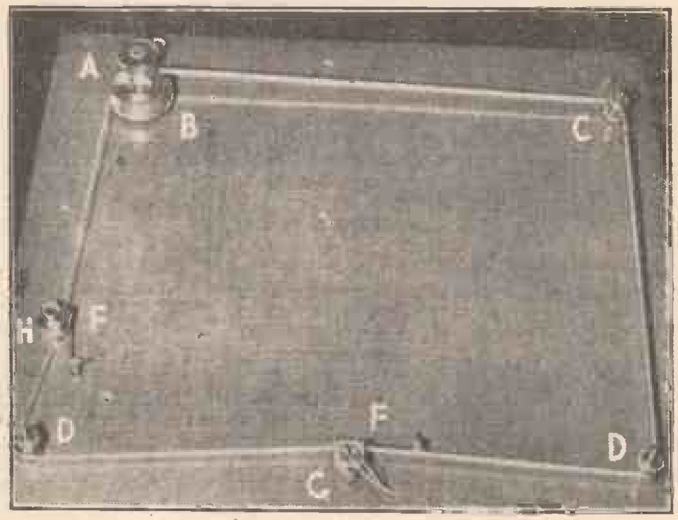


Fig. 1.—General view of the completed recorder.

Recording Tape or Wire

Around the capstan and the three corner rollers is placed a band of "Diamond" recording tape or of "Crown" recording wire, whichever you prefer to use. The capstan will drive this recording medium around, and to overcome possible slips a "pinch" wheel is arranged to press the medium on to the capstan. This pinch wheel A is held on to the capstan by a tension spring, which doesn't show in the diagram as it is behind the board. To keep the band of tape taut, one of the three corner rollers is not mounted directly on to the board; instead, the spindle of the roller passes through a slot in the board and is mounted into a strip of metal the end of which is pinned to the board. In this manner the spindle can move to left or right within the slot on the arm of metal. At the back of the board the strip of metal is held with a tension spring so that the roller is always trying to pull outwards, thus keeping the loop taut.

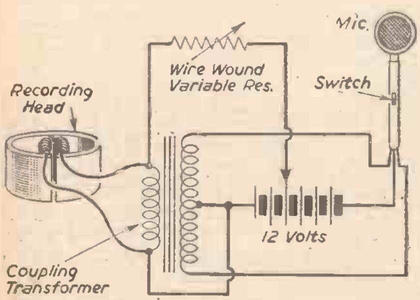


Fig. 2.—Push-pull, self-amplifying microphone, with D.C. biasing to the recording head.

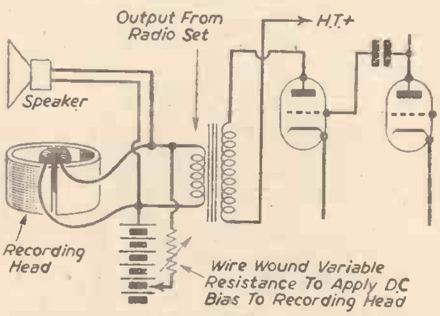


Fig. 3.—Utilising extension speaker sockets to feed the recording head.

To join the two ends of the magnetic tape together a piece of self-adhesive selotape is used; the ends should be firmly joined with the adhesive on the glossy side, and any surplus adhesive should be neatly trimmed away to leave a smooth edge. The wire should be joined by knotting carefully and trimming back the ends.

Fig. 1 (F) shows the recording head, and H in the same figure the playback head; the latter can be placed in any position, either close to or away from the recording head. If you wish to record longer phrases it is suggested that you fit more pulleys, so that the wire or tape can zig-zag up and down the board, instead of just moving around the edge. Once you have the principle mastered, you can even fit up a recorder with spools of tape or wire.

To energise the head you can either use a self-amplifying microphone to record speech (Fig. 2), or if you wish to record a radio programme or re-record a record for testing purposes you can connect the recording head to the extension speaker sockets of your radio, at the same time connecting a pick-up to the pick-up sockets (Fig. 3); when a record is played through the pick-up it will then be recorded on your wire or tape through your recording head. It must be emphasised, however, that re-recordings made in this way are for your private use only; performances in public, for whatever purposes, are an infringement of copyright and likely to be frowned upon by the owners of same.

For playback purposes one really needs a sensitive amplifier, as the amount of energy stored in the recording medium is quite small. Although the stage gain of the domestic radio between pick-up sockets and output is not very great, one can overcome the difficulty by connecting headphones into the extension speaker sockets and connecting the playback head to pick-up sockets (Fig. 4). To get the playback louder at least a three-stage amplifier would be needed.

Playback Head

Recording and playback heads are quite easy to make. Referring to Fig. 5, you will notice a brass cup having a flange, which helps to fasten it down to the base-board. A is a piece of old felt hat forming a pad, B is a piece of spring (an old gramophone governor spring is suitable). The felt pad lightly presses the tape T on to the gap C in the head. The winding on a strip of mumetal is shown at E,

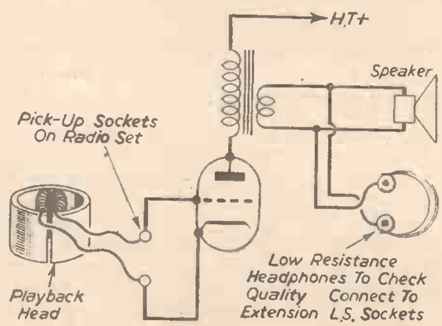


Fig. 4.—Method of using headphones for checking quality when using the playback head.

the two ends of the winding meet at C and pass through the wall of the brass cup so that the tape T can be made to slide across the ends of this mumetal strip. A thin flake of mica D separates the two ends of the strip; this mica also passes through the wall of the cup, but its purpose is to keep the two ends of the mumetal strip no more than a thousandth of an inch apart and thus form the magnetic "gap." What looks like sacking in Fig. 5 is the magnified grain of the bakelite board seen in Fig. 1,

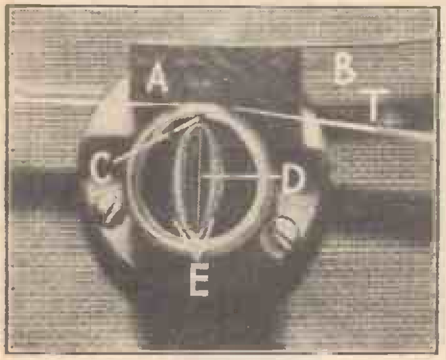


Fig. 5.—Enlarged detail of the playback head, showing the windings on the mumetal strip.

and the head shown in Fig. 5 is a magnified reproduction of that in Fig. 1. If you have nothing in your junk box similar to the brass cup shown, cut off a piece of brass tubing about $\frac{1}{2}$in. diameter and $\frac{1}{4}$in. long. Slit this down one side and, with a well-cleaned and tinned hot soldering iron, thinly tin the inside and outside of the tube near the cut and also the two edges of the cut; this tinning should be as thin and smooth as the surface of a tinplate can, so while the tube is still hot and the solder "wet" wipe it off with a piece of rag to avoid any ridges or blisters of solder. Next, take a piece of mumetal $\frac{3}{8}$in. wide and roughly $1\frac{1}{2}$in. long—this metal is very expensive, costing about 3s. per square inch, so to avoid spoiling it practise first with a piece of tinplate. Mumetal, by the way, is the very opposite to a magnet; it will not retain magnetism.

Winding the Mumetal Strip

Having cut your piece of metal to the right size, clean the edges with a fine file to remove all burrs, then thinly tin the ends for about $\frac{1}{4}$in. on both sides, once again making sure to wipe off all surplus solder while it is "wet." With a pair of square-jawed pliers give a slight set to the ends so that if the strip is held upright and regarded on edge with the sets to the left, the top set will point at 11 o'clock and the bottom set at 7 o'clock. Now wrap the strip with two layers of selotape and wind on about 120 turns of 32-gauge wire; try to leave a space in the middle of the strip to allow for bending round into a circle, winding the wire evenly on both sides of the space—in Fig. 5 E indicates the two half-windings. Having wound the strip, bend it to lemon shape (Fig. 6) and place it within the brass tube so that the two ends which have been set at a slight angle poke through the slit in the tube, as in Fig. 6. The slit in the tube should push the two ends of mumetal together so that there is no gap discernible between them. You can then push between the two ends a very thin flake of mica, making a gap of about one-thousandth of an inch between the two ends. When you are satisfied that all is ship-shape, apply a hot, tinned soldering iron (but without any extra solder) to the gap, so that the ends of the strip and the tinned tube fuse together. If the wound strip is left loose within the brass tube you will find it difficult to make any recordings, as the gap in the head will move and vary in size. When the soldering is firm, file away any surplus metal, which will be the ends of the mumetal strip poking through the slit in the brass tube.

Polishing the Tube

When you have filed these ends level with the tubing, well polish the tube at this spot with a fine metal polish until the surface is very smooth, as any roughness would soon scrape off the oxide coating on the recording tape. If you have decided to use wire for recording, file a narrow channel in the tube and across the gap for the wire to run in.

Matching Transformer

This type of head will be a low impedance head and will need a step-up matching transformer to couple it to the impedance input of a valve, which is high. Fortunately, there are plenty of small microphone transformers available quite cheaply. For a temporary test where no microphone transformer is available a speaker transformer can be used.

Not much power is needed for recording, so don't shout into the microphone. As an example, if you were trying to magnetise a needle, a 6in. nail, and a jemmy, the needle would need only a few ampere turns of wire in comparison with the jemmy. Remember that in recording you are only trying to magnetise a few molecules of material a thousandth of an inch long (the width of the gap).

The fitments shown in Fig. 1 to the left of the head and below the tape, and between head G and roller D, are bakelite sockets to which are connected the adjacent heads. To make connection one has only to plug in the relative plug, and arrangements are made for either recording or playing back. Both

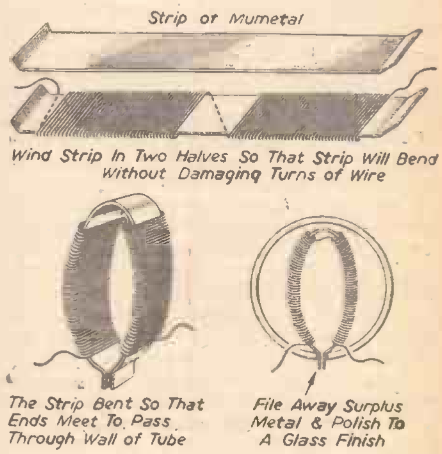
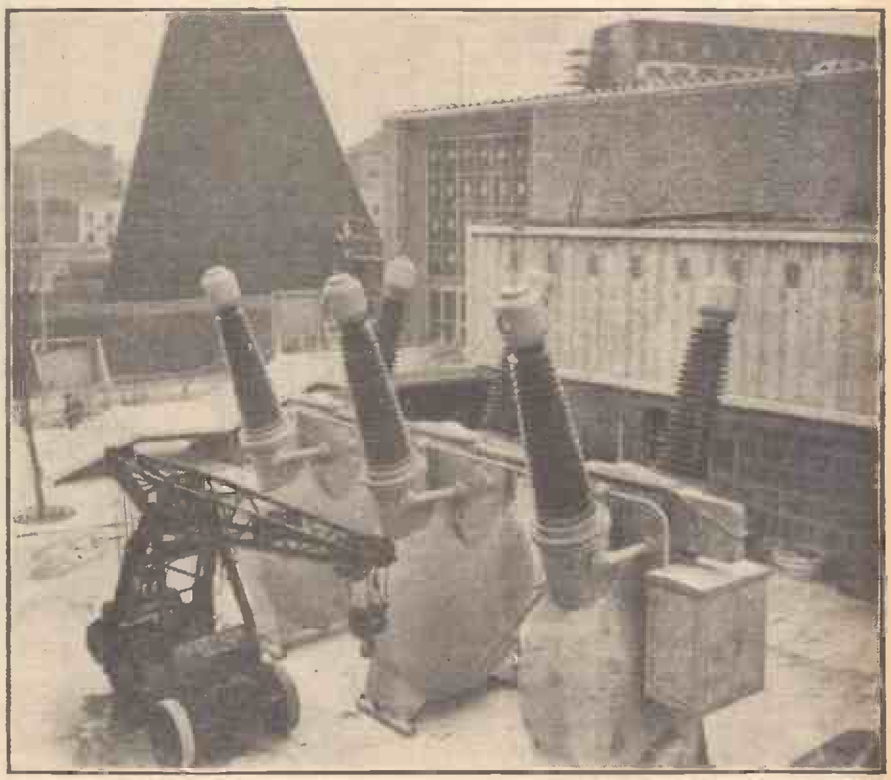


Fig. 6.—Method of winding and bending the mumetal strip, showing how the ends of the strip protrude through the slot in the brass tube.

the heads shown in Fig. 1 are made in exactly the same way, except that H was made in a brass cup and G in a piece of brass tube fitted between two pieces of brass plate.

Sixty-ton Oil Circuit Breaker



This huge B.T.H. oil circuit breaker can be seen at the South Bank Festival of Britain Exhibition. The total weight is over 60 tons—the largest made in this country—and it has a capacity of up to 275,000 volts. In the background looms the Mining Section of the Exhibition.

Building Aluminium Boats—4

With Notes on Design

By G. F. WALLACE, A.F.R.Ae.S.

(*Continued from page 233, May issue*)

IF a gunwale angle is being used this should now be riveted on. The skegs, bottom stringers and centre-board trunk should now be assembled, as already described, for the other components. The deck sheeting should be laid on the boat and marked off to shape. Cut the deck plating to shape and rivet up as already described for the bottom plating. Before riveting the decking on make sure that any fittings that are inaccessible once the decking is on have already been assembled. Now assemble all the minor fittings, such as mast steps, rowlock brackets, seat bearers, etc.

Painting the Hull

The hull is now ready for final painting. First remove all filings, drilling swarf, etc., then remove any oil or grease and touch up any parts where the priming coat has been removed. Two coats of finishing paint over the primer are usually sufficient.

Boat Design

Designing your own boat is as much fun as building it, and is not very difficult provided you keep to certain simple rules and have an elementary knowledge of solid geometry. As for the method of construction previously described, the following method of design is simplified for amateur use and, in consequence, has a number of limitations. It does not include calculations of metacentric height, curves of areas or metacentric balance. Such things are a waste of time on a small boat in which the crew form the major item of weight. All curves in plan are arcs of circles, and both angle of flare and angle of Vee in a Vee-bottomed boat are constant from stem to stern. It is only in speed boats that a varying angle of flare or Vee is really necessary. It is also assumed that the chine angle is constant and that the cross-sections are straight lines. Actually, neither of these assumptions is mathematically correct. In a curved bow, the angle of chine would only be constant if there was no angle of flare, i.e., the bottom making an angle of 90° with the sides. Provided the bow is reasonably sharp, the change of angle in the chine angle is very small, two or three degrees at the most, and can easily be taken up when riveting the chine angle. In general, it can be taken that the tangent of the bow curve at the stem should not exceed an angle of 35° to the centre line of the boat. This means, in effect, that you cannot use the apple bow of the Dutch barge type of boat. As regards the sections, the side would only be straight if there was no angle of flare, or if there was no curve in plan, as in a punt.

Angle of Flare

When flare and curves in plan are combined, the sides become conic surfaces and the sections are conic sections, i.e., hyperpolas or parabolas. If the angle of flare is not great and the bow curve not excessive, the section of the sides is the tail end of a hyperpola and, therefore, near enough a straight line for practical purposes. This may all sound a little theoretical, but is the reason for the following limitations. As previously stated, the tangent of the bow curve at the stem should not exceed 35° to the centre line of the boat, and the angle of flare should not exceed 25°, as illustrated in Fig. 32. When commencing the design of a new boat the first thing to decide is the length, as this is the leading dimension. Small racing boats, for instance, are classified by length—12ft. National, 14ft. International, etc. Other dimensions of the boat—beam, freeboard, sail area, rudder size, centre-board size—are best determined by a study of existing boats of similar design and length which are known to be successful. The majority of small boats in this country are of round bilge design, and the following points must be borne in mind when comparing round bilge with hard chine designs. For the same length, the hard chine boat should have less beam than the round bilge boat and, in the case of sailing boats, less freeboard. The hard chine boat will draw less water, and, in the case of sailing boats, will require a bigger centre-board ; in the case of rowing and motor boats a bigger skeg is necessary. Flat-bottomed boats also usually benefit by having a small skeg forward, as this improves the control of the boat in high winds. When comparing boats, care must be taken to compare like with like ; for instance, the sail area of a family picnic boat should not be compared with that of a 14ft. International dinghy, even if the overall lengths are the same. As a rough guide it can be assumed that the beam of a boat varies as the square root of the length, and also sail area varies directly as the length and as the square of the beam. This is expressed mathematically as follows:—

If boat A is x feet long and y feet beam, and boat B is z feet long, then the beam of boat B is $\frac{y \times \sqrt{z}}{\sqrt{x}}$

If the beam x of boat B is w and the sail area of boat A is m, then the correct area for boat B is $\frac{m \times z \times w^2}{x \times y^2}$

Fig. 32.—Diagrams showing tangent of boat curve and angle of flare.

Flat or Vee-bottomed

Having got some idea of the length and beam of the boat, the next thing is to decide whether it is to be flat or Vee-bottomed. As previously mentioned, there is a lot of unwarranted prejudice against flat-bottomed boats in this country. They are far more popular in America, and in the Far East nearly all boats, great and small, are flat-bottomed. The chief disadvantage of the flat-bottomed boat is that, owing to its small displacement, it is apt to be uncontrollable in choppy seas and high winds, and sailing boats of this type are not good performers to windward. It is considered, however, that a lot can be done to improve flat-bottomed boats in this respect by proper design of skegs, centre-boards and rudders. The second disadvantage is that they pound heavily in rough water; this is not so serious structurally in an aluminium boat as it is in a wooden boat, but it is always uncomfortable for the crew. The Vee-bottomed boat is a development of the flat-bottomed boat, and is an attempt to partially overcome the disadvantages of the latter. In general, Vee-bottomed boats have a greater displacement, are better performers to windward, and do not pound so badly as flat-bottomed boats. As against this, there is much more work in building them. The frames are more complicated, needing an extra gusset, and there is an extra watertight joint at the bottom of the Vee. The Vee-bottomed boat, there-

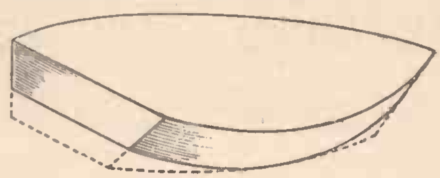


Fig. 33.—The base plan.

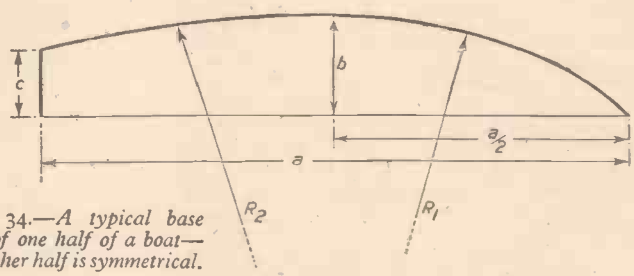
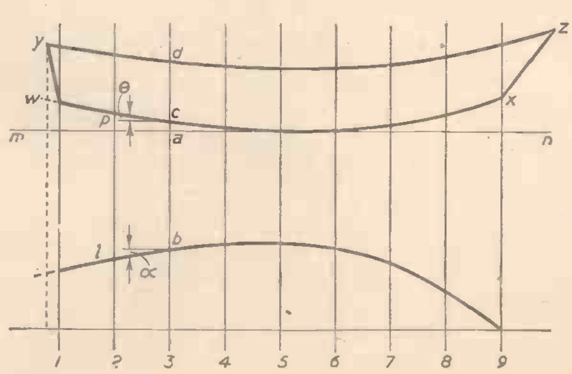


Fig. 34.—A typical base line of one half of a boat—the other half is symmetrical.



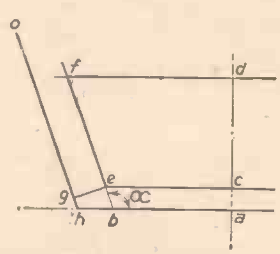
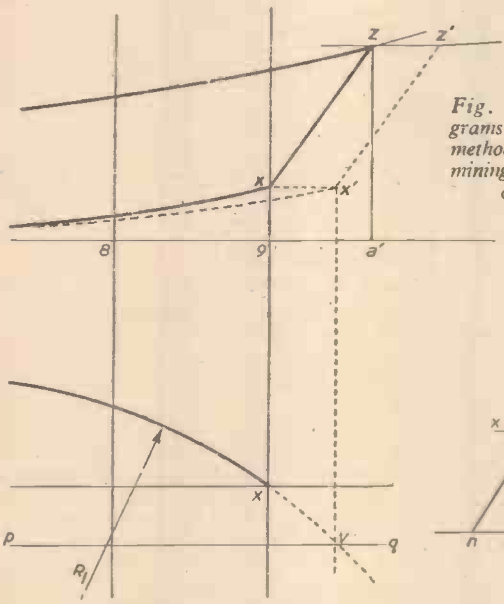


Fig. 35.—Base line elevation and plan, and cross-section at frame 3.

fore, requires at least 25 per cent. more man-hours to build, and it is considered that this type is only justified for fast racing boats or power boats that are going to be used habitually in rough water.

The Scow Bow

The shape of the bow must now be decided, and in this connection it is suggested that the reader should consider the merits of the scow bow. Like flat bottoms, it is not very popular in this country, its use being confined to praam dinghys. It is more widely used in America, where the bilgeboard scows of the Great Lakes are some of the fastest sailing craft in existence. The scow bow is usually considered suitable for smooth water only, but it is the most common form of bow for Chinese junks, many of which are noted for their seaworthiness in the rough waters of the China Sea. In a flat-bottomed boat of light displacement and with the correct amount of rocker on the bottom the bow is normally clear of the water, and a sharp bow does not do any trade anyway, except in rough waters. The advantage of the scow bow is that it makes the boat easier to construct and gives more room in the boat for a given length.



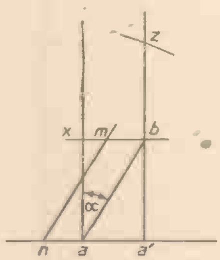


Fig. 37.—Diagrams showing the method of determining the angle of rake

Some mention must be made of the double-ended boat, which is the standard type for canoes but is rearly used for dinghys. It is supposed to be a more seaworthy type, but it is doubtful if this applies to boats under 18ft. long. Pointed bows usually give a long, narrow boat, but if used in conjunction with a scow bow give a boat of more normal proportions. An advantage of the double-ended boat is that, if it is symmetrical about the mid-section, a considerable amount of time is saved in drawing, marking out, etc. As previously mentioned, the freeboard and width of transom are decided by comparison with similar boats to the one being designed.

The Base Plan

The first thing to determine when laying out the boat is the base plan. This is illustrated in Fig. 33, and is, in effect, the projection of the sides and transom of the boat on to a plane parallel to the centre line at a depth equal to the maximum depth of the boat. The maximum beam of the base plan is the beam at the chine of the centre section of the boat, i.e., the maximum beam minus the amount of flare. It should be noted that it is assumed that the maximum depth and maximum beam both occur at the mid-section. The length of the base plan is the maximum length minus the amount of overhang of bow and stem. This is not easily determined in advance, but on the type of boat being considered is usually 9in. to 18in. less than the overall length. Fig. 34 shows a typical base line, the dimensions a, b and c have already been fixed, and it is necessary to determine the radii R_1 and R_2. These are given by the following formulæ:

$$R_1 = \frac{a^2+4b^2}{8b}$$

$$R_2 = \frac{a^2+4\,(b-c)^2}{8\,(b-c)}$$

It should be noted that it is only necessary to draw on half of the boat as it is symmetrical about the horizontal centre line. Having drawn in the base line, the next thing is to draw in the frame positions and number them off. These are the lines numbered 1 to 9 in Fig. 35. Now draw the base line in elevation, indicated by m-n in Fig. 35 and the chine line w-x. The height of w and x above the base line m-n should be such that they are just clear of the water when the boat is fully loaded. This means that the volume of water displaced by the boat below the line joining w and x parallel to the base line must be equal in weight to the total weight of the boat. The shape of the line wx must be such that the first third from each end is nearly straight fairing into an easy curve into the middle third. From this it will be apparent that the correct height for w and x must be obtained by trial and error. The sheer line y-z is now drawn in, the only rule governing the sheer is that it is normally greater at the bow than at the stern.

Cross-sections of the Hull

The cross-sections of the hull can now be drawn. As an example, consider frame No. 3, Fig. 35. Draw a horizontal line representing the base line and a vertical line representing the centre line of the boat. Mark off the beam a-b on the horizontal line and from b draw a line at an angle α equal to the angle of flare. From a mark off a-c, the height of the chine line above the base. From c draw a line c-e parallel to the base line. From c mark off the distance c-d equal to the depth of the boat at this frame and draw d-f parallel to the base line; c-d-f-e represent the true shape of frame No. 3, also c-e is the width of the bottom at frame No. 3, d-f is the width of the gunwale, and e-f is the true length of the side. This is repeated for every frame in the boat, and the resultant cross-section drawing is shown in Fig. 36. It should be noticed that the gunwale and chine points in the sections should lie on a regular curve; if they do not, check the drawing carefully to see that there are no mistakes. In Fig. 35 w-y represents the transom, and the rake of the transom, if any, is quite arbitrary. The width at y is found by extending the base curve R_2 (Fig. 34) to cut the projection of y and laying it out as for the frames. In obtaining the line x-z it is assumed that the width of the stem is constant and that the angle of flare at the bow is constant. This fixes the angle of rake of the bow and if it is required to alter the angle of rake, then either the angle of flare or the width of stem must be varied. The angle of rake is obtained as follows: from point a in Fig. 37 draw a line with the angle of flare α and mark off x so that a-x is the height of x above the base line; draw a line through x parallel to the base to cut the line from a at b, then x-b is half the width of the stem. Through b draw a vertical line to cut the gunwale line at z. This gives the vertical height of the stem z-a^1; mark off the distance z-a^1 above the base line in elevation and draw a horizontal line. Where this line cuts the sheer line is the point z, which can now be joined to x to give the rake of the stem.

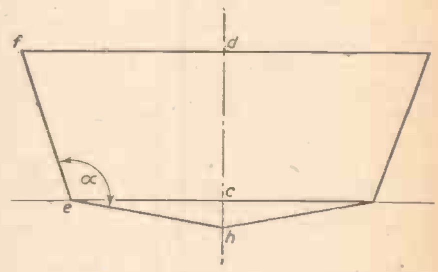


Fig. 39.—Section at frame 3 for a Vee-bottomed boat.

In practice, this would be done on Fig. 35, in which the gunwale curve is already drawn and has only been done separately for purposes of illustration. It may be found that the width x-b is greater than is required; in this case mark off x-m the required half width of the stem. Through m draw a line parallel to a-b to cut the base line at n. In the plan of the base line (Fig. 37) draw a line p-q parallel to the centre line and a distance a-n from it. Extend the radius R_1 to cut this line at v and project to the elevation and mark the point x^1 representing the new base of the stem. Obtain z^1 as previously described for z. It will be noticed that this slightly increases the length

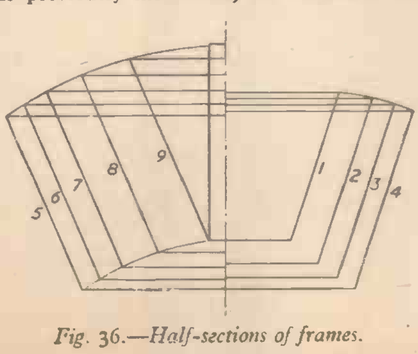


Fig. 36.—Half-sections of frames.

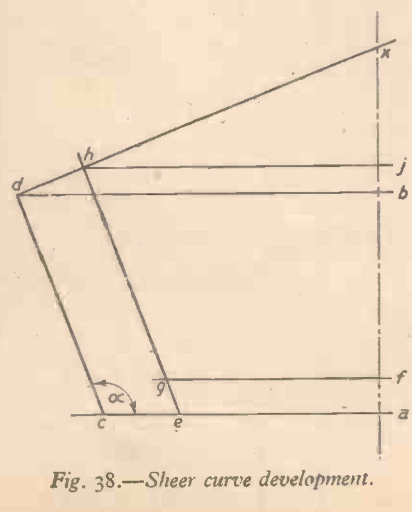


Fig. 38.—Sheer curve development.

of the boat and alters the curve of the chine. In consequence, the width of the stem should be fixed before the other frames are laid out. Certain other information can now be obtained from the drawing in Fig. 35.

Referring to frame No. 3 again, measure the length of the curve *b-l* and the angle of the tangent of this curve to the horizontal. The length *b-l* is the true developed length of the side of the boat between frames 2 and 3 and α is the faying angle at frame 3. Now measure the length of the curve *p-c* and the tangent of *p-c* to the horizontal θ. The length *p-c* is the true developed length of the bottom between frames 2 and 3 and θ is the faying angle of the bottom at frame 3. Repeat this for all the other frames.

The development drawing of the bottom can now be made; this is done by plotting out the width of the bottom represented by *e-c*, the distances between frames being the true lengths *p-c*. In making the development drawing of the sides, the true length of side between frames is *l-b* and the true depth of the side is *e-f*. The height of *e* above the datum, however, is neither *a-c* nor *b-e*. In development the line *e-f* swings back so that it lies in the same plane as *o-h*, the side at frame 5 and the widest point of the boat. From *e* draw a line at right angles to *f-b* to cut *o-h* at *g*. Then *g-h* is the height of *e* above the datum line in the development of the sides.

Sheer Curve Development

It is possible to so arrange the sheer curve that its development is a straight line. This means that the edge of the sheet can be used as the gunwale and datum, thus saving time in marking out and sawing up the sheet. This is done as follows: mark out the lines *a-c* and *a-b* in Fig. 38, *a-c* being the width of the section at the point of maximum beam and *a-b* being the height. From *c* draw a line at the correct angle of flare α. From *b* project to *d*, which is the sheer line at this section. From *d* draw a line *d-x* at right angles to *c-d*. For any frame section lay off the base line width *a-e* and the chine height *a-f*, and obtain the point *g*, as previously described. Extend *e-g* to cut *d-x* at *h*. Then *h* is the sheer line point at the frame in question and *h-j* the deck line. This is repeated at each section and the corresponding sheer line points plotted in the elevation to give the sheer line. This method is not suitable for all designs, as it tends to give a very exaggerated sheer if the bows are full or the flare angle excessive.

So far it has been assumed that the boat is flat bottomed. If it has a Vee bottom all that is necessary is to impose the Vee on to the sections drawn as for a flat-bottomed boat. In Fig. 39 the section of frame 3 from Fig. 35 is reproduced. If the boat has a Vee bottom, a line is drawn from *e* at the correct angle of Vee α to cut the vertical centre-line at *h*. Then *h* represents the keel line of the boat at this frame. This is repeated for all frame positions and the resultant *c-h* dimensions plotted in the elevation to give a keel line under the chine line. With a Vee-bottomed boat the volume of the Vee must be included in the calculations of displacement referred to previously. It is possible to give more rocker to the chine in the Vee-bottomed boat, but the middle two-thirds of the chine should be under-water. Excessive angles of Vee should be avoided, and little is gained by making it more than 15 deg. to the horizontal at the mid-section.

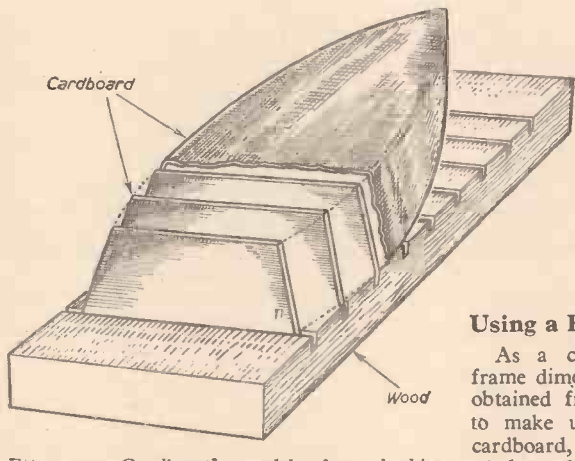


Fig. 40.—Cardboard model for checking purposes.

The layout drawing as in Fig. 35 should be drawn out $\frac{1}{4}$ or $\frac{1}{6}$ full size. At this scale it should be possible with care to measure off the various dimensions to within 1/16 of an inch, which is accurate enough for practical purposes. This means that lofting is unnecessary, and the drawing dimensions can be laid out full size directly on to the sheet metal of the bottom and sides. At $\frac{1}{6}$ full size a boat 18ft. long can be laid out on a standard drawing board 3ft. 6in. long.

General Arrangement Drawing

In addition to the layout, a general arrangement drawing of the complete boat is required in order to fix the position of various items such as seats, centre-board trunks, mast steps, etc.

In the accompanying examples of general arrangement drawings it will be noticed that no development drawing or any dimensions are given for the deck. The reason is that various small errors that accumulate during building usually result in the gunwale being anything up to $\frac{1}{4}$in. out, and it is best to mark off the shape of the deck plates from the boat.

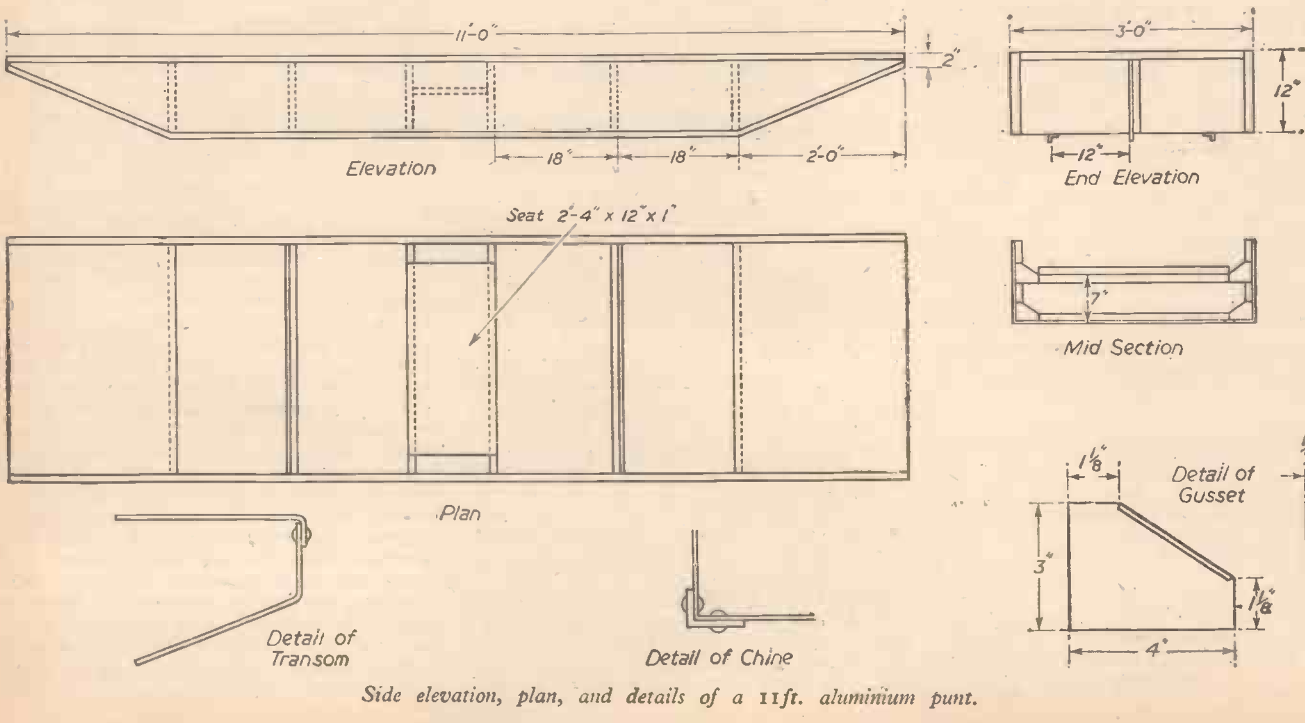
Using a Half-model

As a check on the correctness of the frame dimensions and development drawings obtained from the layout, it is a good plan to make up a full model of the boat in cardboard, as shown in Fig. 40, to a scale of $\frac{1}{4}$ or $\frac{1}{6}$ full size. The frames are cut from thick cardboard or plywood and mounted on a piece of wood at their correct spacings and height. The developments of side and bottom are then cut out in thin cardboard and they should lay on the frames to give a fair curve and good fit at the chine.

Careful Checking Necessary

If there appears to be any discrepancy, the dimensions of the layout should be carefully checked. If any mistake has been made this model will show it up and save a lot of trouble later.

(To be continued.)



Side elevation, plan, and details of a 11ft. aluminium punt.

Principles of Ultrasonics

Practical Applications : Generators : Bibliography

By F. W. COUSINS, A.M.I.E.E.

SOUND and noise are almost synonymous terms to most people, so that it would seem appropriate to preface a study of ultrasonics with the strict scientific definitions. Sound is the perception of external stimuli accepted through the ear and sense of hearing: also the wave motion or vibration which gives rise to such stimulus when applied to the ear. In this respect sound may be considered to include that branch of mechanics which deals with vibratory motion. The practical engineer will not require proof in order to understand that all sounding bodies are in a state of vibration. Noise, however, is subjective and its study cannot be divorced from the realms of psychology; probably the best definition of noise is the one given by the B.S.I., viz., "Sound undesired by the recipient."

Ultrasonics, sometimes called supersonics, although this latter term is falling into disuse, is the science of mechanical vibrations and radiations in solids, gases and fluids, which have frequencies in excess of those which, in a sound wave, would be in the aural range. Such frequencies may be considered to lie between 20,000 cycles/second and 5×10^8 cycles/second. The wavelengths will vary with the velocity of propagation in different media (see Table 1), but very often the wavelength will approach that of visible light, 5,000 to 7,000 A° ($1A° = 10^{-8}$ cm.).

TABLE I
VELOCITY OF SOUND AT 15° C.

Substance.	Velocity cm/sec.
Solids	
Ash	470,000
Beech	335,000
Brass	350,000
Copper	360,000
Lead	125,000
Oak	400,000
Steel	500,000
Liquids	
Water	145,000
Alcohol	120,000
Gases	
Air	33,200
Helium	95,400
Oxygen	31,700
Water vapour ..	40,000
Hydrogen	128,000

Wave Motion

The propagation of all sound is in the nature of a wave motion through elastic media, but the movement of any particle of the media is purely local, each particle oscillating about a mean position. The oscillatory motion is in the same line as the direction of advance of the wave. This is termed longitudinal motion and may be contrasted with transverse motion as in water waves.

It will be understood that ultrasonics is outside the aural spectrum, in much the same way as the vast majority of electro-magnetic waves are outside the visual spectrum.

The Practical Applications of Ultrasonics

A large number of investigators have contributed to our knowledge of the phenomena surrounding high frequency sound waves. Submarine detection and communication between submerged submarines inspired a large amount of original work. It other fields the studies were only laboratory curiosities and it is only now, with improved ultrasonic generators, that many of these curiosities begin to have the appearance of an industrial application; a special paragraph is hereinafter devoted to an explanation of the principles of these modern generators.

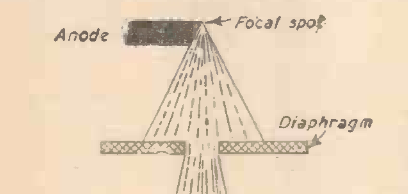


Fig. 1.—Radiographic exposure for non-destructive testing.

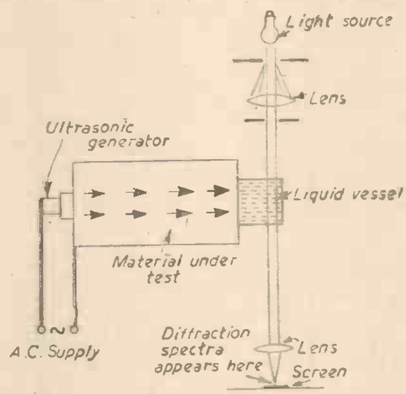


Fig. 1a.—Method of ultrasonic non-destructive testing.

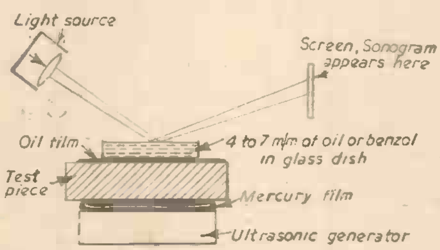


Fig. 1b.—Another method of ultrasonic non-destructive testing.

Prior to a consideration of possible commercial values, it is of great interest to record that the common bat, *vespertilio* of the order Chiroptera, in the animal kingdom, avoids obstacles in its substantially blind flying by generating ultrasonic waves with its mouth of a frequency upward of 50,000 cycles/second, and receiving the echoes of the said waves reflected from objects in and around its line of flight.

Phenomena Associated with Ultrasonics

1. Biological—destruction of bacteria and small forms of life.
2. Degassing of liquids.
3. Production of colloidal forms.
4. Coagulation of aerosols.
5. Detergency.
6. Communications and depth finding.
7. Non-destructive testing of materials and component parts.

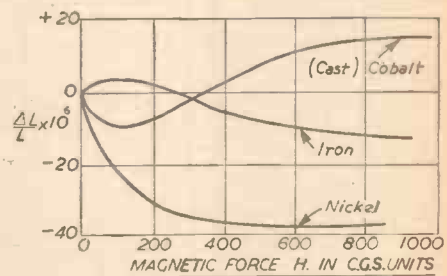


Fig. 2.—Joule effect in iron, cast cobalt and nickel.

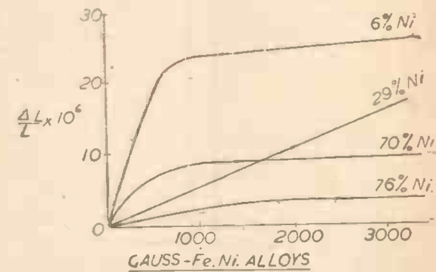


Fig. 3.—Joule effect in iron-nickel alloys.

1. The leading study of biological effects of ultrasonics has probably been undertaken by Dognon and Biancani.[1] It has been found that the high frequency waves are capable of killing bacteria, small fish and other small animals. The destruction is usually due to cavitation and the waves are able to disrupt completely cell membranes and micro-organisms.

2. Degassing of liquids—liquids subjected to the high frequency waves are degassed by the fact that the waves tend to cause the microscopic gas bubbles in the liquid to coalesce. Boyle, Taylor and Froman[2] investigated this and drew the conclusion that the gas bubbles are already there in a microscopic form and that coalescence is brought about by the radiation pressure of the waves.

3. The colloidal state is a state of subdivision of matter in which the particle size varies from that of true "molecular" solutions to that of coarse suspensions, the diameter of the particles lying between 10^{-7} and 10^{-5} cm. Ultrasonics may be employed to transform immiscible liquids such as water and oil into an emulsion which exhibits true colloidal characteristics. A tube containing the liquids is often placed at the focus of a parabolic reflector under water and the high frequency waves are so generated under the water as to reflect from the said reflector and agitate the liquids in the tube. The emulsion so formed may then be examined for colloidal state by seeing if it exhibits the Tyndall effect*. Rschevkin and Ostrowsky have produced fine emulsions of mercury, sulphur, tin, bismuth, lead, copper and silver in water. It is generally agreed that the dispersion is caused by cavitation.

4. Aerosols are colloidal systems, such as a mist or fog, in which the dispersion medium is a gas. No cavitation occurs when the aerosol is subjected to the high frequency

* Cone of light directed into suspension—cone becomes visible.

waves, but the particles tend to coagulate. This phenomena has been used to clear the air of tobacco smoke, etc.

5. Detergency—the dust and dirt in clothes and on surfaces may be removed, to some extent, by ultrasonics, but the power of the waves has to be of an appreciable order. An ultrasonic washing machine for linen has been suggested, and certain laundries have considered the advantages of such a

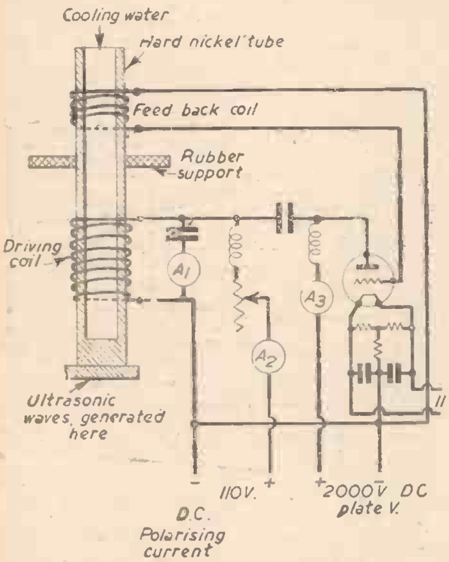


Fig. 4.—A tubular type of magnetostriction generator.

method. No practical equipment for such work is known to the writer, but from a recent article[3] it would appear that the Mullard Laboratories have made experiments in this direction.

6. Ultrasonic waves may be concentrated into a beam of small cross-sectional area, and this facilitates their use in surface communications.

In the homogeneous medium of salt water great use of submerged ultrasonic generators has resulted in the location of icebergs[4]; signalling through the water from ship to ship, and the calculation of the depth of the ocean bed from the surface. In many of these applications the echo principle is employed and the time lapse between transmission and reception is carefully measured.

7. Non-destructive testing is of interest to all engineers in its unique approach to a very difficult problem. Two methods of non-destructive testing are fairly well established. I refer to magnetic crack detection[5] with such apparatus as the "Magnaflux" semi-portable crack detector, and the use of X-rays in the extensive science of Radiography[6]. In the latter case the process is analogous to the use of ultrasonics.

Flaw Detection by X-rays

Fig. 1 shows in diagrammatic form the basic principle of crack or flaw detection by X-rays, which are a form of radiant energy similar to visible light. Their distinguishing feature is their very short wavelength, 120A° to 0.06A°, and the feature is responsible for the ability of X-rays to penetrate materials which absorb or reflect ordinary light. It is a characteristic of ultrasonic waves that they have very short wavelengths and many materials, especially those possessing acoustic hardness offer excellent media for the transmission of the ultrasonic waves. Metals are excellent transmission agents. If the media is not homogeneous, that is to say, it has invisible hollows, cracks, flaws or great porosity, then the transmission of the waves is seriously disturbed from the transmission characteristic to be obtained in a flawless portion of that media.

Mühlhäuser[7] protected such a scheme in 1931 and the technique has been advanced by Sokotoff[8]. Two methods of ultrasonic non-destructive testing, due to Sokotoff, are shown diagrammatically in Figs. 1a and 1b.

The Generation of Ultrasonics

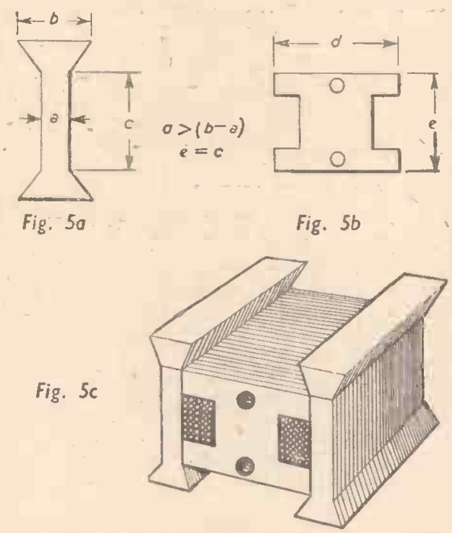
The generation of ultrasonic waves may be accomplished with a specially-designed whistle, or siren, but these pieces of apparatus have little practical application. From many attempts in the past to perfect an ultrasonic generator, two types have now been left in a position of unrivalled supremacy; they are:

1. The magnetostriction generator and
2. The piezoelectric crystal generator.

Both of these generators are electro-mechanical in operation and, for the reader to understand the niceties of their operation, the physical basis of the phenomena of magnetostriction and piezoelectricity will have to be explored. This exploration, however, has filled many excellent books, and any shortcomings in an article of this nature may be repaired by the bibliography attached.

The Phenomenon of Magnetostriction and the Magnetostriction Generator

Magnetostriction phenomena appear in two distinct forms, and they may be classified as follows:



Figs. 5a, b and c.—Showing the component parts of and built up and wound vibromotor.

Form 1. Alterations in the physical dimensions of a magnetic material incident upon the magnetisation of the said magnetic material.

Form 2. Alterations in the magnetic characteristics of a magnetic material incident upon the subjection of the said magnetic material to mechanical stress.

Both Form 1 and 2 are further subdivided scientifically into effects; the effects under Form 1 are classified according to the deformation produced, while the effects under Form 2 are classified according to the (reciprocal) magnetic changes. It has been shown in many works on this subject, [10], [12] that the primary source of magnetic moment in ferromagnetic material is the spin of the electrons in certain unfilled shells of the atoms of these materials, and that the spins may be aligned into domains, called Weiss domains. A sample in the demagnetised state is thought to be everywhere self-saturated, the directions of the magnetisation vectors being directed at random. Upon magnetisation, however, the alignment of the magnetisation vectors occurs. In this way a change in dimensions may be associated with alteration of the magnetisation vectors of the individual domains. If the material elongates in the direction of the applied magnetic field it is termed positive magnetostriction, and negative magnetostriction if a reduction in size is recorded.

The magnetostriction effects under Form 1 and Form 2 are given in tabular form below, so that the reciprocity may be appreciated.

Form 1.	Form 2.
Longitudinal Joule effect.	Longitudinal Villari effect.
Transverse Joule effect.	Transverse Villari effect.
Barrett effect.	Nagaoka-Honda effect.
Guillemin effect.	Reciprocal Guillemin effect.
Wiedemann effect.	Reciprocal Wiedemann effect.

The Joule effects, of the order of 10^{-6} in./in., are changes in the *linear dimensions* of a ferromagnetic† when a magnetic field is applied along a specified direction, while the Barrett effect, observed with difficulty, considers the volumetric magnetostriction, its order being 10^{-7} cubic in. per cubic in. The Guillemin effect treats the *bending* which a ferromagnetic exhibits when exposed to a magnetic field and finally the Wiedemann effect, treats of the twisting of a ferromagnetic under the combined action of circular and longitudinal fields.

The Villari effects refer to changes in magnetic induction due to longitudinal and transverse mechanical stress, and the Nagaoka-Honda effect the change in magnetisation resulting from a change in volume.

The reciprocal Guilleman and Wiedemann effects will need no explanation.

The Joule Effect

From the viewpoint of the magnetostriction oscillator or generator of ultrasonic waves, the most important effect, from this profusion of effects, is the Joule effect, and a graphical representation of this is shown for iron, cast cobalt and nickel in Fig. 2 and for iron-nickel alloys in Fig. 3. Naturally, impurities in these materials and varying grades cause the characteristics to vary considerably. It will be noted that nickel shows the largest effect and it is very popular in many modern generators. Magnetostriction oscillators or generators were first studied by Pierce[13] and they comprised thin rods within a solenoid excited by a small alternating current superimposed over a steady magnetising current, the rod being set into longitudinal resonant vibration. To overcome undesirable stresses at the centre of such rods, the modern

† The Joule effect has also been noted in non-ferromagnetics by Kapitza, Roy. Soc, Proc. A.135, 556, 1932.

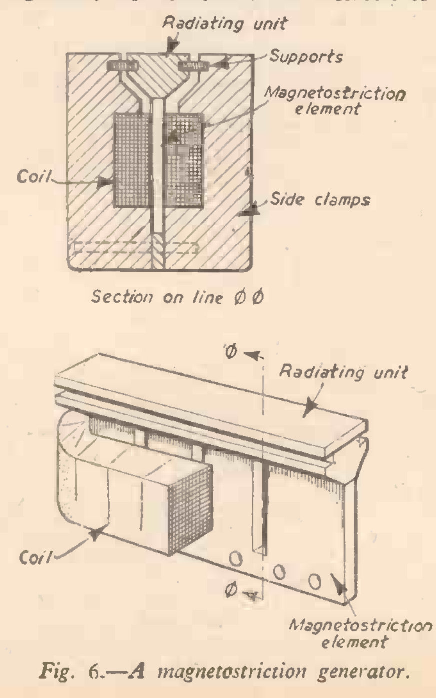


Fig. 6.—A magnetostriction generator.

oscillator is usually circular with toroidal windings.

Fig. 4 shows a tubular type of generator using the Joule effect as perfected by Schumb, Peters and Milligan[14] to study the cavitation erosion of ship's propellers. The nickel tube was mounted vertically and longitudinal vibrations of 9,000 cycles/second were produced. The tube was hard drawn nickel of 12in length, ⅝in. O.D. and 0.028in. wall thickness. A not dissimilar type of vibrator

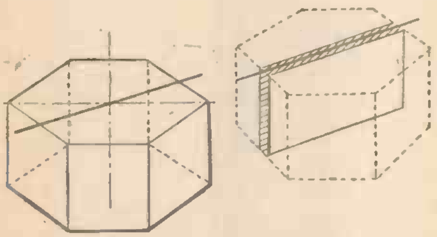
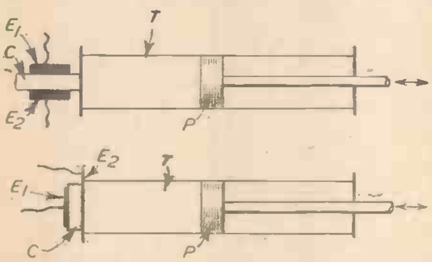


Fig. 7.—Slice of quartz cut from a crystal.



Figs. 8a and 8b.—Two simple ultrasonic generators using quartz crystals.

has been disclosed in British Patent No. 283,116.

Two modern magnetostriction generators are typified by the generators disclosed in British Patents Nos. 610,221 and 621,125. The former, due to Société de Condensation et d'Applications Mecaniques, is shown at Fig. 5a, b, c. Fig. 5a, is an elementary magnetostrictive plate; the body of length "c," vibrating lengthwise, is the key part of the vibromotor. The trapezoidal heads permit the required frequency to be achieved with a short plate. Fig. 5b shows an elementary magnetic plate, the dimension "d" being greater than (b−a); also dimension "e" = "c." Fig. 5c shows how the vibromotor may be built up and wound. The latter, due to the well-known Submarine Signal Co., will be readily understood from the drawing and its appended references at Fig. 6.

The Piezoelectric Effect and the Piezoelectric Crystal Generator

Properly ground plates or bars of quartz and certain other crystalline materials, such as Rochelle salts, show a mechanical strain when subjected to an electric charge. Conversely, mechanical stress may be set up in the crystal when a potential difference is applied across appropriate faces of the crystal. This last mentioned effect is the one with which we are primarily concerned in the ultrasonic generator art. The pioneer investigators of the piezoelectric effect were the brothers Pierre and Jacques Curie (1880). Lord Kelvin enunciated the thermo-dynamic principles of the phenomena and intensive studies were undertaken by Woldemar Voight in 1894.

In 1910 Voight published his famous "Lehrbuch der Kristallphysik," which enumerated the 32 crystal classes in which piezoelectric effects may exist. The First World War accelerated practical applications of the phenomena and Langevin in France succeeded in utilising vibrating quartz plates as sound emitters for sub-oceanic work.

The theory of piezoelectricity is most clearly and thoroughly presented in Cady's classic work[15] on the subject and the more serious reader is referred thereto for authoritative information. It can be generally shown, however, that if a slice of quartz is cut from a crystal as indicated in Fig. 7 and pressure applied to the opposite faces of the slice, electrical charges will be produced. Lippmann showed that this had a reciprocal effect in that electrical charges could be so applied as to cause the crystal to develop elastic deformations. If the electric charges are produced by an alternating current, the quartz may be subjected to vibrations at a frequency in harmony with the frequency of the applied electric field. In this way the vibrating quartz may be used to generate vibrations in other associated media.

It has been shown by Wood[16] that the density of quartz is 2.654 gm./c.c. and Young's modulus is 8×10^{11} dyne/sq. cm. The velocity of compression waves in the quartz is

$$\frac{\sqrt{8\times10^{11}}}{2.654}=5.5\times10^{5}\text{ cms./sec.}$$

Thus $\lambda=\frac{5.5\times10^{5}}{f}$ where

λ is the wavelength in cms. and

f is the frequency in cycles/sec.

If both faces are free to move, the fundamental mode of vibration will have a nodal plane in the slice centre, and the slice thickness will be $\frac{\lambda}{2}$.

The frequency f‡ for a slice thickness of "t" vibrating in its fundamental mode will be

$$f=\frac{5.5\times10^{5}}{2t}=\frac{275\times10^{3}}{t}\text{ cycles/sec.}$$

Cady[15] shows two simple ultrasonic genera-

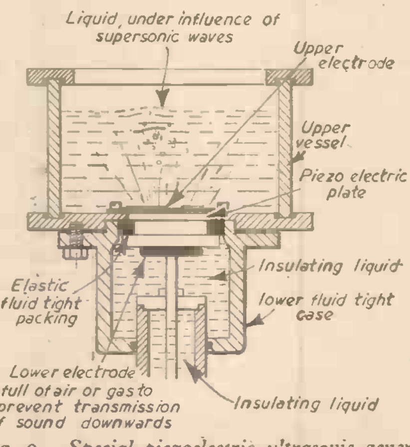


Fig. 9.—Special piezoelectric ultrasonic generator. General constructional details only.

tors using simple quartz crystals and they are reproduced in Figs. 8a and 8b.

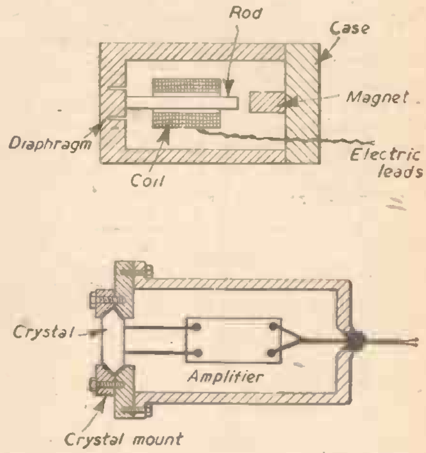
Fig. 8a comprises a crystal bar "c" for lengthwise vibration, the electrodes E_1,E_2 being of tin-foil. The crystal is in abutment with the tube T and the piston P, which is slideable in the tube, reflects the radiations.

Fig. 8b comprises a very similar arrangement for higher frequencies, the crystal being made to vibrate across its thickness.

Typical modern crystal ultrasonic generators are disclosed in British Patent No. 619,679, due to the Submarine Signal Co., and also in British Patent No. 619,872, due to Société de Condensation et d'Applications Mecaniques; the last mentioned generator is shown schematically in Fig. 9. It is specifically designed to cut down losses, one electrode being in contact with the liquid to be treated, or if this should be a conductor of electricity the liquid *per se* may act as one electrode, the other electrode being contained in a receptacle filled with insulating fluid.

A comparison of the driving force in dynes for magnetostriction and quartz crystal subaqueous loudspeakers has been given by Olson[17], the schematic arrangement of the loudspeakers or vibrators is shown at Figs. 10a and 10b.

The driving force in dynes generated in the



Figs. 10a and 10b.—A magnetostrictive and a piezoelectric subaqueous vibrator.

rod of the magnetostriction device (Fig. 10a) is given by the relationship

$$F=\frac{4\pi NIk}{r}\sin\omega t$$

In the piezoelectric quartz device (Fig. 10b) the relationship is

$$F=\frac{YA\epsilon K}{l}$$

where F = driving force in dynes.
- N = number turns in coil.
- I = abamperes.
- k = constant—Joule magnetostriction effect.
- r = reluctance.
- $\omega=2\pi f$.
- f = frequency in cycles/sec.
- t = time in seconds.
- Y = Young's modulus in dynes/sq.cm.
- A = area of crystal (cross section).
- ϵ = applied voltage in statvolts.
- l = effective length of crystal in cms.
- K = crystal constant 6.4×10^{-8} quartz.

Conclusion

In conclusion, as an index of the increasing interest of ultrasonics to industrial applications, attention is directed to some of the more recent patent specifications filed.

Patent No. 527,562. Reimar Pohlman. Massage apparatus for effecting massage by vibration at supersonic frequency.

Patent No. 602,095. E. G. Budd Manufacturing Co. A method of welding, including indicating the condition of the weld by mechanical oscillatory energy.

Patent Nos. 615,578 and 615,579. Testing of solids for fissures and other defects by supersonic waves.

Also Patent No. 615,684. Electro-acoustic transducers, Sperry Products, Inc.

‡ For refinements of this calculation see Proc. Inst. and Radio Eng., Vol. 14, p. 447.

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2. Boyle, etc. Cavitation in the track of an ultrasonic beam. Trans. Roy. Soc. Canada (iii) 23, 187, 1929.
3. Ultrasonics. R. R. Whymark. Electrical Review. 15th April, 1949.
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5. Magnetic Crack Detection. C. B. Young. 1942.
6. Radiography in Modern Industry. Eastman Kodak Co., Rochester 4, N.Y.
7. Mühlhäuser. German Patent 569,598 (1931).
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9. G. E. Review. D. Williams. March, 1942, page 161.
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14. Metals and Alloys, 8, 126, 1937.
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17. Olson, H. F. Dynamical Analogies. 1943. Elements of Acoustical Engineering. 1947.

The Mosquito Auxiliary Engine

A Practical Engine for Cyclists

IN our August, 1950, issue we gave a comprehensive article dealing with the latest motor-assisted bicycles. Since the article was published, other auxiliary engines have appeared on the market, among these being the Mosquito, which we have had under test. This 38 c.c. engine is made by Mosquito Motors, Ltd., Moorfields, Liverpool, 2, and can be fitted to any type of bicycle, normal, light or heavy without any modification. It can be attached in a few minutes by only two bolts which fix it to the stiffest part of the frame.

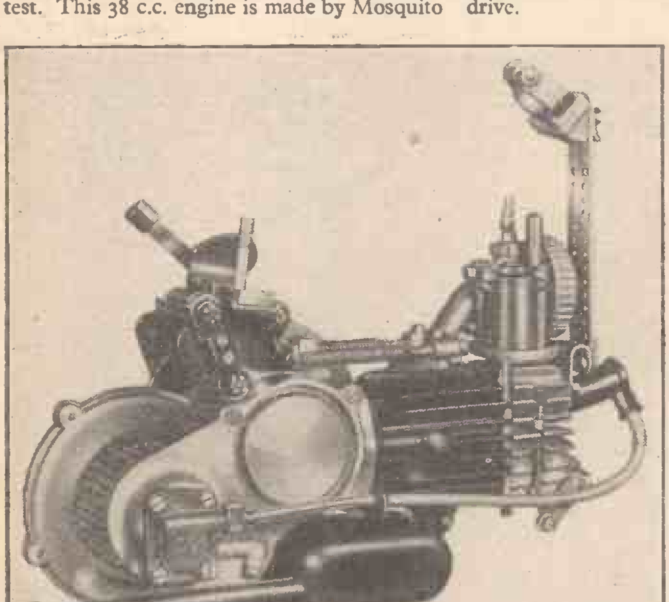


Fig. 1.—The Mosquito auxiliary engine for cycles—showing the large diameter ribbed driving roller. Drive pressure is ensured automatically by two springs.

It is a two-stroke engine having counter-current scavenging and a piston with a flat head. The mixture consists of 2½ to 3oz. of oil for each quart of petrol. The position of the engine increases the stability of the bicycle and the numerous cooling fins allow the Mosquito to work perfectly also in climbing and under highest temperature conditions. The ignition is thoroughly sheltered and the engine will work in the heaviest rain.

The Drive

The drive is by a large-diameter ribbed roller driven through reduction gears. The drive pressure is ensured automatically by two springs so that the engine follows exactly the contour of the tyre. The compact arrangement of the engine and the drive is shown clearly in Fig. 1.

The elastic swinging suspension, which can be seen above the drive, neutralises the vibrations and ensures that the roller adherence is kept constant. The width of the Mosquito has been reduced to a minimum, and no modification of the crank assembly of the bicycle is necessary.

It is so small that the chainguard covers it completely and only the silencer protrudes (see Fig. 2). By moving the lever, which is shown above the suspension in Fig. 1, the engine is disengaged from the tyre so that the bicycle is at all times thoroughly free. If it is desired to pedal with motor disengaged, the rider does not feel the least extra resistance.

An important thing to consider with friction-drive motors is tyre wear, but with the Mosquito it is practically equal to that of motorised bicycles with chain or gear drive.

The crankshaft, connecting-rods and driving roller are respectively mounted on roller, needle and ball bearings, and the automatic carburettor is provided with single-lever control with air filter, fuel pump and choking device.

Insurance

Regarding the driving licence, payment of a fee of 5s. enables one to obtain a provisional driving licence. Before a Road Fund Licence will be granted, a certificate of insurance must be obtained. This can be obtained from the Iron Trades Mutual Insurance Co., Ltd., Iron Trades House, 21-24, Grosvenor Place, London, S.W.1. The rates of premium, which will cover all riders and not be restrictive to any class of use, are:

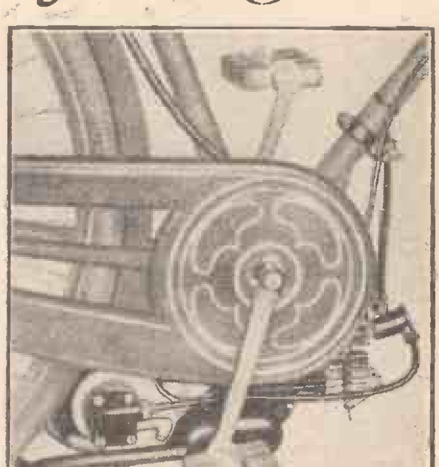


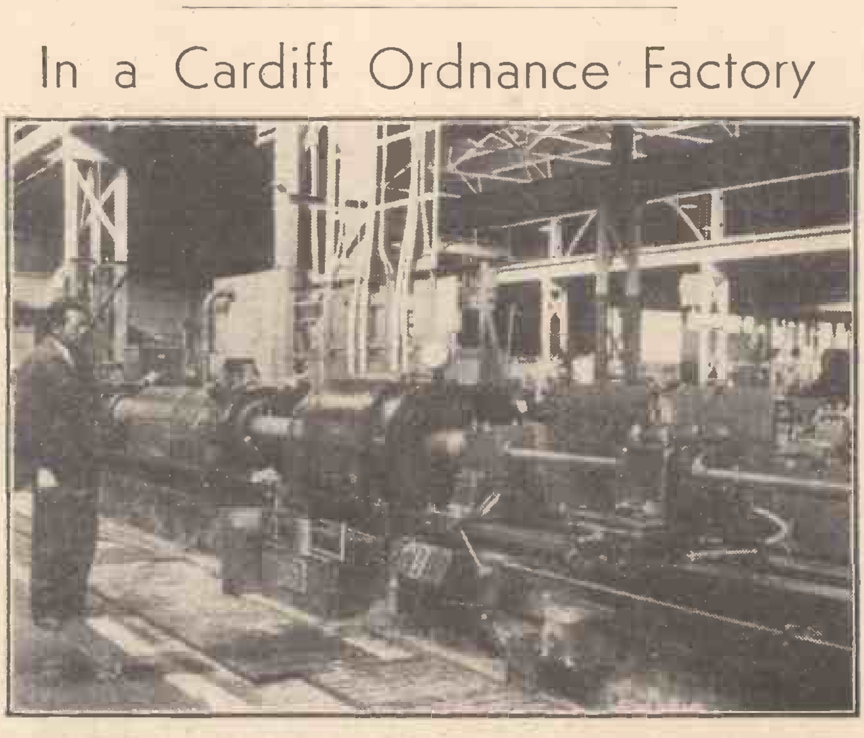
Fig. 2.—Some idea of the smallness of the Mosquito unit can be gained by comparing it with the size of the chainguard.

Comprehensive cover (subject to the insured bearing the first £1 of each and every claim)	£1 12s. 6d.
Third party, fire and theft ..	17s. 6d.
Third party only	11s. 9d.

Characteristics of the Mosquito Engine

Piston displacement	38 cc.
R.p.m.	4,200
Corresponding speed	20 m.p.h.
Minimum speed	4 m.p.h.
Gradient climbed without pedal assistance	5-6 per cent.
Fuel consumption	250 m.p.g.
Fuel tank enough for ..	125 miles (approx.)
Net weight of the engine ..	15lb. (approx.)

In a Cardiff Ordnance Factory



Boring the barrel of a 20-pounder tank gun at the Cardiff Royal Ordnance Factory. The time taken in the boring is now only one-third of the time required at the end of the war.

A Trip by Flying-boat

A Description of a Flight to Madeira

By MAURICE F. ALLWARD

SINCE last November, when B.O.A.C. replaced the last of their flying-boats with Hermes landplanes, it has been left to privately-owned Aquila Airways to run the sole remaining flying-boat service operating from this country. Once a week a flying-boat takes off from Southampton Water and commences the 1,300-mile flight to Madeira, lovely Portuguese island about 400 miles off the north-west coast of Africa. The return journey is made four days later, and while at the island a quick shuttle service is run to Lisbon.

Bearing in mind the controversy aroused over the elimination of flying-boats by our national air corporations, I was very pleased when business recently took me on a flying visit to Madeira, and enabled me to gain first-hand experience of travelling by this type of aircraft which seems so popular with passengers and unpopular among airlines.

Arriving at the Marine Airport, Southampton, at 8 a.m. we had cleared the emigration and customs formalities and were cruising down Southampton Water within an hour. For some time we taxied past the famous docks to which vessels of every nationality come from all over the world, particular interest being shown in the *Queen Elizabeth* which had berthed the previous day. The flight was to be the first one by flying-boat for most of the other passengers, who included British and American holiday-makers, businessmen and an elderly couple travelling under doctor's orders, and we were all looking forward to the trip.

The "Take-off."

For those who love the sea, the actual take-off in a flying-boat is a thrilling experience. We had been cruising along at half power, but as we turned into the straight the engines were opened full out and with a terrific surge of power we started on the take-off run. Aircraft accidents are rare these days, but when they do occur it is usually during landing or take-off. The disastrous consequences on a big landplane of engine failure at take-off are well known, but as we sped over the water it was comforting to know that only in the most restricted area is this an anxiety to the flying-boat pilot. Soon our speed was that of an express train, with spray flashing high past the windows until, quite suddenly, all became relatively quiet and we were airborne. The time was 9.10 a.m.

Our Hythe flying-boat, the Royal Mail Aircraft *Hampshire*, had looked deceptively small from the quayside, for she was actually a double-deck airliner, divided up into a number of spacious cabins, each seating up to six passengers, and complete with a promenade deck and bar, and a well-equipped galley. When going aboard I had asked for "a seat with a good view" and had been placed in the main cabin amidships. The adjacent window sloped outwards slightly, making it possible to look almost straight down and so obtain a wonderful "plan-orama" of the green fields of the Isle of Wight as we climbed steadily on our way. Unfastening our seat belts, and adjusting our arm-chairs to a lazy angle, we all settled back comfortably. A feature commented on by several of the passengers was the way our cabin was conveniently sheltered from the glare of the sun by the high-placed wing—an amenity denied to the passengers of most modern land-based airliners as these have low-placed wings.

By 10.10 a.m. we were crossing the Brest peninsula and heading out over the Bay of Biscay while coffee and biscuits were served. A note from the captain informed us that our ground speed was 170 m.p.h and that we were due to arrive at Funchal, the capital of Madeira, at 5.15 p.m. local time. Three hours then passed during which we cruised serenely above an almost unbroken ocean of white clouds, before Cape Finisterre, on the tip of Spain, was sighted. The time was 12.50 p.m. or rather 11.50 a.m. Madeira time, as we lost an hour on the way out. We had covered 585 miles of our journey. For an hour fortunate gaps in the clouds afforded us views of the olive hills of Spain moving slowly beneath us like pictures on a vast cinema screen. A surprising feature was the absence of any transport on the road or life in the fields. A pleasant hour was then spent eating an excellent lunch, the variety, number and size of the courses of which almost proved too much for me. Soft

Map showing the Madeira route operated by Aquila Airways, Southampton.

(Above) Aquila's Hythe "Hampshire" moored in Funchal harbour, Madeira.

(Left) There is no sheltered bay, and the flying-boats use the open sea at Funchal.

drinks were also "on the house," and those who preferred something stronger ordered their choice from the bar.

Over the Atlantic

As the *Hampshire* left the Spanish coastline and headed out over the vast expanse of the Atlantic, the knowledge that below us an "emergency" landing-ground stretched all the way to our destination induced a feeling of security. After all, it seems logical to use flying-boats on long over-water routes, for their ability to land in any but the stormiest seas is obviously a safety feature in the event of an emergency and their greatest advantage over landplanes. They have done so not once but many times. Most recent example of such adventures, which with landplanes would have been disasters, was the forced landing through fuel shortage of the *Bermuda Sky Queen* in the Atlantic in 1948, in waves six to eight feet high, without any harm to the flying-boat, passengers and crew.

At 5 p.m. another mesage from the captain informed us that the Porto Santo islands were sliding by the port windows, and soon afterwards Madeira itself came into view, a mountainous mass towering above the *Hampshire*, but a welcome sight after hours of limitless sea.

No wonder that flying-boats are the only aircraft capable of operating to the island as it was obviously impossible for an aerodrome to be built at reasonable cost. This also explains how Aquila are able to operate their Madeira-Lisbon shuttle service before returning to the United Kingdom, for as far as Portugal is concerned it is cabotage traffic—a foreign company running a domestic air line. Happily, the Portuguese authorities took the lenient view that as they could not operate landplanes to the island, and since they had no flying-boats themselves, they were quite prepared to let an outside company provide the air service, with consequent benefit to all concerned. The 500-mile trip takes four hours as against about 36 hours by steamer.

Touching Down at Funchal

For some minutes we flew parallel to the coastline, watching the villages passing by, little patterns of white and peach-coloured houses with bright red roofs, until Funchal came into view.

There is no sheltered bay for landing at Funchal, and Aquila's service to Madeira provides an interesting study of open sea operations with flying-boats, proving that regular flights to unsheltered alighting areas are possible in certain cases, although, as might be expected, bad weather has sometimes interrupted the service. But most of the hold-ups have been caused by bad weather at the Southampton end.

Preparing for the run-in, we flew close to the face of the cliff in order to get in the triangle of calm air formed as the wind blew upwards over the top. Then there was a view of the water coming up to meet us, slowly at first and then seemingly to race past the wing tip floats at fantastic speed until with a gentle swish our keel touched and we were down. The time was 5.15 p.m. as predicted by the navigator over nine hours earlier.

The *Hampshire* was then taxied towards the protection of the small harbour breakwater. Flying-boats, of course, do not need brakes like landplanes, as the drag of the water is more than sufficient to slow them up quickly as the engines are throttled back. Drag drogues are carried, however, and as we neared the mooring buoy one was released over the starboard side to provide a gentle turning action, swinging the bow round and enabling the buoy to be picked up.

This simple buoy constituted Aquila's "terminal base" at Madeira. One could not help contrasting it with some of the elaborately equipped B.O.A.C. bases along their old South African route, the overheads of which were largely responsible for the Corporations' decison to withdraw its flying-boats. Aquila's arrangements at Funchal would not, of course, be suitable for a high-frequency service, but for the tourists who form most of their passengers it is ideal. All the "glamour" of a foreign port is evident from the moment the aircraft taxies into the small harbour. All too efficiently the gaily painted local harbour launch *Angiolina* came alongside to take us ashore and a memorable flight was over.

Radio Control of Mechanisms

Simple Position-control Systems Briefly Explained

By DENIS HART

THE easy way to acquire an understanding of an unfamiliar technical art is to specify first what its aims are, and then examine the possible ways of achieving them, side by side with methods and techniques already familiar and well understood. This, briefly, is what the writer has done in the following notes on the radio control of mechanisms.

The aims can be defined as the remote control, by means of an intermediate radio link, of the position of selected components of a distant piece of mechanism; or, if we include telemetering, the remote indication, by similar methods, of such information as temperatures, velocities, pressures, etc.

To be practical, let us add at once that radio position-control includes such applications as the flying under radio control of a full-size Service aircraft, as was successfully carried out many years ago with the R.A.F. *Queen Bee*. The "selected components" of the *Queen Bee*, for instance, were all the essential flying controls. There are many simpler examples, and at random one could quote the remote operation of a camera shutter for nature photography and the steering of a model yacht—both of which have been done.

Amongst practical examples of radio telemetering there is the daily release of meteorological balloons, which, as they ascend through the atmosphere, send back through a small transmitter suspended underneath readings of barometric pressure, temperature and humidity. The signals from the balloon are recorded at special ground stations and, after the necessary interpretation, are used in the preparation of weather forecasts.

Position-control Systems

For the time being, however, we will consider position-control systems only, and compare them with the most familiar radio-communication systems of all—sound and television broadcasting. When the announcer reads ou the nws, sound waves from his voice cause the ribbon or diaphragm of the microphone to vibrate, and this mechanical movement produces corresponding EMFs, which are amplified and applied as modulation to the carrier wave of the transmitter. At the receiving end a minute fraction of the power radiated by the transmitter is picked up, amplified, demodulated, amplified again, and then applied to the speech coil of the loudspeaker. The diaphragm or cone

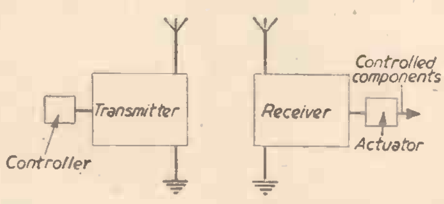


Fig. 1.—Elements of the radio position-control system.

of the loudspeaker is thus caused to vibrate in such a way that it produces sound waves which are a passable imitation of those originating in the studio, and it is obvious that the movements of the loudspeaker cone are a more or less exact copy of those of the microphone diaphragm.

In a television system the movements of the spot on the screen of the picture tube are an even more faithful imitation of the complex antics of the scanning spot in the studio camera tube. In both these systems we have already virtually attained our object.

Obviously, there are many desirable modifications, and we have exaggerated a little in inferring that the spot on a television CRT can be considered as a mechanical "component"; but all the essential elements of a position-control system are there. In their simplest form they are as set out in Fig. 1.

Starting from the left, it will be seen that the microphone has been replaced by the controller, which, we will assume, can react on the carrier of the transmitter without the aid of a separate modulator—in the most elementary case it will merely switch it on or off.

Function of the Actuator

At the receiving end the loudspeaker has been replaced by an actuator, about which we will have more to say later on in this article. Its function, in our elementary system, is to react to the signal delivered by the receiver and change the position of the controlled element. Perhaps this needs a little more explanation; again taking the simplest possible case the actuator might consist of an electromagnet solenoid, the armature of which is pulled into the coil when current passes in the output stage of the receiver, and, for example, switches the propulsive system of a model boat. For the sake of completeness—and our elementary system is now quite complete—it ought to be added that the power output available from most practical receivers is so limited that a sensitive relay is incorporated between the output stage of the receiver and the actuator itself in order to step up the power level sufficiently for the latter.

Let us now revert for a moment to modulation methods. It was mentioned above that we would assume for the sake of simplicity that the controller merely switched the carrier on or off. In many practical cases, particularly with models, this actually happens, so that the controller and modulator are one and the same .

But suppose we want two or three, or even more, actuators simultaneously under control. In such cases we must turn to more advanced methods of modulation, and a typical system is outlined in Fig. 2.

Here we have in effect two modulators, each of which can impose on the carrier its own tone whenever required to do so by its controller. At the receiving end the detector output is fed to two tuned filters, one resonating to the frequency of the first modulator and the other to that of the second modulator. The receiver is thus able to discriminate between signals originating in the two modulators, and delivers separate operating currents to the corresponding actuators.

"Multiplexing"

This is an example of what telecommunications engineers call "multiplexing," meaning the provision of a number of communications channels via one basic link. Although we have described a simple method using separate tones, there are, of course, others, such as pulse-time multiplex. Also, the reader will have justifiably assumed that amplitude modulation was intended to be tacitly understood, but other methods are perfectly feasible, and in the writer's experience phase, amplitude and pulse-width methods have all been used.

We now know how to control the position of one or more simple actuators simultaneously, but on closer inspection it must be admitted that the scope of control of which our system is capable is extremely limited. Like the clutch on a cheap car, it is a two-position device and is either "in" or "out." This is perfectly adequate for some applications and where extreme simplicity is called for, as in model aircraft work, in which it is sometimes used, and it will enable such a model to be steered straight ahead or, say, sharp right at will. In model aeroplane jargon it is often known as a "bang-bang" system, for reasons obvious to anyone who has ever watched it work.

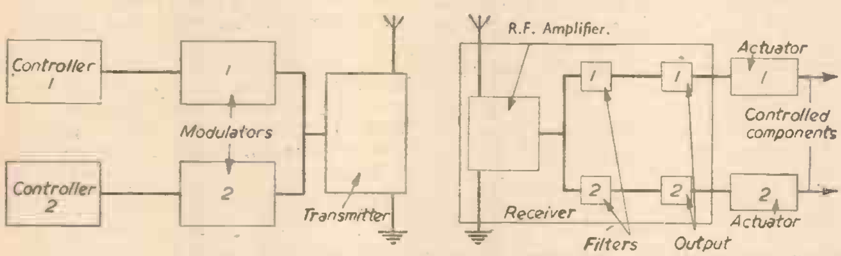


Fig. 2.—Outline of the two-channel control system.

"Proportional Control"

The next step, then, is to obtain a finer degree of control over the movements of the actuator, and if in fact we carry our requirements to their logical conclusion we would like to make it take up and hold any extreme or intermediate position corresponding exactly to settings made to the controller. With more complex equipment this can be, and is, carried out, and such arrangements are known as "proportional control" or, occasionally, "infinitely variable" systems. In their most advanced form they comprise true position-control servo-mechanisms, usually working upon the principle of the "self-balancing bridge."

A satisfactory compromise between the exacting performance requirements and the usual calls for simplicity, reliability and lightness can be achieved by replacing the two actuators of Fig. 2 by relays arranged to switch a steering motor to the required direction. In this case a signal through channel 1 will turn the control to one side, and a signal through channel 2 will turn it to the other. In the absence of signals in both channels the control remains stationary, so that any intermediate position may be held by switching off both controllers when the required degree of movement has been obtained.

For Model Power Boats

This system finds favour in model power boat practice, in which it is used to control the rudder, and where a relatively slow movement of the control is less important than accurate position setting. It appears most convincing to the onlooker but does not "handle" as realistically to the operator as systems using a true position-control servo-mechanism. It has also been used professionally in model aircraft designed for research work.

If we can be satisfied, however, with a mere two- or three-fold increase in the number of positions our elementary system provides it is possible to obtain results quite acceptable, for model work at least, by a certain amount of re-design to our simple "bang-bang" actuator.

In Fig. 3 our actuator solenoid S attracts a small armature A attached to the rocker R, which is pivoted as shown and carries at its extremities two pawls P1 and P2. In the absence of signals this rocker is kept firmly against its backstop by means of a suitable spring. W is a star-wheel pivoted at its centre and subjected to a constant torque applied in the direction of the arrow. In the absence of signal, and therefore of energising current, the pawl P1 prevents its rotation, but as soon as the solenoid is energised pawl P1 is moved downwards away from the bottom limb of W and W is driven round 45° by the applied torque. Its further travel is prevented by P2, which has meanwhile engaged the next limb, but as soon as the solenoid is de-energised a further 45° rotation takes place. Thus, for every complete pulse of current W rotates through 90°.

Let us now imagine that E is a pin mounted eccentrically on W and engaging in a slot in the tiller bar T. In the position shown in Fig. 3 the rudder is hard to the left, and after the passage of the next pulse of current will clearly return to neutral as the pin E moves from position 2 to 3. In fact, we may deduce that over the complete cycle of events, when E moves under the influence of four consecutive pulses of current around positions 1 to 4 inclusive, the rudder

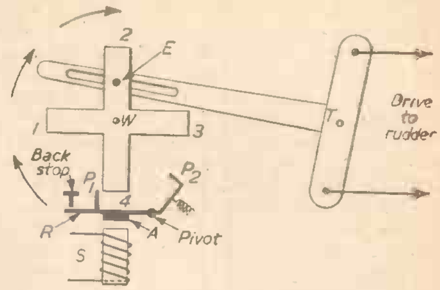


Fig. 3.—Sequence-type three-position actuator.

will move from neutral to left, then back to neutral, to right, and finally to neutral again. We can thus make the rudder take up any one of three positions, and obviously the system may be developed to include any desired number of positions.

Notice, however, that only one channel of communication is required, since we are controlling one actuator and using one controller only. We have succeeded in making one actuator perform three different operations in a known sequence, but, of course, it is up to the operator at the controlling end to remember which response was obtained to his last command and to deduce from this and his memory of the sequences which response will be forthcoming next—apparently he is unable to make, for instance, two right turns in succession. With practice, however, it becomes quite easy to flick through the two or three unwanted positions of the sequence with an actuator of the type described so that the required movement appears to be direct.

Operating Torque

A further important design point is also brought out in Fig. 3. We have stated in our description that a constant torque is applied to the star-wheel, the function of the rocker and pawls being to control its motion, not to produce it. The operating power of the system thus depends only on the applied torque, and we need only just sufficient power from the receiver and relay to operate the rocker arm. This is a highly desirable state of affairs in the case of light models, where the system is most often used and where the receiver output power is of the order of a few milliwatts. It enables the energy needed to operate the system to be stored in a lighter and more effective form than is possible with electricity; batteries of all sorts are notoriously heavy for the amount of energy stored, and no electric motor is yet known which can deliver a steady torque without continuously consuming current. In practice the torque is usually provided by a specially-designed clockwork mechanism, or, more simply, by a twisted skein of the familiar model aircraft driving rubber. An obvious disadvantage of this method is that it can provide only a limited number of movements for one winding of the driving mechanism, but the system is widely used in model practice and has attained a great degree of popularity. It is the system which is most likely to be found in commercially-made model control equipment, which perhaps speaks for itself.

Modern Plas

The Manufacture of Plaster of Pari

THE mineral gypsum is one of the world's common commodities. Almost every country has its own natural resources of this nowadays indispensable material. Available figures over the last quarter century show that the world's annual output of gypsum products has centred around ten million tons, the average British production for home consumption averaging about one million tons per year.

Clearly, therefore, gypsum is an important substance. It is a very interesting material, also, viewed from a scientific aspect, and its technical and everyday applications are almost without number.

It must have been in very ancient times when someone made the chance discovery of the fact that this white mineral earth, after it had been powdered and heated, could combine with water and set to a solid mass. Yet such a discovery forms the basis of all our present-day common plasters, and just because the large natural deposits of this mineral at Montmartre, near Paris, were employed locally for the extensive manufacture of a hydraulic or water-setting plaster the prepared material somehow or other obtained for itself the name of *plaster of Paris*, although, apart from this chance association, the material has nothing whatever to do with the French capital.

Gypsum is nothing more nor less than calcium sulphate, $CaSO_4$. Its name is a Greek one, meaning chalk, although in actual fact it has nothing in common with chalk, which is calcium carbonate, apart from its superficial white appearance.

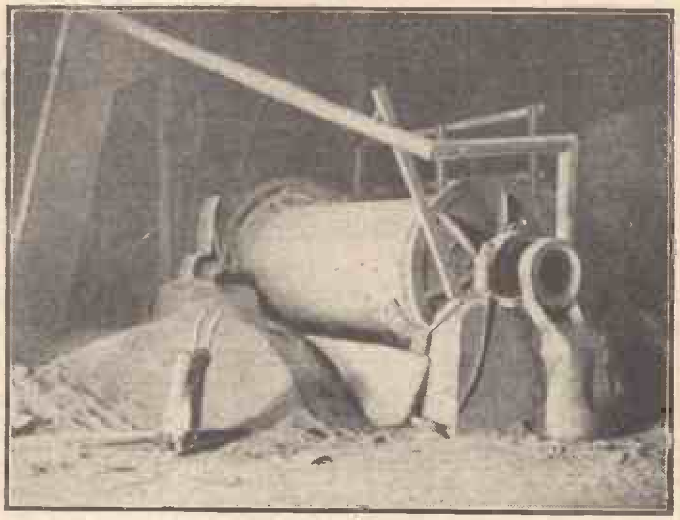
Raw Gypsum

Native gypsum occurs in a loose combination with water. Its chemical formula is $CaSO_4 2H_2O$. Even in this "raw" state gypsum has a number of important uses. Under the guise of *terra alba* (white earth) or "mineral white," it functions as an important filler for paper and cotton fabrics, as an "extender" for distempers and paints, as a dusting powder for scattering in mines in order to keep down explosion risks, as an inert medium or diluent for the modern highly-potent insecticidal powders of the "Gammexane" type, as an ingredient of Portland cement in order to retard its setting-time, and even as a means of improving (or "Burtonising," as it is called) the water used for the brewing of ales.

When the gypsum is found in clean, nicely coloured, fine-grained masses it is called *alabaster* (the name is said to be derived from Alabastron, a town of ancient Egypt where there were quarries of this material), a mineral which is used mainly for ornamental purposes. There is, also, a crystalline variety of gypsum which is almost transparent and which is called *selenite*, from the Greek *selene* (the moon), in reference to its soft, pearly lustre.

It is, however, after the common native gypsum has been converted into plaster, or "plaster of Paris," to give the prepared material its more conventional name, that it attains its most important uses.

Plaster of Paris is very simply manufactured. The native gypsum is screened from all other earthy matters. It is roughly crushed, dried to remove obvious moisture, and then ground to a fine, impalpable powder either between stones (the old-fashioned method) or in a revolving cylinder known as a "tube mill," in which hard steel balls pound the white material to an extremely small particle size.

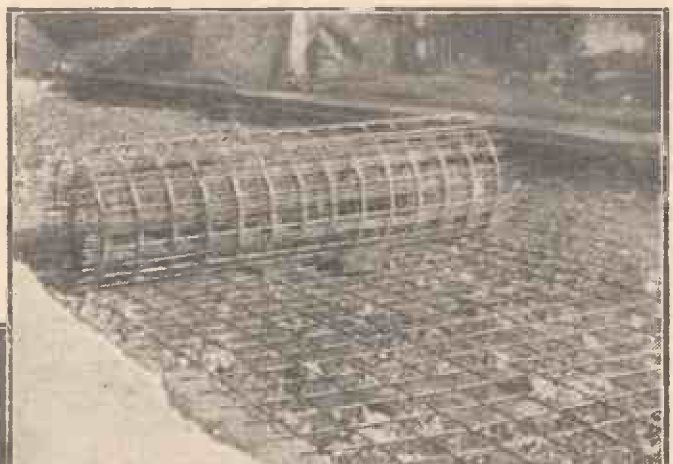


A slow-speed revolving steel cylinder or "tube mill" used for the fine grinding of industrial materials such as limestone and gypsum.

Next comes the "boiling" of the powdered gypsum. This is a curious term to use for the treatment of a powder, but the powdered gypsum is charged into iron containers called "kettles," in which it is carefully heated and in which the escape of the chemically combined water gives the gypsum powder the appearance of a boiling liquid.

This boiling must be very carefully done, to which end the material is agitated during the whole of the process. The temperature must be kept around 130 deg. C. If it is allowed to rise considerably above this mark the whole of the water contained in the gypsum is driven off and the material is said to be burnt. As such it consists of anhydrous calcium sulphate, $CaSO_4$, and it becomes useless for ordinary plaster purposes since it will only recombine with water very slowly and with the greatest reluctance, requiring days or even weeks for its setting.

It is important, also, to see that only very high-grade raw gypsum is used for plaster manufacture, for if the crude material is contaminated with other substances, such as chalk or china clay, which do not take part in the controlled dehydration, these inert materials will remain in the finished plaster and will thus dilute it, taking away from it serviceability and strength.



(Above) Stout wire netting gives additional strength to a concrete road. (Left) Painting a plaster statue with a solution of wax in benzene to impart a surface-lustre to the cast.

How Plaster Sets

The precise chemical and physical mechanism underlying the setting of plaster of Paris is not difficult to understand. Let us consider it in this manner:

We have already seen that the composition of native gypsum (calcium sulphate) is represented by the formula $CaSO_4 2H_2O$. In this formula the "H_2O" represents the water content of the material, and the expression "$2H_2O$" signifies that in native gypsum each molecule of calcium sulphate, $CaSO_4$, is combined naturally with two molecules of water. Hence we obtain the formula, $CaSO_4 2H_2O$. Chemically speaking, this is the *dihydrate* of calcium sulphate since it contains two molecules or units of combined water.

er Production

its Uses

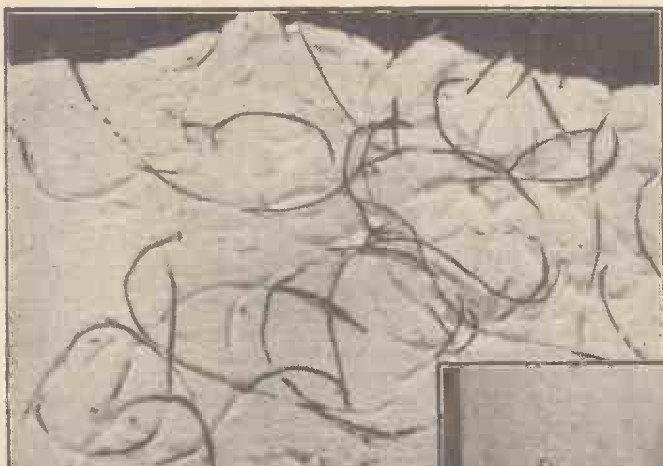
By J. F. STIRLING

Gesso, a simply-made plaster material which is produced by slaking plaster or whiting with glue water.

Now, when this dihydrate (which is natural gypsum) is heated to a temperature around 130 deg. C., a portion of its combined water is driven off, and thus it is converted into what is known as the "hemihydrate," having the formula $CaSO_4H_2O$. This hemihydrate is the white powder which we know as plaster of Paris.

The actual "transition temperature" at which the dihydrate changes into the hemihydrate of 108 deg. C., that is just over the boiling-point of water, but, in practice, to make sure of the action being complete, the plaster of Paris is manufactured at about 130 deg. C.

You see now why this matter of temperature is so important in plaster manufacture, because if 130 deg. C. is substantially exceeded the remaining water in the hemihydrate (plaster of Paris) begins to be driven off, so that ultimately (and very definitely at temperatures above 200 deg. C.) there is produced the completely dehydrated calcium sulphate, consisting of $CaSO_4$ and nothing more.



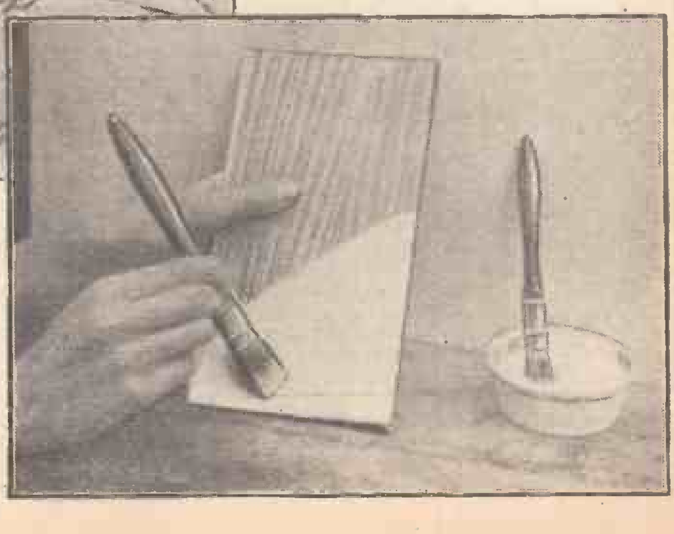
Anhydrite

The completely dehydrated material is known as "anhydrite." Although it is useless for plaster purposes, it is becoming a substance of increasing industrial importance, for which purpose it is sometimes manufactured synthetically. It can also be obtained from natural sources. Its industrial importance results from the facts that sulphur for the manufacture of sulphuric acid can be obtained from it, and that by treatment with nitrogen it can be turned into "nitro-chalk," a valuable fertiliser, and also into ammonium sulphate, another fertiliser, by reaction with synthetic ammonia made from the nitrogen of the atmosphere.

We must, however, resist the temptation to explore these interesting chemical by-ways and return to our main theme of plaster of Paris and its setting mechanism.

When the calcium sulphate hemihydrate, $CaSO_4H_2O$ is treated with an appropriate amount of water, it not only absorbs the water but it chemically retains it. That is to say, the added water is not merely mechanically mixed with the white powder but it actually enters into chemical combination with it. The result of this process is a reconversion of the hemihydrate, $CaSO_4H_2O$, into the dihydrate, $CaSO_42H_2O$. Such is the principle of the setting of plaster of Paris.

Good plaster of Paris is not a pure substance in that it does not consist solely of the hemihydrate. The latter makes up its greatest bulk, but it also contains some unchanged dihydrate and a little of the completely anhydrous or water-free calcium sulphate.



(Above) Sectional view of a plaster block reinforced with horsehair.
(Right) Liquid plaster, which is merely a thin gesso, brushed over a wood panel to provide a smooth white surface.

Now, the anhydrous calcium sulphate, although only sparingly soluble in water, is more soluble than the dihydrate, so that when water is added to plaster of Paris the anhydrous calcium sulphate partially dissolves in the water and becomes converted to the dihydrate. This crystallises about the undissolved particles of dihydrate in interlocking needle-like crystals. The dihydrate which results from the absorption of water by the hemihydrate also crystallises in needle crystals which interlock firmly and so give rise to the solid mass of "set" plaster. It is probable that the unchanged particles of dihydrate in the plaster form nuclei about which the re-formed dihydrate crystallises and interlocks.

The setting of plaster of Paris is accompanied first by a *contraction* of the mass of material, but this is followed by an expansion which is due to a change from the crystal system of the hemihydrate into the bulkier crystal form of the dihydrate. So that, as a final result, the plaster expands very slightly on setting, a fact which makes it so admirably adapted for the taking of sharp castings and for similar accurate work.

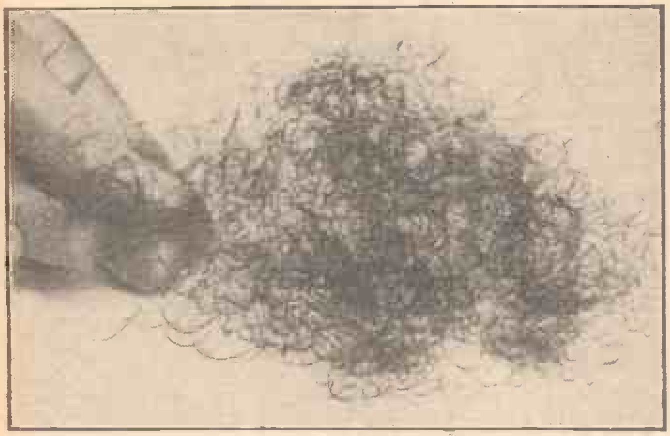
Retarding the Setting

If the water used for the slaking of the plaster contains any substance which can possibly interfere with the formation of dihydrate crystals, such a substance will retard the setting and even actually prevent it. All colloid materials have this retarding property because it is not easy for anything to crystallise when it is interspersed with jelly-like matters. Hence, if we dissolve glue, gelatine, starch, gums or any similar substance in the slaking water of plaster of Paris the setting of the plaster will be retarded in proportion to the amount of colloid which is present. If an excess of such colloid material is present the plaster will not set at all.

The Romans must have had some knowledge of this property for it is reported that they used animal and, maybe, human blood to slow down the setting of their plasters.

Conversely, if we dissolve in the plaster slaking water anything which will tend to crystallise, the internal crystallisation of the plaster, and therefore its setting, will be speeded up. Thus, materials such as common salt (sodium chloride) will *accelerate* the setting of plaster. Indeed, anything which materially increases the solubility of the gypsum will do this. Weak hydrochloric acid, acetic acid, tartaric, phosphoric and citric acids all reduce the setting time of plaster, but borax and alum retard the setting.

We have seen that when native gypsum is heated to about 200 deg. C. it becomes con-



Horsehair gives additional strength to concrete.

verted into anhydrous calcium sulphate, $CaSO_4$, and in this condition is said to be "burnt." Such material, which, as we have further seen, may take long periods to set, is supposed to contain calcium oxide, CaO (quicklime), in addition to anhydrous calcium sulphate, the lime being dissolved in the sulphate and thereby forming a "solid solution." This material has been used under the title of "flooring plaster."

If the gypsum is heated to about 600 deg. C. not only is it completely dehydrated to anhydrous calcium sulphate, $CaSO_4$, but the product refuses to reabsorb any water. The material, consequently, will not set, even after a prolonged period, when mixed with water. It is said to be "dead burnt," in which condition it is without practical interest.

"Hard Finish" Plasters

When native gypsum is calcined at red heat and the resulting anhydrous calcium sulphate is immersed in a bath of alum solution and again calcined and powdered, the product, when slaked with water, sets comparatively slowly. In this condition, the plaster is known as *Keene's Cement*. It is one of the "hard finish" plasters, used for "skimming" or surfacing walls. A peculiarity about it is that the partially-set cement may be reworked with water and that, in these circumstances, it will set as well as if its first setting time had not been interrupted.

What is known as *Martin's Cement* results when sodium or potassium carbonate, as well as alum, is used in the above process and the subsequent reheating is done at a higher temperature than that used for Keene's cement.

Parian Cement is merely another of these "hard finish" plasters based on gypsum. It is made by treating the gypsum with borax solution in a similar manner to the above.

Plaster of Paris, after setting, is characteristically porous. It can, however, very readily be impregnated with agents such as size or glue solution, or with solutions of various common waxes which not only give it increased strength but which allow its surface to be painted on without subsequent absorption of the paint medium.

Plaster casts are notoriously brittle. Any of these impregnation processes at once decreases the brittleness of the plaster, as will, also, the incorporation with the plaster of a fibrous material such as asbestos powder.

(Above) A network of leaf-like crystals or "spheralites," similar to those which form in a setting mass of plaster of Paris, and by whose continual spread and interlocking the plaster mass is given solidity and coherence. (Right) Replacing missing pieces in a plaster picture-frame moulding by means of a plastic stick of gesso.

A microscope view of asbestos powder, showing the fibrous character of the material which aids the interlocking and "keying" of plaster particles.

For a really effective reinforcement of a mass of plaster, and for making it practically impossible to fracture the plaster mass completely there is nothing like horsehair, the hair being padded or otherwise forced into the plaster mass in its wet stage.

Steel wool can be used for the above purpose, but there is a risk here of the surface being discoloured, particularly under conditions of dampness. It can, however, give an enormously tough plaster mass.

When slaking plaster of Paris it is better to add the plaster to the water than the water to the plaster. Estimate the necessary quantity of water required. Then shake the plaster into the water by degrees, stirring continuously. Good plaster should have the consistency of thick cream. It will usually set solid within ten minutes, although the nature of the water has an influence on the precise setting time. It is not safe to remove a plaster from a mould under half an hour from its apparent setting.

To prevent the plaster from adhering to the side of the mould, the latter may be oiled or greased, but, in the case of statue work, where the grease would stain the surface of the casts, it is a better plan to brush the mould surfaces with white of egg, and, after drying, to apply to the same surfaces a very thin cream of china clay mixed up in strong soapy water.

Good Gesso

We have noted that when plaster of Paris is slaked with glue or gelatine water its setting can be delayed or completely prevented. If, however, sufficient glue is used, the glue itself will harden, binding the plaster mass into a hard, unyielding mass.

There is, however, no need to use plaster of Paris for this purpose. Common whiting will do equally well and the product is known as "gesso" (pronounced "jesso"), which is an Italian word for plaster.

Although gesso may not contain any plaster of Paris, it is excellent stuff for amateur moulding work, but it has nothing like the quick setting time of true plaster of Paris and may, indeed, in large masses, require up to a week to harden out.

To make good gesso, dissolve 1 part of high-grade glue in 12 parts of water. Add to this a few drops of carbolic acid to prevent the glue from going mouldy and thus destroying itself. This is the stock "gesso solution."

As the gesso medium or "aggregate" you can use whiting alone, or whiting admixed with plaster of Paris, either or both with or without additional admixture of a colouring matter such as lampblack, red oxide or ochre.

For the best work, the most satisfactory gesso aggregate is whiting mixed with about a quarter of its bulk of zinc oxide.

To make the gesso, all one has to do is to warm the gesso solution and to stir into it sufficient gesso aggregate to make a stiff paste which, when moulded between the fingers, will remain "put" and will not flow.

If the gesso is made to a thin cream consistency it may actually be brushed on to surfaces such as wooden panels, walls, fabrics, etc., thereby providing a coating which can be painted or drawn on.

Making a One-inch Micrometer

Constructional Details of a Serviceable Instrument for the Home Workshop

By A. D. STUBBS

The finished micrometer.

OF course, when you have finished the micrometer, you will find that the first job needing a "mic" is just under 2 inches, and if you proceed accordingly to make them in 1-inch steps you will eventually end up with a boxful of micrometers.

I did contemplate a larger one, to incorporate 1- and 2-inch distance pieces, but as even a 3-inch "mic" would not necessarily be the limit, I decided on the smallest size, and here it is.

Starting from zero, my design, Fig. 1, can be improved upon, as the stirrup is just a little ungainly. If you can cast the combined body, stirrup and anvil in iron a lot of artistic possibilities will arise, but having decided upon a stirrup from ⅛in. steel plate, I had to give myself riveting room, or else resort to welding with the probability that distortion would occur.

The stirrup shown in Fig. 2 is machined all over, the thickness being taken down to 7/32in. Incidentally, the whole of the instrument is polish-finished except the bores of the body and cap. I do not show any rivet holes in the stirrup, because these are better drilled from the anvil and body. The stirrup was turned up on the faceplate, as a complete circle, and afterwards cut with a slitting saw. I still keep coming across the discarded segment, which might come in useful one day!

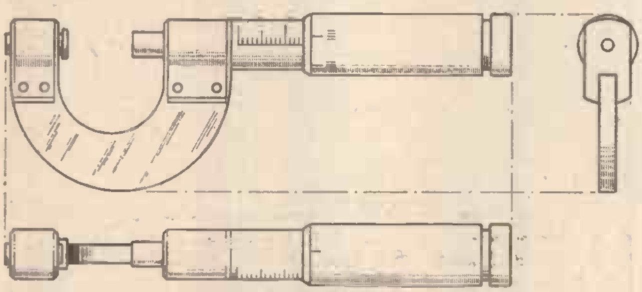


Fig. 1.—Side elevation, plan and end view.

Anvil and Body

The anvil and body, Figs. 3 and 4, are made from a 3in. piece of 1in. black mild steel, turned down to 29/32in. diameter, the next operation being to mark off and drill the offset main hole, with the object of machining the slots for the stirrup before the two component pieces were parted.

In their Siamese twin state, the anvil lay on the threaded end of the body, enabling me to drill 17/64in. from the other end for 1-⅜in. depth. The ¼in. Whitworth tapping drill followed for another 9/16in. then a No. 43 drill went through to give me a tapping size for the eventual ⅛in. Whitworth thread. And, by the way, all threads should be tapped in the lathe to ensure alignment.

Centring on this hole, I turned the middle portion down to ½in. diameter, and then got to work on the two flat sides with a milling cutter. The 7/32in. slots were removed in a series of cuts with the slitting saw, using the stirrup as a "go" gauge, and it is a nice hard push fit. To ensure that the joint bedded right home, I slightly radiused the corners of the stirrup with a file. The anvil was then parted from the body, leaving me enough metal to face the remote end of the body. To face the outside end of the anvil I used an end mill.

Pallet Screw

My first pallet screw, Fig. 5, was a cheeseheaded setscrew, with the end turned down to remove the slot, the remainder of the head having a couple of flats milled off for a special spanner, but later I made another from ⅛in. silver steel, with the outer face of the head full diameter, milling flats on the inner part of the head.

Fig. 6 shows the silver steel screw. The only points to watch here are that the thread must be as perfect as possible and that the business end of the micrometer screw must not be otherwise than dead flat, and at 90° to the axis.

The cap and nut, Fig. 7, both came out of ⅝in. diameter mild steel, the nut alone being knurled, for appearance sake, and then came the marking of the divisions.

I selected the ¼in. Whitworth screwing for the sake of its twenty threads per inch, so the body marking divisions correspond. Setting up for screwing 20 t.p.i. I centred the body, but without holding it for rotation, and put on my faceplate, to "drive" by.

Tooling the Markings

A sharp-pointed vee tool was then set up on its side, and the longitudinal marking line cut .002in. deep by winding in my topslide feed. The same tool was then changed over to normal position, and the topslide set with the tool tip against the left-hand end of the ½in. diameter of the body.

To ensure taking up all gear teeth, bearings and any other sources of slack, I gave the faceplate two complete turns by hand, backwards, marked the faceplate so that I could repeat 360° precisely, and then fed in the tool to touch my longitudinal line, the point being about .002in. below the surface of the body. A hand twist on the lug end of the body gave a perfect zero marking, full length, as shown in Fig. 1.

The remainder is easy. Withdraw the tool, turn the faceplate once precisely, wind in the tool, another hand twist (a short one this time), and there's another fifty thousandths marked up. Be careful not to turn the faceplate more than 360°. If you do, it will be necessary to go back half a turn, to ensure taking up all the slack.

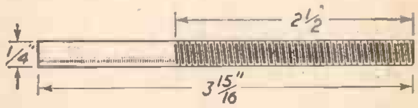


Fig. 6.—Screw.

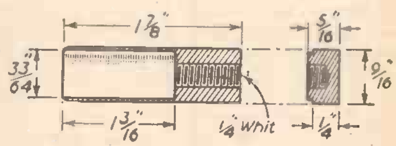


Fig. 7.—Sections of cap and lock-nut.

To mark out the fifty divisions on the bevelled end of the cap, I used the same procedure, with the change wheel ratio reversed. As a point of interest, I have a dial on the tailstock end of my leadscrew with a peripheral scale divided into 125 millimetres. The mm. just don't mean a thing except that as my leadscrew is 8 t.p.i. they are to me each .001in. This is principally to give me a fine reading when feeding with the leadscrew, but geared up to the mandrel it gives me practically any division I need.

For the cap, I set the cross-slide for taper turning 20°, at which angle the cap had been bevelled, and used the same sharp-pointed vee tool, again on its side, cutting a .002in.-deep mark at each fiftieth of a revolution, each tenth division being longer. To avoid the amateurish mess I inevitably make if I try to etch figures, I used the same tool, cross-slide reset to normal, to cut one, two, three and four cuts respectively at each tenth division on the full diameter of the cap. The unmarked tenth division is my zero, as in the plan, Fig. 1.

(Continued on page 282)

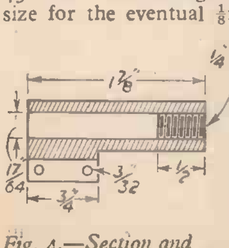


Fig. 4.—Section and end view of body.

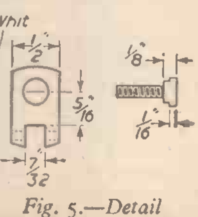


Fig. 5.—Detail of pallet.

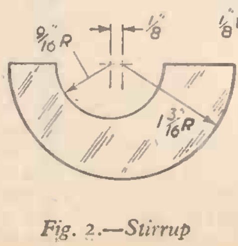


Fig. 2.—Stirrup

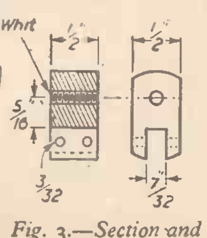


Fig. 3.—Section and end view of anvil.

The WORLD of MODELS

By "MOTILUS"

The Production of Scale Models : A Fine Model Cargo Vessel : Architectural Models

IT is often interesting to see behind the scenes and watch the production of scale models, whether being made by the skilled hands of craftsmen or in the process of machine production, whereby scale models can be put on the market at lower prices than the hand-made craftwork.

Mass-produced Models

Even mass-production in the model world requires a large amount of skilled labour. The designer, the tool-maker, the precision worker on small parts and the experts on assembly and final testing all have to play their part, and this is particularly so in the manufacture of model railways, now so universally popular. Gauge O (1¼in.), or a scale of 7mm. to 1ft., is still the size most in demand for the model railway hobby, as it is suitable for either clockwork, electric or steam propulsion. A review of the processes involved in the production of the ready-made gauge O models that can be bought to-day may interest readers.

First, the locomotive, which has to be designed in suitable model form, based on an actual prototype. In doing this the designer has to bear in mind that the finished locomotive may be fitted with either a permanent magnet unit, with electric power collected from a centre rail on the track, or with a clockwork mechanism, when only hand-winding is necessary ; or the most realistic method of steam propulsion may be used, generally by means of a cylindrical boiler heated by a methylated spirit lamp.

When drawings are complete the main locomotive body parts are stamped out of metal, usually tinplated steel. If the quantity to be produced is large, the tinplate sheets are colour-printed first, then punched out and assembled. This avoids the painting process, except for wheels and other small parts, which are hand painted. When only small quantities are required, however, printed tin is not used, and the locomotive has to be entirely painted and lined by hand.

The Press Room

First operations, then, take place in the press room, where the various sections are punched out from tinplate sheets or printed tinplate according to the type of locomotive ; the mechanisms for electric or clockwork propulsion are made in another department. Eventually all parts come together in the assembly room, after being painted where necessary. Then the finished model is ready for testing.

The illustrations, Figs. 1, 2 and 3, show some of these operations in a Northampton factory, where models are made.

Rail and points for ready-made track can be pressed out of tinplated steel, which is less expensive than using brass or steel rail of standard bullhead section and building one's own track with cast metal keys. The lengths of track are joined by means of slip-on fishplates.

Except when more expensive rolling-stock is concerned, coaches and wagons are designed and printed on tinplate, ready for stamping out and assembly in a similar way to the locomotives. This method, however, cannot be used when much detail work is required, which necessitates hand work, including painting.

Fig. 1.—Manufacturing model locomotives : after painting, but before final assembly, the number and British Railways crest are applied, by means of transfers, to the model locomotive and tender respectively.

Fig. 2.—Microscopic examination of parts of the mechanism of a gauge 0 model locomotive.

All parts of model railway equipment are thoroughly tested before leaving the factory. The locomotives receive tests on the track, whether they are clockwork, electric or for steam propulsion.

Many railway accessories, such as signals, buffer stops, water towers, bridges and railway stations can be made on a similar principle to that described above, when mass-produced.

Of course, the whole procedure is quite different from that used for hand-made models, which are made by very skilled craftsmen, who have suitable tools for the work and use sheet metal, castings and other material for making small fittings. The general improvement in the making of model

Fig. 3.—Assembly work on gauge 0 model locomotives, after they have been painted and lined.

locomotives, railway rolling-stock and other equipment has resulted in the hobby becoming more universally popular.

Model Cargo Vessel "Pathfinder"

Two new vessels were ordered last year from Messrs. R. and W. Hawthorn, Leslie and Co., Ltd., by the Pan Ore Steamship Company of U.S.A. The first one to complete her trials was *Pathfinder*, and both she and her sister ship, *Prospector*, have been specially constructed for carrying bauxite. There is no cargo-handling gear on board with the exception of winches for general cargo, as the ore is unloaded by grabs working from the shore.

The *Pathfinder* has an overall length of 447ft., moulded breadth 60ft., and she has a mean draft of 20ft. Tonnage is 7,730 and displacement 11,173 tons. Her main diesel engine is of the standard Doxford opposed-piston type, constructed by the shipbuilders at their St. Peter's works.

It is interesting to note that the air-conditioning and ventilating arrangements are perhaps the first of their kind carried out on a large scale. They were designed by the Norris-Warning Co., Newcastle-on-Tyne. Bauxite creates a large amount of dust during loading and unloading and the air-conditioning and ventilation of machinery spaces can continue during these operations, as well as when the ship is under way. All accommodation is air-conditioned from a central plant, which also filters the air and eliminates bauxite dust.

Thus the *Pathfinder* and *Prospector* are two most interesting modern vessels in design and appearance. Their steel decks are painted red, superstructure is all white, and the hulls are aluminium and red.

The illustration Fig. 4 is a model of the *Pathfinder* to a scale of 32ft. to 1in. It shows clearly the unique design, with the superstructure astern, and the long, level deck amidships almost entirely free of deck gear. This model is one of several hundred ship models made for Messrs. Wm. Harvie & Co., Birmingham, by a well-known model-making firm. I understand a selection of these models will be on view in the shipping section of the Festival of Britain, on the South Bank site, in London.

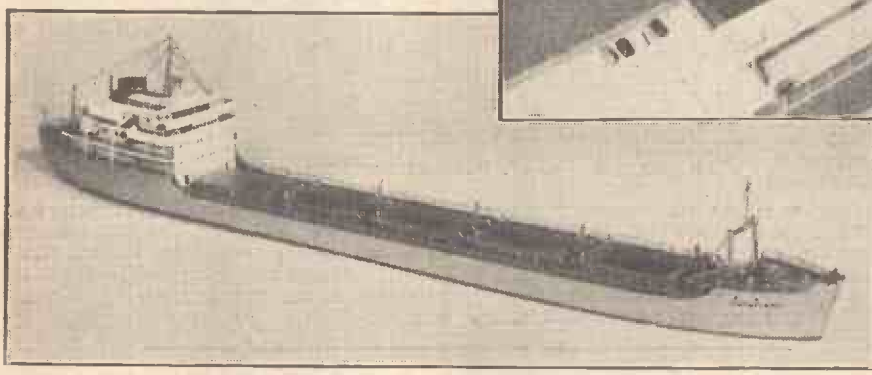


Fig. 4.—A model of the Pan Ore Steamship Company's "Pathfinder," a vessel specially constructed for carrying bauxite. This model is to a scale of 32ft. to 1in. and is part of the collection belonging to Messrs. Wm. Harvie & Co., of Birmingham.

Packaging Exhibition

Early this year the Second National Packaging Exhibition was held in the Empire Hall, Olympia. In conjunction with this, and taking up the whole of the ground floor, was the Metal Containers, Ltd.-Van Leer Exhibition. Main feature of this extraordinary display was a mobile, metal drum factory, in which there is a separate vehicle for every machine, including a car fitted with a generator, giving out 200 KVA. Other cars provide living accommodation for staff and management and a comprehensive canteen, so that the different components, when together, combine to make a complete manufacturing unit. The Van Leer organisation is justly proud of the fact that this mobile factory was driven into the Empire Hall at Olympia and within twenty-nine minutes was producing finished oil drums from raw materials. Visitors to the Hall saw oil drums wherever they turned! Drums of all types and in various colours, applicable to different uses: even full-size glass drums for illuminated display purposes.

When this Van Leer Exhibition was being planned, the whole layout was modelled by technicians of Metal Containers, Ltd., before it was finally approved, and this model was displayed in the Hall. There were also other models of various types on view, many of which had been made by the firm of Bassett-Lowke, Ltd. Among these were some attractive block models of machines, finished in white and strikingly displayed against black backgrounds at different points in the Hall: also a working model of an American drum-making plant, to a scale of $\frac{3}{8}$in. to 1ft., a complete model of the company's Ellesmere Port factory and another of the Springs factory at Johannesburg.

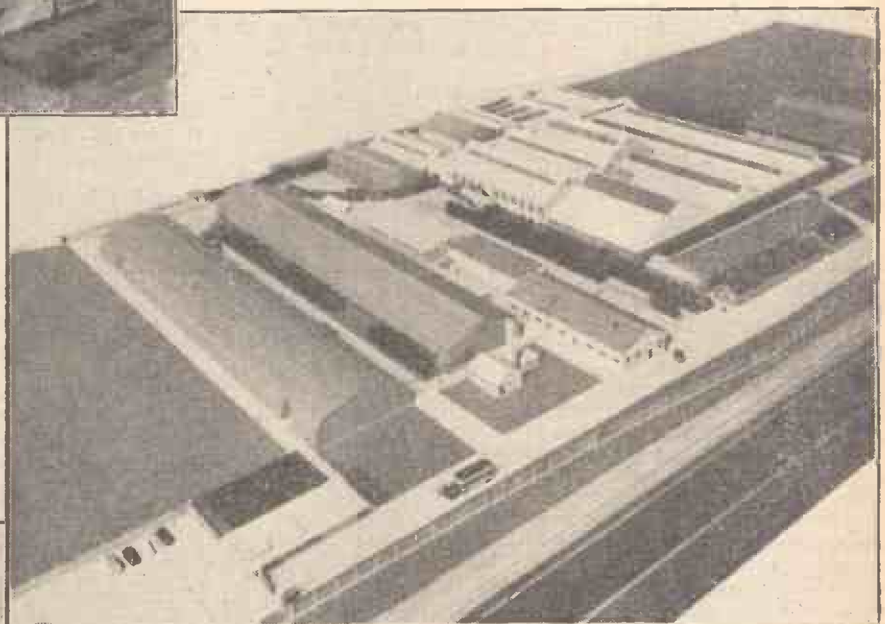


Fig. 5.—This architectural model, to a scale of 12½ft. to 1in., shows in entirety the Ellesmere Port factory of Messrs. Metal Containers, Ltd., where metal oil drums, canisters, etc., are manufactured.

The Ellesmere Port model (Fig. 5), to a scale of 12½ft. to 1in. (1/150th actual size), shows the whole of the works there. It includes two American line drum factories, one recently erected, and other buildings where small canisters, buckets, etc., are manufactured. A railway serves the sheds for transport and this is included in the model, as well as the road approaches for vans and lorries. The interiors of all buildings in this model can be lit up, giving an impression of the factory as it would appear after dark.

LETTERS FROM READERS

Oxygenating Aquarium Water

SIR,—The algæ which bothers Mr. E. J. Harmsworth is probably the innocuous green variety, as opposed to the harmful blue and pestilential brown types, and is usually seen in abundance after continuous use of strong overhead lighting.

The simplest way to rid one's tanks of it is to leave all lights switched off for four days, subsequently reducing the wattage of the tank-lighting systems. A 60-watt bulb over a tank 24in. × 12in. × 12in. should be adequate.

If the tank in question is a cold-water aquarium, perhaps it is situated by a window? Should this be the case, steps should be taken to ensure that sunlight does *not* fall directly on to the tank, since this will promote rapid growth of diatoms, etc., causing "green water," and in any case the eyes of fish are not intended by nature to receive light sideways!

The copper-sulphate treatment should clear a tank of algæ in about 12 hours.

Snails, alas! will not help in cleaning up algæ, are incomplete scavengers, and can become a nuisance in one's tanks. If your correspondent is a tropical-fish keeper he should know that the "live-bearer" family (Pœciliidæ) are gourmets for green algæ, especially the Molliensias, and will keep it under control.

Assisted oxygenation is not necessary if the number of fish is kept to reasonable limits, since oxygen is dissolved continuously, via the water surface, sufficient to balance the tank, provided there is no overcrowding. (Bear in mind that cold-water fish need far more oxygen than their tropical cousins, bulk for bulk.)

Finally, I cannot understand the implied objection to the inclusion of plants as oxygenators, since the æsthetic value alone justifies the presence in the aquarium of such oxygenators as myriophyllum, sagittaria, elodea, etc.

Incidentally, green algæ is a splendid oxygenator!—WM. E. HADFIELD (East Molesey).

Home-made Wood-turning Lathe

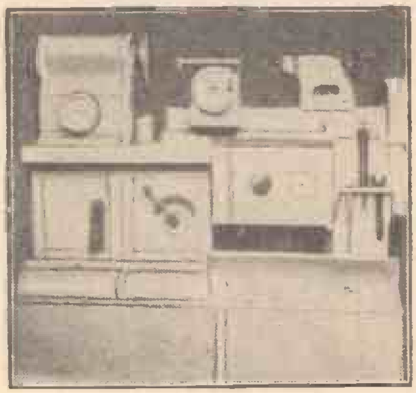
SIR,—Many of your readers no doubt find that the diametrical capacity of the usual wood-turning lathe is very limited unless one can afford the more expensive type, which is beyond the pocket of some people.

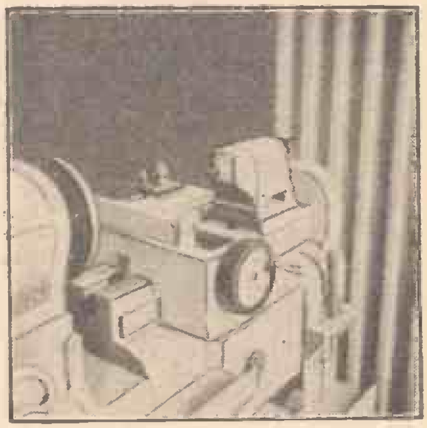
I have overcome this drawback by making my own machine, as shown in the accompanying photographs. It is made entirely of wood—mostly packing cases—with the exception of such essentials as bearings, bed-plate, etc. I now have a machine with which I can turn up 2ft. diameter in the gap, 1ft. over the bed-plate and 2ft. 3in. between centres. The total cost, including the ½ h.p. motor (temporary), was £12.

The bed-plate is of 4ft. x 2in. channel back to back. Headstock is of 6in. x 2in. timber, and has a hollow spindle set in triple ball races with a 9in. faceplate. The traverse, again of wood, is electrically operated and controlled by two very simple limit switches at the rear. This is driven by a motor which I obtained from an old vacuum cleaner and geared down through a gramophone motor. The lead screw is ¾in. Whitworth, which I had threaded on a pipe-screwing machine.

The controls, as seen on the front view of the lathe, are, left to right: 1. Isolator; 2. Traverse direction lever; 3. Traverse speed control.

I have thoroughly tested this machine and find that it is very satisfactory. Its weight is roughly 2¼ cwts.





Two views of Mr. W. Fletcher's wood-turning lathe.

The reason for my sending you this letter is this: I have often wondered how many of your readers have given up their hobby because of loss of limbs in the late war? I have met many, and I am pleased to say that, after spending some time with them, they can do most of the things they thought otherwise impossible.

Incidentally, I have only one arm!—W. FLETCHER (Aberavon).

Law of Gravitation

SIR,—Concerning A. D. Joseph's curious assertion (May issue) that "to resist and attract at the same time is impossible," I would like to point out that action and reaction are equal and opposite; that attraction and resistance are equal and opposite; that, in short, resistance to Mr. Joseph's frustrated apple is merely the obvious result of *attraction*.

Perhaps he, unlike Newton, confuses the verbs "to resist" and "to repulse."—S. F. W. HART, B.Sc. (London, E.).

SIR,—I would presume that A. D. Joseph (Epsom) is the kind of person who thinks he can lift himself in the air by standing in a bucket and pulling at the handle.

The centre of gravity of any object, surely, is the centre of its mass, and therefore it is the core of the earth attracting the apple he mentions. In theory the apple would continue to the centre of the earth. With regard to his version of the Law of Gravity, it should be pointed out that if attraction were not present between two bodies there could be no resistance between them.—L. J. BRYANT (Rochester).

Club Reports

Aylesbury and District Society of Model Engineers

THE March meeting of the society, held at Hampden Buildings on the 21st, was devoted to a chat by Mr. J. L. Maskelyne. Mr. Maskelyne's talk could not be called a lecture, for to do so would create a wrong impression of Mr. Maskelyne. His chat was liberally illustrated with photographs, and he had some very expressive things to say about the tinny commercial models and the free lance adaptations of prototypes with which we heartily agree. We would like to thank Mr. Maskelyne for an enjoyable evening.—Hon. secretary, E. H. SMITH, Mulberry Tree Cottage, Devonshire Avenue, Amersham, Bucks.

Ilford and West Essex Model Railway Club

THE annual general meeting was held recently when the following officers were elected for the ensuing year: President, Mr. R. L. Riddle (who was duly invested with the badge of office by the retiring president, Mr. J. A. Carter); President-elect, Mr. G. J. A. Baker; Hon. treasurer, Mr. S. H. Gilding; Hon. secretary, Mr. E. W. Cornell; Hon. librarian, Mr. G. J. A. Baker; Vice-presidents, Messrs J. N. Maskelyne, W. J. Kohring, N. F. K. Fletcher, T. S. Lascelles, F. H. White, G. R. Dow and Mrs. M. R. Hardy.

The reports of the various officers and of the O gauge, OO gauge, EM gauge and junior sections were adopted, and the meeting recorded its thanks to the local Press and the model railway journals for reporting from time to time upon the club's activities.

The summer programme includes the following events: June 20th, 50/50 sale; July 18th, Mr. H. M. Sell (London Manager, Bassett-Lowke, Ltd.); September 5th, Film Night; September 22-29th, Exhibition at Ilford in connection with Festival of Britain.

Other meetings will be devoted to completing the alterations to the exhibition layout, and it is hoped, with the kind permission of the owners, to arrange visits to the layouts of Mr. W. S. Norris, Mr. Fleetwood Shaw and ERG (Bournemouth), Ltd. A cordial welcome is extended to new members.—E. W. CORNELL, Hon. secretary, 42, Lincoln Road, Forest Gate, E.7.

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17/6

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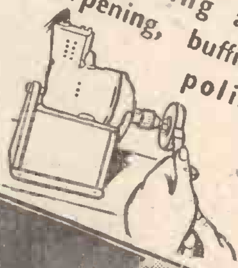

59/6

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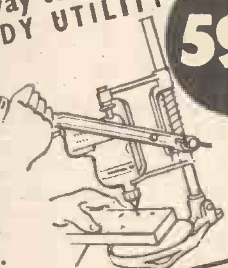

NOT just a drill but almost an electric workshop on its own—that's 'HANDY UTILITY,' the versatile power tool for faster, smoother, deeper drilling in steel, cast iron, brass . . . for easier drilling in wood, perspex, ceramics . . . for grinding, buffing and polishing metal parts . . . for cleaning off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

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ACCESSORY KIT
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OBTAINABLE FROM YOUR LOCAL TOOL SHOP, IRONMONGER OR STORE

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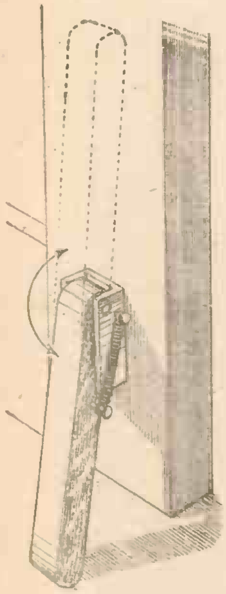
Trade Notes

A Review of the Latest Appliances, Tools and Accessories

"Abingdon" Door Sprag

MARKETED by The Abingdon Rubber Co. Ltd., 505, Kingsland Road, London, E.8, this fitment is specially suitable for garage doors. Attached to the lower part of a door, as shown in the accompanying illustration, the sprag is operated by a flick of the foot, and will hold doors in the open position against the strongest wind. The sprag is also particularly useful for industrial and office buildings and in the home. Fitted inside a door it will give added security, as the door cannot be forced open from the outside. The fitment is of heavy construction, the door fixing being of stout iron channel: the hardwood sprag is spring-loaded so that is snaps easily into the up or down position. A bright yellow finish makes the device easy to locate at night. The retail prices are 10s. per pair, or 5s. 6d. each, post paid.



The "Abingdon" door sprag.

Eyre Smelting Company's New Calendar

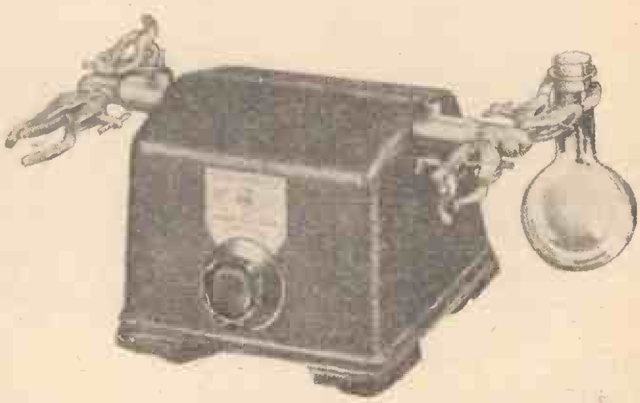
THIS being Festival of Britain year, many friends of the company will be visiting London to see one or other of the exhibitions being held there. Many of them will want to see other features of interest, and as there are a number of these within a small radius of the firm's works, the company have made a new departure in the design of their calendar, which they have just issued. The new calendar takes the form of a map with a coloured decorative border consisting of sketches illustrating some of the many interesting places within easy reach of the works. For those who wish to visit the Tandem Works, or the Aluminium Works at Mitcham, the positions of these two factories are shown, and details are given on the reverse side of the calendar of rail and road services from London.

Copies of the calendar are available to members of the engineering, foundry and allied trades while supplies last. Application should be made on a business heading to the Engineering Sales Department, The Eyre Smelting Co. Ltd., Tandem Works, Merton Abbey, London, S.W.19.

Microid Flask Shaker

THE Microid silent shaking machine accommodates up to four 500 ml. flasks, each half full of liquid. It can be placed on the laboratory bench and does not need permanent fixing. The power consumption is only 60 watts. It can be plugged into A.C. or D.C. lighting circuits, and is continuously variable in speed from zero up to 500 oscillations per minute. Its agitation can be varied instantly from a gentle slopping, useful for viscid solutions such as collodion, to a violent cascade. In a round bottom flask suitably adjusted, the liquid can be made to swirl around the flask on a hollow *horizontal* axis. In a conical flask the liquid can be made to rise spirally up the walls; in returning in droplets to the bottom it is brought into intimate contact with the gaseous phase and is effectively "aerated" for such purposes as hydrogenation. In the incidental daily laboratory operations of dissolving and dispersing solids, extracting residues, emulsifying oils, it abolishes the tedium of prolonged shaking by hand, saves time and accelerates the processes. If suitably supported it could be used for shaking flasks in a thermostatic bath. Since it reproduces so many different types of agitation hitherto attainable only by hand, it may be termed a "wrist-action" shaker.

The casing of the shaker is a heavy, box-shaped iron casting mounted on four vibration-absorbing rubber feet. Running on bearings through the casting there passes a ¾in. diam. spindle fitted at each end with split-sleeve non-ferrous castings to which are bolted four Griffin four-six clamps. Within the casing is mounted a 1/30 h.p. universal, ball-bearing fan-cooled motor which, by means of an eccentric, coupled with a sturdy link motion, causes the spindle to oscillate through a small amplitude. Further particulars and prices can be obtained from Griffin and Tatlock, Ltd., Kemble Street, Kingsway, London, W.C.2.



The Microid flask shaker.

Books Received

Gem Testing. By B. W. Anderson. Published by Heywood & Co. Ltd. 246 pages. Price 21s. net.

THIS book, which is a fifth edition, aims at showing the ordinary jeweller and dealer, in the simplest possible manner, the easy, scientific tests available to him for discriminating with certainty between one stone and another, and between real stones and their substitutes. Since the earlier editions of this work appeared there have been startling developments in the production of synthetic gem-stones. For instance, Verneuil's "flame fusion" method, now 50 years old, has been ingeniously modified to yield a new gem-stone —synthetic rutile—and synthetic star rubies and sapphires. Full descriptions of the new materials, and of other developments in synthetic, imitation, and "faked" stones are given in this volume, together with suggestions as to how they may be recognised. Among the other extensive additions to the book is the description of a new method of using the refractometer, which was first suggested by Mr. Lester Benson, of the Gemological Institute of America. By using the "distant vision" technique, the gemmologist can obtain refractometer readings on curved surfaces, or on tiny faceted gems which give no visible shadow-edge by normal methods of observation. The chapter on the spectroscope has been re-written, and the wavelength tables extended. Several additional minerals have been included in the summary of gem species, and in the tables at the end of the book. There are also a good glossary and index, and many excellent half-tone illustrations. Although the book is intended primarily for the use of those who trade in precious stones, students and members of the general public who are interested in the subject will find a wealth of information in this authoritative work.

Motor Cycling Year Book, 1951. Compiled by Peter Chamberlain and the Staff of "Motor Cycling." Published by Temple Press Ltd. 186 pages. Price 7s. 6d. net.

FOR several years there has been a need for an annual review of all motor-cycling activities—technical developments, sporting events and the touring aspect. The purpose of this book is to fill this gap in motor-cycling literature and to present a complete record of the year's progress and events, including chapters on technical developments, world specification tables, road tests, motor attachments, and touring abroad. The sports side is covered by a general review of racing at home and abroad, and there are individual chapters on the world championships, records and record-breaking, reliability trials, race results, Moto Cross, and speedway racing. The book is lavishly illustrated.

A ONE-INCH MICROMETER

(*Continued from page 277*)

To read the micrometer, the exposed divisions on the body are totalled, each being, of course, 50 thousandths, and to the quotient is added the cap reading above zero, 4 tenths plus 2 being .042in. As the .001in. divisions on the cap measure about 1/32in. apart the instrument is quite easy to read, even down to .0005in.

Assembling

Assemble the body with its screw, cap and nut, run the pallet screw into the anvil, then mount the stirrup.

Drill through the four 3/32in. rivet holes in the one setting, then use the same diameter brass wire for rivets.

To set the micrometer, let the pallet screw be half a turn short of "home," then screw in the cap until the screw face just contacts the pallet. Hold the plain portion of the screw, and adjust the cap until the combined body-cap micrometer reading is zero, and at that point tighten the lock nut. The inevitable slight inaccuracy created in taking up the cap thread slack is now corrected by adjusting the pallet screw.

THE Cyclist
Editor: F. J. CAMM
VOL. XIX JUNE, 1951 No. 349

All letters should be addressed to the Editor, "THE CYCLIST," George Newnes, Ltd., Tower House, Southampton Street, Strand, London, W.C.2.

Phone: Temple Bar 4363
Telegrams: Newnes, Rand, London

Comments of the Month

A WRITER in a contemporary under the heading "No Quarter or Compromise" deals with the "Heal the Split" moves being made to make peace between the various cycling bodies and to find a formula which will accommodate the various points at issue.

His comments are unlikely to do anything to cause the split to be healed. As we have before remarked, the split should be *hailed*, not *healed*. The contemporary in which the writer expresses his point of view is one which has been severely critical not only of the B.L.R.C. but also of the N.C.U., and they are the main antagonists. This contributor says "the only people who can heal the split are those who caused it." This is a nice trite phrase, but it is thoroughly illogical. It is well to suggest that a man who has cut his throat is the best person to heal it.

I agree with this critic when he says that massed-start racing in its latest form has caused much disquiet among the more responsible sport-promoting clubs. But the reason for this disquiet is not what the critic thinks it is. Sports promoters are naturally jealous of the publicity which massed-start racing attracts, to the detriment possibly of their own events. Instead of promoting events having greater attraction and competing by fair means they are adopting the usual underground, hole-and-corner unsportsmanlike methods which in certain directions has been undermining the sport for many years.

The R.R.A. was formed as the result of a breakaway movement, and so was the R.T.T.C. It would be equally true to say that they were dissident bodies. It is perfectly proper if a large body of cyclists want to indulge in a particular form of cycle racing to break away from a body which is opposed to it. On the question of the so-called danger of massed-start racing, where is the evidence of it? The critics in the early days of massed start (not-in-line if you please!) stated that there would be many accidents, that such form of racing would be dangerous to other road users when motor cars came back on the roads in sufficient numbers.

The critics, after ten years, have been proved wrong. Every possible move has been made behind the scenes to get massed-start racing banned, and the underhand methods adopted to this end have merely forced hundreds into the ranks of the massed starters. Naturally this is aggravating to the proprietors of cycling sport, and most of all to that obsolescent body the N.C.U. which which has long ceased to reflect cycling opinion or to exercise control.

We agree that there is no half-way house at which the differences between the two schools can be composed. Each wishes to submerge the identity of the other, that is one reason why the oft-suggested condominium between the N.C.U. and the C.T.C. has failed. There really is no need for the two bodies. We therefore arrive at the point where massed-start racing must be recognised as a new form of cycle sport which is here to stay. It may be scorned on by the elder brethren, but then so was the pneumatic tyre. We do not think that any Government in view of its record will ban massed-start racing.

Healing the Split

By F. J. C.

Festival of Cycling

THERE can be no doubt that the Festival of Cycling will be one of the greatest cycling week-ends. Visitors to the Dunlop Sports Field where the Festival will be held on June 23rd-24th will not only see a sort of cavalcade of cycling, past and present, but exhibitions of riding skill, a grand firework display finale, demonstrations of folk dancing, and be able to listen to famous bands, and one of the best displays of old cycles yet seen in this country.

Sunday's events will include an open-air Church Service conducted by the Archdeacon of Birmingham, accompanied by the Festival Singers, a combined choir drawn from famous cycle factories; a competition between bicycle polo teams, a demonstration of cycle roadmanship by 200 young Birmingham riders.

Midnight matinées have been arranged by Gaumont-Odeon Theatres, the sponsors of the Festival, at their cinemas in New Street and Steelhouse Lane, Birmingham. At those two theatres nearly 5,000 cyclists have been invited as guests.

A special Scots feature in Saturday's programme will be the ceremonial welcome of the party of riders from the Cumnock Rally, which is being held during the same week-end. There will be demonstrations by the Women's League of Health and Beauty, traditional country dancing by the Midland Group of the English Folk Dance and Songs Society.

Britain's ancient crafts to be demonstrated will include a Warwickshire woodturner making bowls, egg-cups and plates; a demonstration of pottery painting by two Staffordshire pottery artists, and an exhibition of repoussé work, roller racing, etc., etc.

The admission fee to the Festival ground will be 1s. 6d. inclusive, and this fee includes a copy of the Festival Programme, entry into competitors events, cinema shows, and the use of ground facilities, such as exhibitions.

Clubs and sections of clubs are invited to take part in the Parade of Clubs immediately after the Festival opening—the first event to emphasise the popularity of club cycling. Four riders from each club or section of the club will take part. Each rider will carry a cane or light pole surmounted by a triangular flag with black background and yellow lettering stating the name of the club.

Seven Members of Parliament will attend the opening—Mr. J. Silverman, Mr. F. L. Shurner, Mr. Martin Lindsay, D.S.O., Mr. F. Longden, Mr. V. F. Yates, Mr. C. C. Poole, and Mr. H. C. Usborne. Mr. A. E. Scott-Piggott, head of the Festival of Britain Liaison Branch will open the Festival. The Lord Mayor of Birmingham and the Mayor of Lymington will be present.

Reg Harris is to appear with four other international stars on the quintuplet which 54 years ago helped by J. W. Stocks to set up the record still standing for the longest distance ridden in one hour on an outdoor track with human pacing—32 miles, 186 yards. Stocks used this "quint" for the 100 kilometres World Championship at Glasgow in the same year, and it is still in first-class running order although it has never had such distinguished riders on its saddles at one time.

Comments on Roads

THE British Road Federation has recently compiled a series of comments by County Surveyors and others on our roads. Here are some of the comments.

"The roads are getting into the state when very shortly they will become completely impassable." (Lord MacDonald, chairman of the Roads Committee of Inverness County Council.)

"Some (West Riding) roads must be seen to be believed. Many are in danger of collapse because they were not made to carry the present volume of traffic, and deterioration continues through lack of funds. . . . An even more vital consideration is that in the event of national emergency, the advent of heavy Service traffic on some of the roads in the Riding would result in their complete collapse within a matter of a few months." (Mr. S. M. Lovell, county surveyor, West Riding.)

"I know from long experience of motoring on the roads of this country and from commercial experience outside my Parliamentary life that for various reasons our roads seem to be hopelessly behind current needs." (Mr. Alfred Barnes, Minister of Transport.)

"One day in the coming summer, a road accident will occur which will involve the millionth person to be killed or injured on the roads of Great Britain since the end of hostilities in 1945. And the rate is still rising. (Mr. James Drake, county surveyor, Lancashire.)

"We all know that increases in the numbers, variety and speed of vehicles on the roads have made our present road system seriously obsolete." (Mr. Herbert Morrison, M.P., Lord President of the Council.)

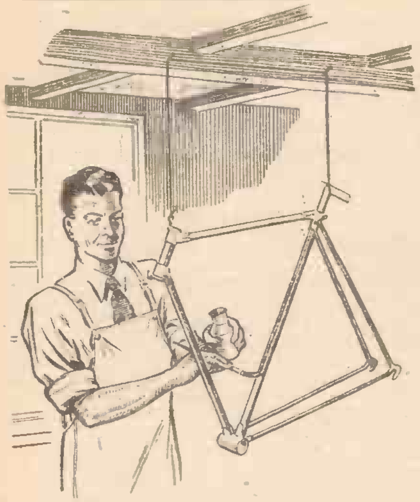
Exports

MORE than £6,375,069 worth of bicycles and motor-cycles were sold by Great Britain overseas during the first quarter of the year, £827,551 up on 1950. Bicycles showed the biggest increase, £771,928; motor-cycles £55,623. Most of the latter (5,436) went to Australia; followed by U.S.A. (1,925), Canada (1,215), New Zealand (1,174) and Switzerland (984).

Malaya was Britain's best customer for bicycles (£639,789 worth), followed by Brazil (£404,237), India (£330,004), British West Africa (£326,414), Pakistan (£277,690), U.S.A. (£227,605) and British East Africa (£212,986).

Overhauling the

To Ensure Maximum Efficiency of Your Cycle it Should be
Preparation for the Touring



When repainting or re-enamelling the frame suspend it from the roof of the shed so that all parts of it can be seen.

AT this time of the year one instantly conjures up thoughts of the delightful week-ends to be spent with a cycle during the ensuing months and holidays. Before we begin to make our plans, however, we must first turn our attention to the machine that is to convey us on those prospective tours. Perhaps it will require a fresh coat of enamel, new mudguards, brakes; in fact, there may be many things that will need adjustment.

Enamelling the Bicycle

There are many first-class enamels on the market which have been advertised in this journal from time to time. Best results are obtained by stripping the machine, as this enables the frame to be hung up whilst enamelling and also provides for easier working. Small unenamelled parts prepare the way for flaking and chipping at a later date, so that it is essential that no small corners are overlooked.

A passable finish may be obtained by enamelling over the old surface, first smoothing it with pumice stone and emery cloth. The real stoved-on finish, however, can only be imitated by first removing the old enamel and applying fresh coats of paint to the bare steel. The old enamel can be removed by one of the popular removers or by dissolving a pennyworth of potash in a cupful of water and then rubbing the resulting liquid over the frame, so that the old coats will be sufficiently softened for them to be scraped off with a knife.

Turpentine should be used to clean the bare steel, which is then well wiped and smoothed with emery cloth.

The tendency to-day is to use bright enamels and thus enhance the appearance of the mount. Enamelling should be done with a soft brush, as a stiff-haired one will give a "brush-marked" finish. After the first coat has been applied it should be allowed to harden (twenty-four hours is usually necessary), and the second application of the enamel should be preceded by a rubbing-down with a very fine emery paper. Relining the frame with transfers will add to its appearance. A paint spray gives the best finish.

Care of the Mudguards

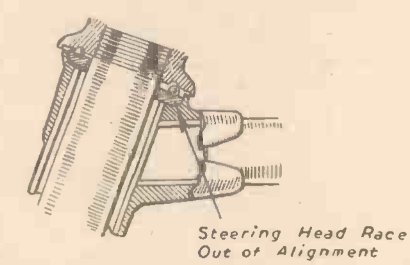
The mudguards should next receive attention. These may either be of steel or celluloid. Dents in steel guards may be removed by placing a sandbag under the guard and hammering with a padded hammer. They can then be given a fresh coat of enamel or, if they are badly dented, new ones should be fitted.

Celluloid mudguards have a tendency to crack if they neglected or dented, and an efficient repair can be carried out by cleaning the cracked edges and uniting them together with a little celluloid (or "pear-drop") cement. A patch of celluloid may be inserted and cemented into position by means of the same adhesive if the cracked area of the mudguard is extensive.

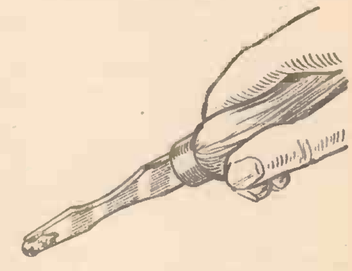
White "safety" rear-flaps can also be repaired in the same way, and usually become temporarily plastic under the influence of moderate heat. Masses of dried dirt, which generally accumulate on the underside of the mudguard, should be removed, using a long, flexible brush for the purpose. This will minimise rusting of the underside of steel mudguards and their life will be greatly prolonged in consequence.

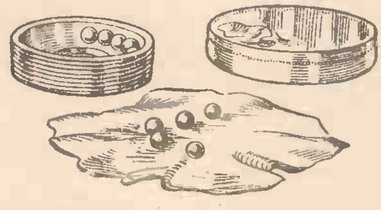
The Brakes

Brakes are a most important item and should receive a very thorough overhaul. When refitting any type of rim brake it is very important to see that the shoes are fitted the right way. The holders will be found either to taper or to have flanges at one end, and this end must be the lower one if the blocks are fitted vertically, or the front end if they are horizontal, otherwise the rotat-

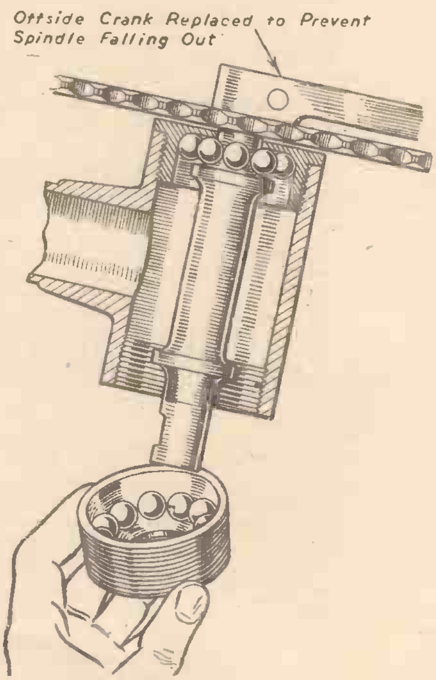


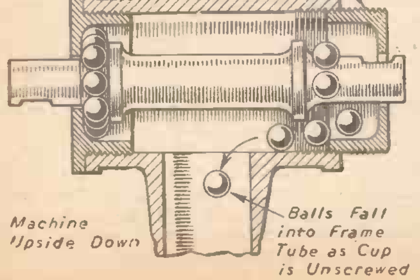
Showing cause of shake in the steering head.

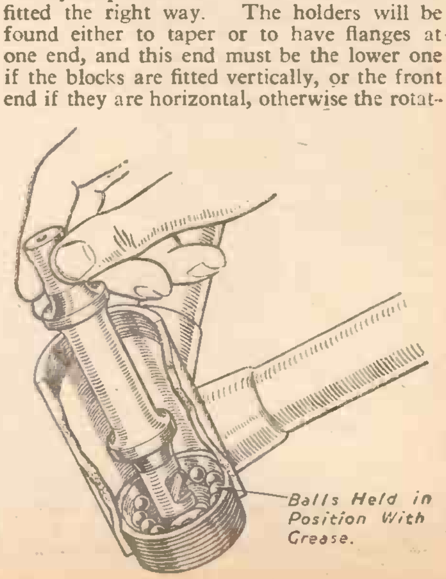




The balls may be picked up by means of a screwdriver having some Vaseline on the end. They should be laid on a piece of cloth and wiped clean so that they may be inspected for rust or pitting.







Above: The bracket is inverted when replacing the nearside adjustable cup, the spindle being held in position by temporarily replacing the chain wheel and crank.

Left: A machine should not be inverted when dismantling the bottom bracket bearing for the reason shown here. As the cup is unscrewed there is a risk of the balls falling into the frame tubes and being lost.

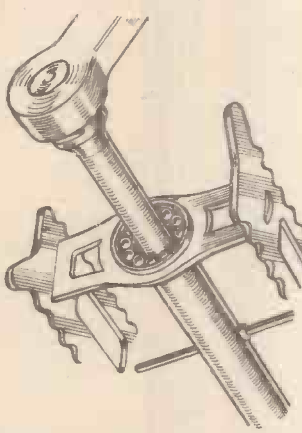
Right: The procedure in reassembling the bottom bracket bearing. Lower the spindle into the bracket after previously screwing in the offside cup from underneath, with the balls held in grease.

Bicycle

Overhauled and Adjusted in Season

ing of the wheel will tend to force the blocks from the holders when the brake is applied.

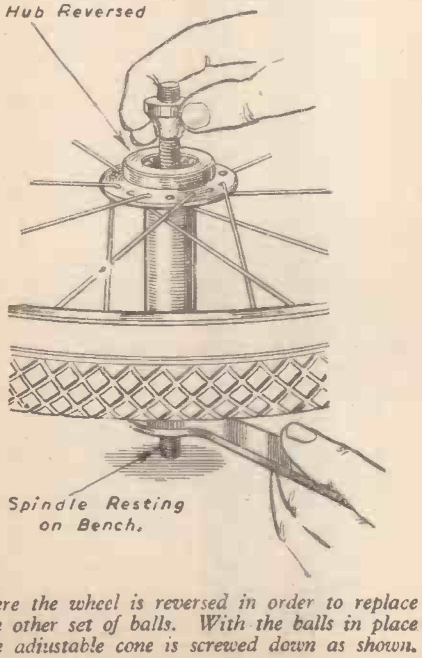
With a cable brake it is essential to attend to the cable itself before refitting. Grease should be forced liberally between the wire and the covering, to prevent breakages and to make the brake easier to apply. The stranded cable of Bowden-operated brakes



Reassembling a pedal after it has been taken apart. The steel balls in the inner cup are placed in position with grease and the spindle is lowered into position.

should be well protected when it leaves the outer casing at the brake end and at the hand-lever end.

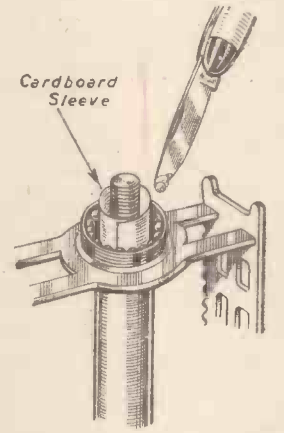
Rust generally attacks these two points, and eventually leads to the strands parting and the cable breaking. Do not let a Bowden cable leave a brake at an angle, as it will prove extremely troublesome. It should lead out straight from the abutment adjustment. If, when the brake lever is operated, it catches the edge of the hole, it will wear, thus causing a strand to break.



Here the wheel is reversed in order to replace the other set of balls. With the balls in place the adjustable cone is screwed down as shown.

Lubrication

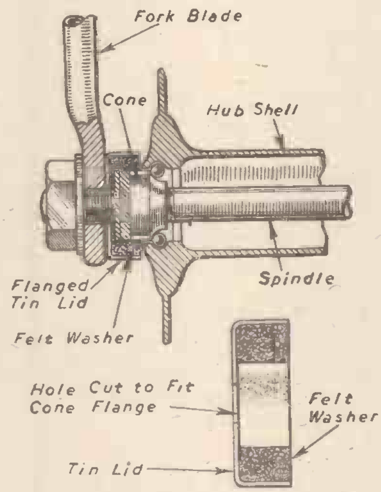
When oiling the hubs, a good quality oil of medium body is recommended. The cycle should be leaned over to one side when injecting the lubricant, as the feed cap is usually situated in the centre of the barrel. When the oil appears on the spindle-cones, spin



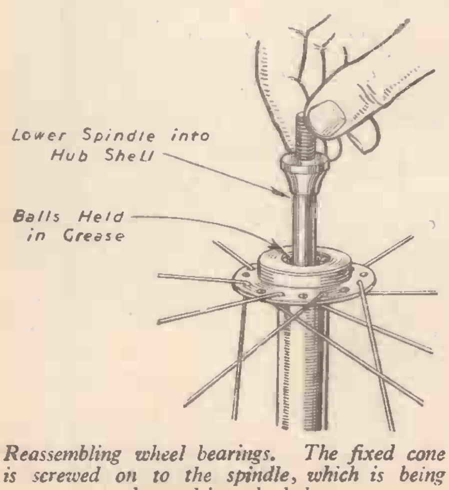
A cardboard sleeve fitted as shown will prevent the balls from falling between the cup and the spindle. The cardboard can be removed after the balls are in place.

the wheel to assist the lubricant to work thoroughly into the bearings.

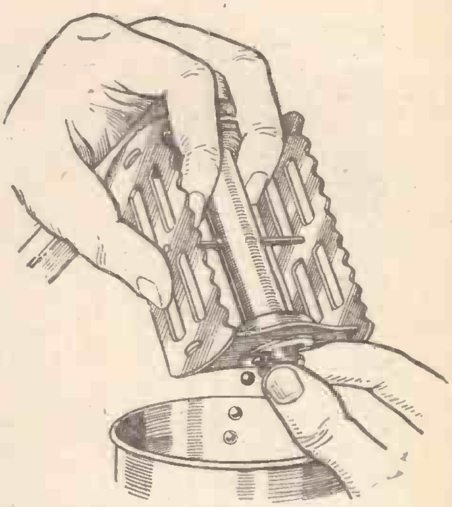
Oil hub-brake bearings sparingly, and make sure that the lubricant does not flow on



Section of hub assembly showing felt oil-retaining washers, which also exclude moisture and grit.



Reassembling wheel bearings. The fixed cone is screwed on to the spindle, which is being lowered into the hub.



Method of removing the balls from the outer bearing of a pedal.

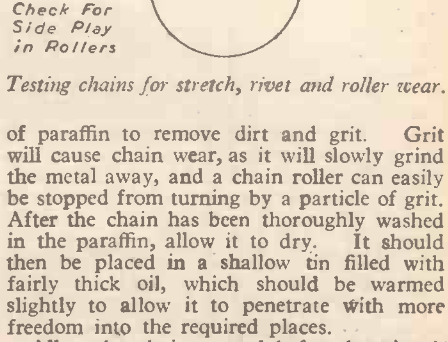
to the brake linings. A time-worn tip, but nevertheless worth mentioning, is to see that the oil does not run down the spokes, as it will enter through the nipple holes in the rim, with disastrous results to the inner tube.

The machine should again be laid on its side during the process of oiling the free-wheel. Thin oil should be used for this. It is as well, before starting on the free-wheel, to squirt a little paraffin through the oil-cap to wash out the dirty oil, which may otherwise cause the pawls to clog. The pedals should be oiled next, and should receive special attention, as they are subjected to more exposure from mud and rain than other parts.

The steering head bearings are neglected more than any others. It is a simple matter to stand the machine upright and drop a little oil into each bearing.

The Chain

Lastly, we come to the chain. This should be removed and washed thoroughly in a bath



Testing chains for stretch, rivet and roller wear.

of paraffin to remove dirt and grit. Grit will cause chain wear, as it will slowly grind the metal away, and a chain roller can easily be stopped from turning by a particle of grit. After the chain has been thoroughly washed in the paraffin, allow it to dry. It should then be placed in a shallow tin filled with fairly thick oil, which should be warmed slightly to allow it to penetrate with more freedom into the required places.

Allow the chain to cool before hanging it up to dry, and wipe away all surplus oil from the outside. To ensure that the oiling process is carried out efficiently, some machines are equipped for the use of an oil gun. By this method of lubrication, oil penetrates right into the bearings, at the same time pushing out the "dirty" oil.

Around the Wheelworld

By ICARUS

Cycles at the Festival

THE opening day of the Festival of Britain did not disclose very much to suggest that the British cycle industry had staged anything worthy of its magnitude. I was told by the Industries Press Officer that a comprehensive selection of bicycles and motor-cycles had been made for the Festival by the Council of Industrial Design at South Bank. I was informed there would be 8 motor-cycles, 20 bicycles, and 4 children's tricycles in the Power and Production Pavilion, the Transport and Communications Pavilion, the Camping Display and elsewhere. Why did not someone suggest a complete exhibit truly representative of the sport and pastime, and not merely representative of a few firms' wares?

And what has the Imperial Science Museum at Kensington done? On the opening day I rang the Museum to know what had happened to the replica of MacMillan's first rear-driven bicycle, only to be told, as I was on March 6th, 1948, that it still was not at the Museum from which it was removed to the fastnesses of Wales for safety during the war. In 1948 I was told that it was due to transport difficulties that the machine and other historic bicycles had not been returned. I have 'phoned the exhibition regularly ever since, and have been fobbed off with footling excuses.

The Imperial Science Museum should realise that it is a state-owned institution, that the exhibits belong to the British public, to whom it owes the duty of seeing that the exhibits are available. Someone there has forgotten the Festival!

Why in any case should the exhibits at the Festival be split up? Anyone interested in cycling is hardly likely to traipse round several sideshows to see the various exhibits, paying an entrance fee every time. It is a piece of absurdity, for example, to exhibit a tandem cycle in the Gallery of Metals.

R.R.A. Triennial Dinner

THE Triennial Dinner of the Road Records Association which was held at the Connaught Rooms on April 13th was a nostalgic affair for the numerous record breakers of the past who forgathered under the chairmanship of the president.

The room was not altogether ideal in that numerous pillars prevented those seated at the sprig tables from observing those at the top table. The acoustics were also very poor, but otherwise this once-every-three-year event was well organised.

The toast of the association was proposed by H. Green with a response by W. H. Townsend, the secretary. The important toast of the evening, Record Breakers Past and Present, was proposed by H. H. England in anecdotal style with responses by E. V. Brown and A. R. J. Hill, whilst Cycling, the Sport and Pastime, was dealt with, if somewhat sketchily, by S. R. Baron with responses by S. T. Capener and W. Oakley.

It is my view that three years is too long a gap and these reunions should be held at least once every two years.

Old-world Charm of English Roads

OFFICIAL publications concerning the Festival of Britain which are circulating in the U.S.A. with the object of attracting visitors to the Festival contain the following rhapsodic encomium:

"Those who are accustomed only to the stark efficiency of Continental highways, which bore their tree-lined way through the countryside, intent merely on tracing the most direct route between two given points, will be agreeably surprised by the charm of British roads. In England roads have character. They think nothing of making a detour in order to spare a tree, or to avoid cutting off the end of a cottage garden. . . .

". . . The excellent condition of the roads which serve even the most remote towns and villages in Britain is often a source of genuine surprise to the visitor. Their smooth, dustless surfaces and well-maintained edges, their reliable signposting and the care with which danger points have, as far as possible, been eliminated, all excite admiration. Here is evidence indeed of the skill and conscientiousness of the highway authorities of Britain."

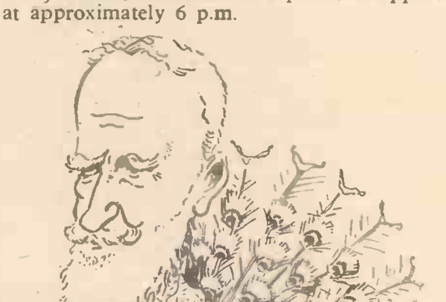
The most commendable sentiment contained in this lyrical description appears in the last sentence. Were it not for the "skill and conscientiousness of the highway authorities" many of our principal highways would have collapsed long ago owing to Government diversion of the funds intended for roadwork.

The Late Harry Parsons

HARRY PARSONS was the first man to cover 22 miles in the hour on a bicycle. He died in February, aged 79, but his real interest was motor-bicycles. He founded the Parsons Engineering Co., Ltd., Southampton, and was formerly chief designer to the Rudge Whitworth Company. In the 'nineties he built a Quad and claimed to have designed the sociable or side-by-side machine. He evidently found the cycling and motor-cycle industry prosperous, for he died worth £165,437.

The London-Holyhead

THE above race which takes place on Saturday, June 9th, bids fair to eclipse any similar road event. The course has now been measured and the total distance, including a detour at Weedon, where there is a diversion owing to bridge construction work, is 267 miles. The race will be started at 5 a.m. and a huge reception is to greet the riders at the finish on the promenade, Holyhead, where the leaders are expected to appear at approximately 6 p.m.



PShaw, Pseudo Psyclist.

The National Railways Beauty Queen will present the awards at an official function after the event. The prizes are extensive, and are of especial interest to independents and professionals, the two classes eligible to compete. The total value of the prizes is over £150. Current star of those certain to ride is Dave Bedwell, stocky five-feet Romford man, who has won all three events in which he has ridden this season. Bedwell will be well supported by clubmates Len West, current B.L.R.C. road champion, and captain of the team, Les Scales, former 5-mile N.C.U. grass track champion, Les Wade, who "makes" team wins rather than winning races individually, and Clive Parker, whose ability is only overshadowed by Bedwell.

Cycle Stands Standardised

THE British Standards Institution has just issued a British Standard for Cycle Stands (B.S.1716:1951).

In view of the variety of parking equipment for cycles at present in use the preparation of this British Standard was undertaken in order to standardise the most convenient types suitable for any particular purpose, and in order to provide guidance to purchasers, architects and others in their selection. The Standard refers only to stands constructed of steel or of concrete, but it is not intended to preclude the use of other materials and designs, some of which are the subject of patents or registration.

Performance requirements are given both for steel stands and those constructed from concrete, and appendices are included containing recommendations on the selection, spacing and maintenance of the stands.

Copies of this Standard may be obtained from the British Standards Institution, Sales Department, 24, Victoria Street, London, S.W.1, price 2s. 6d. post free.

Is Man Carnivorous?

I HAVE received the following letter from the secretary of the Vegetarian Society (National) of Manchester. I publish it without comment.

"May I comment on two statements which appeared in your May issue?

"The first is the incorrect assumption that man is a carnivorous animal. No physiologist would dare to make such a statement because the whole of man's digestive apparatus proves the contrary. The late Sir Peter Chalmers Mitchell (then secretary of the Zoological Society of London) said 'Apes and men were fundamentally vegetarian, just as otters and ferrets were fundamentally flesh-eaters, notwithstanding their readiness to eat carrots or fruit.'

"The other statement was to the effect that no vegetarian has ever achieved anything which has not been equalled at least by carnivores. To take one instance only—in the world of sport a vegetarian holds the two longest cycling records on the books of the Road Records Association—the Land's End to John o' Groats and the 1,000 miles (S. H. Ferris), and the Land's End to John o' Groats walking record is still held (since 1908) by a vegetarian (George Allen).

"The point which vegetarians wish to emphasise is that a suitable vegetarian diet is capable of supplying all the needs of man. Bad diets are chosen by both vegetarians and flesh-eaters. On the other hand, is all the sickness among flesh-eaters any credit to their diet? Our hospitals are not, by any means, full of vegetarians, but meat-eaters!"

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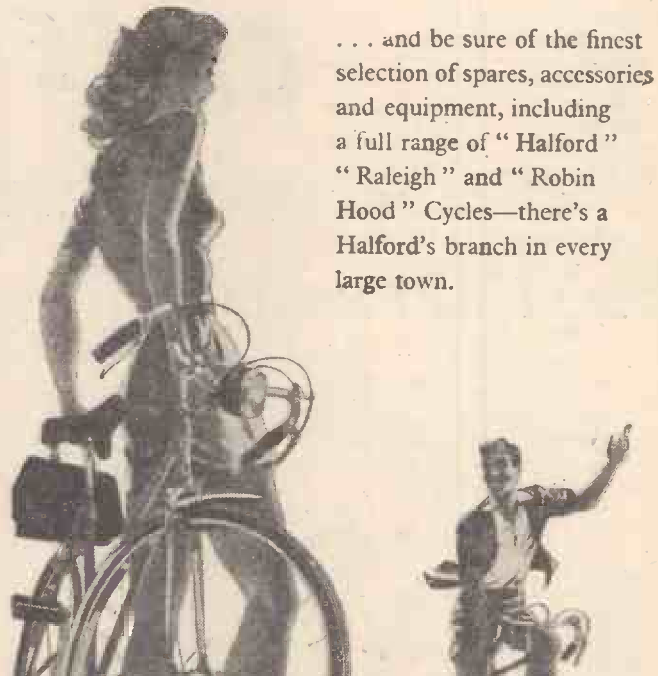

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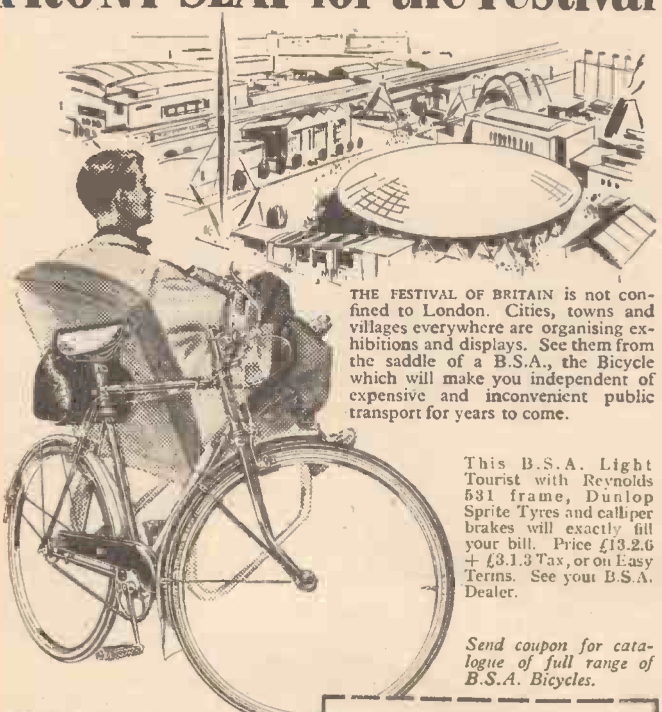

THE FESTIVAL OF BRITAIN is not confined to London. Cities, towns and villages everywhere are organising exhibitions and displays. See them from the saddle of a B.S.A., the Bicycle which will make you independent of expensive and inconvenient public transport for years to come.

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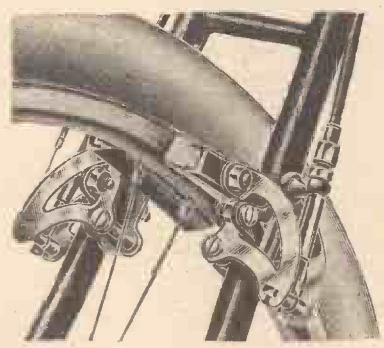

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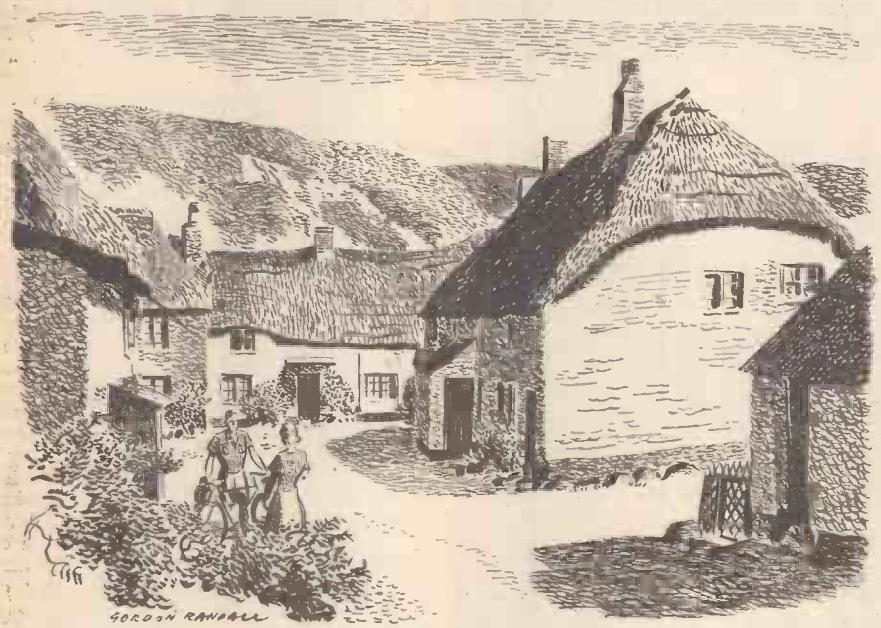
Wayside Thoughts

By F. J. URRY



Hope, South Devon.—The picturesque little fishing village with its charming thatched and whitewashed cottages.

This Weather

A COLD sticky morning wrapped up in fog, and everyone I meet swearing at the conditions, the power cuts and the discomfort. I agree a bit of a fire is very cheerful after a seven miles ride slowly and with circumspection, for it warms my feet and makes me realise there is still a sting of winter left in this weather. But have you considered how very fortunate we Britishers are in the matter of the elements, due mainly to our watery friend the Gulf Stream about which we were informed in our school days. It is, of course, part of the British temperament to swear at the weather when it rains or snows. I came to the conclusion long ago that it is the best weather in the world because it is no nicely assorted. Recently I was out in a chill temperature beautifully tempered by sunshine, the kind of day when you look for the snowdrops in the cottage gardens and think sublimely of the months to come. And to-day the dirty fog has rimmed my collar and made my eyes smart, and to-morrow—who knows?—the sun will probably be shining, and we shall have forgotten yesterday. Such variety goes on all through the year, generally without extremes to bring fear into the hearts of any of us. From month to month we seldom get long spells of any single type of weather, never long enough to weary of the sunshine, or bad enough to keep us inactive because of rain. It is a benison we too seldom appreciate, especially we cyclists, and it is just as well to think of our fortune in this respect. Added to our roads, our scenery and our history, there is no land in the world so perfectly equipped for the cyclist. I expect I am as ungrateful as most other people in cussing the weather just because it doesn't act as I desire, but the overall picture is indeed a very delightful one.

Home Is Very Good

AS I grow older I sometimes wonder why the younger folk are so keen on foreign touring. Is it a sort of kindly ostentation, this gentle brag of foreign travel, or is it, as so many of them tell us, the desire to sample other lands while their responsibilities are light, and the necessary money is not an undue handicap? I am inclined to think it is the latter, and it is difficult to criticise such decisions. When I was young, foreign travel was much more of a wheeling adventure than it is to-day, when everything is made easy for the Continental wanderers; and I must confess that when in middle life I crossed the Channel I found nothing in the matter of scenery to give any greater joy than the vistas of my own land. Perhaps that was because snow—so firmly allied to Switzerland—never had any appeal to me, for I always looked upon it, as Mark Twain said, as "merely adding another pang to winter." It was pleasant to meet other people speaking other tongues, to sample another way of life; but from the scenic angle I got no greater thrill than I can find in Yorkshire, Wales, and The Lakes, or Scotland. Many foreign-travelled cyclists seem to know much more of other lands than of Britain, and when I speak to them on this subject the reply is that they intend to "do" the home lands after they have settled down. I wonder? Many of the younger generation I know who have settled down after their foreign scampers, have, alas, given up cycling, and will never now see this best of all countries through the eyes of the cyclist. Maybe I am parochial, and love the quiet charm of my land with a native intensity unshaken, yet I often deplore the fact that so many folk I talk to know so very little about it, and give the guerdon to foreign touring without the knowledge of comparisons.

Why Cavil?

CLUB subscriptions are rising, and some of my young friends are inclined to be critical of the fact. Why? Is there anything we need with which to carry on life that has not risen? If so I don't know of it. Do you think the expense in connection with club organisation should be the exception? As a matter of fact it is the exception because it is one of those services which seeks not a profit, but the performance of a sound job which is considered satisfactory if it makes ends meet. I mention this matter because it is important. A man or girl who undertakes honorary work for the benefit of friends ought not to be subjected to financial worries as, I'm afraid, many club officials are at the present moment. Let us face the facts and be honest with ourselves. Most people at work are earning double the wages than was the case fifteen years ago, and the younger element nearer three times this amount, and yet some of them seem to think clubs can be successfully run on the old subscription. We cheerfully pay more for our tyres, our repairs, our bicycles, our fads and our touring, while our equipment in the matter of bags and mackintoshes is far more than double. But we buy them, and it is only when club subscriptions are discussed that we begin to plead poverty. It is unfair, and it seems to me a little unsporting to expect an honorary service to be the cheapest thing in the cost of living; indeed, it is a certain method to disgust that ever valuable individual, the honorary worker. I agree that many clubs are subsidised by their rich supporters, and I am glad of it; but they cannot expect such generosity without the members themselves showing their willingness to make their reasonable contributions. It seems to me this paragraph is needed to implement the appeals to reason, and the loyalty to club life.

Festival Rally

FOR the first time in the history of cycling—as far as I remember—the trade, the sport and the pastime are at one in running a Festival of Britain Rally for the propagation of cycling. This is a fine gesture to a fine game, and I am glad in feeling this gigantic show piece is bound to be a success. The dates are Friday evening, June 22nd, Saturday the 23rd, and Sunday the 24th, and the venue, the Dunlop Sports Ground at Fort Dunlop, could not, in my opinion, be bettered, for there is space and accommodation second to none. And the spot is particularly appropriate, for without Dunlop cycling could not have spread in such a spate of travel, for to my knowledge the old solid tyre would have shaken my bones too painfully to remain a cyclist at three score and ten. That, however, is by the way; the great thing is that cycling is going to get its biggest boost of the century, for the folk concerned with the enormous work of organisation mean to make this Festival Rally the occasion for putting over the story, not only on the spot selected, but through some 600 cinemas in picture form throughout the country. The aim, I understand, is to make the Rally a colourful display, attractive and variegated with items of interest for everyone, from the toddler with his trike to the octagenarian when he has returned to three wheels. Naturally, the separate items are not fully decided, and details of them will, no doubt, be given in the Press from time to time; but I understand much effort is to be expended in linking the pastime with country life, so giving the beholder a contracted vision of what cycling can mean to the public. Remember, cycling can be everyone's game, and that will be the main notion behind the Rally, to widen the appeal of the bicycle which can give you so much for so little. I hope all cyclists will note the dates. All club folk will make this fixture prominent in their run lists, for it is the rider who encourages the public to venture into a field of pleasure endless in its variety. No doubt in later issues there will be much more to tell when the arrangements are finalised; but in the meantime book the dates, and if you are keenly interested get into touch with the secretary, E. T. Bannister, C.T.C. Offices, 3, Craven Hill, London, W.2.

CYCLORAMA

By H. W. ELEY

ICKLETON. Cambridgeshire. A village of great antiquity laying close to the Essex border.

Kingdom of Birds

ONE of the many delights of country life is that it brings you close to the kingdom of birds. And many are the varieties which abound in this pleasant Derbyshire countryside. Just now, I am revelling in the return of the house-martins . . . those dainty little birds which so many people confuse with swifts. Back they come each season . . . to the very same corner in the barn or shed, taking up their residence again as if they had never left these shores for sunny climes. Soon, the swallows, diving like meteors in the sun, and gathering together, later in the year, to hold their "conferences" prior to leaving us. Chaffinches, robins, fly-catchers, yellow-hammers abound . . . and at night the tawny owl takes up his position in the tall lime tree and hoots mournfully in the dusk. . . .

A Dunlop Occasion

SCOTTISH cycling is going to be in the spotlight of publicity this year, following the all-star track meeting promoted by the Dunlop Rubber Co. Ltd. at Helenvale Park, Glasgow. An event of this nature, where leading professional and amateur trackmen compete, is bound to give a stimulus to cycling generally, and one feels bound to congratulate Dunlop on its enterprise. But the great tyre firm has always been a sponsor of "big sport" and readers may recall the famous meeting at Herne Hill, held in 1938, to mark "Dunlop Jubilee" year.

Faithful to the Bike

I RECENTLY visited the home of a "county magnate"—and his residence could quite justly be regarded as one of Mrs. Hemans' "stately homes of England." As I rode up the long tree-lined drive the magnate's big gleaming car was parked in front of the house. In a garage I saw two other fine cars. And . . . I also saw a bicycle. I inquired from my guide as to whom it belonged . . . and was told with a smile that it belonged to "His Lordship." Then my guide "opened out" and told me how "the boss" still loved a bike and, whenever he could, ignored his cars, and rode into the lanes on his cycle. Somehow, I feel that this wealthy man is not the only magnate who remains faithful to the cycle! Probably in his far-away youth he had been a keen member of a cycling club, and had never lost the magical lure of a bike . . . a road . . . and freedom!

"Safety First" in the Village

IT is quite wrong to imagine that in the "heart of the country" there is no need for "safety first" teaching. In the part of the country where I now live lorry traffic along the narrow lanes is quite heavy, for there are milk-collecting depots and quarries in the vicinity, and riding a cycle calls for perpetual alertness. We have two good enthusiasts in the safety first cause . . . the village schoolmistress and the village constable! They drill the children in the salient points of the Highway Code, and do all they can to promote safety on the roads. Come to think of it, I fancy that much more could be done in the schools: so many kiddies now ride to school, and a little intelligent teaching in school would strengthen the "lectures" given at home.

Exit the "Tramp"

HOW rarely does one meet, nowadays, a real authentic "tramp"! Years ago, as one travelled the English highways, it was impossible to go far without meeting several "wayfarers"—shod with incredible gaping boots, bundles on shoulders, tin cans (and frying pans) attached to the person with odd bits of string; picturesque . . . but quite insanitary. Miles and miles they plodded, from town to town, mostly sleeping under hedges or in old barns and sheds—occasionally "putting up for repairs" at some casual ward. I suppose that the rationing system, identity cards, and the tighter control of the individual have together spelt "finis" to tramping and tramps. I do not know, but it is singular that one may now ride mile upon mile and never see a dirty, bearded, ragged fellow squatting by the roadside, paring a chunk of cheese with a jack-knife or mending some tattered bit of his unhygienic clothing. Where have they all gone? The question is intriguing. . . .

Beechy Bucks . . . for Famous Men

BUCKINGHAMSHIRE is a county I love. I love its glorious beeches, its woods, its glades where in autumn the wood-fires burn with aromatic fragrance, its little inns. And it is a county of the great: Milton, the towering giant of English letters, lived at Chalfont St. Giles, and his cottage is still preserved there. At Olney once lived the gentle poet Cowper—and it was on the vicarage lawn where he is supposed to have tamed those hares he so loved. Turn to politics, and we find that the great Disraeli lived at Hughenden in leafy Buckinghamshire, and if we saunter around that pleasant place we shall doubtless muse upon great days and great achievements—of "Dizzy" securing the Suez Canal for Britain, of his triumphal return from Berlin, of pale primroses . . . the great man's favourite flower, still worn by the faithful when the 19th of April comes round. Finally, if we journey to Jordans, we shall be in the country of William Penn, the founder of Pennsylvania. Great names . . . woven into a lovable county, where the noble beech trees are kings, and the quiet woodland glades beckon us into their cool shade. . . .

Inn Names

MY old-time love for the English inn and its sign burns brightly still, and I am constantly on the look-out, as I ride through villages, for curious and uncommon inn names and picturesque signs. I saw a sign the other day which is new to my modest collection . . . the "Swan and Salmon." It is in ancient Derby, and I do not think I have ever seen it before. "Swans"—both black and white—are common enough. "The Three Swans" is not unusual, but the combination of swan and salmon is new to me. In previous "Cyclorama" notes I have deplored the scarcity of inn signs which have definite links with the cycle and cycling. My collection includes "The Bicycle Arms," near Rotherfield, in Sussex, but there ought to be far more inns dedicated to men of the wheel.

Kiss of the Morning

AT this time of the year wise is the rider who gets up early and cycles abroad while the earth is fresh and the air pure, and when field and hedgerow are sparkling with dew. In the country folks know that the "best of the day" is in the early morning, and I have taken a tip from old countrymen, and often ride out just as daylight comes streaking over the hills and the world is very quiet. Then it is that one sees the beauty of coppice, and meadow, and trees. Then it is that the birds sing most sweetly in the orchard and hedgerow. Then it is that the young rabbits venture from the warrens, and frisk in the first glint of the sun. An hour's ride, and I am more than ready for coffee and scones at Lilac Cottage, where Widow Cundall likes to fortify me for my ride home. . . .

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