The Wireless Constructor

6D MONTHLY

EDITED BY
PERCY W. HARRIS, M.I.R.E.

VOL. VI. JULY, 1928. No. 21.

OUR SEVEN-VALVE SUPERHETERODYNE

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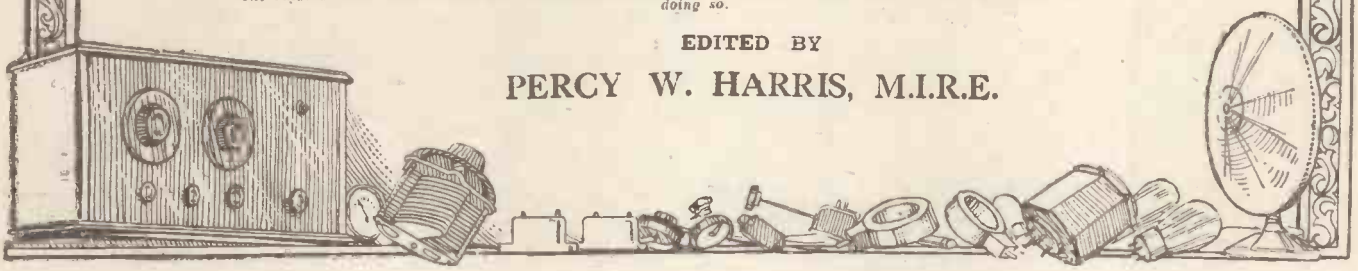
CONTENTS

As some of the arrangements and specialities described in this Journal may be the subject of Letters Patent, the amateur and trader would be well advised to obtain permission of the patentees to use the patents before doing so.

EDITED BY

PERCY W. HARRIS, M.I.R.E.



The WIRELESS CONSTRUCTOR

Edited by
PERCY W. HARRIS,
M.I.R.E.

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THE EDITOR'S CHAT

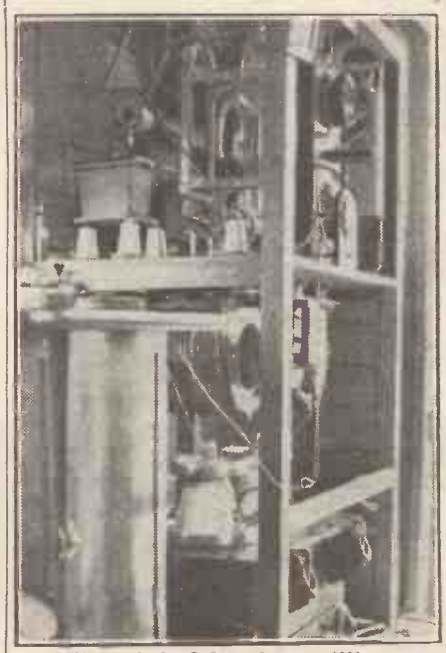
Percy W. Harris, M.I.R.E., the Editor of the "Wireless Constructor," discusses the question of receiver "test reports" with special reference to the Seven-Valve Super-Het. which he describes elsewhere.

READERS of the WIRELESS CONSTRUCTOR are well acquainted with the attitude of this journal towards what is generally called a "test report" of a wireless receiver. Long lists of stations heard on a wireless receiver, while interesting in themselves, and indicative of the powers of the receiver described, can be very misleading to the general reader unless the conditions under which they were obtained are detailed and a definition given of the terms employed. Thus while scientists and research laboratories throughout the world are continually investigating receiving conditions with the view of discovering the laws which control such matters, the valuable theories that have been put forward do not all square up with the facts or explain some of the matters which badly want elucidating.

Variable Factors

If a thousand people in different parts of the country were all provided with identical receivers, and if all were equally skilful in the manipulation of the instruments, then on a given evening the reception results would be widely different in different parts of the country. If all listeners possessed identical aerials then local conditions, such as screening, would vary the results, and even if we were able to clear away all obstacles producing screening or absorption, we should still fail to obtain uniformity.

We now know that the wireless waves not only follow the curvature of the earth, sliding round the surface with their fronts approximately vertical to the earth's surface, but that they also speed upwards from the aerial from the transmitting station, strike against the conducting layer of upper air known as the "Heaviside layer," and are reflected down again, combining or interfering with the waves which are received directly. These and other complicated effects, some of which are understood and others not, combine to produce reception conditions which in some spots are remarkably good and others exceedingly poor. Thus it frequently happens that a reader using a WIRELESS CONSTRUCTOR set is able to obtain with it far better results than were ever achieved with the original model in the WIRELESS CONSTRUCTOR laboratory. In giving a description of what a WIRELESS CONSTRUCTOR set will do, an endeavour is always made to give a general report which will indicate what the receiver is likely to do under average conditions, with the average aerial, in the hands of the average reader. It would be very easy each month to give a long list of stations with every set published, but for the reasons just explained a general test report is considered more helpful to the reader than the type which indicates the very best that can be done in ideal conditions.



A section of the 2-kw. transmitting gear fitted into one of the B.B.C.'s test vans, which has been searching for a suitable site for the new London Regional Station.

An Outstanding Set

This month, however, we are giving a detailed test report with the description of the "Seven-Valve Super-Heterodyne Receiver," with a list of stations received on five evenings' test with this set on a frame aerial of 2-ft. sides. There we have a case where all are equal in regard at least to the aerial. Every one of the stations received was logged at loudspeaker strength. Every station was positively identified, and the stations were picked up without recourse to a wave-meter or other device not generally available to the average home-constructor. In order that the stations might be identified it was necessary to listen to some of them for long periods, sometimes half an hour being occupied in the test of one station. In other cases stations announced themselves or gave evidence of identification within a minute or two of tuning in, and sometimes, too, a

The Editor's Chat—*continued*

station which was quite weak when picked up roared in with tremendous volume half an hour later. Indeed, during some of the rather lengthy periods of listening, stations faded from full loud-speaker strength down to practically a whisper and back again to the same strength as before within two minutes.

Good Quality

As pointed out in the article, all the stations were not received on one evening during the preliminary tests, but after this list had been compiled it was found possible to pick twenty-five or thirty stations on the speaker after dark on any one evening. It would be absurd, of course, to say that this number of stations was worth listening to for their programmes, for an analysis of the material being transmitted showed that a good proportion of the items consisted of ponderous talks in German, but one usually has a round dozen really good alternatives to the local station.

So far as quality of reproduction is concerned, this was found to be very pleasant and satisfactory, but it must be remembered that distant stations are often distorted by what are known to investigators as high-speed fading effects. Indeed, in investigating such effects the receiver has been most helpful, while its selectivity and the ease with which one can change from one station to another by using a calibration chart, prepared when the instrument is first made, is one of the most delightful features of the receiver. The cost—a vital point—including seven suitable

THE PORTABLE FOR EVERYONE!

Dear Sir,—Allow me to congratulate you on the results of your "Roadside Four." Its volume is excellent on London and 5 G B in the daytime. Langenberg is as loud as 5 G B after dark, tests having been made at Clacton-on-Sea, Dartford, in Kent, and also Southend, with excellent results.

I have made detail alterations as follow: the on-and-off switch, if placed at the top of side panel, allows one to carry two accumulators (an advantage when touring). The 2-mfd. condenser is placed flat against baseboard, screwed to a crosspiece of ebonite, at each side of which are placed two Clix sockets, the connections from top being made with stiff wire. The H.F. and Det. valves are covered with an ordinary rubber balloon. The case is made of light wood covered with Rexine, and four small rubber heels are screwed on base of cabinet, thus allowing the lid to be moved for direction.

Yours faithfully,
H. MEAD.

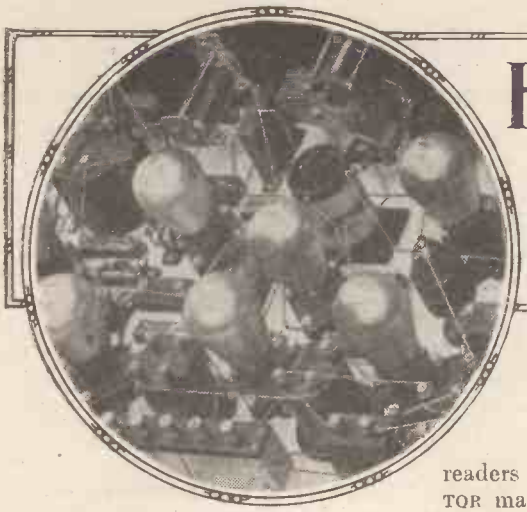
London, N.13.

valves, but excluding frame, loud speaker and batteries, should not exceed about eighteen pounds. This presumes, of course, that the reader will buy everything new, although an examination of the parts shows that most readers have a large number of them already on hand.

One of the reasons why the design of this super-heterodyne was undertaken was the great number of requests for such an instrument from the Dominions, together with the usefulness of a frame aerial in cutting out a large percentage of atmospheric interference and jamming.

A Successful Set

A WIRELESS CONSTRUCTOR set which has achieved more than usual popularity in distant countries is the "Short-Wave Three," described in the WIRELESS CONSTRUCTOR for January of this year. On another page we are reproducing a letter from a reader in India in which he describes the results he has obtained there in the reception of both the Home Country and Australia. His results are so interesting that we are reproducing them fully, showing that the reception of 5 S W was not a matter of "freaking" for a few minutes, but was such that the programme was enjoyed throughout. Many similar letters of appreciation have been received from South Africa and Australia.



HOW THE SUPERHETERODYNE WORKS

An interesting and instructive article upon the theoretical features of the famous super-heterodyne, with particular reference to the seven-valve receiver which is described constructionally elsewhere in this issue.

By PERCY W. HARRIS, M.I.R.E.

FOR some time I have been working on a super-heterodyne receiver which could be offered to WIRELESS CONSTRUCTOR readers, not as an experimental design requiring experience and skill to operate, but as a set which, in the hands of the average reader, would yield results very little inferior to those which the most experienced super-heterodyne enthusiasts can obtain. The present design is offered with confidence as a set which is easy to build, easy to operate, much cheaper than the usual super-heterodyne, and far more than usually free from the troubles which arise in the construction, operation, and adjustment of a multi-valve set. No outside aerial is used, reception being effected entirely on a small frame, and thus the flat-dweller has just as good a chance as the man with a large garden. Appearance as well as efficiency has been considered, and the pleasing lines of the set have been very favourably commented upon by those who have seen and handled it.

French Invention

The super-heterodyne method of reception is by no means new, and while the invention is generally credited to Armstrong, the American inventor, it is probably more accurate to state that it was separately invented by M. Lucien Levy, a well-known French inventor, and Major Armstrong in the United States. In this regard it is interesting to note that Standard Telephones and Cables, Ltd., who own the patents in this country, grant their licences under a Levy patent, and not under an Armstrong patent.

Contrary to the impression held in many quarters, the super-heterodyne principle is by no means difficult to understand, and, in order that readers of the WIRELESS CONSTRUCTOR may fully appreciate this set, I would like to occupy a little space with a brief explanation of its theory, so that it may be compared with other forms of reception and its real virtues appreciated.

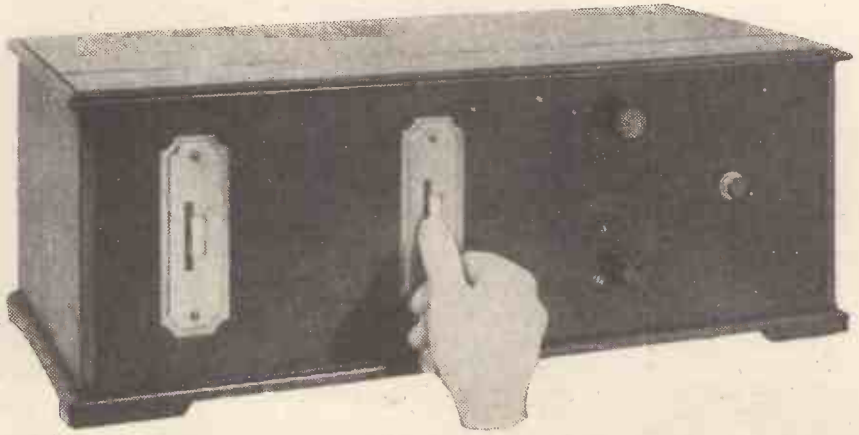
Multi-Valve Circuits

If we sort out the various multi-valve arrangements, we soon find that the differences are not so great as might at first appear. Starting our investigation at the output end, we find that in normal conditions a maximum of two low-frequency stages is used, although the last valve may be duplicated for parallel or push-pull operation. Preceding the one or two low-frequency stages we come to the detector, which obviously will always be one valve, and any further valves in the circuit will be found to precede the detector and, therefore, to be devoted to high-frequency magnification. Thus a five-valve set usually has two stages of low-frequency, a detector and two stages of high-frequency; a six-valver having an additional stage of high-frequency.

It is, indeed, the high-frequency end of a multi-valve receiver which calls forth all the skill of the designer. If real efficiency is to obtained in the ordinary circuit arrangements, each stage of high-frequency must be tuned and must, therefore, have its own tuning control, while interaction between stages, producing self-oscillation, must be counteracted by one of several methods. We have, first of all, the old "losser" method, in which self-oscillation was prevented by reducing the efficiency of amplification per stage; the neutralised method, which has a deservedly large vogue; or the more recent "screened-grid" method in which one of the chief causes of feedback producing self-oscillation is cut out by means of a new design of valve. The neutralised method and the screened-grid method are only practicable in two or more stages when elaborate precautions are taken to prevent interaction between stages.

Separate Tuning

The "losser" method is now obsolete for ordinary sets, and whether we use the neutralised method or the screened-grid method, very great care has to be taken in the layout, and we must have a separate tuning control for each stage.



The use of drum control for the condensers enables an exceptionally neat panel appearance to be obtained.

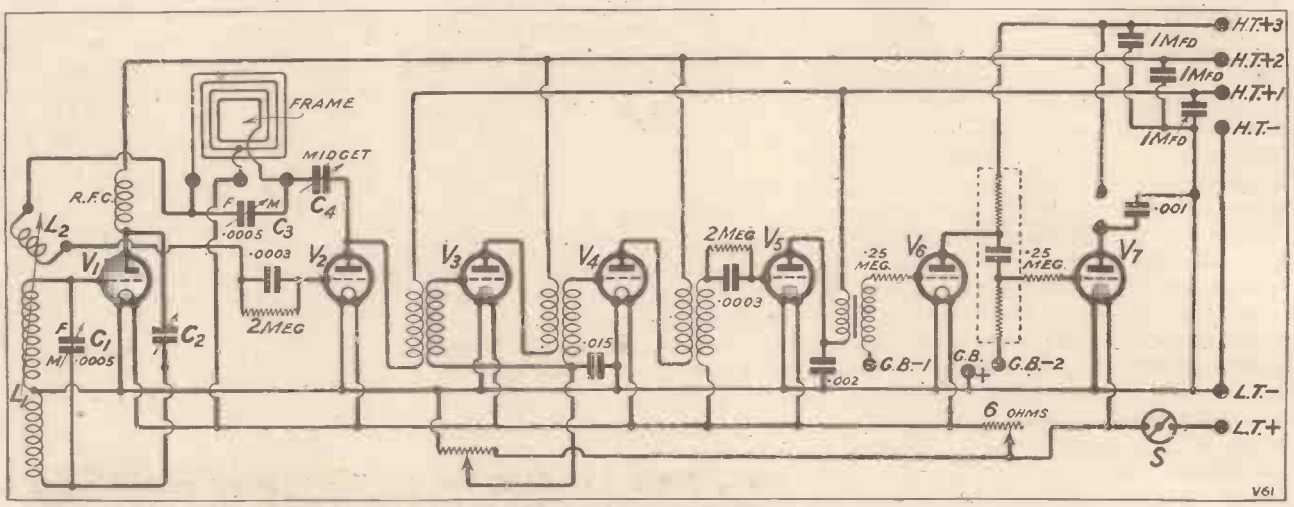
How the Super-Heterodyne Works—*continued*

Now let us consider for a moment the difficulties we are "up against" in either a neutralised or a screened-grid valve receiver having three stages of high-frequency. Firstly, we must have a tuning control for the circuit coupled to the aerial; secondly, a tuning control for the first high-frequency stage; thirdly, a control for the second stage; and, fourthly, a control for the third stage.

Gang Control

Thus there are four separate tuning controls. If our layout is carried out with extreme care, if the condensers and coils are accurately matched, and if our valves are all well-matched, then it is possible to link all the four condensers so that one dial will operate all four, but only those who have done practical work in the design and operation of such receivers can appreciate the great difficulty of accurate matching throughout.

A more reliable scheme is to use two main tuning controls instead of one, the first being for the circuit coupled to the aerial and the second for the three high-frequency stages. This gives two tuning controls, which are by no means difficult to handle. It has the great advantage of enabling a standard design of receiver to be used with practically any aerial, whereas when one control is used for all circuits the use of the set with an aerial which differs much from the electrical features of the aerial for which the set was designed will give difficulty. It is indeed usual in such sets to make the tuning of each individual stage fairly flat in order that slight variations will not give trouble. An ingenious solution of the difficulty has been adopted by some American set manufacturers who are now marketing neutralised six-valve receivers in which the first or aerial circuit is not variably tuned at all, the grid and filament being connected across a choke coil. This valve thus acts just as a "pick-up" and gives very little amplification and no selectivity itself, but as there are two tuned stages of high-frequency following this, adequate amplification and selectivity are readily obtained. The particular advantage, of course, in this scheme is that the tuned stages can be adjusted at the factory irrespective of the aerial with which the set is to be used, one tuning control being then a practical proposition. Where great accuracy of tuning is required, a slight adjustment of small "trimming" condensers is made, but a large number of stations can be picked up free from one another by the simple operation of one tuning dial.



The circuit of the 7-valve super-het. discussed in this article. The full details of its construction will be found elsewhere.

A Single Wave-Length

Obviously it would be of very great advantage if all the high-frequency stages could be made either untuned or with fixed tuning. Of course, if they were all untuned we should get no selectivity at all, and if they were tuned with fixed tuning the set would pick up one wave-length only. This would be an admirable scheme if everyone wished to listen to one particular station which would be constant in its wave-length; but such is not the case, and we must legislate otherwise.

The Super-Het.

Having considered in detail the average multi-valver and its tuning difficulties, we are now in a position to appreciate the super-heterodyne. Briefly, a super-heterodyne receiver is one in which the circuit coupled to the aerial is tuned in the ordinary way, the stages of high-frequency all tuned to a fixed wave-length, and a special arrangement incorporated in the receiver by which the wave-length we desire to receive is converted to the exact wave-length at which our high-frequency stages operate. The detector and low-frequency stages in a super-heterodyne receiver follow exactly the same lines as in any other multi-valve receiver, and therefore the main difference is confined to the frequency-changing scheme upon which we rely for our successful operation.

If you look at the front of the receiver shown on the previous page, you will see two drum tuning controls. That on the right controls the tuning condenser for the frame aerial, while that on the left controls the variable condenser on the frequency-changing device. Three other small knobs will also be seen, the first of which is the usual on-and-off switch, the second the reaction control (which is only used when we desire to work the set at its most sensitive and selective point), and the third an adjustment for controlling the high-frequency

How the Super-Heterodyne Works—*continued*

portion. This last control is seldom altered, and by simple tuning on the two dials alone, without touching any other control, a very large number of stations can be picked up on the loud speaker.

Further Advantages

The wave-length or frequency at which the high-frequency stages work being fixed, troubles of individual tuning are no longer present, and as only one variable condenser is necessary for the frequency-changing scheme we have no problems of "ganging." Furthermore, as we can choose the frequency of our high-frequency stages to suit our purpose best, we choose one corresponding to a long wave-length. High-frequency magnification at long wave-lengths is very much simpler and more efficient than on short. This gives us a further advantage.

Now let us see how the seven valves are used. Starting at the output as before, we have two low-frequency stages, a detector and four valves preceding this. Of the four, two are used for high-frequency magnification and two for the special frequency-changing scheme. You might at first think that as there are only two stages of high-frequency, a detector, and two low-frequency stages, it is rather extravagant to use seven valves to get what would be otherwise obtainable with five; but this is not really true, and the overall efficiency of this seven-valve set is greater than would be obtainable by five valves used in the ordinary way, quite apart from the very great simplicity of handling which accompanies the application of the super-heterodyne principle.

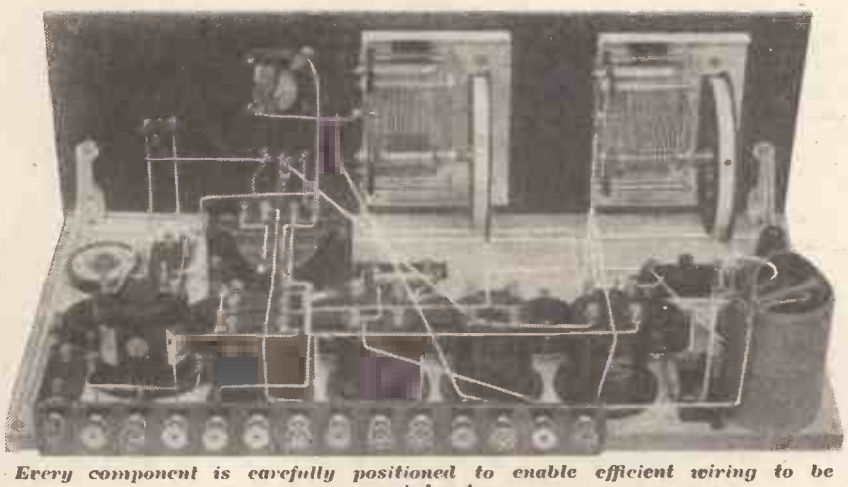
The Frequency-Changing

We must now consider how our frequency-changing scheme works. First of all, we pick up by means of the frame aerial the signals that we wish to receive. We will assume, for simplicity's sake, that these are of a wave-length of 300 metres, corresponding to a frequency of 1,000,000 cycles. Our high-frequency stages in this set (by the way, they are generally called "intermediate frequency" stages, as the frequency used is intermediate between the usual high-frequency and the low-frequency—I am calling them "high-frequency" in the present article so that they may be compared with the ordinary high-frequency stages in a set) operate at a wave-length of approximately 6,000 metres, corresponding with a frequency of 50,000 cycles. What we have to do is to convert the frequency of 1,000,000 to a frequency of 50,000 before it can be amplified by our high-frequency stages. This may seem rather a tall order, but in practice the idea is quite simple.

First of all the incoming signals induce high-frequency currents into our frame-aerial circuit. Let us now set up an oscillating valve, with a tuned circuit which can itself radiate any frequency we desire within certain limits.

How Beat is Produced

Let us arrange that it radiates a frequency of 1,050,000 cycles and that this radiation also affects the frame aerial. We shall now have in the frame-aerial circuit two currents, one of a 1,000,000 cycles set up by the incoming signals and the other of 1,050,000 cycles. True, the frame aerial will not be exactly in tune with the 1,050,000 cycles, and if the oscillator were some way away it would not affect it, but owing to the fact that it is close by and strongly coupled to the frame, the 1,050,000-cycle oscillations will force themselves in it, and so we shall have the two currents mentioned having a 50,000-cycle difference between them.



Every component is carefully positioned to enable efficient wiring to be carried out.

It is easy to understand that at a certain moment the oscillations of the two frequencies will coincide, the resultant current being at a maximum, and at other times a peak of one frequency will correspond with a depression of another and the resultant current will be at a minimum. If you have ever listened to two clocks ticking in a room, the ticks being of slightly different frequency, you will know what I mean by this. The result is that every now and again, at equally-spaced intervals, the current will rise to a maximum, the frequency of the maxima being exactly equal to the difference between the two frequencies (in this case, 50,000 cycles).

Now if we pass this mix-up of the two frequencies to a detector valve (we do this by connecting the frame-aerial circuit to a detector), the "beat note" will be picked out, and we shall have in the output side of the valve a plain 50,000-cycle current, which, of course, is just what we desire for our high-frequency stages.

The Second Detector

Actually, then, we have an oscillator valve adjusted by its tuning condenser to 1,050,000 cycles and the frame aerial tuned to a 1,000,000 cycles, the frame aerial being connected to a detector valve, the output of which is connected to our high-frequency stages. After the signals have been magnified at high-frequency they come to a second detector valve which converts them into low-frequency currents for operating the loud speaker.

The first detector serves purely for the purpose of picking out the beat frequency, and passing it into the intermediate frequency we desire for our high-frequency stages. So far we have considered a wave-length of 300

How the Super-Heterodyne Works—*continued*

metres, corresponding with a frequency of a million, and we have considered that our oscillator is adjusted to give a frequency of 1,050,000 cycles. Exactly the same effect will be obtained if our oscillator is adjusted to 950,000 cycles, for in this case the difference between the oscillator and the received signals would be just the same, namely, 50,000 cycles. If now we desire to receive a wave-length different from 300 metres, it is only necessary to tune our frame aerial to it and to readjust the oscillator condenser so that the *difference* between the frequency we desire to receive and those of the oscillator is exactly 50,000 cycles.

Easy to Operate

If our high-frequency circuits were tuned to 100,000 cycles, then the difference would have to be 100,000; the whole point being that the difference between the oscillator frequency and the frequency we desire to receive must always be exactly the same as that of the high-frequency stages we are using.

It will now be realised that the operation of tuning a super-heterodyne is exceedingly simple. First of all the frame-aerial circuit is tuned to the wave-length we want, and then the oscillator condenser is varied until the difference in frequency between it and the frame-aerial circuit is exactly 50,000 cycles. Nothing is heard until this difference is obtained, and just at the correct point (or, rather, two points, for we get two readings on the oscillator dial for every station) the signals will come through loudly on our loud speaker.

There is no need to make calculations and, indeed, there is no need to know anything whatever about the principles of super-heterodyne working in order to operate the set! All we have to do is to set the frame-aerial tuning dial at a given point and vary the oscillator dial until we hear signals.

Stable Stages

The high-frequency stages of this receiver being tuned to 6,000 metres are particularly stable, and have little of the usual tendency to burst into oscillation which characterise high-frequency stages working on the usual wave-lengths. At the same time, however, all three circuits being tuned to the same frequency *will* oscillate of their own accord unless we take some precautions to stop them, so that in the present case we use the "losser" method, which, while very inefficient on the ordinary wave-lengths, is by no means to be despised on this very long wave. The two grid circuits of the high-frequency valves, instead of coming to negative direct, are joined to the slider of a potentiometer. When this slider is at one end of its travel, the two grids are at zero potential, and at the other at the maximum positive potential of the accumulator. When the slider is at zero point, the intermediate stages oscillate, so that what we do is to turn the slider until the grids are just sufficiently positive to prevent oscillation occurring. At this point the high-frequency stages are in a very highly selective and sensitive state.

Full constructional details of the receiver discussed in this article will be found elsewhere in this issue.

Highly Selective

One of the great advantages of a super-heterodyne receiver is that it is very highly selective. It is quite easy to design a "super-het." which will tune out stations separated by only 10 kilocycles. Furthermore, as a frame aerial is used, interference is often cut out by rotation of the frame, so that the unwanted signals are coming in a direction at right angles to the frame itself, thus producing very little effect upon it. If, however, both stations are in the same line, which occasionally happens, we are entirely dependent upon the selectivity of the set itself. Extreme selectivity in a super-heterodyne, however, is always accompanied by considerable distortion, and the aim in the receiver discussed has been to give a high degree of selectivity, at the same time retaining good quality. The selectivity is such that, no matter where the set may be used—even a mile from a main station—a large number of other stations will be received free of interference. Just how close to the wave-length of the local stations other stations can be received will depend upon how close to the local station the receiver is situated; but, to give an example, in the WIRELESS CONSTRUCTOR laboratory at Wimbledon, Cardiff and Union Radio, Madrid, are receivable free of London, although the adjustments for Cardiff have to be carefully carried out to obtain clear separation. Stuttgart, Manchester, and Toulouse, on the one side, and Prague and Barcelona on the other, present no difficulty. Above and below these waves a very large number of stations are receivable at any time after dark.

Exceptional Sensitivity

I would like to draw the special attention of readers to the test report published with this set. Quite early in the experiments it became evident that here was a receiver of more than usual distance-getting properties combined with good volume. By using a good aerial, telephones for very weak signals, a wave-meter, and considerable skill, it is possible to compile a test report giving a large number of stations with quite an ordinary receiver, and I have repeatedly made it clear in this journal that reports of this nature can be very misleading. Accordingly, in preparing the list of stations received on this set, only those stations are given which were fully and properly received at loud-speaker strength.

In every case the station was definitely identified, and in every case the strength of reproduction was not less than would be considered sufficient by any reasonable person to give adequate loud-speaker reproduction in the average room. In a large number of cases the strength had to be deliberately reduced for comfortable listening. Whenever a station was picked up it was listened to sufficiently long to obtain a definite identification. This often meant prolonged listening to one station, and thus the stations received were not all picked up on one evening. Five evenings were devoted to the tests which gave the list of forty-five stations reproduced on another page.

Complete Identification

Whenever practicable, the station was observed long enough to hear the announcement of the name of the station. Twenty-three stations were identified in this way. The number would have been larger but for the fact that many stations on

(*Continued on page* 153.)

SUMMER AND SHORT WAVES

By W. L. S.

IT still is not clear in the minds of many which of the various bands of short waves may be classed as "summer" and which as "winter" waves. The whole business has been made rather more complicated than necessary by a few little misunderstandings that cropped up when short waves were first, so to speak, "laid open to the public" by the successes of the amateur transmitters who did the pioneer work.

My immediate reply to a questioner to this effect would be that none of the short wave-lengths were "summer" or "winter" waves. The difference is that to receive any particular place we must choose our wave-length according to the time of year and the amount of daylight.

That is to say, if two stations in different parts of the world wish to get into communication with each other, the wave-length on which it will most easily be done will not be the same in summer as in winter, if the work is to be done at any particular time of day. On the other hand, if the same wave-length is always to be used, a different time will have to be employed in summer and winter.

Real D.X.

Broadly speaking, the band of wave-lengths round about 20 metres is probably the most useful band at this time of year. 2 X A D and the nearer short-wave American broadcast stations are received with very great regularity, although one has in this country to sit up until about 1 a.m. to catch them at their best. In the winter they come in at a much more convenient hour—7 p.m. onwards—but are not nearly so strong or so consistent from day to day.

For real long-distance work the enthusiast cannot possibly have a better time than from about 5 a.m. till 8.30 a.m. on this wave-band. Australians and New Zealanders fairly romp in, and the Pacific coast American stations (those "6's and 7's" that were formerly considered the most difficult stations in the world to receive) may now be heard in large numbers. The month of June is probably the best in the year for these stations and this wave-length.

The 45-metre band is also in excellent trim for European stations during this month. Whereas during the winter they are not heard much after 6 p.m. or so, they continue to come through, particularly the more distant European countries, until midnight or after. By that time, returning to the 20-metre band, we can hear the Americans.

Few African Stations

Unfortunately, there are comparatively few stations in South Africa and Asia, but those few can best be heard on this 20-metre band. There is practically nothing from this direction on the other wave-lengths; on 20 metres or thereabouts, however, they may occasionally be heard at 6.30 to 8 p.m. I am referring, of course, to the amateur stations. There is no dearth whatever of commercials from the direction of Asia! The call-signs of those in Java alone would fill a complete receiving log!

The reason for the shortage of amateurs in these climes is most probably the severity of the atmospherics in the tropics.

It will be seen that the short waves have been responsible for popularising summer reception to a great extent. Although, as I have pointed out, we lose stations that we have been receiving through the winter, and find them again on a different wave-length (assuming that their transmitters are capable of operating on the second wave-length!), on the longer waves we too often lose distant stations in the winter and do *not* find them again until the following winter!

It will be interesting to hear how the summer affects the range of 5 S W on 24 metres. I believe that up to now he has not been well received in India.

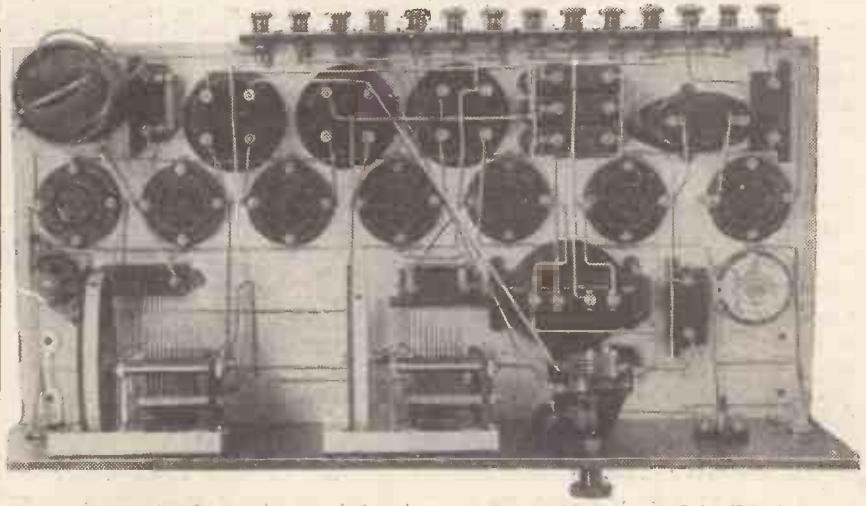
HOW THE SUPER-HETERODYNE WORKS

—continued from page 152

the Continent are relays, and with these a general announcement is made from each station of all the stations relaying the particular programme, so that positive identification of the individual station in this way is not possible. Stations of this character were first identified by their particular group, and then the relative position of the station compared with others in the same group soon identified the particular member of the group. This method was used with German and French relays. A few stations, such as Budapest, were identified by the language of the announcement, as well as by their relative positions.

Wave-Lengths Not Reliable

Relative positions, however, were never relied upon as the sole means of identification, for occasionally the Continental stations wander from their authorised wave-lengths, although these tests indicated, when a chart was afterwards prepared, a very big improvement has taken place recently in this regard. The Barcelona (Radio-Catalana) station was, however, badly out according to the position it is supposed to occupy. Fortunately, this station was one identified by announcement. Paris (Radio L L), a station which I have not heard before, was not picked up while London was working, but late one evening when a number of the French stations were giving out election results.



A general view of the seven-valve super-het, which is described in this issue.

Some typical faults and remedies reviewed.

By P. R. BIRD.

A Crystal-Set's Tricks

GENERALLY speaking, the queerest queries hide themselves in complicated valve sets, but even a simple crystal set can conceal a lot of mystifying tricks up its sleeve, as anyone who has built several of these sets can testify.

And when one does come across a mysterious trouble in a crystal set the very fact that there are so few wires and so few components make it all the more mystifying. I remember such a case occurring last December when a fellow I know decided to make up a simple crystal set for the old folks at home.

He had already built several sets for himself, including one ambitious four-valver, and although he had had his fair share of little difficulties and trials he had never failed to make one work or to get the good results he expected of it. Until, that is, he made up this "simple" crystal set.

The First Test

With the idea of keeping expense as low as possible he used a variable condenser which had previously seen service on his own valve set. For connection across this he made himself a coil on a cardboard tube, the coil having sixty turns or so with tappings for the aerial connection. The telephones, also, he had used before, and they were in good condition, so the crystal detector was the only new component, and he paid several shillings for one of the cat's-whisker variety.

As he had made a dozen such coils before and knew that the wiring would not take him long he did not start the construction of the set until a week before he intended giving it away as a present. In the course of the first evening he had completed the whole of the wiring, stuck some very neat indicators on the panel, labelled the terminals, and put the set aside, intending to give it a test the next evening. When the time came he hooked up the aerial and earth, connected the 'phones and—more for the sake of form than anything else—listened in to hear the local station.

To his surprise there was not a sound. Glancing inside revealed the fact that everything appeared to be in order, connections tight, etc., so suspicion fell on the telephones. When these were tried on the valve set they gave excellent signals, so the home-made coil came under suspicion. To make sure there was no break in this the battery test was applied, and the coil passed at every tapping with honours.

At this stage, after a good deal of cogitating, the puzzled constructor decided that it must be either a faulty piece of crystal or else something wrong with the variable condenser. First, a new piece of crystal was tried, but neither tickling nor fierce jabbing with the cat's-whisker would bring the slightest sound into the telephones.

A Wasted Evening

The upshot of this wasted evening was that a very puzzled and disturbed constructor decided he would have to buy a new variable condenser, this being the only component that he was not sure about in his own mind. Very unwillingly, the next evening he undid his careful soldering and took off the old condenser, and then put on the new one.

When all had been soldered up tight again, he connected up aerial and earth once more, donned the telephones, and with the air of a man who has at last got down to the root of his troubles he listened again. Listened hard. And listened in vain! "Not a sound was heard, not a bugle note." And, like the man in the poem, he thought to himself, "I would that I could utter the thoughts that arise in me." (But unfortunately the children were listening.)

Much as it went against the grain to give in to a simple crystal set, he had to give that one best. Either it was dumb, or obstinate, but in any case it was no good for a Christmas present as it stood, though, as he said, "there was no room in the blessed thing for a fault to hide."

Unless you have had the bad luck to come across a similar case you may find it quite difficult to believe where that fault was lurking, but one of those components never had worked and never could work, and that was the most innocent-looking component there—the crystal detector. It was a rather nice-looking little detector, with a glass shield, adjusting knob, and nice enamelled black clips for fixing it to the panel.

As is usual with crystal detectors, the clips which held the glass shield acted also as contacts for the wires to carry the connections through the panel; but in this particular case the black enamel had been applied too freely, so that between the cat's-whisker holder and the screw which carried the contact through the panel the manufacturer had carelessly

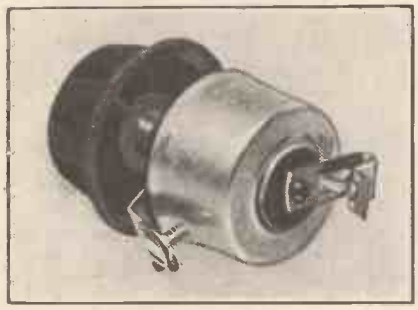
(*Continued on page* 209.)

FURTHER NOTES ON MAINS UNITS

By the Editor

Some interesting facts concerning fixed condensers and resistances suitable for use in mains units.

OUR series of articles on mains units, how they work and how to build them, published during the last few months, has brought me much interesting and gratifying correspondence from readers. In addition, it has been the means of bringing to my notice the most recent progress made by a number of firms, not only in this country, but abroad.



A neat variable resistance of the compression type—the Clarostat.

Size and Capacity

There has been a certain amount of heartburning in certain quarters regarding the photograph which appeared in the May issue on page 17, entitled "Condenser Comparisons." The condensers are of widely different sizes, and I thought it was quite clear that the main object of the photograph was to show that the leading makers' mains condensers were considerably larger than the same makers' condensers for purposes such as shunting across high-tension batteries where they are not submitted to such a strain. No mention was made of the actual capacity of the larger units shown, nor of the voltages at which they had been tested, and it was not intended in any way to suggest that any one make of condenser was larger or smaller than that of a rival maker for the same capacity and mains test voltage, which brings me to a further point I would like to emphasise regarding mains condensers and their intelligent use.

The increasing adoption of moving-coil speakers requiring high-quality amplifiers to work them has led to a steady increase in the voltage applied to the output valve of a set, and it is by no means uncommon to find valves such as the L.S.5A and B.12 used with 400 volts on the plate. This means, as I have been careful to show in previous articles, that an even higher voltage than this is actually applied to the input filter unit, and that any sudden interruption of current in the output circuit may bring about a surge of voltage which may momentarily rise to a very much higher figure than the 400 volts desired. Thus with high-voltage valves the mains units must be designed to use not only special mains unit condensers, but mains unit condensers designed to work on really high voltages, far higher than those to which they would be subjected in a small eliminator designed to give a maximum of 150 to 200 volts to a receiver.

Improved Condensers

The Telegraph Condenser Company, who claim to be the first to place on the market some years ago a range of condensers tested for 600 volts D.C. for mains units, have recently introduced modifications into their range, the first being the reduction of the size of the condensers, the second an increase in the test voltage from 600 to 800 volts D.C., the maximum working voltage being 400. Specimens of these condensers have now been submitted to the WIRELESS CONSTRUCTOR laboratory.

High Voltage Tests

Messrs. The Dubilier Condenser Co., Ltd., who also have a very high reputation in the manufacture of condensers for mains units, are able to supply condensers of quite reasonable size and price suitable for working on high voltages such as those mentioned at the beginning of this article. The specimens submitted to the laboratory have been tested by the makers at 1,200 volts D.C., and have a maximum working voltage of 600 D.C. or 400 A.C. The size of an 8-mfd. condenser to this specification is but 4¼ in. by 2⅛ in. by 4¾ in. high; the 2-mfd. type being smaller, in proportion to its capacity.

Kroblak mains resistances are manufactured in very convenient sizes.

Further Notes on Mains Units—*continued*

It is not only home constructors that I would warn against unsuitable condensers. I opened up a mains unit, now sold in this country, the other day and found that the condensers used were the ordinary small Mansbridge type which the makers would be the last to recommend for the purpose. While the eliminator worked satisfactorily, it is impossible to conceive that it can continue for long without breaking down, particularly if the user was in the habit of changing his voltages frequently, thus submitting the condensers to the surges to which I have referred.

A Useful Type

In this case, of course, the manufacturer had obtained compactness in his instrument by sacrificing efficiency and by cutting his margin of safety. Compactness, however, can be obtained in such units without any sacrifice of safety or efficiency provided one obtains the right design of component for the purpose. For example, consider the multiple T.C.C. condenser shown in the accompanying illustration. It measures 5 in. by 2½ in. by 5 in. deep, with a total capacity of 16·2 mfd., made up of one condenser of 8 mfd., two of 2 mfd. (these three are for the filter itself), three of 1 mfd. (for shunting across the output tappings), and two of ·1 mfd., which are necessary in the gas-filled rectifier types of unit for shunting across the two halves of the high-voltage transformer windings.

A new super-power wire-wound resistance specially made for mains units.

This particular condenser is designed to work at 250 volts A.C., and thus is very suitable for the Raytheon type of rectifier previously described. An adequate factor of safety is provided, for the condensers are tested at 500 A.C., which means they will stand considerably more than this at direct current pressure, an A.C. test being much more drastic than one of the same D.C. voltage.

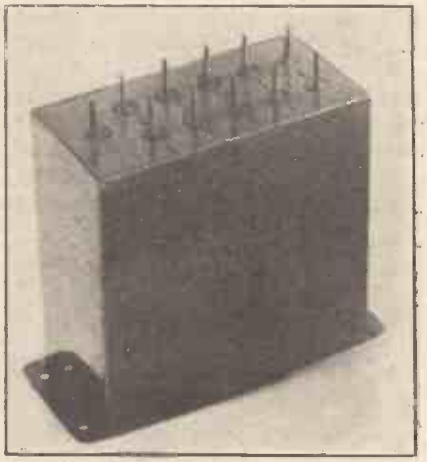
Controlling resistances on the output side are always rather a problem in a mains unit, as they absorb a good deal of energy which must be dissipated as heat. A very well-designed resistance for mains units submitted to the laboratory is the R.I.-Varley Super-Power wire-wound resistance, which is so designed as to allow a maximum of air circulation around the windings, and has metal fins which further aid considerably in dissipating the heat which is generated in the resistance. Various values are obtainable and they are interchangeable in the standard clips used by this company for their wire-wound anode resistances.

Satisfactory Resistances

Another very satisfactory series of fixed resistances which we have been using in our experiments is the "Kroblak," shown in an accompanying photograph, and sold in this country by Wholesale Wireless Company. The Kroblak resistances can be obtained in a wide variety of values, and are wire-wound on a fireproof tube. After the winding is finished the whole unit is encased in vitrified enamel, so that the appearance of the finished article is that of a small black porcelain tube with substantial soldering lugs at each end. These resistances have been used for many hours at a time, carrying so much current that the temperature of the resistance has risen to a very high figure, but in all cases they have stood up well to the test, and measurements afterwards have shown that the resistance has remained constant.

Another form of resistance which has attained considerable popularity in the United States is continuously variable by means of a knob, and one of these, the "Clarostat," has been submitted by Messrs. Claude Lyons, of Liverpool, who are the British agents. The Clarostat is of pleasing appearance, with a well-designed knob which has to be turned two or three times to take the resistance from maximum to minimum value.

The minimum of the variable submitted to us proved to be in the neighbourhood of 1,000 ohms, while the maximum was many megohms; progress from minimum to maximum being quite smooth. The resistance material is apparently a mixture of carbon and powdered mica, pressure on the mass decreasing the resistance by bringing about a more intimate contact between the carbon granules. On this pressure being released, presumably the tiny mica flakes act as a multitude of minute springs, separating the carbon again and increasing the resistance.



A valuable component is the T.C.C. block condenser with which a large number of different capacities may be obtained.

Mains L.T. Units

Next month I hope to tell you something of the problems which have been faced and overcome in evolving satisfactory mains units to supply filament current. There are several different ways of doing this, and one of the most popular is to use a special type of valve in which the heater which produces the electronic emission is heated by "raw" A.C. Experience with these valves shows, however, that it is better partially to smooth the current before feeding it to the valves, but more of this later.

BUILDING A 7-VALVE SUPERHET

By PERCY W. HARRIS M.I.R.E

This "last-word" receiver is the outcome of a considerable amount of research and experiment on the part of the author to discover a design for a superhet, that can be guaranteed to give exceptionally good results in the hands of the home-constructor. It embodies a novel design of oscillator-coupler which has very definite advantages over the types usually associated with this class of receiver.

Elsewhere will be found a special article on the theoretical side of this magnificent set.

THE list of components given in this article is that actually used in the receiver. The experienced constructor can vary many of these at choice, but the beginner should confine himself to the list and the suggested alternatives. Remember that a super-heterodyne receiver of this kind has to be designed as a whole, and that the layout has been very carefully considered and worked out to obtain the results desired.

One novelty in this instrument is the oscillator coupler, which I designed specially for this set, and which is astatic, so as to have a very limited field. It has a very definite advantage, for the frame aerial can, if desired, be stood immediately over it without unwanted interaction taking place. It is very simple to make, although those readers who prefer to buy it ready-made can now purchase it ready-wound for use from one or two firms advertising in this journal.

Drum-controlled variable condensers are used in this set, but if desired the ordinary type can be used. The front panel measures 21 in. by 7 in.—exactly the same size as that of a popular three-valver, the design for which is issued by a firm of valve makers. Full instructions for cutting the panel to take the drum controls are issued with the condensers themselves.

The First Step

The first step should be to mount the two variable condensers, the on-and-off switch, the reaction condenser, and the potentiometer, on the front panel, attaching at the same time the two brackets to the front panel so that the complete assembly can be stood against the baseboard when

FORTY-FIVE STATIONS ON A FRAME

Station Name	Frame Condenser Reading	Station Name	Frame Condenser Reading	Station Name	Frame Condenser Reading
Vienna	172	Berne	121	Bournemouth	82
Freiburg	170	Aachen	116	Breslau	81
Budapest	167	Hamburg	115	Dublin	80
Milan	165	Toulouse	112	Newcastle	77
Munich	162	Manchester	110	Belfast	74
Brussels	152	Stuttgart	108	Koenigsberg	73
Daventry (5 G B)	148	Union Radio Madrid	106	Hanover	68
Berlin	146	Paris Radio LL	104	Rennes	67
Lyons	143	Leipzig	103	Lyons	63
Langenberg	141	London	100	Cologne	60
Rome	133	Cardiff	97	Bordeaux	52
Bruenn	132	Prague	95	Malmo	47
Barcelona (Catalana)	131	Barcelona	92	Munster	40
Frankfurt	127	Petit Parisien	90	Nurenberg	32
Kattowitz	124	Gleiwitz	83	Stettin	30

NOTE.—All above were received at loud-speaker strength on a frame aerial, and were positively identified by announcements of name of station, programme items, or other unmistakable indications.
Six-volt valves. H.T.+1=60 volts. H.T.+2=90 volts. H.T.+3=120 volts.

Building a 7-Valve Superhet—*continued*

it is desired to check up the positions of the components. Do not yet attach the panel with its brackets to the baseboard.

Now lay out all the parts in exactly the positions shown on the baseboard and screw them in position. When this is done you can need a small piece of round wood, which can very conveniently be a piece of the stiffening stick inserted in the packets of Glazite wire.

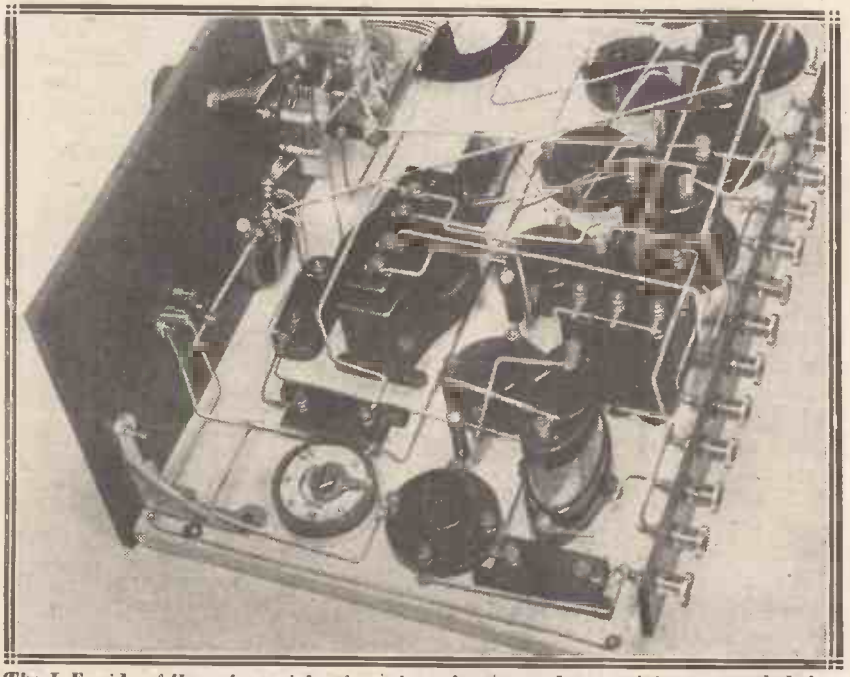
The first step is to pierce the former and wind the two windings shown according to the drawings. Take particular care to wind the two halves connection at the beginning and end of each winding, and then when the windings are complete solder the two middle ends together.

The rotary portion has a winding of twenty turns on the 2-in. former. After you have secured the two ends, take a sharp instrument and part the

COMPONENTS REQUIRED

Panel, 21 in. × 7 in. × $\frac{3}{16}$ in. or $\frac{1}{4}$ in. (Pilot, Radion, Becol, Ebonart, etc.).
Cabinet with 10-in. baseboard (Cameo, Caxton, Artcraft, Pickett, Raymond, etc.).
2 Panel brackets, small type (Magnum, Cameo, Peto-Scott, etc.).
Ebonite strip, 14 in. × 1½ in.
14 Indicating terminals: Aerial (3), L.T.+, L.T.—, H.T.—, H.T.+1, H.T.+2, H.T.+3, G.B.+, G.B.—1, G.B.—2, L.S.+, L.S.— (Eastick, Belling-Lee, Igranic, etc.).
2 Drum condensers, ·0005 mfd. (Cyldon).
1 Potentiometer (Lissen, Igranic, Peto-Scott, etc.).
1 Micro condenser, panel-mounting type (Igranic).
1 On-and-off switch (Lotus, Igranic, Duco, Lissen, etc.).
7 Valve sockets (Lotus, Benjamin, Bowyer-Lowe, etc.).
1 Calibrated rheostat, 6-ohm (Igranic, Magnum, Bowyer-Lowe, etc.).
1 Fixed condenser, ·001 mfd. (Dubilier, Lissen, T.C.C., Atlas, Mullard, Igranic, etc.).
2 Fixed condensers and clips, ·0003 mfd. (Dubilier, Lissen, T.C.C., Atlas, Mullard, Igranic, etc.).
1 Fixed condenser, ·002 mfd. (Lissen, Dubilier, T.C.C., Mullard).
1 Fixed condenser, ·015 mica (Dubilier).
3 1-mfd. Mansbridge type condensers (Lissen, Dubilier, T.C.C., Ferranti, Mullard).
2 Grid leaks, 2-megohm (Dubilier, Lissen, Mullard, etc.).
2 250,000-ohm grid leaks (Pye, see article).
1 Adjustable baseboard condenser, ·00003 to ·00025 mfd. approx. (Formo, Igranic, Rothermel).
1 R.F. choke (Magnum, R.I.-Varley, Lissen, Marconiphone, etc.).
3 Super-heterodyne transformers (Marconiphone).
1 R.C.C. unit, type A (R.I.-Varley, Mullard, or other wire-wound type for valves of 25,000 to 50,000 impedance).
1 L.F. transformer (Pye 2·5 to 1, R.I.-Varley, Mullard, Marconiphone, Ferranti A.F.3 or A.F.5, Igranic, Royal, etc.).
1 Tube, 2½ in. diameter × 3½ in. long (Atlas "Pirtoid").
1 Tube, 2 in. diameter × ⅞ in. long (Atlas "Pirtoid").
1 Centre-tapped frame aerial (Rothermel Bodine, or Peto-Scott).
No. 24 D.C.C. wire.
6 H.F. type valves.
1 Power or super-power valve.

proceed to the construction of the oscillator coupler. For this you will require a Pirtoid tube 2½ in. diameter by 3½ in. long, and a piece of tube 2 in. diameter and ⅞ in. long for the rotating portion, and a quantity of No. 24 D.C.C. wire. You will also *in opposite directions*. The beginning and end of each winding is secured by threading the wire through three holes (into one, out of the other, into the third, and back out through the first hole, pulling the wire quite tight). Leave about half an inch for winding between the tenth and eleventh turns, piercing a hole in the former. Do the same on the opposite side, then gradually enlarge the holes without injuring the windings, so that they are forced apart. You will then be able to push the wooden rod through both holes, leaving it projecting at each end for about half an inch.



The L.F. side of the set consists of one transformer and one resistance-coupled stage.

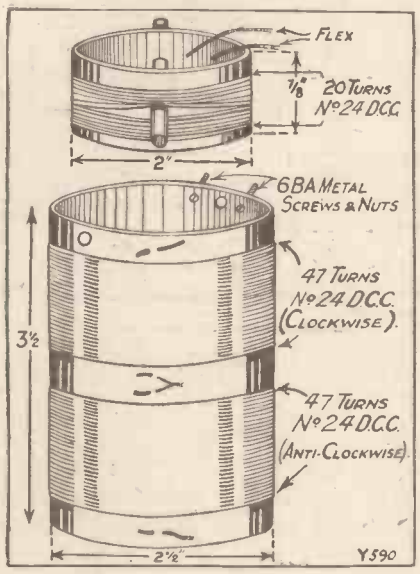
Fitting the Pick-Up Coil

The next step is to cut the wooden rod accurately so that it will just fit inside the end of the larger tube. When you have cut this to exact size, carefully drill a small hole in each end of the rod, and then make corresponding holes in the end of the larger tube, so that two thin brass nails can be pressed in, one at each side, to form the pivots. The 2-in. tube will then revolve in the end of the larger tube if desired. This is the "pick-up" coil for the local oscillations and is connected to the grid of the first detector.

It is a good plan after the windings have been made (taking care to wind the wire on tightly with turns touching) to bake the coils in a warm but not too hot oven and then to paint all windings with a good quality shellac varnish, replacing the coils in

Building a 7-Valve Superhet—*continued*

the oven to dry the varnish. This treatment has two advantages, the first being that the coils are properly waterproofed, and the second that all turns will be kept securely in place.



Two 6 B.A. metal screws are passed through holes with the countersunk heads *inside* the larger tube. They are then locked tightly in position by a lock-nut on the outside of the former, which draws the countersunk head of each screw into the material of which the former is made, making it practically flush with the inside. This prevents the rotating coil fouling the screw and possibly causing a short-circuit. Be particularly careful that no parts of the screw or the lock-nut come in contact with the windings on the larger former. To make quite sure that this does not happen it is not a bad plan to put an insulating washer of waxed cardboard between the lock-nut and the former itself, using a smaller brass washer between the lock-nut and the insulation.

A Peculiarity

After the screws have been fixed securely in place tin them, solder flexible wires to the two ends of the moving coil and join the ends to the screws. A neat job can then be made with stiff wiring from the oscillator to the parts to which it is joined.

It will be noticed that three supersonic transformers are used, all of the same pattern. This is rather a "break-away" from the convention that one of the supersonic transformers must be of what is called the "filter" type, tuned with a fixed condenser either inside the casing or externally, while the others are of a fairly flatly tuned type. The Marconiphone supersonic transformers are so designed that when the three are used together tuning is sharp enough to be thoroughly practical, yet not so sharp that distortion arises from too peaked a curve. Again, in the low-frequency side it will be seen that the combination of transformer and resistance coupling is different from normal, for whereas generally we follow the detector with a resistance stage, coupling the first low-frequency valve to the second by a transformer, in the present case this procedure is reversed.

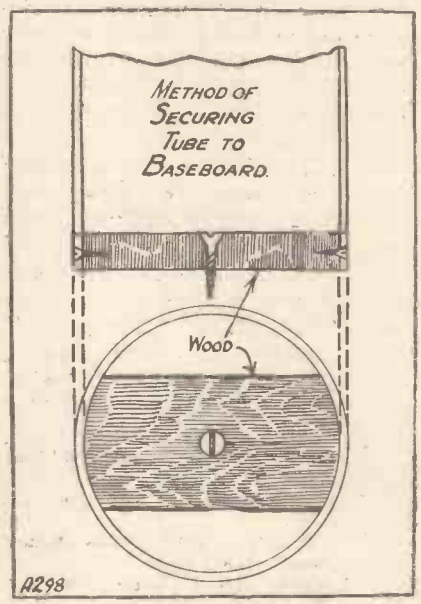
Vital Feature

This point and a number of others regarding the design I shall discuss next month, but before going further I should like to say most emphatically that this order of a transformer followed by a resistance must be adhered to if this set is to work properly. The rules which apply in ordinary types of receivers do not necessarily apply in supersonic designs.

For reasons which will also be discussed next month, the primary of the low-frequency transformer is shunted by a condenser of ·002 mfd.

The special astatic oscillator coupler designed specifically for this set.

(a considerably larger value than usual), while the loud-speaker terminals are shunted by a ·001-mfd. condenser and the potentiometer by a ·015-mfd. condenser between



the slider and negative L.T. Only one filament resistance is used, this controlling the first six valves.

It will be noticed that between the grid terminal of the low-frequency transformer and the grid of the first low-frequency valve, as also between the grid terminal of the resistance coupler and the grid of the output valve, are placed ¼-megohm grid leaks. I have used the Pye leaks for this purpose because, in addition to being good in themselves, they are made with extension wires at each end.

Soldering Leaks

One end of this wire can be soldered directly to the grid terminal of the valve holder, while the other can be soldered to the wire coming from the transformer or the resistance coupler, thus obviating the necessity of a grid-leak holder, and making a very neat and compact scheme. Other makes of ¼-megohm grid leaks can be used, but the ordinary grid leak must be used in a holder, and no attempt should be made to solder wires to the brass end-caps, otherwise the leaks may be destroyed. In the case of the Pye leak there is a wire already soldered on to each end, which makes the attachment a very convenient process.

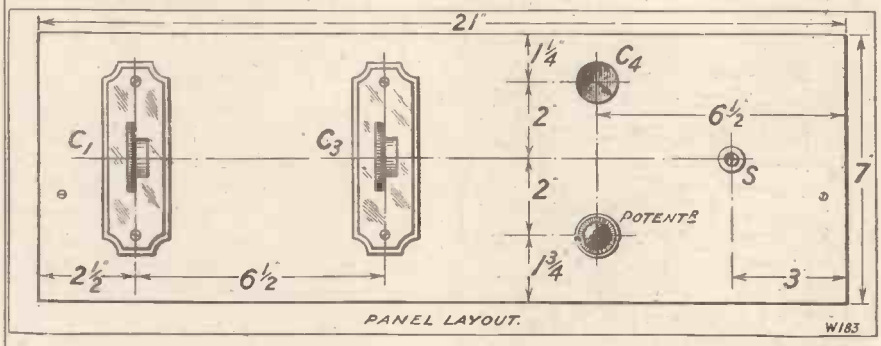
Building a 7-Valve Superhet—*continued*

The oscillator uses the Hartley circuit with a centre-tap on a coil which has its two halves wound in opposition so that the exterior field is extremely restricted. This, I believe, is a novelty in super-heterodyne design, and no doubt partially accounts for the very stable working of this instrument. The reaction condenser of the Hartley circuit is a small baseboard adjustable condenser. I have used a Formo with a maximum capacity of ·00025 mfd. and a minimum of ·00003 mfd., used near minimum, but the value is not at all critical, and can be varied through quite a wide range without substantially altering results.

Simple Wiring

The layout of parts is such that the wiring is quite a simple matter, and more than usually detailed photographs have been provided to show just how the wires go. It is worth while taking pains with this set to make the wiring quite neat, and those who do not care for soldering will find that practically every component is fitted with terminals. The battery connections on the terminal strip are so arranged that the leads from them to the components in the set are as short as possible, and examination of the wiring of the supersonic transformers shows that these leads, too, are especially very short. The leads from the variable condensers to the oscillator and the frame-aerial terminals at the back are somewhat longer, but a neat job of this wiring can be made by careful study of the wiring diagram and the photographs. Notice that the frame of the oscillator condenser is joined to filament. This must only be done with this particular make, as the frame is not in electrical connection with either set of plates. It is advisable in this set to use insulated wire, such as Glazite, and to take all precautions possible to prevent short-circuit, for no one can face with equanimity the loss of seven valves through a wrong connection. For this reason, when you have wired up the receiver complete, check over every wire most carefully with the wiring diagram.

A centre-tapped frame is used with this set, and for my tests I have used the Bodine, but Messrs. Peto-Scott also make an excellent frame well suited to this receiver. For those who want to make their own, full details of how to wind a frame suitable for this set was given in last month's issue in connection with "The Diamond Three." A centre-tapped frame *must* be used.



PANEL LAYOUT. W183

An Important Point

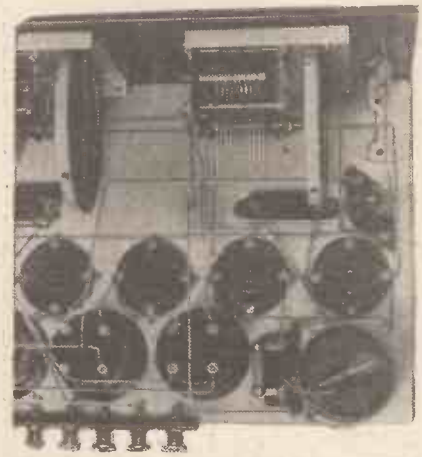
The choice of valves is important in any super-heterodyne, and for the very best results valves should be matched for the purpose. In order to overcome difficulties in this direction, I have designed the set so that the same type of valve is used throughout, with the exception of the power output valve. One thus has six valves of one type out of which one can pick the best pair for the important radio-frequency stages. Valves which may not exactly match in these two stages will be perfectly satisfactory elsewhere in the set, and a little later I will tell you how to match the valves yourself to make sure that they are quite suitable for the purpose.

The valves then should be, in the 6-volt range (which I recommend for this receiver, although it will work quite satisfactorily with 2-volt types): Marconi or Osram D.E.L.610 for the first six and a D.E.5 or D.E.5A for the output valve, preferably the latter if you are prepared to use more H.T., such as this super-power valve requires. In the Mullard range of valves the first six should be the P.M.5X, and the output a P.M.6 or a P.M.256, these being


A "close-up" of the oscillator coupler and the oscillator valve. Note the H.F. choke on the right.

Building a 7-Valve Superhet—*continued*

power and super-power valves respectively. In the Cossor range the 610 H.F. and a 610 L.F. or the Stentor Six for the output. In the Six-Sixty range, the S.S.6075 H.F. and the 610P. or 625 S.P. respectively;



The valve holders and the intermediate transformers are laid out in two parallel lines.

and in the Ediswan range the H.F.610 or the P.V.5.D.E. respectively, with the corresponding 2-volt valves of the same makes if it is desired to run off a 2-volt accumulator. Better results will be obtained with the 6-volt valves than with 2, but at the same time those who are compelled to use 2-volt valves should not let this fact hinder them in building the receiver, for using the 2-volt valves throughout I have received twenty-five stations on the loud speaker in one evening.

Preliminary Adjustments

And now for preliminary adjustments and testing. Put your reaction condenser (the small micro condenser mounted on the panel) at minimum. Put the adjustable winding on the oscillator so that its windings are parallel with the windings of the larger former, turn the potentiometer knob as far as it will go to positive (anti-clockwise position), connect up your batteries, putting 54 to 60 volts on H.T. positive 1, about 90 volts on H.T. positive 2, and 120 on H.T. positive 3. The grid bias for G.B.1 should be about one and a half or three volts, and on G.B.2 the value recommended by the maker for the valve you use as an output valve. Put the power output valve in the last socket and "H.F." valves in the fifth and sixth sockets, these being the second detector and the first note-magnifying valve respectively. Join up your loud speaker, but do not trouble to join up the frame aerial, although you can do so if you desire—it will not affect the preliminary experiments.

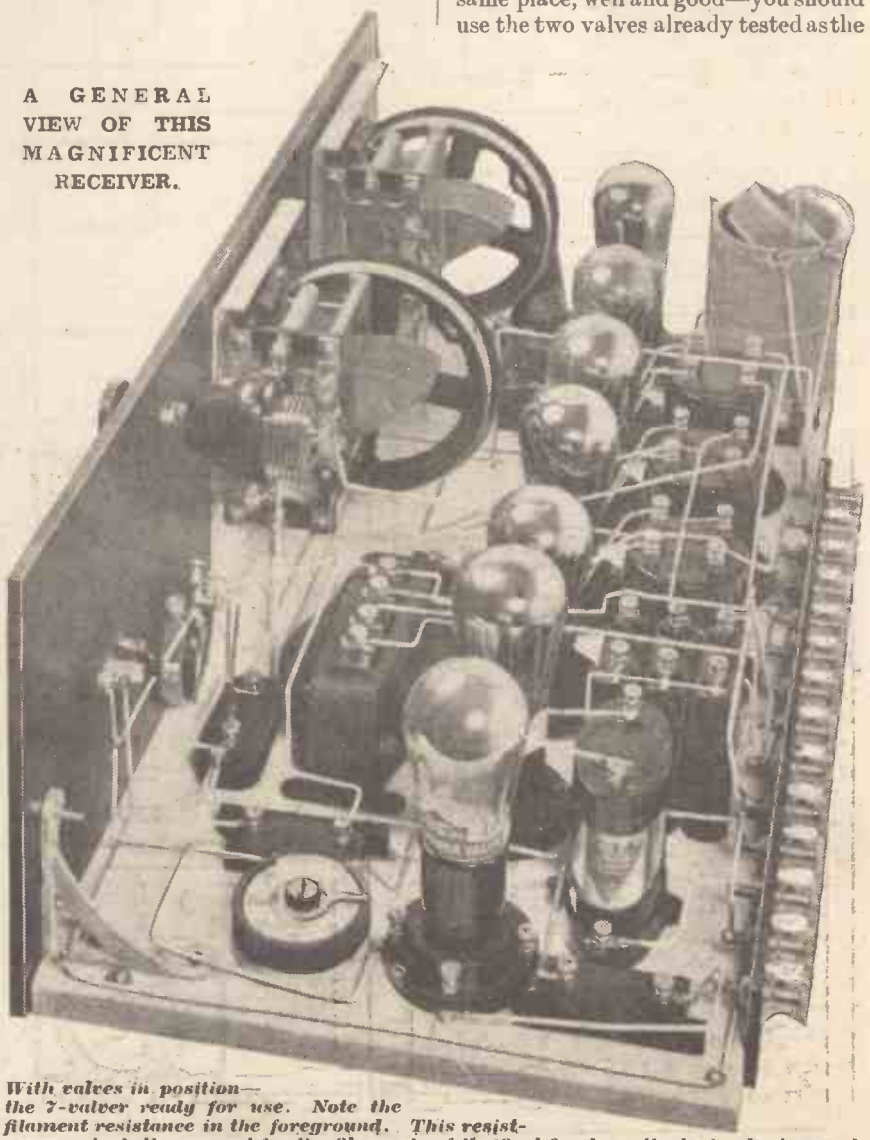
Testing for Oscillation

After you have switched on, tap the detector valve with your finger-nail and you should hear a slight ringing in the loud speaker which will indicate that your two L.F. stages are functioning properly. Now place a valve in the fourth socket and slowly turn the knob of the potentiometer in a clockwise direction. You will soon come to a point where you will hear a click, indicating that the set is oscillating, and as you turn the knob back the click will appear again as the set goes out of oscillation. Turn the knob backwards and forwards two or three times so as to determine the point where the click starts.

Matching the Valves

Make, if you like, a tiny mark on the panel with a pin point to show the position of the knob pointer where oscillation starts. Now withdraw this valve and place a second one in the same socket, again noting where oscillation starts. If it starts in exactly the same place, well and good—you should use the two valves already tested as the

A GENERAL VIEW OF THIS MAGNIFICENT RECEIVER.

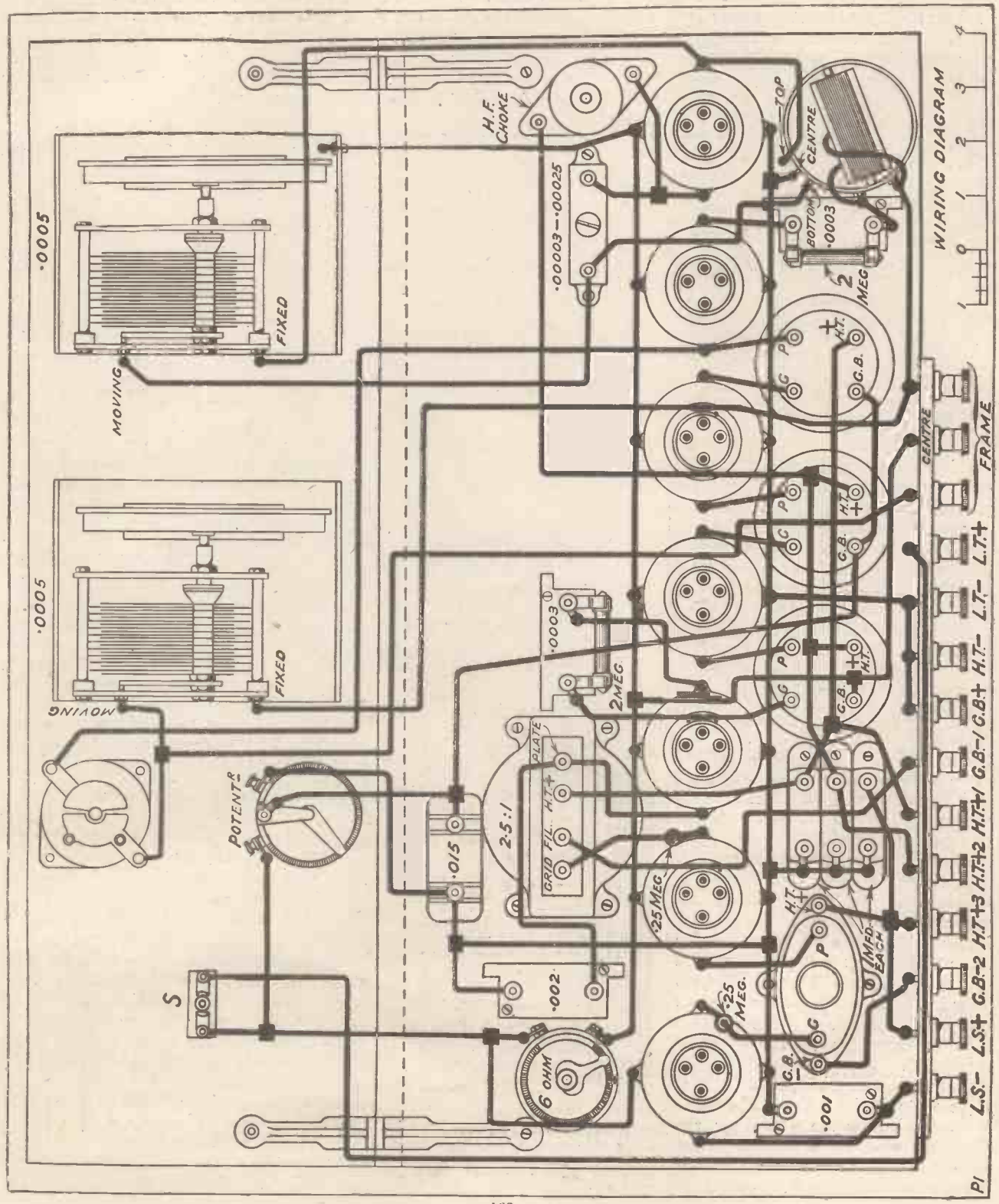


With valves in position—the 7-valver ready for use. Note the filament resistance in the foreground. This resistance controls the current for the filaments of the first 6 valves, the last valve (nearest the camera) having the full voltage across its filament, thereby needing no resistance.

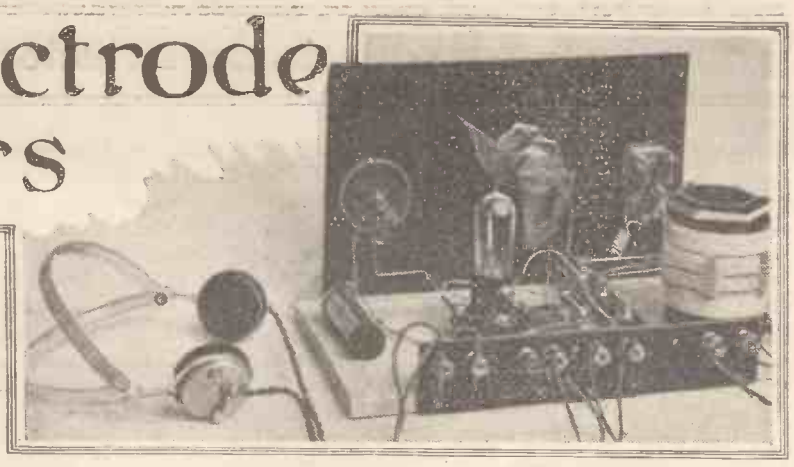
Building a 7-Valve Superhet—*continued*

pair in the third and fourth sockets. If oscillation starts at a different place, test the other valves and pick the two which have their oscillation points nearest to one another. When you have picked a pair of valves for the third and fourth sockets place the remaining two in the first and second sockets and join up the frame aerial. The knob of the adjustable condenser of the oscillator should be

(*Continued on page* 210.)



Four-Electrode Detectors

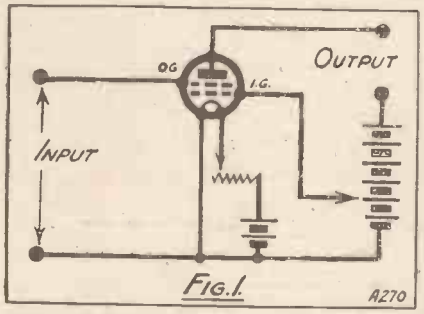


An interesting description of some novel "tetrode" rectifying circuits with which extremely good results can be obtained. A special feature of these circuits is that they operate on very low H.T. voltages.

By J. ENGLISH.

THERE is something about the valve detector that always appeals to me; both in theory and practice I find it quite the most fascinating stage of the receiver. Perhaps this is because it functions so differently from the valve amplifier. It is not so simple in theory, nor so perfect in practice, yet amazing results are often obtained with a simple one-valve detector set.

The unique position of the detector valve as transformer of H.F. into L.F. energy whereby the inaudible incoming H.F. currents are made audible, gives rise to intriguing complications which are of great interest



when designing a receiver for the highest efficiency and freedom from distortion. We have yet to develop the valve detector which shall transform H.F. into L.F. energy with a hundred per cent efficiency and without distortion.

Improved Valves

Now after all this I must not encourage you to believe that I am going to describe some new detector arrangements approaching this ideal. The subject of this article has to do with the development of the double-grid or tetrode valve as a detector, and I hope to show that as a rectifier it does certainly give better results than the ordinary valve.

Some years ago the tetrode valve was first put to practical use for broadcast sets by Messrs. Dowding and Rogers in the Unidyne circuit, of which they were the originators. This detector circuit gave excellent results without any H.T. battery at all, but owing to the deficiencies of available tetrode valves then the tetrode detector has never been widely used.

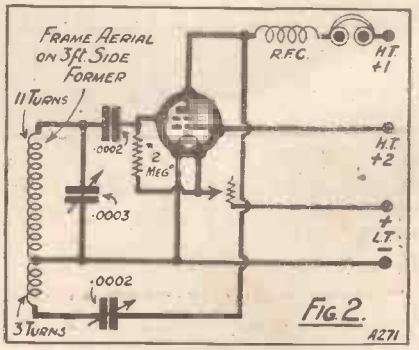
Now, however, owing to the enterprise of a firm of British manufacturers, Messrs. Aneloy Products, we have available some very efficient tetrodes of various types—H.F., R.C., power, super-power, etc. This, of course, lends quite a new interest to the study of the tetrode valve.

Although I find the ordinary valve as a detector of great interest, the tetrode in the same capacity has proved even more attractive. An account of some of my experiments may therefore be of interest to other amateurs who wish to keep abreast of new developments.

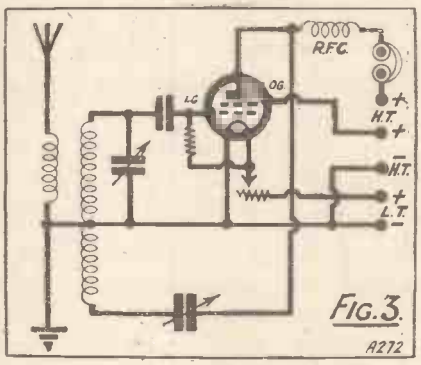
Use of Inner Grid

Before launching out upon experiments with the tetrode either as amplifier or detector, it is necessary to become familiar with one or two fundamental points about this type of valve. First of all, you will observe from Fig. 1 that, of the two grids, the one nearer the filament is given a small positive potential by connecting it to a suitable tapping point on the H.T. battery.

The other (outer) grid is used as the control electrode like the single grid of the ordinary valve. Now the



effect of making the inner grid positive is to reduce very considerably the anode-filament resistance of the valve so that for a given positive anode voltage a greater anode current flows through the valve than if the positive inner grid were not there.



The tetrode, therefore, is able to do the work of an ordinary valve with a considerably smaller H.T. voltage. This reduction in the working anode voltage is the primary feature of the tetrode, and some of the modern types require but one-third to half the anode voltage of the three-electrode valve for the same results.

Variable Factors

The second fundamental feature of the tetrode is that the degree of amplification obtainable, or in other words, the magnification factor of the valve, depends upon whether the inner or the outer grid is made the positive electrode. If the latter is so used then a marked increase in the magnification factor is noticed, and although the impedance of the valve is also increased yet it is considerably lower than the impedance of a three-electrode valve having the same magnification factor.

Because of its lower impedance the R.C. type of tetrode gives as much amplification on 60 volts H.T. as an ordinary valve of the same type gives on 120 volts H.T. In detector circuits

Four-Electrode Detectors—*continued*

it is therefore usual to connect the outer grid to the H.T. battery in order to obtain the benefit of high amplification on a relatively low anode voltage.

Returning to practical considerations, we have in Fig. 2 the theoretical circuit of one of the first experimental receivers put on test. This is nothing

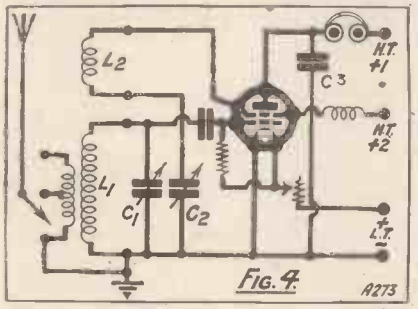


FIG. 4.

but the ordinary one-valve set with capacity-controlled reaction, the inner grid producing the necessary reduction in the impedance as described above.

From Fig. 2 you will see that it is an easy matter to replace the tetrode by an ordinary valve, and this facilitates comparisons between the two types. As it is easier to make comparisons of results on a weak signal I used a 3-ft. frame aerial instead of the normal outdoor wire.

Smoother Reaction

I then found that while an efficient type of three-electrode valve required 30 volts H.T. for good 'phone signals at 15 miles from 2 L O, the tetrode yielded equivalent results with so low an anode voltage as 9 volts with 6 volts on the inner grid. Moreover, with the tetrode the control of reaction was very much smoother, requiring no delicate adjustments of grid and anode potentials as with the ordinary valve. The remarkably smooth control of reaction is quite a feature of the tetrode detector, and this makes it doubly attractive for short-wave work where absolute freedom from "backlash" in the reaction control is really essential for good reception.

The practical result of replacing the ordinary valve detector by a tetrode is to obtain equal rectification efficiency, smoother reaction control, with a considerable reduction in battery power. This was found to hold good for other detector circuit arrangements, and in every case application of the anode voltages normally associated with the three-electrode detector resulted in signals considerably louder than any provided by the latter.

In these circuits where the inner grid is made positive we are using the tetrode solely as a low anode-voltage detector, and the most suitable valves are the general-purpose and low-frequency types. Of the latter the A.P.412 L.F. is a good example.

Now the high-magnification tetrode, where the outer grid is made positive as described above, is also quite easily substituted for the ordinary valve, requiring only another connection from the outer grid to the H.T. battery. The best valve for the ordinary regenerative circuit is of the type A.P.412 H.F.

Louder Signals

The latter valve has the outer grid connected to a terminal on the valve base, whereas in the L.F. types the inner grid is so connected. A representative circuit using this valve is given in Fig. 3, and an experimental receiver based on this circuit was found to give very good results, signal strength being greater than with circuits such as that of Fig. 2.

An enthusiastic experimenter of my acquaintance, living on the outskirts of London, receives quite clearly such distant stations as Aberdeen, Berlin, and other Continentals, etc., on an indoor aerial and the circuit of Fig. 3, using nothing more than a 9-volt grid-bias battery as H.T. supply!

This type of tetrode detector is certainly admirably suited to D.X. work on the minimum of power, and there is nothing to equal the thrill of logging some distant station on such a small set as a single detector valve. With this circuit reaction control was also noticeably smooth and even.

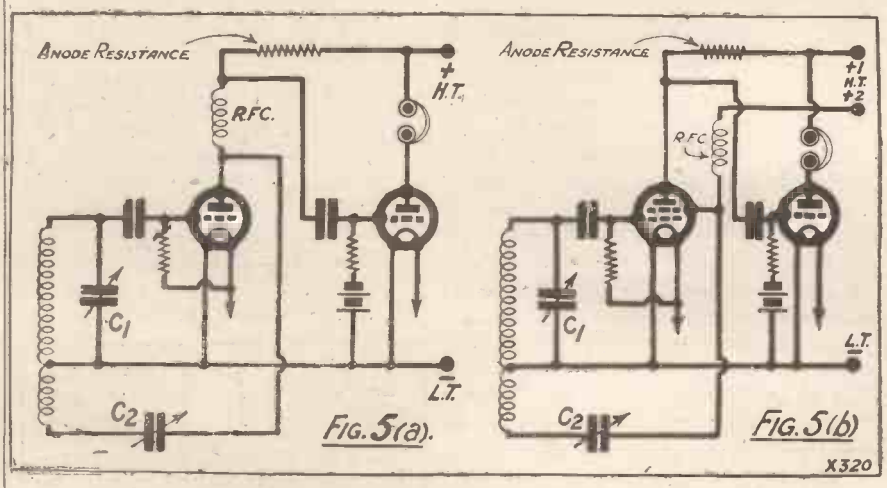
High-Mag. Valves

The high-magnification tetrode detector, like the corresponding R.C. type three-electrode valve, is peculiarly suited to resistance-capacity coupling. Very often an R.C. valve is used in the detector stage, usually when preceded by an H.F. valve, anode-bend rectification being employed. In such cases a tetrode of the type A.P.412 H.F. or 412 R.C. can be substituted, with the advantage of retaining the same degree of amplification while using not more than 60 volts H.T.

When a resistance-coupled detector is not preceded by an H.F. stage, it is often difficult to obtain a sufficient degree of reaction. The special circuits described below are more satisfactory in this respect.

Several interesting things happen when the tetrode is used in special detector circuits which are only possible with the four-electrode construction where we have another grid to play with. These circuits introduce several new features of interest.

One of these special circuits is reproduced in Fig. 4, and this forms the basis of a successful experimental one-valver used by the author. The receiver is really just the ordinary regenerative detector-valve high-magnification type, but with the essential difference that the outer grid is used as the reaction "anode,"



Four-Electrode Detectors—*continued*

the actual anode being reserved for the audio-frequency output only. This results in an exceedingly smooth reaction control without critical adjustments, while other advantages accrue from the separation of the L.F. and H.F. output at the anode itself.

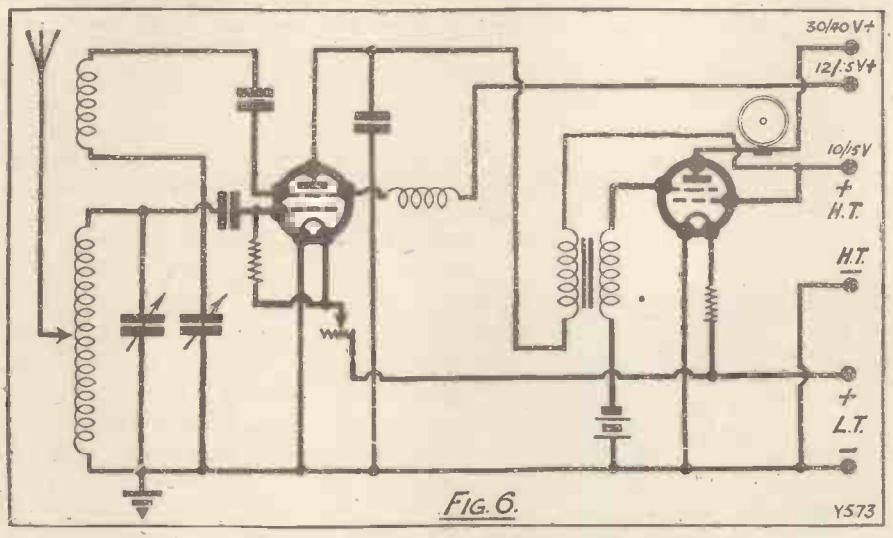


FIG. 6.

One of the photographs is a close-up of the tetrode valve, showing the method of making connection to the outer grid terminal on the valve-cap by means of a flexible lead terminating in a spade terminal, the valve used being an A.P.412 H.F.

This experimental one-valve set was first of all used without any aerial or earth, in order to study the best adjustments for rectification efficiency and reaction control.

Less Filament Current

The first thing to be noticed was that no reaction effects could be obtained until the outer-grid potential reached some 12 volts positive. Below this the set would not regenerate, however much it was coaxed. Also, if the anode potential was more than 20 volts or so, the outer-grid potential needed a slight increase for maximum reaction, every increase in one requiring an increase in the other. There appeared to be no definite ratio between anode and outer-grid volts for the best results.

As regards the filament voltage, although the A.P.412 H.F. valve is rated at 3·8 to 4 volts, it was never found necessary with these low battery voltages to attain this figure; 3 volts being ample. The normal filament current is only required when much higher anode and outer-grid voltages are used. There is therefore some economy in filament current.

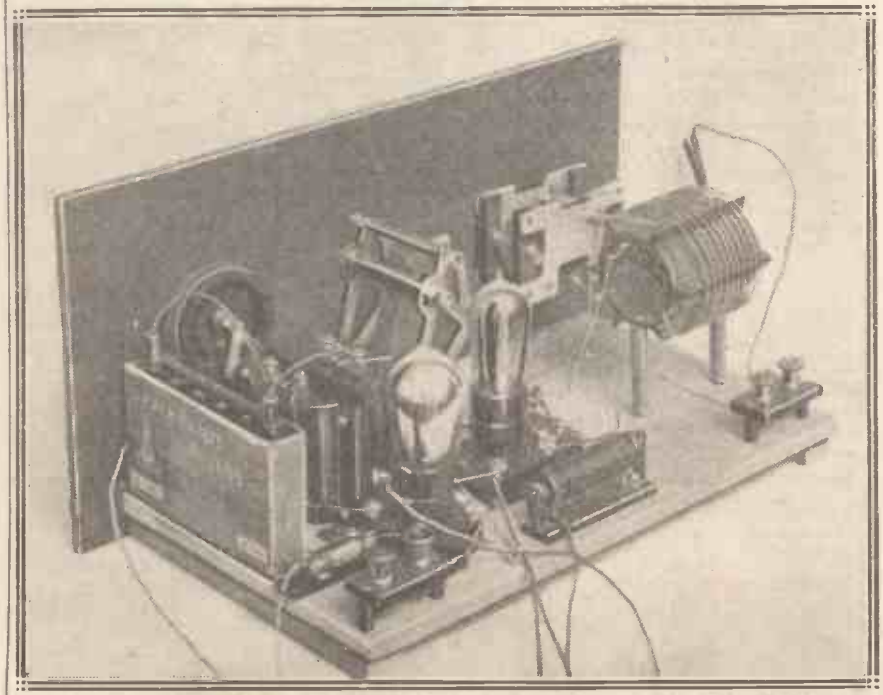
The adjustment of grid potential for efficient rectification proceeds in the normal manner as for ordinary valves, the grid-condenser method of rectification, as in the case of the latter, giving the louder signals. For anode-bend rectification a grid bias of 4·5 to 6 volts negative was found necessary.

The receiver was next connected to the frame aerial mentioned above, and very good 'phone signals were obtained from 2 L O at fifteen miles, and from 5 G B, the latter being nearly as strong as the London station. Quite a number of foreign stations were received fairly well after dark, and for weak signals quite low voltages were found necessary, just enough on the outer grid to produce sufficient reaction for easy control.

Excellent D.X.

When connected to a normal outside aerial over a dozen foreign stations were received in broad daylight, signals being very clear. On the whole the signal strength obtained was exceptionally good in view of the small battery voltages used. For similar results the best three-electrode valve requires at least treble these voltages.

One curious effect noticed was the necessity of connecting a small fixed condenser, about ·0001 to ·0002 mfd., from anode to filament negative. Without this condenser the capacity of the reaction condenser had to be increased to produce sufficient reaction. Similarly, the insertion of an H.F. choke in the anode lead increased the difficulty of obtaining sufficient reaction. The necessary anode by-pass condenser C_3 is shown in Fig. 4.



A short-wave receiver using two four-electrode valves. The connections to the additional grids are made to small screw terminals fixed on the bases of the valves. You will notice a flexible lead is joined to the additional terminal on the nearer tetrode.

Four-Electrode Detectors—*continued*

In my opinion the most important feature of this detector arrangement is that it is eminently suitable for R.C. coupling. Unlike the usual arrangement no difficulty is experienced in obtaining sufficient reaction.

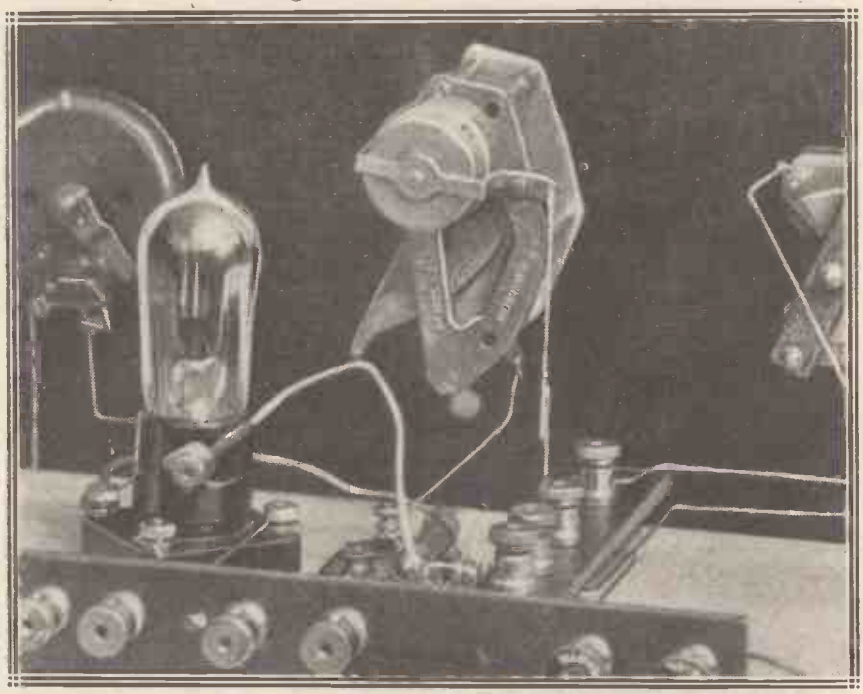
A Successful Circuit

Moreover, if you compare Figs. 5a and 5b you will see that there is no condenser in parallel with the anode resistance of diagram (b). This is an advantage because the condenser C_2 of diagram (a) is virtually in parallel with the anode resistance, thus decreasing the amplification on high notes. The circuit of Fig. 5b works very well indeed.

In one of the photographs you will see another experimental receiver wherein a transformer-coupled amplifier has been added to the detector. Both valves are tetrodes, the detector being an A.P.412 H.F., and the amplifier an A.P.412P. The addition of an L.F. amplifier presents no difficulty whatever, and the necessary connections are made in the orthodox way, as will be seen from Fig. 6.

Notice that another connection is required to the H.T. battery for the second grid of the L.F. amplifier, in this case the inner grid, as is usual for tetrodes when used as L.F. amplifiers. The anode of the detector and the inner grid of the amplifier can very well be given a common terminal as the required voltages in each case are about the same.

In its final form this receiver gave excellent loud-speaker results on an outdoor aerial from 2 L O and 5 G B. Quality was all that could be desired, and volume of signals up to the standard of the normal two-valve set supplied with much higher battery voltages. In the case of the present receiver the maximum anode potential applied to the amplifier never exceeded 40 volts, and even with 30 volts results were extraordinarily good, the second valve handling quite a respectable input without distortion.



This photo very clearly shows the connection to the inner grid of a typical four-electrode valve. The lead provided with a spade terminal takes this inner grid direct to an H.T. plus terminal in accordance with the circuit illustrated in Fig. 1.

The L.F. Transformer

As regards the transformer, a component having a ratio of 3 to 1, with a generous primary, was found most suited to this type of tetrode detector. You will notice in the photograph of the receiver that a short-wave coil is shown in position. With this tuning unit reception was carried out on the lower band of short wavelength with very satisfying results.

A slightly different H.F. choke was found to be necessary here, and a replaceable type was used, as will be seen from the photograph. While no great amount of time was devoted to short-wave reception several interesting transmissions were received, and on one occasion 2 F C, the Sydney short-wave station, was heard quite clearly. On all occasions the control of reaction provided by this detector-valve arrangement proved eminently satisfactory for short-wave reception. For the best results a grid leak of 5 meg. and rather low outer-grid voltages were found necessary.

As you are doubtless aware, the best short-wave set is undoubtedly a simple regenerative detector followed by one stage of L.F. amplification, the control of reaction being the smoothest obtainable. In all these respects this two-valve set was quite satisfactory, and even with the detector on the verge of oscillation no threshold howl developed, as is very often the case with the three-electrode detector when transformer-coupled.

A Definite Improvement

As a result of these experiments I am led to the conclusion that the tetrode as a detector is certainly an advance on the three-electrode valve. Apart from the reduction in H.T. battery voltage, the special circuits mentioned above give considerable amplification and remarkably smooth control of reaction.

Although the ability to use low anode voltages is not a great advantage where the detector is used in a multi-valve receiver in connection with an H.T. eliminator, it is of great importance in one-valve sets and small receivers in general, particularly in view of the novelty and efficiency of the reaction control in special circuits.

Also, when worked with higher potentials up to 30 or 40 volts, the tetrode detector is capable of a greater undistorted L.F. output than is possible with the three-electrode valve supplied with the same anode voltage.

Therefore I can advise all experimenters to try tetrode valves, especially in their smaller sets and in their short-wavers. I am sure they will be agreeably surprised at the results they obtain, and will think twice before they go back to ordinary three-electrode detectors—if, indeed, they ever go back.

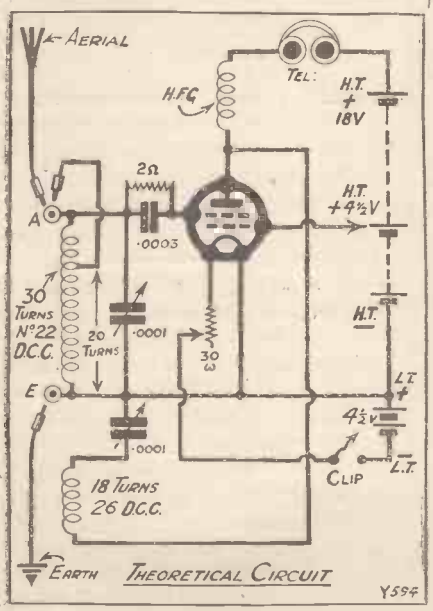
"TINY TIM"

Just the 1-valve set you want for the summer—'phones, batteries, and everything in a 9-in. by 7-in. case! Designed and described by A. S. CLARK.

THERE are many who prefer a portable set intended for working telephones to a loud-speaking portable receiver. This is partly because at the present time portable receivers which give loud-speaker results cannot be produced with really small dimensions and weight, and partly because of the question of cost.

Now these portable sets which are intended for telephone reception may be broadly divided into two classes, both of which have their advantages. (Unfortunately, they both have their disadvantages.) Firstly, there are those which depend entirely on a frame aerial wound inside the case for picking up signals; and, secondly, those for which an aerial has to be fixed up. The trouble with the first type is that more valves are required than with the latter for given results. Whilst the trouble of always having to fix up a special aerial is obvious.

With the set described, a compromise has been made between the two types. Thus while the advantages of both are obtained, the drawbacks are at a minimum.



No Aerial Necessary

In spite of the fact that only one valve is employed, and the inside measurements of the set are only 9 in. by 7 in. by 3 in., no aerial or earth are required for short-range reception. For instance, up to ten miles from 2 L O signals can be heard anywhere by simply putting on the 'phones and tuning in. On the other hand, only small pieces of wire as aerial and

ORIGINAL COMPONENTS USED.

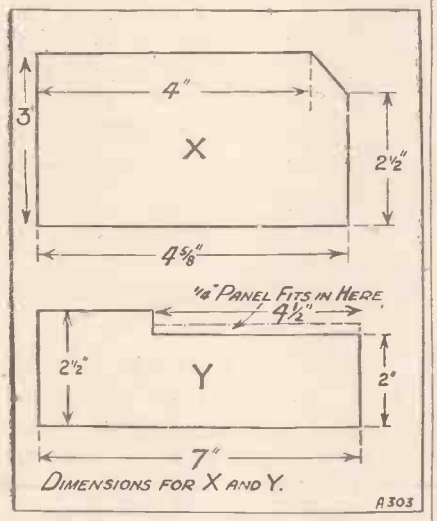
- 2 ·0001 variable condensers (Peto-Scott).
- 1 H.F. choke (Magnum).
- 1 ·0003 condenser with grid-leak clips (Dubilier).
- 1 2-megohm grid leak.
- 3 Plugs and two sockets (See article for type). (Eelex.)
- 1 30-ohm Variable resistor (Magnum).
- Aneloy R.C.C. or H.F. valve.
- 5 Standard flash-lamp batteries.
- Pair telephones.
- ¼ lb. 22 D.C.C. wire and small quantity of 26 D.C.C. wire.
- Spring clip or similar device.
- Brass handle.
- Small brass fastener.
- Quantity rubber-covered flex.
- Some ⅜ in. and ⅛ in. plywood, cotton-wool, varnish, tacks, etc.

NOTE.—Alternative components of good make may, of course, be used where considerations of size and space permit. (See text on this point.)

You can see how small the whole thing is by the hat and gloves!

"Tiny Tim"—*continued*

carth need be erected for long-range reception. The weight of the set is sufficiently small for no trouble to be experienced even if it is taken out for a day's ramble. The photograph which shows the size of the set com-



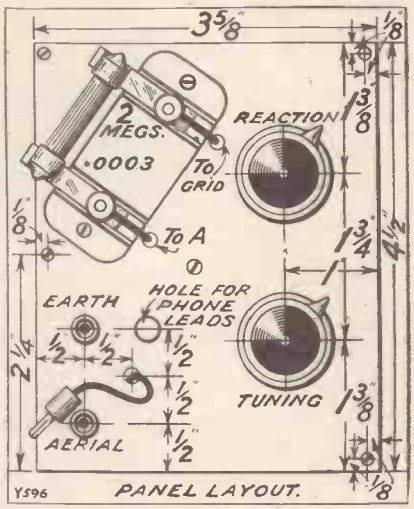
pared to that of a hat gives a good idea of its genuine portability.

The set is contained in a light wooden case, which is completely home-made, the coils being wound round the outside so that they will act as a small frame aerial when required. Looking at the photograph of the inside of the set, it will be seen that a small compartment is provided into which the valve is packed by means of cotton wool. The filament battery and rheostat are also contained in this section. As the panel on which the controls are mounted is only 4½ in. by 3⅝ in., it was found necessary to cut away a little of the end-plates of the variable condensers. It was also necessary to slightly rearrange the grid-leak clips. These component alterations are, however, of a simple nature, and such that anyone may carry them out.

Constructing the Case

A diagram of the theoretical circuit is given, from which it will be seen that a four-electrode valve is employed. This was chosen so that the amount of H.T. required could be kept at a minimum. As far as the rest of the circuit is concerned, it is a perfectly standard arrangement. A tap is provided on the tuning coil so as to be certain that the necessary wavelength range is covered, and reaction is obtained in the usual capacity-controlled manner.

In another part of this article a list of the components required to make this set will be found. If makes other than those indicated as used in the original are chosen, great care must be taken to see that they will fit in, or can be adapted to do so. The reason for this will readily be appreciated on looking at the photographs of the panel.



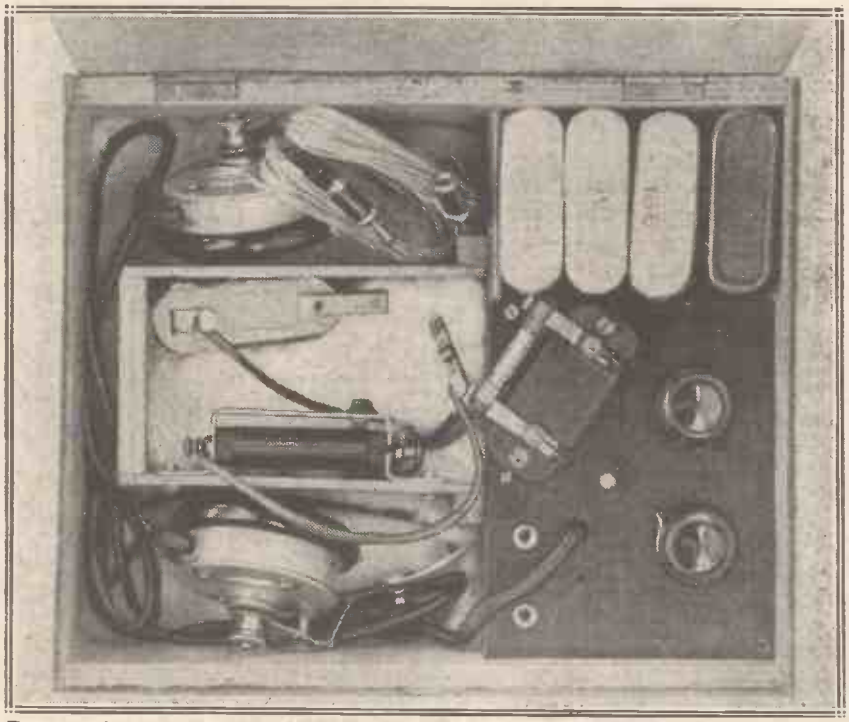
It is quite probable that two of the mica type of variable condensers could be used in place of the ones shown, which are really reaction condensers.

The first thing to do is to make the case which is to contain the set. For this 5-ply ⅜-in. wood and 3-ply ⅛-in. wood is used. The amount to buy may be gathered from the diagrams showing all necessary dimensions. Care should be taken to cut the wood square so that the box presents a neat appearance when completed. Screws are not required for joining the pieces of wood together as small brads or pins about ½-in. long were found quite strong enough.

Positions on Panel

The lid may be attached by the hinges at this stage, but do not fix the handle or fastening clip on to the case yet. When the partitions are inserted and fixed to the sides of the box by means of the ¼-in. fillets, attention may be turned to the panel.

The holes which are dimensioned on the drilling diagram may be made right away, but the positions of the others should be marked from the actual components as space for them is so limited. It will be seen that the panel is secured by means of three screws to the fillets below.



Even the 'phones go inside the case! Note the single dry-cell, which provides L.T., and the low-tension clip on the end of the flexible lead.

"Tiny Tim"—*continued*

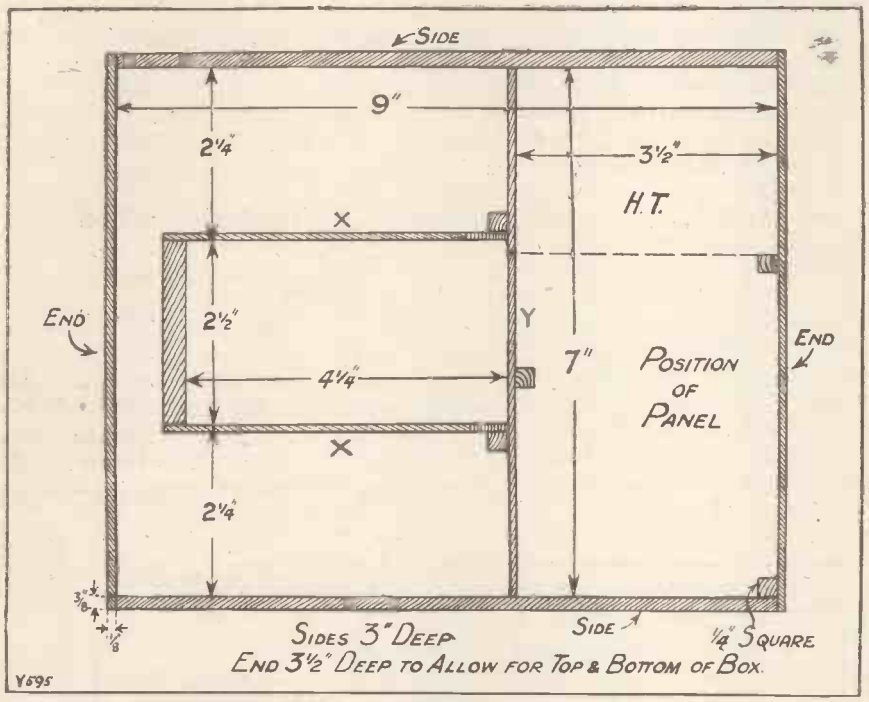
Before any components are actually fixed to the panel attention must be given to the variable condensers. Four small pieces have to be cut off each of the ebonite end-plates and hand-capacity screens. Reference to the back-of-panel photograph will show how much.

This job is quite easily done with an ordinary hack-saw. Care should, however, be taken to see that the cuts are not made sufficiently near to the bolts to expose them, otherwise the assembly of the condenser may be upset.

The Wiring

When the variable condensers have been thus prepared they may be mounted on the back of the panel, together with the R.F. choke and the sockets for aerial and earth. Now mount the grid condenser on the top of the panel. The grid-leak clips have to be slightly bent so that they may be put on in the opposite to usual way. It will also be observed that nuts are used instead of the usual terminal screws, the shanks being cut off close to the nuts. This is necessary to allow the lid of the case to shut properly.

Attention may now be turned to the wiring. On looking at the photograph of the back of the panel it will be seen that there is very little actual wiring on the panel. What there is should be carried out with 18 gauge tinned copper wire encased in short lengths of Systoflex.



The actual connections may be gathered from the wiring diagram.

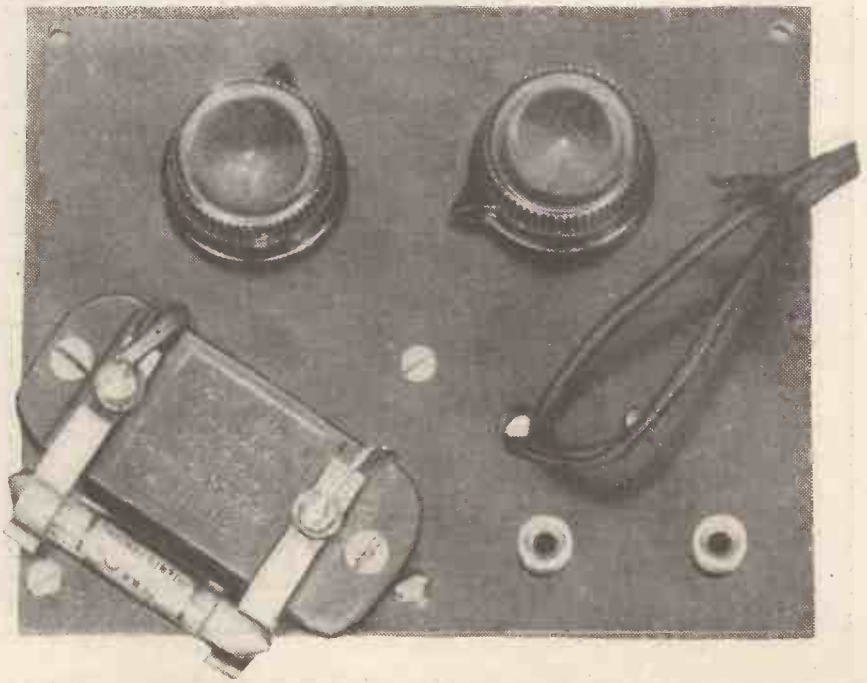
It will be seen from this diagram that a number of rubber-covered flexible wires have to be joined on at various places. All the wires which run from the panel to some component outside of same, excepting those to the coils and one from the telephones, are flexible wires. These wires should be made about 9 in. long, as they may easily be shortened afterwards. One lead from the 'phones is attached direct to the H.F. choke.

Winding the Coils

Having prepared the panel the next step is to wind the coils. The diagram showing details of the windings is really self-explanatory. The ends of the coils and the tapping wire are taken through small holes in the wood so that they emerge on the inside under the panel. After the wires are threaded through the holes these should be plugged with matchsticks to hold the wire firm. About 6 in. of wire should be left on the inside. The gap in the centre of the winding is to enable the screws holding the handle in position to be inserted without damaging the windings.

Both coils are, of course, wound in the same direction, and the turns are placed close together. The coils should be wound on as tightly as possible in order to avoid the possibility of any slackness.

The coil tap is made in the following manner. When the whole of the



No space is wasted. In order to get the lid to shut the grid-leak clips are reversed, and the condenser terminals are replaced by nuts, the shanks being cut short.

"Tiny Tim"—*continued*

22 gauge wire is wound on, a small hole is made between the 20th and 21st turns, through which a piece of the 22 gauge wire is threaded. Now bare the end of the 20th turn for about ½ in. and tin, after which the tapping wire may be soldered to it. (The wire should be prised up with a screwdriver or similar implement while baring and soldering.)

Battery Connections

Before fixing the panel in place, four small holes should be drilled in the partition wall opposite the compartment for the valve. These are to take the flex wires as indicated on the wiring diagram. Now join up the wires from the coils to their correct points, cutting them as short as possible while allowing the panel to be turned up on end. The letters will make quite clear how to connect these wires. Next thread the flexible wires through their holes, and after making sure no wires will touch the moving vanes, screw the panel in place.

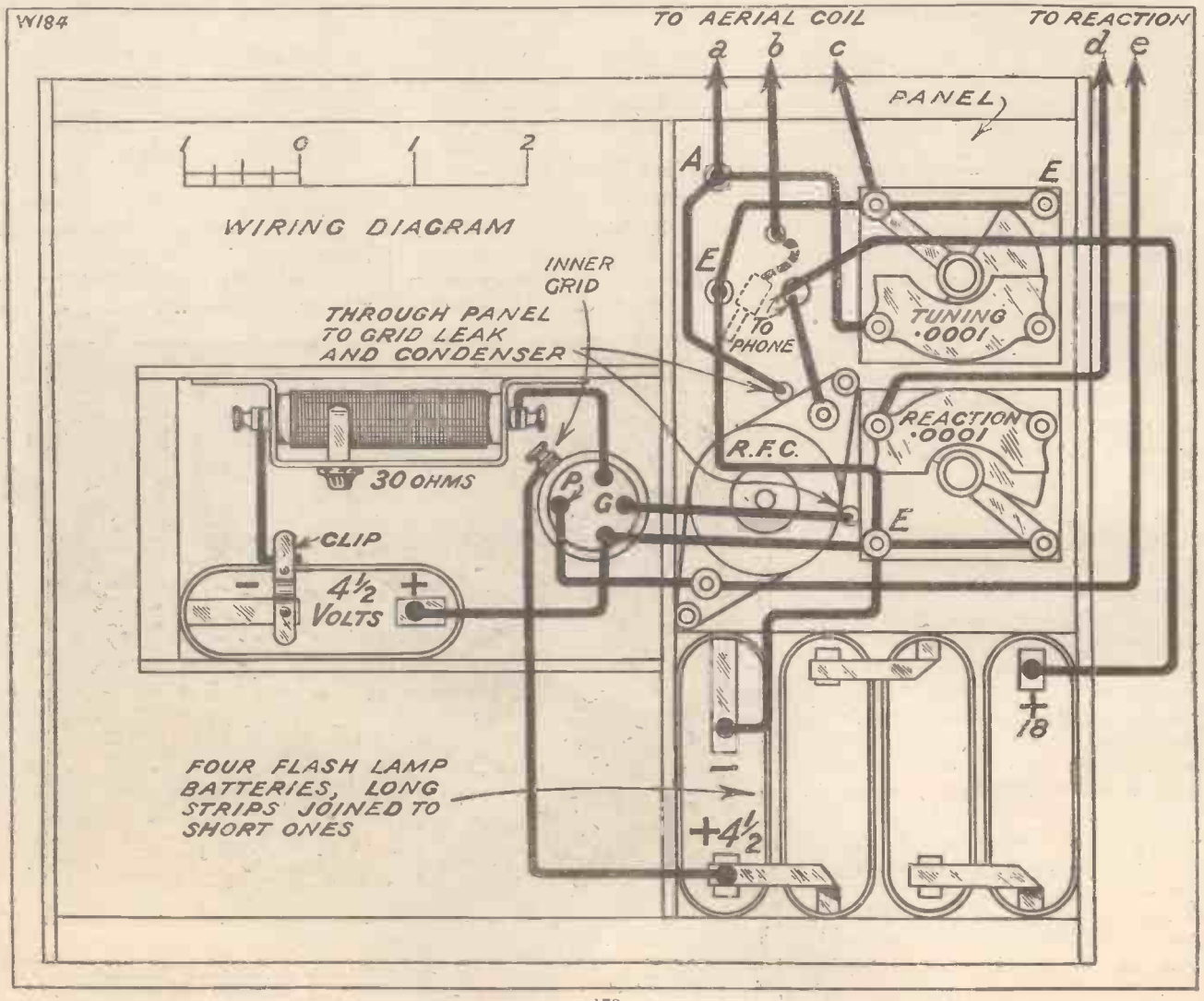
The next operation is to mount the fixed resistor and connect up same together with the valve to the necessary flex leads, which should be cut conveniently short. The wires are connected to the valve pins by baring for about 1 in., slipping the wire down the split of the pin and twisting up so that no wires can short. The valve and battery are now securely packed in with cotton wool.

The batteries for H.T. may now be connected up as indicated in the wiring diagram; the three leads, one from the telephones, being soldered in place. The batteries are placed upside down at the side of the panel. All that remains to complete the set after attaching the handle and clip for holding lid shut is to cover the wiring with thick brown paper, stuck in place with shellac varnish, and to give the whole case a coat of varnish stain.

Any pair of telephones may be employed, providing they will fit in the compartment provided. The type with metal bands are desirable, and they should have headpieces which will swivel round, if possible. The best type can be gathered from the photographs.

The Valve to Use

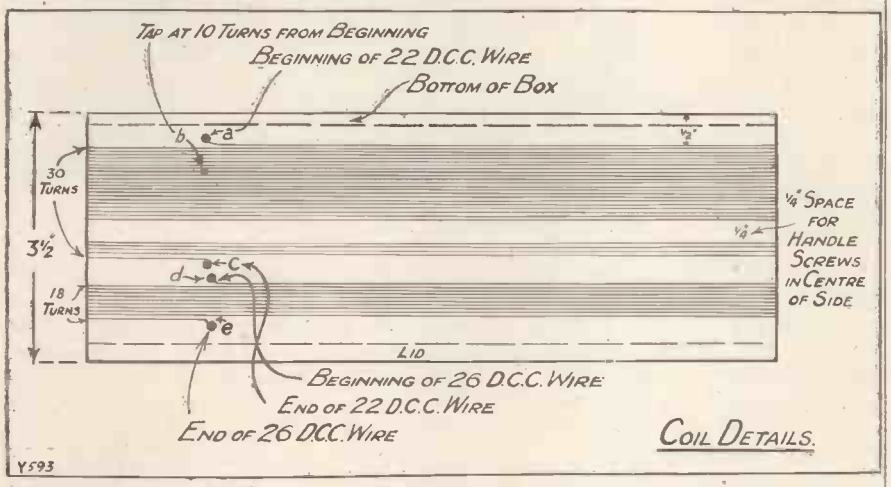
The valve employed is one of the Aneloy Products' range. Several types were tried, namely, screen-grid, R.C.C., L.F., and H.F. They all worked well with the H.T. voltage of 18 (4½ volts on the terminal). The lower the impedance the louder were the signals, but reaction control was smoother with valves of higher



"Tiny Tim"—*continued*

impedance. The R.C.C. and H.F. types gave a good compromise between the two extremes.

Lengths of 24 gauge D.C.C. wire are employed for aerial and earth, the former about 20 ft. long and the latter about 9 ft. These wires end in plugs which go into the sockets provided. Plugs of the type which will fit into one another are required. When the lower range of wave-length is required, the plug from the tap is connected to the aerial.



COIL DETAILS.

The Earth Connection

All that is necessary with the earth, if no definite earth connection is available, is to lay the earth wire along the floor underneath the aerial wire. As already mentioned, however, no aerial or earth is required for short-distance reception.

All that is required to start the set working is to fix the battery clip in place. The flash-lamp battery will last quite a long time on the one valve, but it is nevertheless advisable to run the filament at as low a temperature as good results will permit.

The frame aerial is not very directional, it only being necessary to place it roughly in the correct direction. Hand-capacity effects will not be found very noticeable, but it is as well to tune with one hand, one knob being adjusted at a time.

An Underground Test

Good 'phone strength can be obtained anywhere up to about 10 miles from 2 L O. Signals have been heard at 16 miles, and from 5 G B at about 90 miles. (The above were, of course, received on the frame.)

With the aerial and earth wires roughly erected 5 G B always came in at good strength, as also did several Continental stations. As a test of the sensitiveness and utility of the set, it was taken to a restaurant in London and used in a smoking-room which was situated below the street level. Good signals were heard with the set just resting on the lap in any position, and if a set can work underground in this way it can be relied upon to give excellent results under ordinary conditions!

THE HALE CIRCUIT

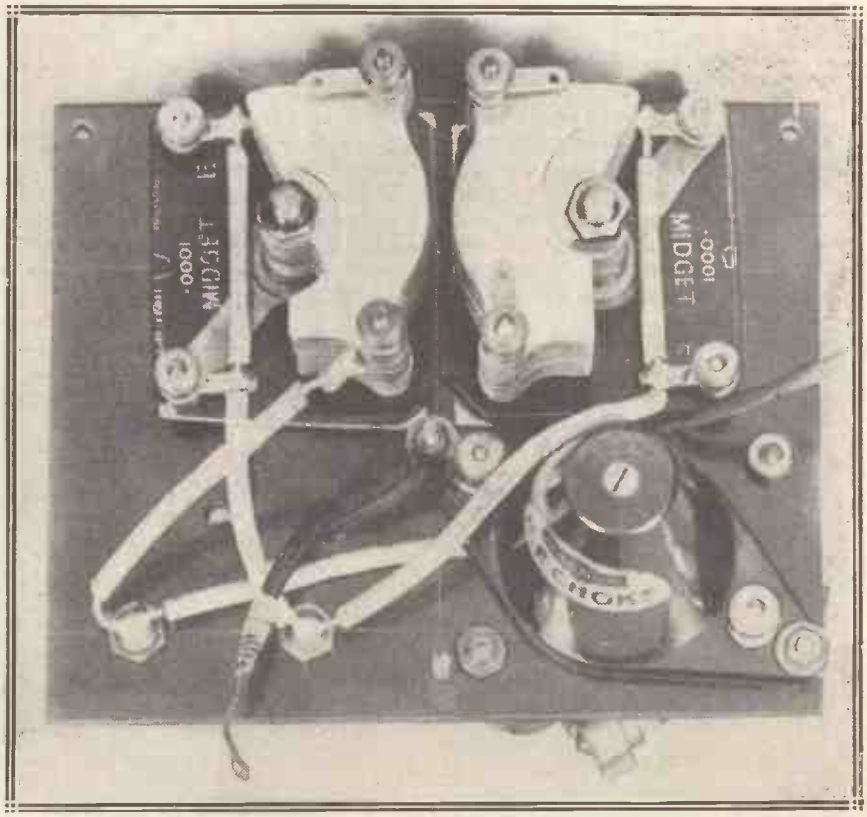
SIR,—Re a "Reader's Results" in the May issue of the WIRELESS CONSTRUCTOR concerning the Hale circuit on the short waves. I have been carrying out experiments on reflex circuits for the past four years, and have come to the conclusion that the Hale circuit on waves from 20 to 2,000 metres is a wonderful hook-up.

The following is a list of *short*-wave stations that *can* be received on the above circuit: 3 L O (Melbourne), 2 X A F, 2 X A D (Schenectady), K D K A (Pittsburg), P C J J (Holland), Radio Vitus, and numerous British and French amateurs.

The quality from stations such as 2 X A F, and P C J J is a revelation.

Wishing the WIRELESS CONSTRUCTOR continued success.

Charlton, S.E.7. A. J. WATTS.



The condenser alterations which are mentioned in the article are clearly shown in this photograph.

RADIOGRAMOPHONICS

A new series of articles, specially written for the constructor who wishes to use his radio receiver and loud speaker for the reproduction of gramophone records.

By A. JOHNSON-RANDALL.

WE have received for test one of the Igranic Phonovox gramophone pick-ups. The pick-up itself is an exceedingly well-made device, which operates on the permanent-magnet system. The working parts are neatly enclosed and protected by a black bakelite casing and a ferrule is fitted which is so arranged that the pick-up may be used with all types of tone arms. When fitting the Phonovox to the tone arm, the makers point out that it is essential for the pick-up to be at approximately the same angle in relation to the surface of the record as was the needle in the original sound-box.

This can easily be done in the case of the Phonovox by setting it so that the bottom surface is parallel with the record.

On test the pick-up proved to be very sensitive, so much so that it was possible to use "half-tone" needles with advantage.

Good Reproduction

The device showed no tendency to chatter unduly, and the reproduction obtainable, in conjunction with a three-stage resistance amplifier and a moving-coil loud speaker, was good. When compared with pick-ups of other types, the Phonovox seemed to emphasise the scratch a little more, but this may be due to the fact that there is less cut-off on the higher frequencies with this component. The pick-up is good value for money (the price is 37s. 6d.) and can be recommended.

It is interesting to note that the Igranic Co. also supply a plug-adaptor and volume control for use with their pick-up.

Adaptor Provided

Those who do not wish to modify their existing receivers can utilise the low-frequency side of their sets by simply plugging the adaptor into the detector-valve socket in place of the detector valve itself. Full details of how to do this are supplied with the component.

Readers are still asking me what needles they should use for radio-gramophone work. The reply is that it depends upon the sensitivity of the pick-up and the amplification given by the L.F. stages. Where possible, I much prefer a "half-tone" needle, because I think that wear on the records is minimised, and in addition the background "hiss" is less.

If, however, the pick-up is rather insensitive and the amplifier one with only moderate magnification, the obvious thing to do appears to be to employ a loud needle.

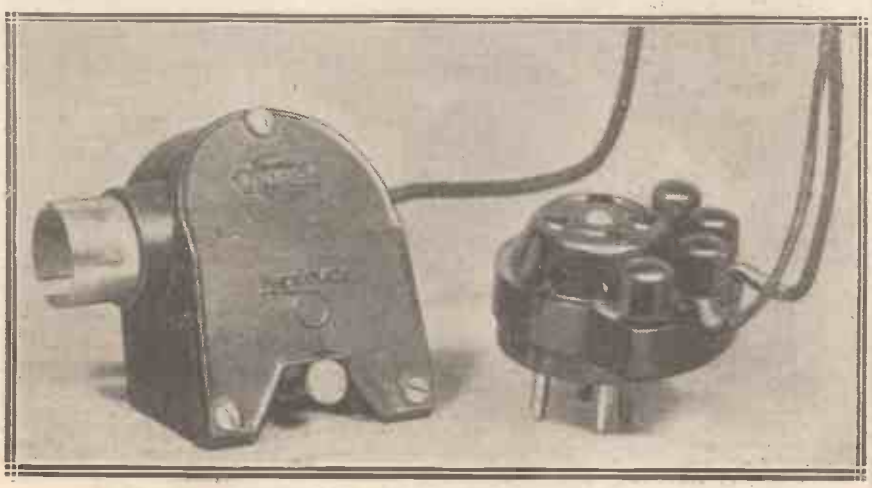
I have tried fibre needles and I do not like them for this type of work so well as the ordinary steel pattern. Please remember that it is just as important to use a new needle in the pick-up each time the record is changed as it is when employing the standard sound-box.

A troublesome fault has recently developed in my amplifier. As I have previously mentioned, it consists of three resistance stages, the values of the anode resistances being 150,000 ohms, 100,000 ohms, and 80,000 ohms respectively. The grid leaks are each 1 megohm and the coupling condensers 1 mfd. The output circuit is choke coupled and the whole amplifier has been most carefully designed and has always been perfectly stable. During the last week or so there has been a marked tendency for the amplifier to oscillate at a frequency above audibility.

A Simple Remedy

The only method of detecting the trouble is to place a milliammeter in the plate circuit of the second valve, and to observe the increase in plate current when oscillation occurs. The fault is in all probability the result of a partially sulphated cell in the H.T. supply which is fed from a battery of accumulators giving a total of 300 volts. As can be imagined, with 150 small cells to examine, it is no easy matter to find out just which cell is likely to be a little "off colour," but readers who are having similar trouble

(*Continued on page 212.*)



The Phonovox (Igranic) pick-up, with special plug-in adaptor.

READERS' RESULTS

The "Short-Wave Three" in India

SIR,—You will be interested to hear that I built the "Short-Wave Three" described in the WIRELESS CONSTRUCTOR of January, 1928.

I have "tuned in" Java (A N H and A N E), P C J J (British), 2 N M, 3 L O and 5 S W, all on the loud speaker at R.5 to R.7 strength. I am enclosing copies of acknowledgment cards from 2 N M and 3 L O, and also the full programme of 5 S W, which I tuned in on the 5th inst.

Wishing your paper every success.

I remain,

Yours faithfully,

JOSEPH ALAMS.

Ballard Estate, Bombay.

Report to the B.B.C.

SIR,—On Thursday night, April 5th, at 12.30 (midnight) Indian Standard Time (7 p.m., G.M.T.), I picked up the enclosed programme from 5 S W on a three-valve set (Det. and 2 L.F.). The reception on the loud speaker was as clear and loud as is the signal from our local broadcasting station, 7 B Y (3 kw.), situated five miles away, which I tune in on a Brownie crystal set and the note-magnifiers of the short-wave set.

If I only knew shorthand I would take down every word that came through; anyway, I have just mentioned snatches of words and sentences I was able to write down. I am enclosing an addressed, stamped envelope for an acknowledgment card.

"Empire Broadcasting has come to stay."

Thanking the B.B.C. for the fine programme.

Yours faithfully,

JOSEPH ALAMS.

Confirmation From Australia

MR. JOSEPH ALAMS,

SIR,—With reference to your letter of January 30th, we thank you very much for your report of reception of our short-wave station, and are glad you were able to hear us so successfully.

These transmissions are being continued from 18.30 to 20.30 every Sunday, G.M.T., and any further reports you care to send us will be appreciated.

Thanking you for your interest.

We are,

Yours faithfully,

Broadcasting Company of Australia Pty., Ltd.

(Signed) M. CONDER.

Confirmation From 2 N M

MR. JOSEPH ALAMS,

SIR,—Many thanks for your letter of January 30th, reporting on my transmissions, which I can assure you I greatly appreciate. My present licence expires on March 1st, but I am glad to say the Postmaster-General has just renewed same for another three months. Any further reports you care to send will be greatly welcomed and appreciated.

Yours faithfully,

(Signed) GERALD MARCUSE.

"Radiano Results"

SIR,—I have been going to write to you many times before (but better late than never) to thank you for your wonderful "Radiano Three." I have had my set over a year now and have had wonderful results. I am using Cossor valves and Eureka transformers. Have heard a good many three-valvers, but none to beat your wonderful set, not only for number of stations, but for volume and purity.

Wishing you and your paper every success in the future, am enclosing list of stations received during the year I have had set:

Milan, Aberdeen, Langenberg, Paris (Ecole Superieure), Rome, Brunn, Frankfurt, Kattowitz, Berne, Glasgow, Hamburg, Toulouse, Manchester, Stuttgart, Madrid, Leipzig, Cardiff, Barcelona, Petit Parisien, Gleiwitz,

The original model of the "Short-Wave Three," the set upon which Mr. Alams obtained the above results.

Readers' Results—*continued*

Bournemouth, Breslau, Dublin, Newcastle, Belfast, Konigsberg, Edinburgh, Cologne, Nottingham, Bordeaux (Lafayette), Kiel, Munster, Nurnberg, Stettin, Kaiserlautern, and several others not identified.

Long Waves.—Huizen, Berlin, Hilversum, Warsaw, and three others not identified. All the above on speaker.

I remain,
Yours faithfully,
T. A. F.

Berks.

Australia on One Valve

Sir,—You may be interested to know that I have received 3 L O, Melbourne (32 metres), 2 X A D (21·96 metres), 2 X A L (30·91 metres) and 2 X A F (32·37 metres), also numerous amateur stations, on Mr. Thomas's "Improving the Single Valver," as described in the Wireless Constructor for February. I am using home-made choke and coils on "Becol" former.

I can get all the above at very good strength, and with a one-valve amplifier can be heard on loud speaker. In the course of experimenting I was astonished to find I could get all the above stations to come through well with aerial and earth disconnected!

Yours truly,
C. J. C.

Devon.

The "Radiano" in Kent

Sir,—Having seen several letters in the Wireless Constructor regarding the "Radiano Three," I thought it might be of interest to let you know my experience of it. We have had all main B.B.C. stations on the loud speaker; 5 X X, 5 N O, 2 L O and 5 G B come in at full loud speaker, the others at good loud-speaker strength. Cardiff is a station hard to get in this locality, but we have had it, also Plymouth and Leeds-Bradford relays. Continental stations amount to about 25 on the loud speaker, several of which we cannot identify; Langenberg, Stuttgart, Cologne, Frankfurt, Hamburg, and Toulouse come in at enormous volume. Hilversum, Motala, Kalunborg, Koenigswusterhausen, Radio Paris, Daventry, and two we cannot identify, on the long waves. The valves I use are two P.M.3's and a P.M.4 in the last stage. High-tension, 100 volts. Thanking you for such a splendidly designed set.

Yours truly,
L. B.

Faversham.

The "Roadside Four"

Sir,—Having made up the "Roadside Four" given in the Wireless Constructor this month, I am pleased to be able to write and say how delighted I am with the set.

I have already succeeded in bringing in several foreign stations with careful adjustment, whilst 5 G B comes in very well. The local station is so powerful that it has to be "modulated down." I have not tried the set at a distance of more than 20 miles from London, but, having received Germany and Spain at my address, I have no doubt about the reception.

The outer case I have made up different from the one shown in the book. It is constructed of plywood, and the total width is only 6½ in., which, to my mind, is a great saving when the set has to be carried about or stood on a shelf.

Furthermore, the aerial being placed round the set has resulted in increased volume. There is only one snag against the two advantages claimed above, and that is that for long-distance reception the case has to be turned in the direction of the station, whereas with the case as per book the lid containing the aerial need only be moved.

I have also found that an aerial wire connected to the top or earth terminal of the aerial improves reception of long-distance stations.

Thanking you, and wishing you every success.

Yours faithfully,
W. F. M.

Surrey.

The "Short-Wave Three"

Sir,—I wish to thank you for the splendid short-wave receiver described in the Wireless Constructor, January, 1928. I have been engaged in short-wave experiments for about four years, and have never yet found a set so stable and so free from hand-capacity. Not wishing to purchase coils, I constructed them, and have achieved very good results. On Sunday, January 8th, I received between 8 and 10 p.m. forty different "Yanks" at good 'phone strength on two valves. (I search on two valves, and use the last for L.S. work.)

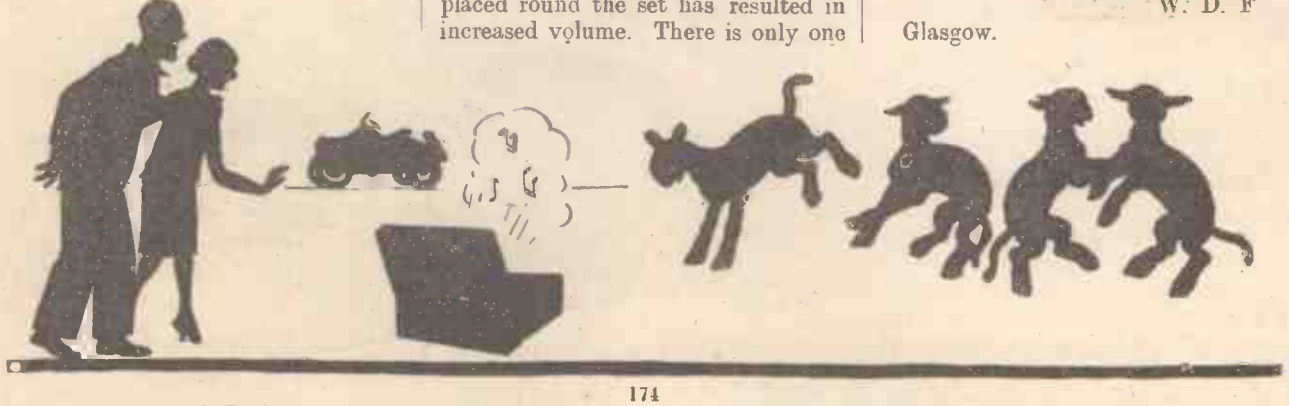
Contrary to the report on the set, I find R.C. coupling very suitable as first valve after det., as it gives a more silent background, which is very suitable on those high frequencies.

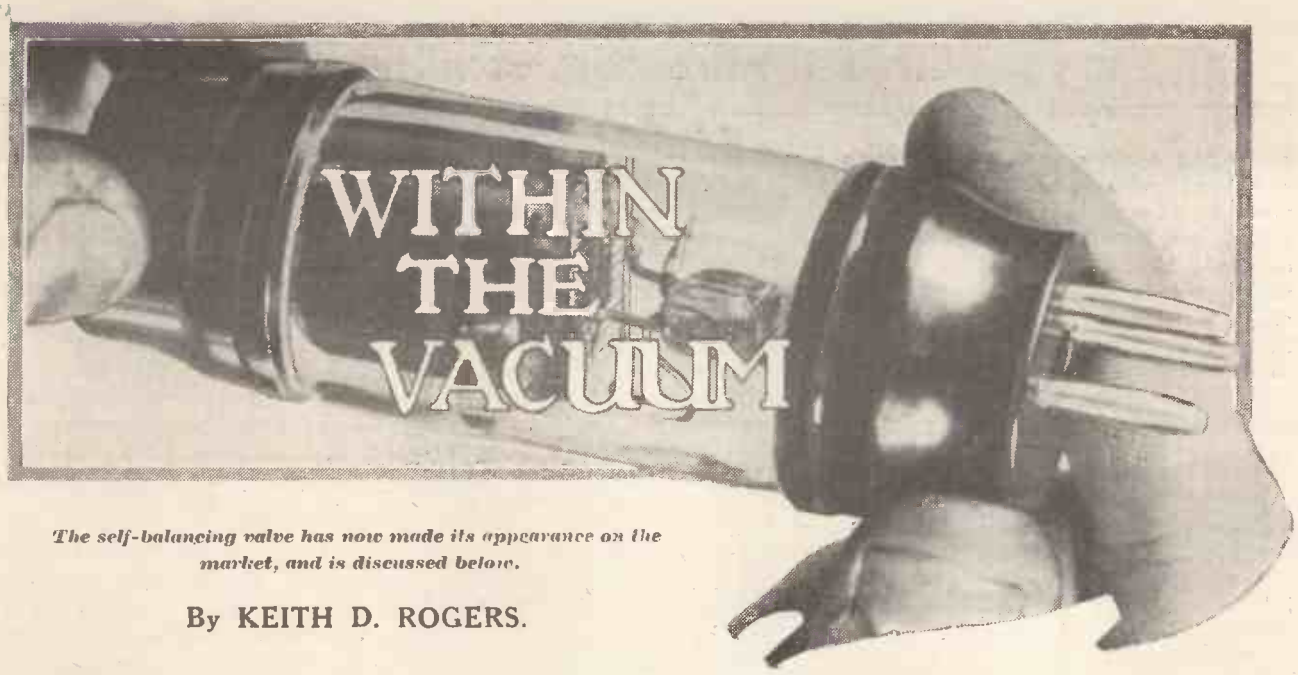
To date, Australia has not come my way, but 2 X A F and 2 X A D are very good.

My best D.X. so far is O P 1 C W, R.6 on two valves, and two stations in South Africa; my total number of "Yanks" being 117 in ten days.

Yours sincerely,
W. D. F

Glasgow.





The self-balancing valve has now made its appearance on the market, and is discussed below.

By KEITH D. ROGERS.

At last the long-awaited "Interdyne" valve has been released for public sale and can now be obtained for use in any receiver requiring a neutralised H.F. stage.

Instead of the flexible lead shown here, the new Interdyne valve sold by R.I.-Varley, Ltd., has a small terminal on the base of the valve.

Readers will remember that this valve is of the self-neutralising type designed by Dr. Robinson, and consists of the P.M.5X type of valve with an extra grid and plate assembly so arranged that they are shielded from the electron flow, but so that their inter-electrode capacity is the same as that of the main grid and plate.

In effect we then have a double valve, with two grids and two plates, and therefore two grid-plate capacities, which are equal, but only the one grid and plate assembly is active and takes any part in the operation of the valve.

The remaining grid and plate unit is used as the neutralising capacity. So we have the two grids connected together and the plates taken one to the ordinary plate pin on the holder and the other to the external terminal.

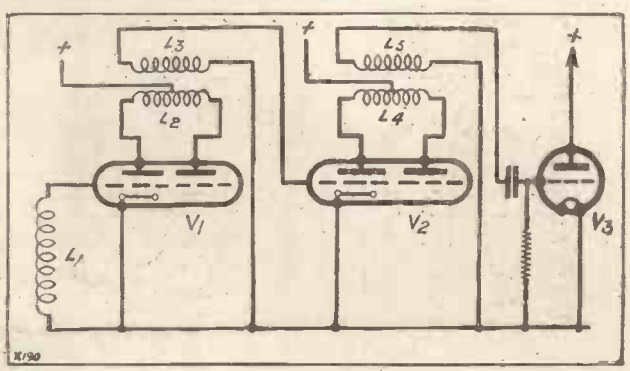
Self-Neutralising

The connections to the external circuit are shown in the diagram, which will make clear exactly how the extra grid-plate capacity takes the place of the ordinary neutralising condenser.

On test I found the Interdyne valve quite up to scratch as regards its amplification powers, and two stages of ordinary split-primary transformer coupling were found to be quite stable using this valve.

It must be realised that all efforts must be made to keep the external capacity as low as possible. In other words, the wiring must be well spaced and the transformers well designed, or the balancing effect of the valve will be upset. The grid-plate capacity *only* is neutralised, the outside circuit being left unbalanced, so if the capacity external to the valve is high, then the whole circuit may be out of balance to a serious extent and trouble may ensue.

A typical H.F. valve of similar characteristics to the Interdyne, but requiring separate neutralising by means of a neutrodyne condenser.



The circuit showing an Interdyne valve used in the place of an ordinary H.F. valve with neutralised split-primary transformer coupling.

Within the Vacuum—*continued*

For the average constructor the self-balancing valve offers great advantages and does away with the fiddling job of neutralising, providing a stable receiver which needs no internal adjustments. As regards ordinary operating efficiency the valve is, as I mentioned above, quite up to the standard of the ordinary P.M.5X, for which it can be substituted in any neutralised receiver.

New Valves

New additions to the already unwieldy stock of valves on the market are the Mullard P.M.4D, a special 4-volt detector, and the Cosmos S.P.16/B, S.P.16/G, and S.P.16/R, 2-volt valves of different types for "general-purpose" work.

The P.M.4D has remarkable characteristics, having an anode impedance of 6,000 ohms, with a magnification factor of 12·5. Thus the slope is a steep one and the "efficiency factor," or mutual conductance, is high. The valve is also recommended for power amplification with loud speakers, but it would appear that here the input would have to be fairly small to avoid overloading. As yet the valve has not been thoroughly tested, and so I can give no experiences concerning it.

The three Cosmos valves are quite good little fellows and give good results, especially the blue spot (S.P.16/B), which makes an exceedingly good detector. The valves should be used under the following conditions if best results are to be obtained.

Anode-Bend Detector

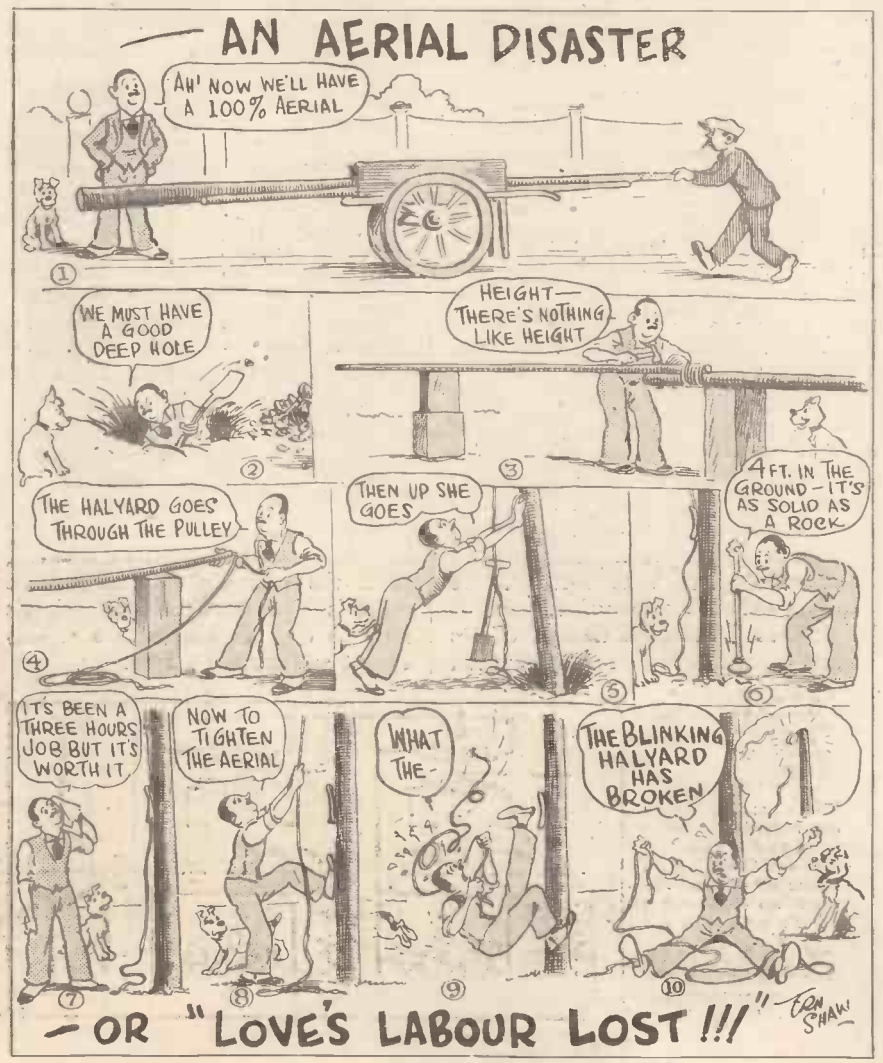
The S.P.16/B is designed for use with tuned-anode neutrodyned H.F., either type of rectification in the detector stage, and resistance or choke-coupled L.F. It is a high-impedance valve having 70,000 ohms impedance with a magnification factor of 35. So it will be seen that it is especially suitable as an anode-bend detector or a resistance-coupled amplifier.

The S.P.16/G is a general-purpose valve of 17,000 ohms impedance with a magnification factor of 16. A good little valve, useful for transformer-coupled L.F. and detector circuits.

For Super-Hets

The S.P.16/R is another general-purpose valve with the peculiarly low-magnification factor of 6·5, with an anode impedance of 16,000 ohms. Therefore the "efficiency factor," or mutual conductance, is only 0·4. It is recommended by the makers for super-het. oscillators, and transformer and choke L.F. coupling, though, in my opinion, the low-magnification factor rather militates against successful operation as a choke amplifier.

All the three valves take only 0·09 amp. filament current; the S.P.16/B needing 2·0 volts, the S.P.16/G 2·0 volts, and the S.P.16/R 1·6 volts.

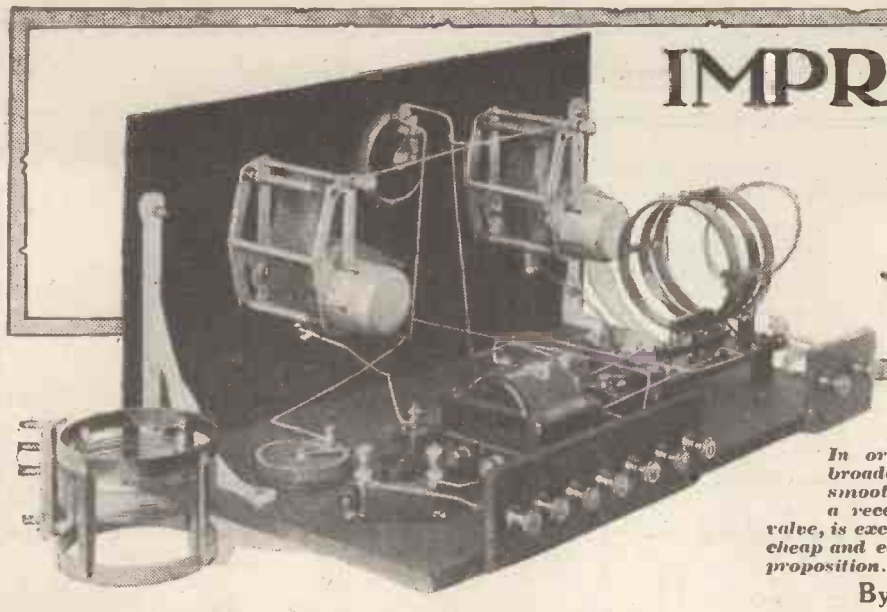


FOR THE CONSTRUCTOR

When fixing up a temporary or experimental layout on a board, it frequently happens that the securing screws available are too long, pass right through the board and, if one is not careful, into the table beyond! A good deal of trouble in this regard can be avoided by nailing two thick strips of wood to the underside, one at each end of the temporary baseboard, so as to lift it above the table.

It is best to use all one-hole-fixing components with metal panels, and the sides of the components connected to the one-hole-fixing bushes must all be connected together in the circuit. In other words, one side of the filament resistances, variable condensers, switches, etc., which are on the panel are all electrically joined through the panel, and must go to some common point, such as earth. This means to say that no components of which one side is not common must be mounted on the panel unless they are completely insulated from it.

IMPROVING THE SHORT-WAVER



In order to receive the distant short-wave broadcasts you must have a set giving a smooth, easy control of reaction. And here is a receiver which, using a separate oscillator valve, is exceptionally efficient in this respect. It is cheap and easy to build, and altogether a first-class proposition.

By L. H. THOMAS (6QB).

IT is well known that America may truthfully claim to be the "home of short waves," and it is an indispufable fact that in this branch of radio our friends across the Atlantic still have the better of us. This being so, it is admitted that we still have quite a lot to learn from them in this direction.

COMPONENTS USED.

1 Ebonite panel, 16 in.×8 in.× $\frac{3}{16}$ in.
1 Baseboard, 16 in.×12 in.
2 Panel brackets.
3 Anti-vibratory valve-holders.
2 30-ohm rheostats, baseboard mounting (Igranic).
1 L.F. transformer (Lissen).
1 ·00013 variable condenser and 1 ·00025 (Ormond).
2 On-off switches (Igranic).
3 ·0003 fixed condensers.
1 "Adjustable fixed" condenser (C.A.V.).
1 2-megohm leak and 1 ·5-megohm leak.
1 Baseboard-mounting neutralising condenser.
2 Two-terminal strips.
2 Baseboard-mounting coil sockets.
1 Seven-way battery cord and plug (Harley).
Small wooden platform and 4 ebonite supports for coils.
Wood-screws, bolts, tinned copper wire, etc., etc. (Note: Any good alternatives may, of course, be used.

A Sound Argument

The writer was reading a two-year-old article in a well-known American magazine which contains more useful information on short waves in one sentence than most three-page articles contain throughout their whole length. The sentence ran as follows: "We cannot go wrong if we remember that what we want is *not* a strong signal, but *any kind* of signal, however weak, but quite free from jamming."

The argument is, of course, the perfectly sound and apparently obvious one that, once a signal has been cleared from all attendant noises and from all trace of other interfering signals, we can amplify it without limit, stopping when we have the signal up to the desired strength.

This is, naturally, a counsel of perfection, since it is theoretically never possible to produce a perfectly clear signal with no trace whatever of interference. If we concentrate more on selectivity and the elimination of unwanted noises, however, we shall be far more successful in all branches of radio, but particularly in long-distance short-wave work.

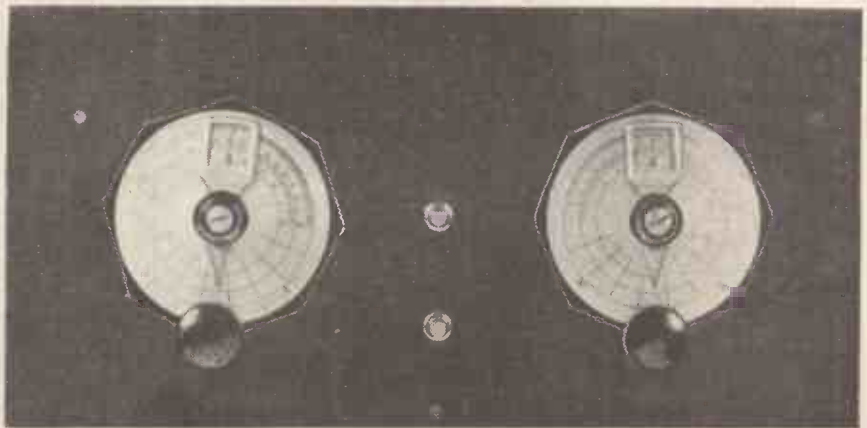
The writer has for a long time been working on these lines, and the set described in this article is the first practical form into which the results of his experiments have been put. The set does not produce signals of incredible strength from any part of the earth, but really does seem to bring in signals that have not been heard on another set, using a more common type of circuit.

Further, by the addition of another stage of L.F. amplification, externally, the signals may be brought up to ample strength without any of the usual background of "mush," crackles and frying noises that most three-valve short-wave receivers of the writer's acquaintance have always possessed.

Separate Oscillator

The circuit employed possesses no startlingly original features; it consists of a detector and one stage of L.F. amplification. The detector, however, is *not* made to oscillate; C.W. signals (for the reception of which the set was primarily designed) are received by means of a *separate* oscillator which produces a beat note with the detector.

The great advantage of this scheme is that the detector may now be worked in an intelligent manner, since it may be kept just below the oscillation point and working in a



You will notice how neatly symmetrical is the panel layout and how well-placed are the tuning dials. The upper switch controls the oscillator, and the other switches off the filaments of the other two valves.

Improving the Short-Waver—*continued*

very sensitive condition. Also, by using a separate oscillator instead of an oscillating detector we eliminate one of the greatest bugbears of real long-distance work—that "spill-over" effect when a loud atmospheric or strong signal from a nearby station hits the set. If one is listening on the very verge of oscillation with the usual set, consisting of a detector followed by one or more note-magnifiers, a noise of this kind will produce an effect in the telephones which is out of all proportion to the actual disturbance created. When one is straining one's ears after a really weak signal and this sort of thing happens one is often deafened for a few seconds, consequently losing the signal and much patience simultaneously.

Absence of Mush

With the separate oscillator arrangement, however, the atmospherics cannot be "exaggerated" in quite this way, and, indeed, the first point noticed when this set first was made to work satisfactorily was the absence of "mush" of this kind.

It may appear at first sight that tuning will be more difficult with a set of this type. In practice this does not, however, appear to be so at all. In the ordinary set we have the main tuning control, usually very critical, and a reaction control which, in most cases, unfortunately has a fair effect upon the wave-length as well.

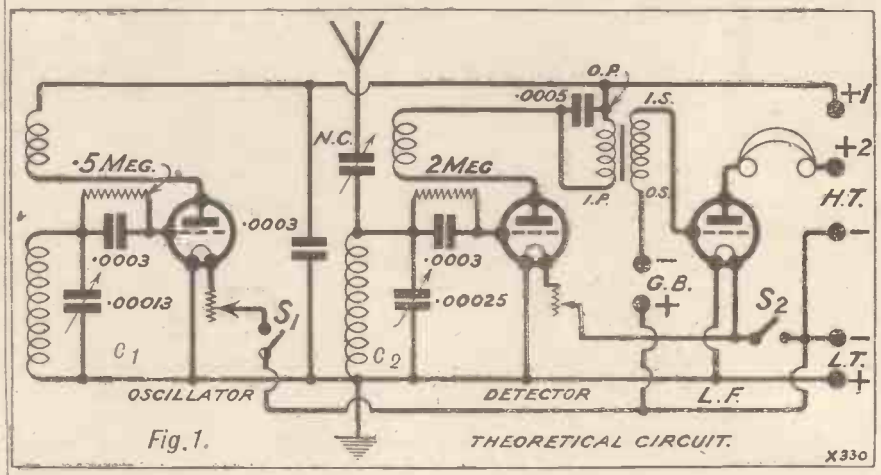


Fig. 1. THEORETICAL CIRCUIT.

That is to say, if we tune in a signal with the receiver oscillating hard, and then reduce the receiver to its sensitive state (i.e. just on the oscillation point), we shall have to move our main tuning control slightly to find the signal again. Thus the two controls always "interlock." Admittedly, by careful design it is easily possible to produce a reaction control that has quite a negligible effect upon the tuning, but it is not everyone who can do it, and most of the sets on which the writer has listened have come very far from fulfilling this condition.

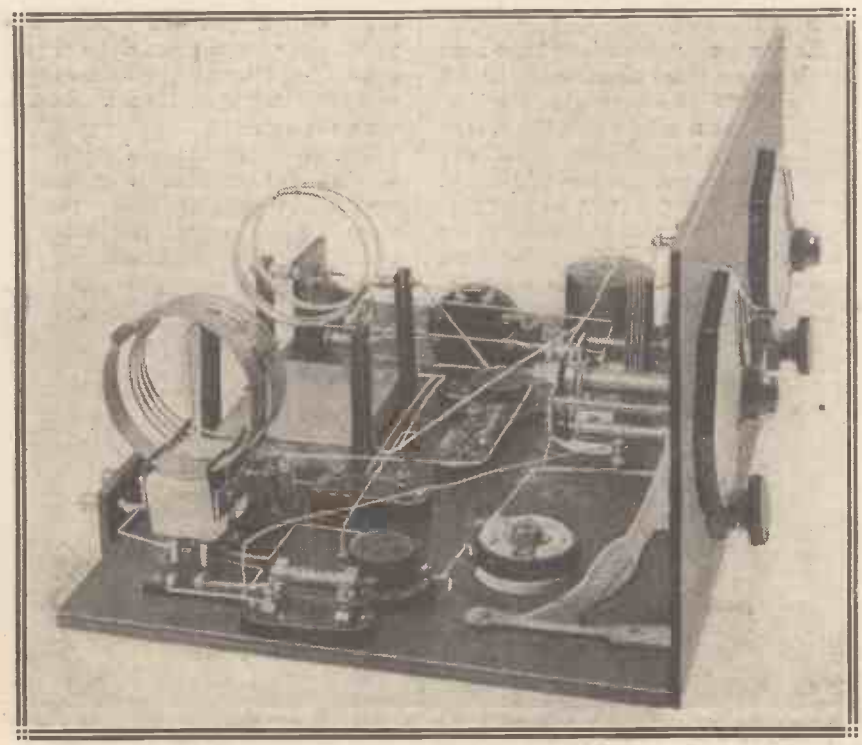
Now let us consider what we have with this separate oscillator circuit. The main control is, of course, the condenser which tunes the grid circuit of the oscillator. Say we have our detector (not oscillating, of course) tuned to 30 metres.

Method of Tuning

Now if we swing the oscillator condenser over a wave-length from about 27 metres to 34 metres we shall hear weak signals in the 'phones as they are "tuned in" by the oscillator, although the detector is some distance "off wave." The condenser tuning the detector grid circuit now acts simply as a rather coarse volume control, and has little or no effect upon the beat note of the signal. Thus if our oscillator heterodynes a signal on about 31 metres, this is received weakly in the 'phones. Swing the detector condenser, however, and there is a point (not very sharp) over which this signal is received at good strength.

Easy to Operate

Thus the operation of tuning consists now simply of rotating the two condensers roughly "in step," and when a signal is heard we leave the oscillator condenser alone, after adjusting the pitch of the beat note so that it is easy to read, and then swing the detector condenser back and forth once or twice until the greatest strength indicates that the two circuits are in resonance.



Notice how short is the grid lead of the oscillator valve. This is the sort of point which must be carefully watched in the construction of a short-wave set.

Improving the Short-Waver—*continued*

This is what should happen theoretically; in actual practice the detector circuit exerts a slight "pull" over the other, with the result that the note of the signal rises or falls by a matter of a few score cycles. A C.W. station tuned in at the pitch at which most people prefer to read C.W. (say about 1,000 cycles) will not vary in pitch by more than about a couple of tones when the circuits are brought into tune. This effect can be used as a vernier control, and is quite useful.

More operating details will, however, be given later.

Fig. 1 shows the full theoretical circuit. C_1 is the oscillator tuning condenser, and C_2 the detector tuning. C_1 is a small short-wave condenser with a maximum capacity of about ·00013 mfd., which gives ample sharp tuning. C_2 is somewhat larger (·00025), on account of the flatter tuning of this circuit, owing to the fact that the aerial is coupled into it and therefore introduces a certain amount of damping.

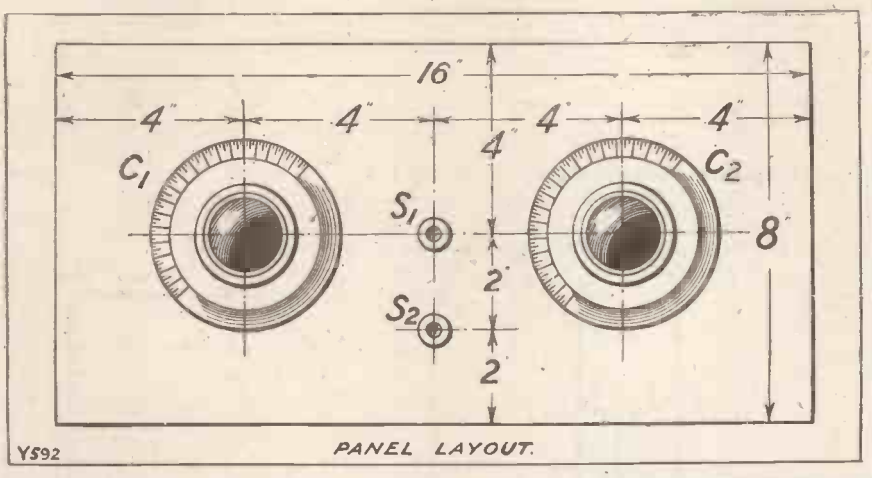
The Short-Wave Coils

These are the only controls on the panel and, after the initial adjustments, the only controls that need be touched at all.

The oscillator and detector circuits are identical, except that different types of coils are used; more of this later.

A separate filament switch has been provided for the oscillator valve, since when one wishes to receive telephony this is switched out of circuit. A rheostat is also included in the filament circuit of this valve, since there will often be one particular filament voltage that will give noticeably better results than any other. A rheostat is also provided in the detector filament lead, but the note-magnifier is always run from the full voltage available.

The upper switch controls the oscillator and the lower the other two valves.



PANEL LAYOUT.

With regard to the coils used, these may all be home-made. In fact, it is usually advisable to make them oneself, simply because the average commercial short-wave coils will not cover the particular ranges that we most want to cover.

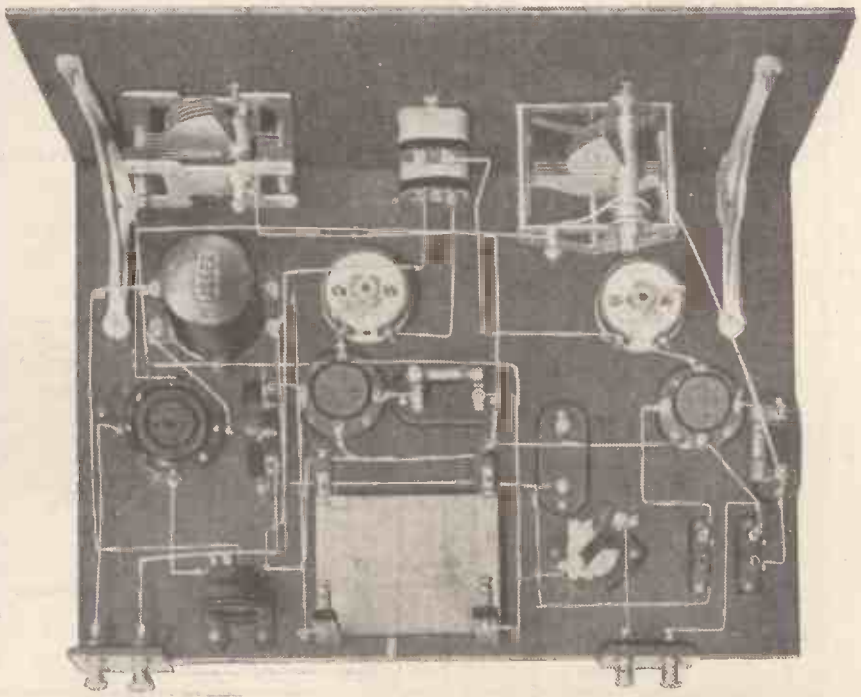
The detector grid coil and reaction coil are mounted on four ebonite feet standing up from a little "platform," which may be clearly seen in four of the photographs. The size of the wooden platform itself is about 4 in. by 3 in., and the legs are 3 in. in height, with telephone type terminals mounted at the top.

The coils are simply wound in any way that pleases the reader most, the ends being bent out so as to fit in these terminals while supporting the coil quite rigidly in mid-air. The writer has practically "standardised" this form of mounting for his short-wave sets, as it leaves nothing to be desired in the direction of simplicity and is apparently very efficient.

Thick Wire Best

The only point to bear in mind is that the coils must be wound with sufficiently thick wire to enable the ends to support them properly, or they will vibrate and produce what the Americans call "wobbulation" on signals received.

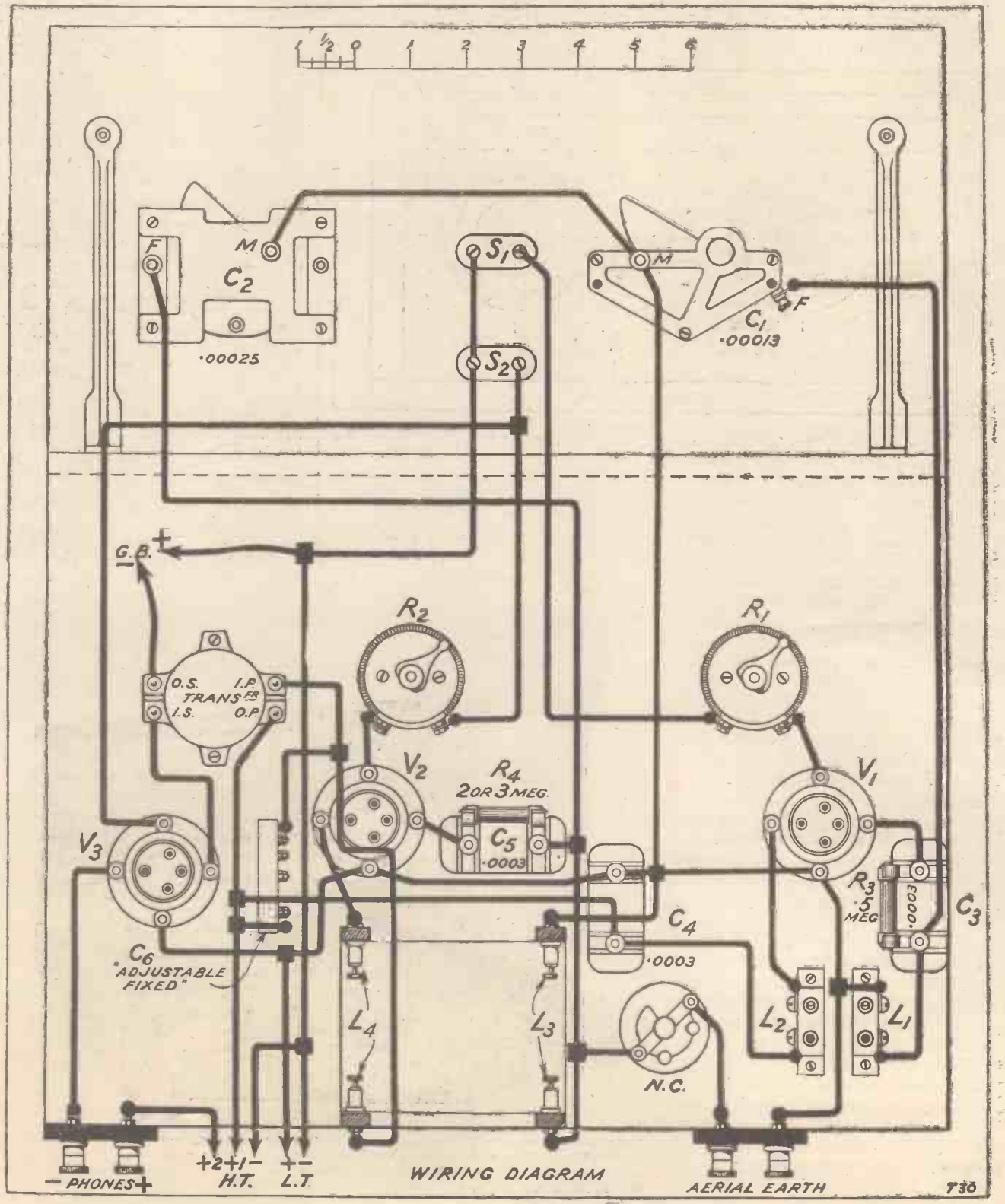
The coils in the oscillator circuits may quite well be something after the same style; actually those used are mounted on the standard plugs and sockets for the sake of convenience.



This behind-the-panel view of the set will assist you, both when mounting the components and when wiring up. You will note that ample spacing for everything has been provided. "Crowding" the components in a set of this nature would be fatal.

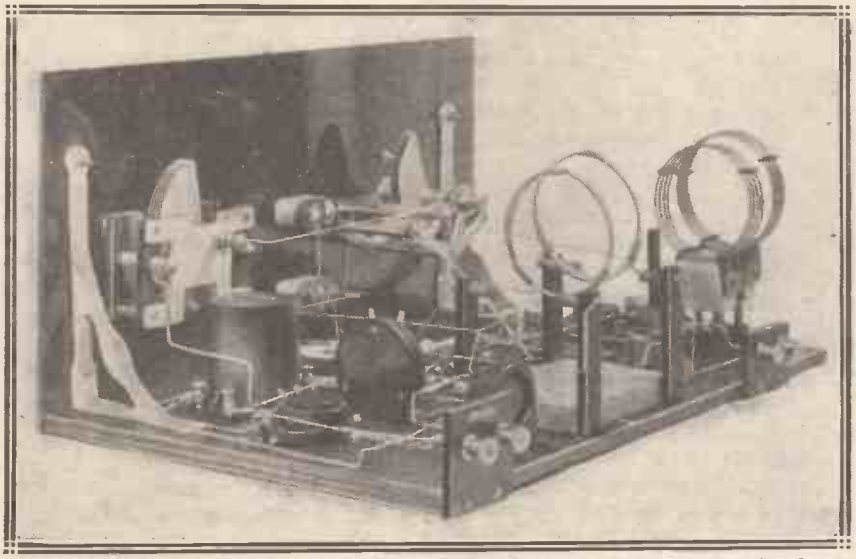
Improving the Short-Waver—*continued*

It will be appreciated that there is no particular point in "low-loss" construction of these coils, since the function of this part of the circuit is merely to produce a beat note with the incoming signals. Various commercial makes of coil fitted on plugs of this kind may be purchased, and any of these will do perfectly well; home-made coils, of course, are equally suitable.



Improving the Short-Waver—*continued*

The only other point in connection with the oscillator is the ·0003 fixed condenser taken from one side of the reaction coil to L.T. This may look unnecessary, particularly if the H.T. supply is shunted by a large condenser, but in order to keep the actual oscillatory circuit as small as possible it has been placed on the baseboard close to the coils and the oscillator valve holder. The whole oscillating circuit is therefore, as far as possible, confined to about one-third of the baseboard, and is practically "self-contained."



You will see that the coils are mounted so that they are well away from the baseboard and all components are well spaced.

The grid-leak and condenser values are apparently not at all critical. The writer used a ·0003 condenser and a ·5-megohm leak, although results with a 1- or 2-megohm leak showed hardly any noticeable difference.

Method of Reaction Control

Strictly speaking, the grid condenser and leak are not necessary at all, but the set was found to oscillate over a wider range and with greater uniformity when they were incorporated. The drain on the H.T. battery is also reduced somewhat.

The grid leak and condenser for the detector were varied over wide ranges. With the particular valves in use, ·0003 and 2 megohms were found to be perfectly satisfactory in every way, although the writer always finds with an *oscillating* detector that a leak with as high a value as 5 megohms is a distinct advantage for short-wave work.

In the detector circuit the problem arose as to how to provide a coarse control of reaction which would be suitable for use if the detector were to start oscillating. The only need for any form of control was simply to provide a means of using a certain amount of reaction without allowing the valve to oscillate.

Finally, the scheme shown was decided upon; this consists simply of the usual "throttle control" system, but, instead of using a variable condenser on the panel, an "adjustable fixed" condenser was placed on the baseboard. The correct value of this is found in the first place, and it is then left alone.

Now, it will be noticed that the aerial is taken to the top of the detector grid coil through a neutralising condenser. This is quite a popular way of "capacity-coupling" the aerial, and is excellent in practice. When a variable capacity such as this neutralising condenser is used, however, we have another advantage; should the set start to oscillate at one particular spot on the wave-length range we can instantly stop it by increasing the amount of this neutralising condenser in circuit.

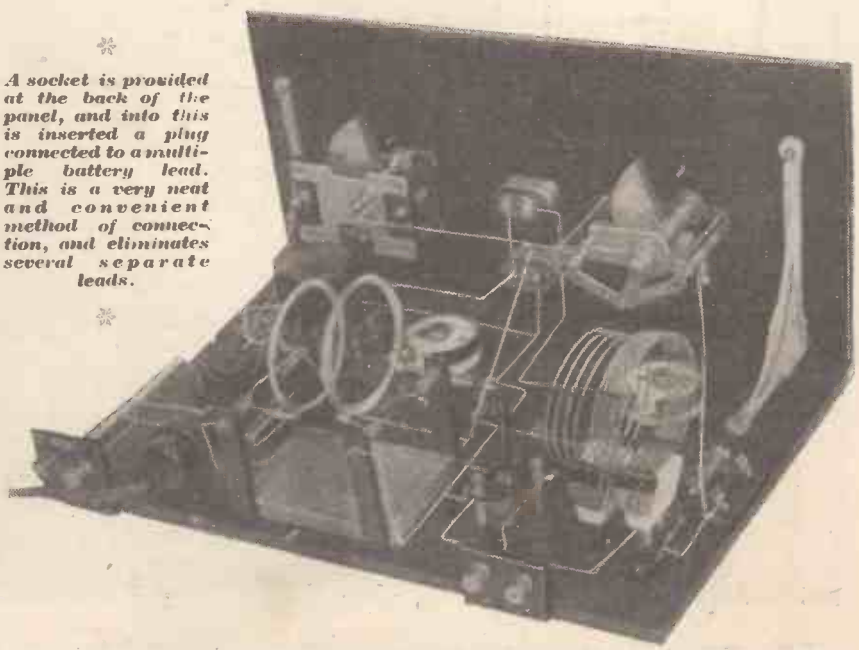
Operating Procedure

This, naturally, increases the damping effect of the aerial, and gives quite a pleasant control of reaction. Thus it is only necessary to decide roughly on the size of the fixed condenser to keep in circuit across the primary of the transformer, and the fine adjustment may be carried out with the aerial series condenser.

This, then, is the procedure. Insert two suitable coils in the "platform," connect up aerial and earth, and set the neutralising condenser about "half in." To commence with, connect up ·0003 across the transformer primary.

(*Continued on page* 212.)

A socket is provided at the back of the panel, and into this is inserted a plug connected to a multiple battery lead. This is a very neat and convenient method of connection, and eliminates several separate leads.



Note the sizes and eminently practical method of mounting the two sets of coils.

Distance Control

Here is a simple, dependable, and inexpensive system which allows the set to be switched on or off at any distance.

From a Correspondent.

THERE is really not much advantage in putting the receiver in a corner of one room out of the way and the loud speaker in another part of the house unless you have some way of controlling the receiver from the "listening point." To control the receiver completely, that is to say, to tune it from a distance, would require a good deal of apparatus, but this is a refinement that not many people can install.

Easily Arranged

Remote control of the on-off switching of a receiver is quite easy to arrange, and extremely pleasant to possess. When you are tired and have settled down to listen to the local programme, you can then choose the items which you want to hear without moving from the room, or even from your chair. There is no longer any need to listen to everything that is transmitted, talks and all, just because you cannot summon up the energy to go into the next room to switch off the receiver.

The heart of the system described here, and indeed of most systems that have been devised, is a relay. This is simply an electrically-operated switch. Given the necessary battery power, the relay can be worked from any distance. A good and sensitive relay takes very little current, a few milliamperes at most, and a single 1½-volt cell is more than enough to work it through the resistance of long leads.

The relay does take some current, however, and in some remote-control systems the circuit is so arranged that the relay contacts are held closed by the current through their magnet windings all the time that the receiver is in use. This is troublesome and wasteful, because it means that the relay battery runs down quickly and needs frequent renewal.

The system of which the schematic diagram is given in Fig. 1 does not suffer from this defect. The components used comprise the relay, a bell-push, a cell, and a reversing switch. The relay is a Post Office "A" relay, an instrument which can still be picked up cheaply from dealers in surplus stores. If you examine the relay you will find that there are seven terminals on its base, while the mechanism is enclosed in a brass case with a hinged glass top.

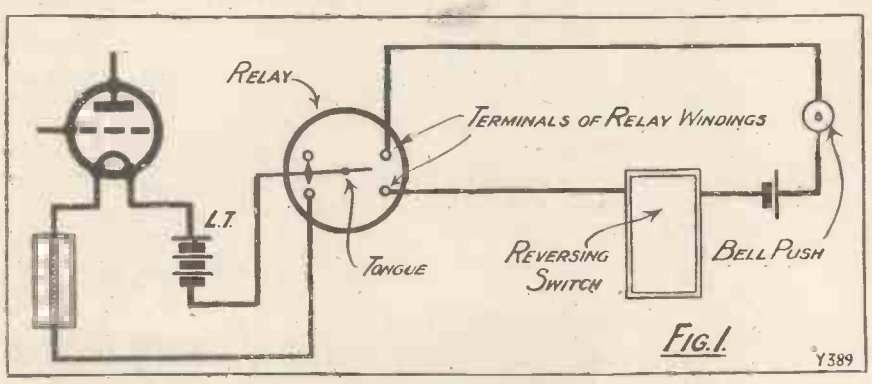


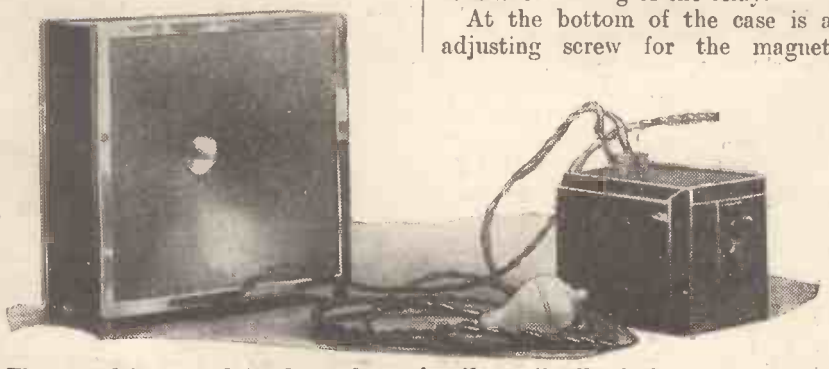
FIG. 1.

The Relay

In the top is a movable contact arm, called the tongue, which can make contact with either of two stops, the spacing and marking stops. The terminals on the base marked S, T and M are connected to the tongue and the two contacts, and these are independent of the remaining connections of the relay.

At the back of the base are four terminals and two brass connecting straps. For our purposes the terminals marked D and U are connected by these straps, and our operating cell leads go to the two remaining terminals. This sends the current through the magnet windings of the relay, making the tongue move over to one stop or the other, according to the direction of the flow of the current through the windings. There are two separate coils on the magnets, and the brass straps put the two in series; this makes for the most sensitive working of the relay.

At the bottom of the case is an adjusting screw for the magnets.



The complete control is shown here, together with the bell-push switch and its extension lead.

Distance Control—*continued*

Turning this to the right moves the magnets so that the tongue rests against the marking stop, returning to it even when it is pushed over to the spacing stop. We have to set this screw till "neutral bias" is obtained, so that the tongue rests against either stop, without flying back to the other one when it is released.

Set the stops themselves so that there is a gap of only about $\frac{1}{32}$ in. between the tongue and one stop when it is resting against the other. If a wider gap is left, the relay will need more current for operation, and if the gap is smaller, it will be difficult to find the correct neutral bias setting.

The Necessary Connections

In the circuit of Fig. 1, the negative of the L.T. battery is connected to the tongue, the filament of the valve to the marking stop, while the spacing stop is not used. A small current through the magnet windings of the relay will then move the tongue from one stop to the other, switching the receiver on or off. We need only a momentary current through the windings; so the operating device is a bell-push.

The current used is thus small, and the circuit is broken again as soon as the tongue has moved. The reversing switch is for changing the direction of the current through the windings. If we press the push and switch on, then we must put over the reversing switch before pressing it again to switch off.

The normal procedure in using the control will be as follows. Press the push for "on," and then at once put over the reversing switch so that the system is ready for switching off again. If the reversing switch is not put over, nothing will happen when the push is pressed. No harm will result, except that current will be taken from the cell so long as the push is pressed, without doing useful work.

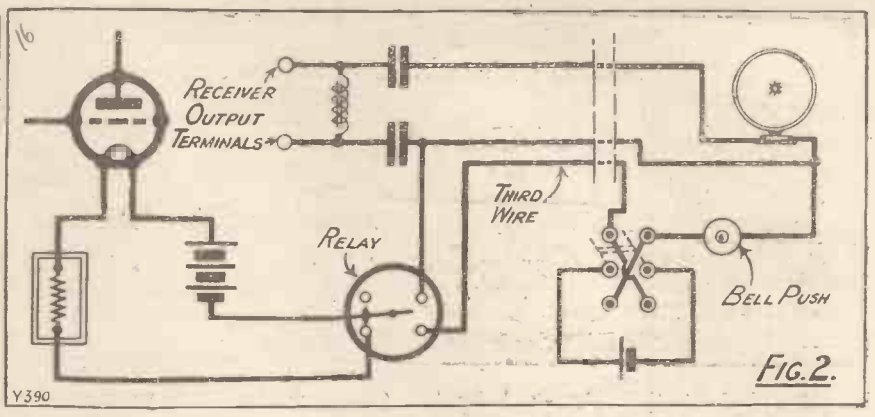


FIG. 2.

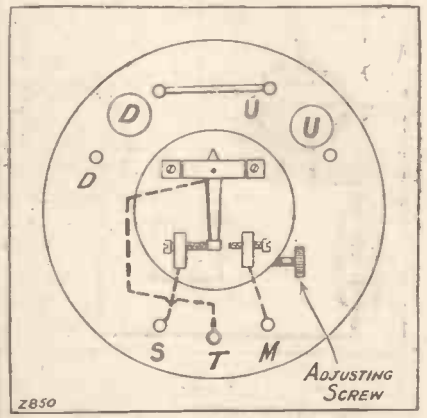
Now we have to apply the circuit of Fig. 1 to the control of the receiver. Fig. 2 shows how this is done. There is no need to run two special leads for the relay, as we can use one of the existing loud-speaker leads. It is possible to use both of the loud-speaker leads without any extra wires, but this is not really satisfactory, as the relay is then shunted across the loud speaker and the volume of signals is reduced. The better arrangement is to run a single wire in addition to the loud-speaker leads. If the existing leads consist of twisted flex, the third wire may be No. 24 S.W.G. D.C.C. wire, twisted in with the flex.

Providing Current Reversal

You are strongly advised to use the filter method of feeding the loud-speaker, with large-capacity fixed condensers in both leads. The loud speaker and relay are then isolated from the receiver, so far as direct current is concerned, and accidental contact between the terminals of the relay windings and those of the loud-speaker contacts can do no harm.

The relay is placed near the receiver. One of the L.T. supply leads, the negative, is interrupted, and the tongue and the marking stop are connected to the accumulator and the receiver L.T. terminal. To the relay winding terminals connect one of the loud-speaker leads and the third wire which has been run.

At the loud-speaker end of the system a small box is installed, containing the reversing switch and a single cell taken from a $4\frac{1}{2}$-volt flash-lamp battery. The reversing switch may be any D.P.D.T. switch, wired as shown in Fig. 2. The lever type of switch shown in one of the photographs gives a neat appearance to the outside of the box.



Showing the connections and markings on the terminals of the relay.

A Convenient Position

The bell-push may be mounted on the box, and two terminals on the top will serve for connecting to the loud-speaker lead and the third wire. It is immaterial which loud-speaker lead is used, and the one chosen can

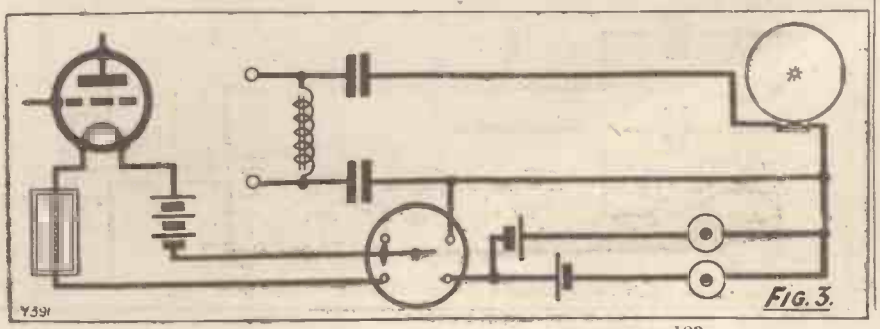
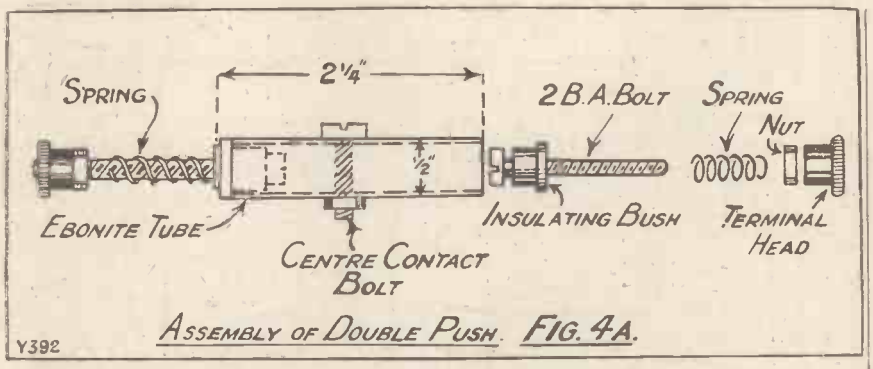


FIG. 3.

Distance Control—*continued*



ASSEMBLY OF DOUBLE PUSH. FIG. 4A.

be identified at the other end by connecting one to the relay and testing on each at the control end.

The box is mounted on the wall in a convenient position. If you prefer to have the push more handy, you can connect it to a length of flex leading from the box, so that you can operate the control from your chair. You will not have complete control, however, as you will have to get up to put over the reversing switch after once pressing the push before you can work the relay in the other direction.

"Cutting Out" the Switch

By modifying the arrangement described, you can secure complete control of the switching from any part of the room, so that you need not move at all to switch the receiver on or off. You will have to put up with the inconvenience of having a flex lead "following you about the room," but, in the writer's humble opinion, the additional comfort secured amply compensates for this.

The circuit of the modification is given in Fig. 3. The relay and its wiring are the same as before, but the reversing switch and bell-push are replaced by two bell-pushes. There are two cells, wired-up in opposite directions, with a bell-push for each. You can fix the two cells in a corner near where the loud-speaker leads terminate, and connect the pushes to flex leads long enough to reach to any part of the room.

Home-Constructed Control

Label the two pushes "on" and "off," and pressure of the required push will send the current through the windings of the relay in the correct direction to operate it. The right way of connecting the cells for "on" and "off" is easily determined by trial.

One of the flex leads to the pushes is common to both pushes, so that it is possible to dispense with the two

A Post Office "A" type relay.

separate pushes and use one double push. If you like making up gadgets of this kind, you can construct a double push on the lines shown in Fig. 4. The barrel of the push is a short length of ½-in. ebonite tube, in the ends of which two panel bushes are a tight fit.

The "pushes" are long 2 B.A. cheese-head bolts, with their heads inside the tube. The centre connection consists of a short bolt fixed with a nut in a hole drilled transversely through the middle of the tube. The assembly of the push will be clear from the diagram. A length of 3-wire flex connects it to the cells and relay leads.

An Important Point

The controls described provide for the switching of the L.T. If you want to include the H.T. supply as well, you can switch this with the same control, but you will need a second relay. Wire this up in series with the first one, and connect its tongue and marking stop in the H.T. negative lead.

It is just as well to retain the ordinary on-off switches on the receiver itself in addition to the relays. The movement of the tongue is slight, and an extra heavy accidental jar may switch on the receiver when it is supposed to be off. The ordinary switches should, therefore, be put "off" when the receiver is to be left for any length of time.

Apart from this, there is really nothing to go wrong in the system, and you can lie back in your arm-chair and choose the items in the programme which you wish to hear literally "with a flick of the finger."

The laying of the loud-speaker and relay extension leads is not a difficult matter, and if the floorboards are not too tightly fixed, instead of twisted flex separate wires can be run along the cracks between adjacent boards. The wires should certainly be run under the boards where they have to enter or leave a room, otherwise the passing of them through the doors may present difficulties.

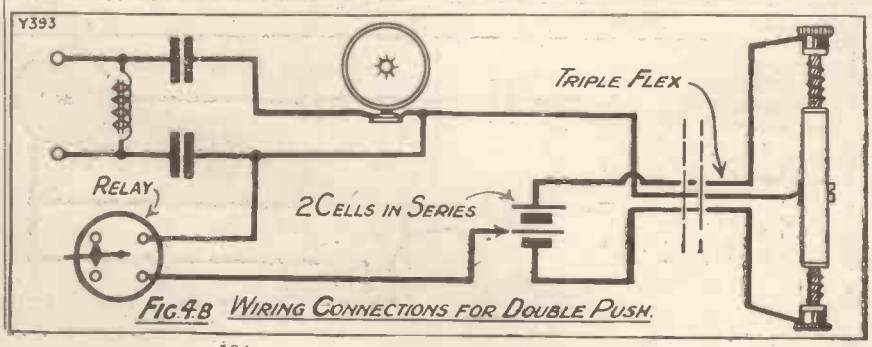


FIG. 4B. WIRING CONNECTIONS FOR DOUBLE PUSH.

"STARS" and the "MIKE"

Why is it that the "Stars" of the microphone, in spite of their tremendous audiences, do not reach the same degrees of popularity that is attained by their colleagues of the stage, with their comparatively tiny audiences?

By NORMAN EDWARDS.

SOME years ago a friend of mine invited me to join him on a visit to a famous film star who was staying at a London hotel. The star had arrived from Hollywood—or wherever it is famous film stars come from—and, with his beautiful wife, had been hailed by the London public with acclamations which almost bordered on the hysterical.

Visiting Valentino

When we arrived at the hotel we found hundreds of people outside patiently waiting for a brief glimpse of the famous profile of the "screen's greatest lover."

As we passed into the foyer and my friend made known the fact that we had an appointment, our reception merged from the realms of ordinary courtesy into those of Oriental obsequiousness, and we were ushered into the star's apartments with all the aplomb and deference shown to great potentates.

Although I was terribly interested in meeting Rudolph Valentino, I came away from the hotel feeling disappointed. On the screen his personality was evident; in real life I found him—ordinary!

"Hero Worship"

Thinking about Valentino the other day, after seeing a revival of one of his films, I began to wonder why it is that although the B.B.C. to-day must have an audience rivalling that of the cinema, no microphone star has yet "arrived" who can command the amazing popularity—the hero-worship, if you like—which, for example, Valentino's film work inspired in his public.

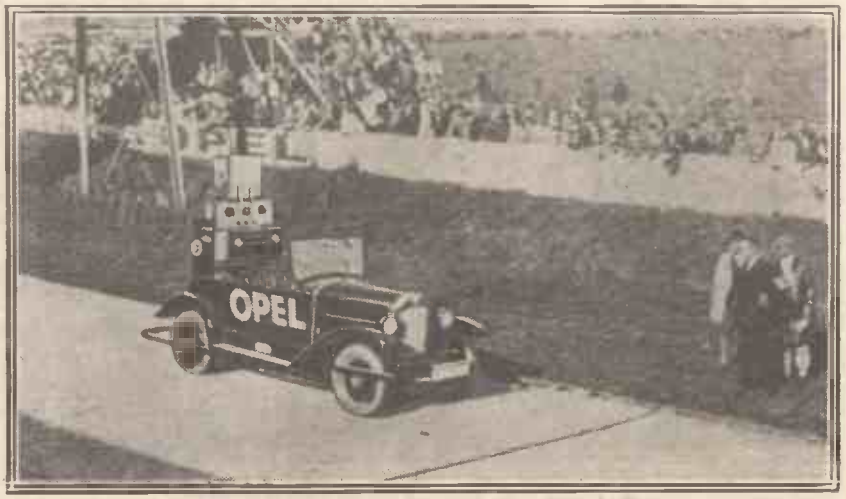
Charlie Chaplin's voice must be unknown to all but a tiny fraction of his admirers; but Charlie's feet, his face and the details of his films, "slapstick" or "straight," command admiration the world over, and his popularity shows no signs of diminishing. In fact, it grows.

In some cases it is the same with the legitimate stage. I have seen hundreds of gallery girls crowding eagerly outside the stage door of a theatre where Miss Tallulah Bankhead is playing, but I have never seen a single person waiting outside Savoy Hill in the hope of catching a glimpse of a microphone star.

Why is this? The microphone does not lack a large band of acolytes who release before it the floodgates of powerful and attractive personalities. It is true listeners cannot *see* them except in photographs, but then film fans cannot *hear* their favourites; they can only see them.

A Possible Explanation

The explanation may possibly be given in two parts: firstly, that although people with powerful and attractive personalities have broadcast, and have from time to time



A wireless-controlled motor which has been demonstrated on the track at Berlin.

"Stars" and the "Mike"—*continued*

proved extremely popular with listeners, their personalities have become, in the process of broadcasting, shall I say, "filleted," due perhaps to the mechanical imperviousness of the microphone to all human, warm-blooded emotion, such as is aroused in the breasts of film fans when they see their favourites on the screen.

Secondly, it may be due, perhaps, to the fact that with the majority of people it is easier to stir the emotions by ocular effect than by aural effect. It is not for me to suggest any profound psychological reasons for this curious difference between the effect of popularity by film and by broadcasting. That subject could be dealt with most excellently by my friend, Professor Fraser Harris; but, after six years of broadcasting, it is rather amazing that *no really outstanding microphone star has yet made an appearance.*

Radio "Hits"

There are plenty of people who have made a "hit" by radio. In the realm of humour we at once think of John Henry, Willie Rouse and A. J. Allan; and there are several people whose microphone success—apart from all other considerations—has been greatly enhanced by beauty of voice and diction. For example, Mr. A. R. Burrows, Mr. Rex Palmer and Sir Oliver Lodge. But has there yet been a broadcasting star who could remotely rival the emotional *popularity* of Valentino or Charlie Chaplin? I cannot think of one.

Where the Film Scores

It may be that broadcasting is still so much in its infancy that the evolution of a technique of emotional appeal only by voice has not yet had sufficient time to develop. Voice appeal, divorced from the assistance of the appeal created by visual appearance, is more difficult to command than the visual appearance appeal divorced from the vocal assistance appeal.

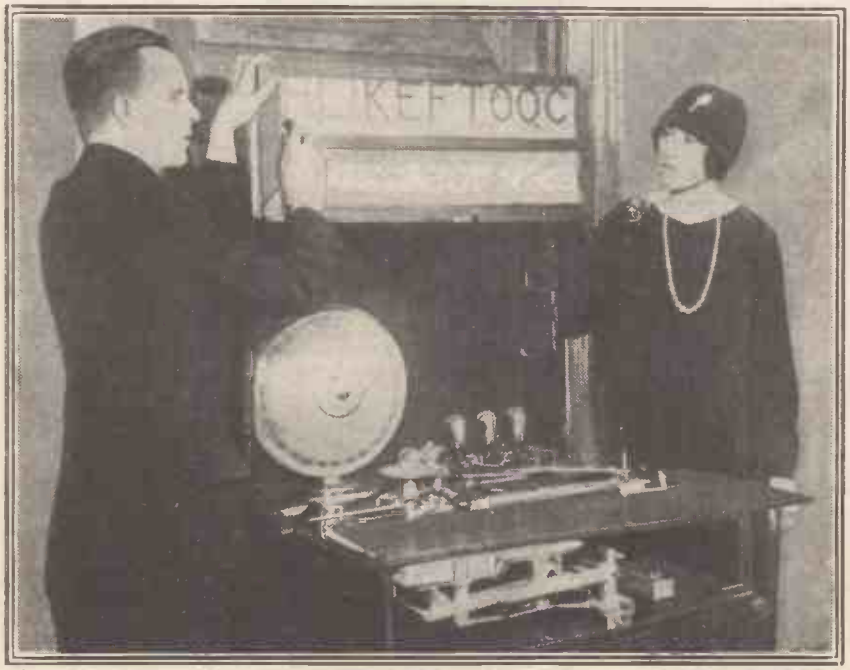
A handsome film hero, tenderly wooing a beautiful girl in the course of an attractive film story, has many things in his favour which the broadcast lover, tenderly wooing a beautiful girl in the course of a radio play, has to do without. The film hero has the wealth of experience gained by years of film technique and experiment—not necessarily his own—which he can draw on cleverly if he is gifted. He has the advantage of suitable settings. For example, a lake shimmering in the soft moonlight; and although he cannot let his audience hear him say to the girl: "I love you!" he can let the audience see his lips form the words, and the recipient of his film affections can shed pearly tears and agitate her uvula in a way which rouses emotion in an audience just as the sun rouses the mercury in a thermometer.

That the whole thing is make-believe does not affect the question. The conjuror's quickness of the hand deceives the eye; the technique of the actor deceives the emotions; and although the hero in the film may actually whisper in the heroine's ear: "Heavens, I could do with a drink!" when the audience fondly imagines his voice is wooing her with "sweet nothings," and although the heroine's tears may be due to a clever use of glycerine, and her uvula may be agitated because the hero is pinching her or making her laugh, the effect—with clever producing and clever acting—is more or less a foregone conclusion.

Lack of Enthusiasm

In the broadcasting studio, the hero possessing a really attractive masculine voice (one of those deep, rich ones with an Irish flavour) stands before the "Mike" and, to get the right atmosphere, probably holds the heroine quite closely in his arms. Tenderly he whispers words of love; even Mike's heartstrings are affected, as yours are (if your set is O.K.); and you get a really wonderful vocal effect—emotional and real. The heroine replies; the catch in her voice, the chattering of her teeth (or whatever happens when one is being made love to by a hero with a deep, rich voice with an Irish flavour), vibrates through the ether and creates an extraordinarily clever illusion as you listen.

But, much as you admire, do you feel like rushing round to the artiste's door at Savoy Hill when the play is over? Do you ever hear of "hysterical gallery girls" mobbing a Mike star? I never do, and never have. Perhaps we may pity the Mike stars because they don't enjoy the fruits of a furore sometimes created by world-famous film stars. But whatever we feel, the fact remains that, although broadcasting commands an audience running into millions, and although some broadcasters have household names, not one of them has yet provided us with a spectacular wave of hero-worship such as Miss Tallulah Bankhead can provide, or which was demonstrated when last I met Rudolph Valentino



A new device based on radio, and called the Visagraph, has been invented so that the blind can read ordinary books, without their being printed in braille, by means of the special vibrations set up by each letter.

HAPPENINGS AT SAVOY HILL

By OUR SPECIAL COMMISSIONER

The Regional Scheme

ALTHOUGH they have given grudging consent to the B.B.C. to start work on the first of the stations planned under the Regional Scheme, I understand that the Post Office are still very uneasy about the proposal. Their attitude is to leave well alone. They believe that the licence revenue has reached its saturation point, and that nothing would be gained in this respect even if a new and better system of distribution were established.

On the other hand, they feel that however good the new system might be, its introduction would inevitably involve a certain amount of dislocation and annoyance among listeners affected. This, in turn, might have an unpleasant influence on the "popularity" of the Post Office. And then there is the menace of an approaching General Election.

Considerations of this kind are responsible for the obstructionism of the Post Office, and their successful delaying of the Regional Scheme for more than eighteen months. It is doubtful, however, whether official obstruction will be able to hold up broadcasting progress any more.

The B.B.C. are hard at the new London twin-wave transmitter, and are determined to get it ready for service early in 1929, not July, 1929, as cautiously forecast when the announcement of the sanction to proceed was made.

A Permanent Orchestra For Broadcasting

It is believed that the plans of the B.B.C. for the early formation of a permanent orchestra for broadcasting have now been completed. This is the most important programme development since the B.B.C. began in 1922.

The new permanent symphony orchestra will consist of between sixty and seventy full-time musicians, with an eminent full-time conductor. The world has been scoured for the musicians, and no expense has been spared to secure something better than anything else of the kind in London or the world.

It is understood that the orchestra will cost about £80,000 a year. There will be no deputising. Sir Thomas Beecham and Sir Hamilton Harty are the two British conductors whose names are mentioned in this connection, but the lists are open to the world, and several foreigners are being considered.

The establishment of this great orchestra will not only be of enormous programme value, but will reflect credit on British artistic enterprise all over the world.

A New Home For The B.B.C.?

Savoy Hill continues to spread itself all over London. Some of its sections are established on the other side of the Strand, in Southampton Street. Others are at Clapham, Roehampton, and Wimbledon. But the process of expansion cannot be stayed even here.

The congestion at Savoy Hill is progressively severe. I gather that the old idea of a "new home for the lot" has been revived, and that an interesting announcement in this connection may be expected before long. A "Broadcasting House" for London would be acceptable from many points of view. Incidentally, it should not be difficult to go one better than New York in this enterprise.

A New Anti-B.B.C. Alliance

The enemies of the B.B.C. have not had much luck lately in their various isolated endeavours. It is unusually difficult now to make any impression on Savoy Hill.

The theatres, the music-halls, and the concert promoters had almost abandoned hope when they were presented with a powerful and unexpected ally. The new development arises out of the steady extension of the B.B.C.'s intrusion into the world of publishing. Under the general title of "follow-up" the B.B.C. has begun the publication of a wide range of books, pamphlets and leaflets which carry advertisements, and are sold to the public. Some publishers have become thoroughly alarmed. The contention is that the B.B.C. has no right to tackle publishing anything beyond the programmes of its various stations.

The controversy concerning the question of political broadcasts is still raging, though the popularity of such a departure from ordinary subjects is assured. This was well demonstrated when Mr. Churchill broadcast his Budget talk.

Happenings at Savoy Hill—*continued*

It is pointed out that its other publishing activities are conducted unfairly. The microphone supplies free publicity, there is no "middle-man," and hence the price charged is uneconomic in the ordinary way.

Plans are under way for a big joint offensive against broadcasting. The object is to secure parliamentary amendment of the Charter of the B.B.C. The effort will come to a head in the autumn.

What About 5 S W ?

It is rumoured that the B.B.C. proposes to allow 5 S W to fade away quietly, and to suspend its transmissions without comment. This would be in accord with the general attitude of the Corporation towards Empire Broadcasting when the idea of 5 S W was first mooted. The short-wave station at Chelmsford has been working for about six months, but its work has been sadly neglected by the publicity side of the B.B.C.

There must have been a considerable volume of reports from overseas, containing interesting stories. But not a word emerges from the "anti-Chauvinistic" purlieus of Savoy Hill. But if it thinks it will escape with the contemplated washing-out of 5 S W it has made a grave blunder.

The withdrawal of even this "experimental" service will be resented by Britishers the world over and would throw back the whole enterprise to foreign initiative.

Cardiff, Manchester, or Glasgow ?

There is bound to be a good deal of heartburning when the decision is taken as to which station of the regional series will follow London. Cardiff was disappointed because the first station was not there. Manchester and Glasgow have jealous eyes on the next place of priority.

I suggest that the right decision would be the North of England, that is, the Pennines station. There the largest population waits to be served, and there the present facilities are the least adequate. But a better way still to solve the trouble would be for the B.B.C. to arrange to start all three stations simultaneously, and make it a race.

Here is a real chance for arousing sporting interest all over the country. After all, there is no need to go on experimenting for ever. If the B.B.C. engineers are worth their salt they will have discovered by now all they need to know to put the whole Regional Scheme in hand forthwith. What little needs to be added to working knowledge should emerge from the early stages of the London station.

The Fate of the Daventry Stations

What will happen to the Daventry stations when the five new twin-wavers are working ? Captain Eckersley's original plan, as sketched out in the B.B.C. programme paper, was to discontinue 5 G B, and to use 5 X X for specialist programmes. But several "snags" have been encountered.

First of all, 5 X X will have to be used to distribute one of the general entertainment programmes in the various "mush areas" in which reception from any of the twin-wavers will be unsatisfactory. Secondly, 5 G B is so strongly entrenched in the affections of Midland listeners that they will violently oppose its removal. Moreover, what is to take its place if it is removed ?

The first theory was that the Pennine station would serve the Midlands as well. But this was obviously bad policy, so was replaced by the idea that London should extend its area to adjoin the Pennines. But here, again, the intense local feeling of the Midlands was outraged. So it looks very much as if 5 G B will stay, and the B.B.C. will have to modify its plans accordingly. Some other part of the country must get along with only one wave. Why not Ulster ?

LABORATORY NOTES by the Editor

Under this heading the Editor discusses some of the many interesting points revealed during experiments carried out in the "Wireless Constructor" laboratory.

MANY readers have recently complained of persistent interference with their reception by noises apparently arising from nearby electric railways and trams. Some systems seem to give much more trouble than others, and a number of listeners whose gardens are immediately adjacent to the electric railway lines are quite free from the trouble, whilst others in similar positions are badly interfered with. With a view to elucidating the problem "The Roadside Four" (described in the May issue) was tested out on the South Western line between Wimbledon and Waterloo.

Both 2LO and 5GB were, of course, easily received when the train was stationary, but immediately the train started the electrical disturbances were so great as completely to drown full loud-speaker strength from the stations. It was found, however, that these disturbances were acutely directional, for when the frame aerial was placed at right angles to the direction in which the train was proceeding the disturbance was negligible, and both programmes were enjoyed in the seclusion of an empty compartment.

Directional Effects

The result of this experiment immediately suggests that readers who live by electric railway lines should endeavour to see that their aerials are placed as near as possible at right angles to the railway lines, for in this position the interference should be at a minimum, while those readers whose aerials are placed at a smaller angle to the line, or in parallel with it, may expect to get much improved results in the way of lessened interference by bringing the aerial as near as possible at right angles.

A frequent source of "artificial atmospherics" in a house is a faulty contact plug belonging to an electric fire, electric cooker, or other power apparatus taking considerable current. Such a faulty connection can usually be found by feeling round the socket or plug.

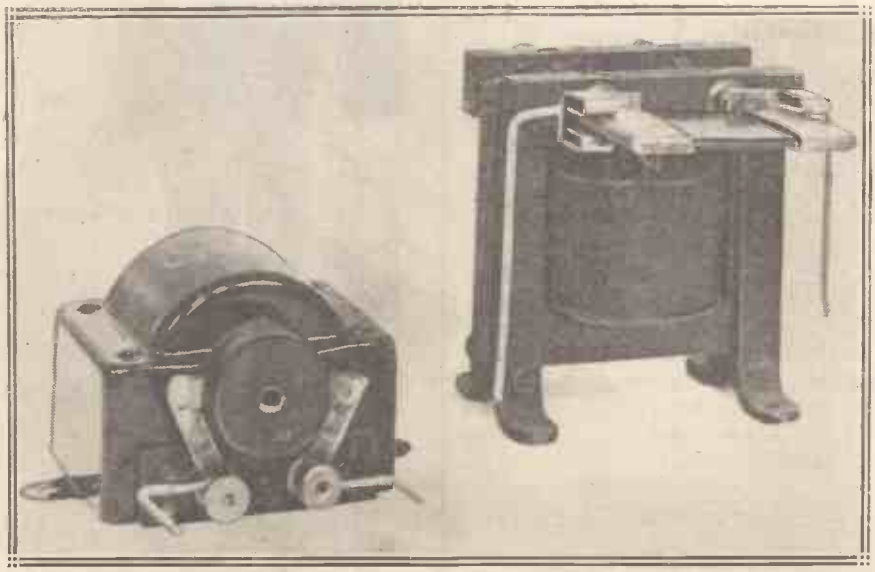
If there is an imperfect contact the chances are that the plug or socket, or both, will feel quite hot, and, of course, the power should not be used until the defect has been remedied. Occasionally, too, on listening close to the socket one can hear crackling noises, similar to that which will be heard in the loud speaker if the interference is causing trouble.

If disturbances of this kind are worrying the reader, and there are electric fires or other similar apparatus in the house, a careful inspection should be made to see whether there are any tiny little flashes or flickerings at the points where the heating elements are connected to their supply leads. A loose screw will often cause this trouble, and is fairly easily remedied.

More Serious Troubles

At the same time, it must not be imagined that all trouble of this kind is simply cured. Some interference caused by tramway systems is quite impossible to remove without redesigning the whole system. We

MORE "WIRE-LESS" CONNECTIONS



Two methods of connecting condensers across the windings of transformers without using wires for this are shown above. On the left, the soldering tags of the condenser are soldered direct to the transformer's soldering tags, and, on the right, the clips which accommodate a plug-in condenser are screwed on to the terminals of the transformer.

Laboratory Notes—*continued*

should not be surprised if in a few years it is made an offence to set up disturbances of this kind from any electrical service, for radio is becoming more and more an important part of our everyday life. It is already an offence to emit volumes of smoke from a motor vehicle, although this may inconvenience relatively few people. Is it not a much more serious offence to run an electrical service which is continually radiating interference in such a way as to upset the reception of, possibly, thousands of listeners in a crowded district?

Microphonic Valves

Reference has already been made in these columns to an epidemic of loose-capped valves, and, similarly, there seems to be a recrudescence of the microphonic troubles which worried us when dull-emitter valves first came into use. Here, again, it is not one particular make, but individual specimens of all the makes which are troublesome.

It is particularly noticeable in portable sets, where we have two distinct causes of microphonic noises. One comes from vibration transmitted through the baseboard of the instrument and is largely eliminated by the use of so-called "anti-microphonic" valve holders, while the other comes from air waves impinged upon the glass of the valve, due to the fact that the loud speaker is placed very close to the valves themselves. This latter microphonic trouble is not cured by anti-microphonic valve sockets, and the Plasticine remedy already referred to in "The Roadside Four" will be found very helpful.

One of the valve makers has already issued a series of valves with double bulb, and with an evacuated space between. While this does a great deal to get rid of the trouble, it makes the valve a little too bulky to use in portable sets of compact design. It is much better to design the valves in such a way that there is no need for this precautionary measure. Some of the makers have progressed very well in this direction.

An Accumlator Advantage

Accumulators when purchased new require in most cases a very long and careful first charge in order to put them into proper condition for use. The life and general functioning of the accumulator depend largely upon the pains taken with this charge, and it is very much better if the user can supervise this himself.

To overcome the main difficulty several makers are now supplying their accumulators in what is called the "dry charged" state, so that it is only necessary to fill them with acid and allow them to stand for about an hour in order to fit them for immediate use. At the same time, readers should note that the useful first discharge that can be given a battery so treated is much less than its normal discharge, and the battery should not be run for very long before it is charged again in the ordinary way.

If, for example, you buy a 40-ampere-hour (actual) accumulator dry-charged, do not expect it to give a 40-amp.-hour discharge in the first instance. You will probably get about half of this figure. The battery should then be charged in the normal way, after which you can take the normal discharge from it. The makers are to be congratulated upon finding means of supplying the user with cells which do not require this tedious first charge, and the user should not grumble if, in the first case, he does not get a full discharge from his cell.

A complete short-wave receiver station, including a portable aerial, designed and made by Messrs. R.I.-Varley, Ltd., for the Sudan Government.

A Mains Tip

Here is a little tip for users of A.C. mains units. Occasionally such units will give slight noises (not the hum due to insufficient smoothing). Try reversing the plug in the electric-light socket and you will generally find that one way is better than the other.

We have recently come across several cases where faults in a wireless receiver have been traced to the fact that the builder has endeavoured to solder a wire on the metal end-plug of a little tubular grid leak. This is always a dangerous proceeding, and requires great skill in order that no injury may be done to the leak itself. The main trouble which arises when one endeavours to solder to the end-cap is that the interior connection breaks away. This is because in many makes of grid leak the interior resistance element terminates in two fine wires, one at each end. The metal end-caps are each drilled with a small hole, and when the leak is assembled one end-wire is pushed through the hole in one end-cap, and held in position with a spot of solder.

Avoid Soldering

The other cap is then put on, the wire brought out through the middle, soldered with the touch of a hot iron, and the wire cut off. You can see how this is done if you examine the ends of some grid leaks. If now a hot iron is applied to the end of a grid leak in order that another wire may be soldered to it, there is a very big chance that the original spot of solder will melt, and the interior wire become disconnected. In any case, grid-leak clips are very cheap, or can even be improvised from a piece of tin or brass, in a few moments.

One firm, however (Messrs. Pye, of Cambridge), supply their grid leaks with long wires attached to each end, so that they can, if necessary, be joined by means of these wires. If, on the other hand, they are to be used with clips, the wires can be cut off.

CHATS AT THE WORK-TABLE

Many points of practical interest to all radio constructors are dealt with under this heading.

By R. W. HALLOWS, M.A.

A Trouble Saver

A TOOL that will make a wide appeal to amateur constructors of wireless gear is the combined drill and countersink illustrated in one of the photographs. The drill portion is just over a $\frac{1}{4}$ in. in length, long enough, that is to say, for dealing with such panels as are in general use for radio work. It has

The combined drill and countersink that is described in this column. It is easily made and is an extremely useful gadget.

a diameter of 5/32 in., which means that it passes a 4 B.A. screw comfortably.

Immediately above the drill is the countersinking part of the tool, whose angle is such that it makes a recess into which B.A. screws fit snugly. It will actually countersink screws with heads up to $\frac{3}{8}$ in. in diameter. The tool is provided with a $\frac{1}{4}$-in. shank, which means that it can be used in any ordinary hand drill.

Not the least of its advantages is that both drill and countersink are provided with two nearly straight flutes. It is, therefore, the simplest business to sharpen one part of the tool or both by means of a fine file should the edges become dull. It will be realised at once what a time-saving tool this is when jobs are at hand which demand a good deal of drilling and countersinking.

All holes, whether for 4 B.A. screws or for wood screws, can be made with this one tool, so that there is no need whatever to keep on exchanging drill for countersink and countersink for drill—and probably losing whichever of them is required just when it is wanted—as one has to do in the ordinary way. If the hole is intended for a round-head or cheese-head screw one simply runs the drill portion through and stops before the countersink comes into action. For a countersunk screw one gives a few more turns in order to make the necessary recess for the head.

An Idea for Tool-Makers

Not a few of the suggestions made in these notes, from time to time, have been adopted by tool-makers and manufacturers of "gadgets" for the wireless set. It is possible now, for example, to obtain at reasonable cost both $\frac{3}{8}$-in. drills with $\frac{1}{4}$-in. shanks and insulated links, which enable variable condensers mounted towards the back of the baseboard to be operated by dials upon the front of the panel. Here is another idea which some enterprising tool-maker may care to take up.

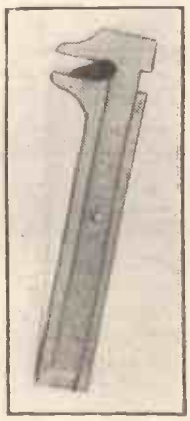
Ebonite tapping is so easy that most of us, when we have a number of holes to thread in this material, mount the tap in the chuck of the hand drill and do the work in about a tenth of the time that would be taken if a tap wrench were employed. Now, why should there not be a combination of a No. 32 Morse drill and a 4 B.A. tap?

It seems a perfectly simple tool to make. The drill part, which need not exceed $\frac{3}{8}$ in. in length, has two or three straight flutes, and these flutes are continued to form those required for the tap. The shank might be $\frac{5}{16}$ in. or $\frac{1}{4}$ in. With this tool one could make a tapped hole, so to speak, in one. The point would be placed in the punch mark and one would then simply drive it straight through.

The Calliper Gauge

A second photograph shows another most useful tool for the constructor, again very reasonably priced. This is a small calliper gauge which enables the diameter of rod, wire, and so on to be ascertained instantly and with quite sufficient accuracy for ordinary purposes.

As will be seen, the gauge looks very like a small adjustable spanner, so

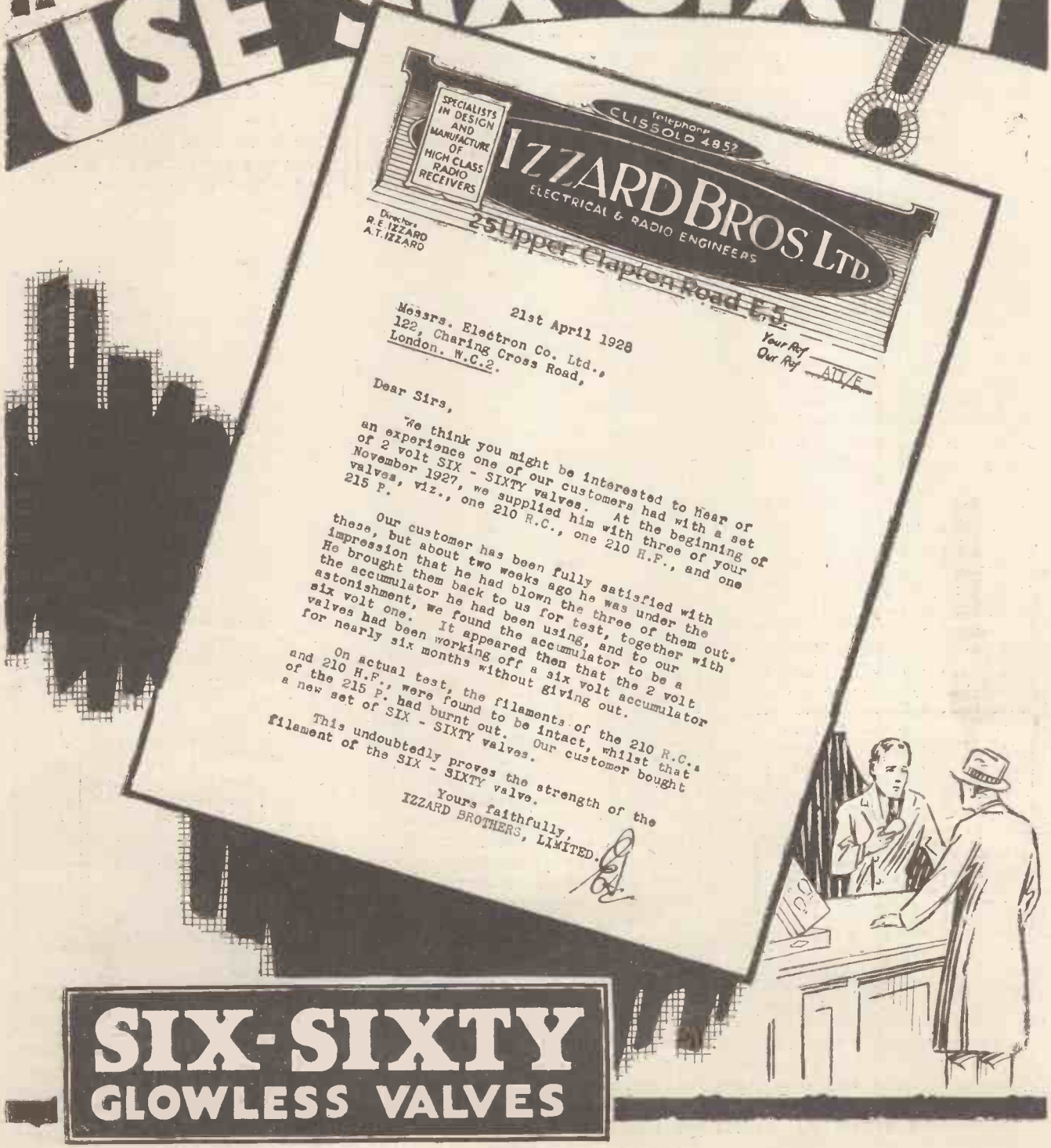


A calliper gauge is a tool that should find a place in every constructor's workshop, for it can be put to a hundred and one uses.

like it, in fact, that there may be a temptation in moments of emergency to use it for tightening up nuts. This temptation must be strongly resisted, otherwise the instrument will quickly be ruined, since it is made of brass and is therefore fairly easily

The Moral of this Letter is —

"USE SIX-SIXTY"



SIX-SIXTY
GLOWLESS VALVES

Advt. of The Electron Co., Ltd., 122-124, Charing Cross Road, London, W.C.2. Tel.: Regent 4366.

Chats at the Work-Table—*continued*

dented or distorted if roughly handled.

The outer jaw is all of one piece, with a slider which moves in a dovetail groove in the body of the instrument. It is graduated along its lower edge into thirty-seconds of an inch and along the upper into single millimetres. To use the instrument one opens the jaws, places between them the material whose diameter is to be measured and then closes them upon it by means of the small knob provided, which is actuated by the thumb.

Fitting "Vernier" Dials

When the jaws have been tightly closed on to the object its diameter can be read off at once on either the inch or the millimetre scale. Its usefulness will be at once apparent. What drill is required to make a hole that will just allow a Glazite lead to pass through a screen or sub-baseboard? Put the wire between the jaws and its exact measurement is read off at once. You have only to find a drill that is of slightly larger diameter to make sure of a neat job.

A slow-motion dial is advertised as suitable for ¼-in. spindles; are yours ¼ in.? If the gauge shows that they are, well and good. Supposing that it measures them as 7/32 in., you know that a copper-foil packing will ensure a good fit. If, however, they are 9/32 in., you will see at once that those particular dials will be unsuitable for your purpose. There

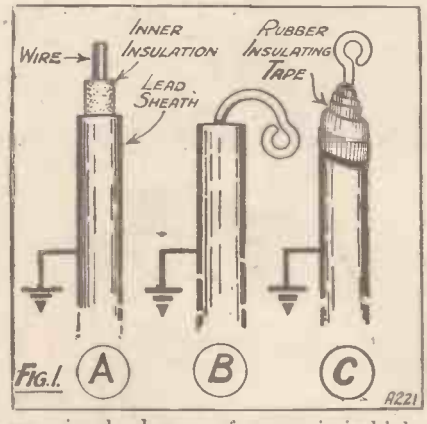


FIG. 1.

are simply heaps of ways in which the calliper gauge is useful—in fact, when you acquire one it will not be long before you wonder how you ever managed to get on without something of the kind.

You can measure the thickness of ebonite sheet; you can detect instantly the undersized B.A. screw or nut (these are unfortunately only too common); if the drills from your stand or container have got mixed there is little difficulty in sorting them out according to size; by measuring across the faces of a nut you know at once just which spanner is required to grip it firmly. Every

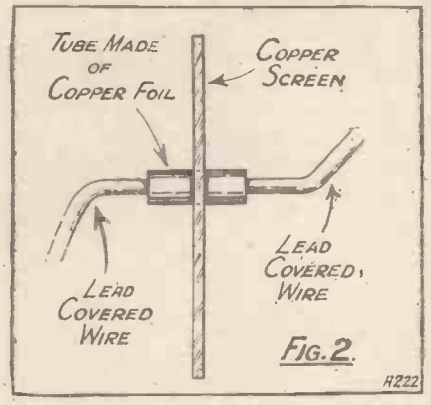


FIG. 2.

wireless man will see for himself dozens of other uses.

Lead-Covered Wire

With the coming into its own of the rational screening of high-frequency stages, lead-covered wire is being used increasingly for leads that carry currents at widely different potentials, especially upon the high-frequency side of the receiving set. It is straightforward enough stuff up to a point, but its use demands a certain amount of care, as will be realised in a moment—if it has not already been realised somewhat expensively by the occurrence of a devastating short-circuit.

This type of conductor consists of an outer sheath of lead within which is a layer of insulation surrounding the wire itself, as seen in Fig. 1A. In his enthusiasm for the making of neat jobs the constructor may well bare the end of the inner wire right down to its roots. Should this wire be carrying current at a potential widely different from that of the earthed screen a short-circuit can easily occur, as shown in Fig. 1B, if contact takes place between the wire and the earthed sheath.

Far Better Method

There are two methods by which wire of this kind can be dealt with. The first consists in leaving a certain amount of the inner insulation between the outer casing and the wire, as seen in Fig. 1A. This, however, is not ideal, since a thoughtless bending of the wire may cause a breakage of the insulating covering and contact between the conductor and its sheath.

A far better method is that seen in Fig. 1C. The lead sheath is cut away carefully with a sharp knife and a quarter of an inch or so of the inner insulation is left. The inner wire having been formed into a loop, a tight binding with rubber insulating tape is made. In this way the possibility of a short-circuit is eliminated in ordinary circumstances. When, however, the wire passes through an earthed screen it must not be forgotten that the edges of a hole drilled in copper or aluminium are sharp, and that lead is exceedingly soft.

Leads Through Screens

By far the soundest way of taking a lead-covered wire through a screen is seen in Fig. 2. Discover with the help either of the calliper gauge already described, or of the drill plate, what size drill is necessary to pass the wire. Then select a drill two or three sizes larger. Cut off a strip of copper foil about three-quarters of an inch in width and roll this round the lead covering so as to form a tube. Pass the tube through the hole drilled in the screen and work the wire through it.

There need now be no fear that the lead casing will be cut by the sharp

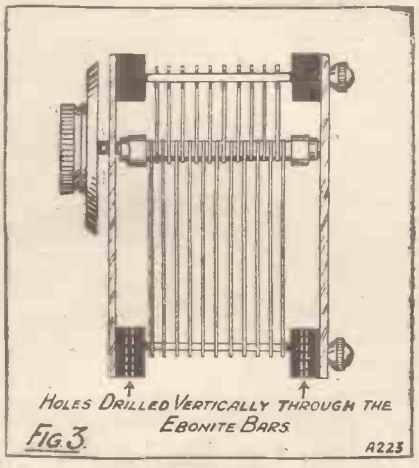
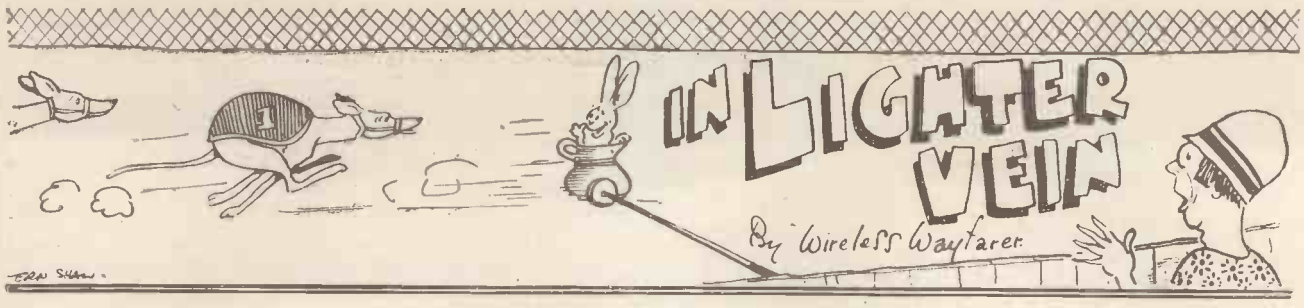


FIG. 3.

edges, and perfect contact is ensured between the lead and the copper owing to the comparatively large surface presented by the inner part of the tube. Assurance may be made doubly sure by scraping the lead bright just where it issues from the

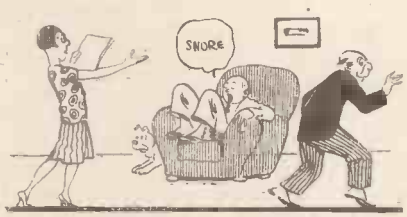
(*Continued on page 212.*)



"AT last!" cooed Miss Worple.

"What has happened?" I queried, "Have you backed the winning greyhound, or have you placed with some publisher those beautiful poems of yours?"

Of course, you don't know Miss Worple's poems. She is one of the highest of the high-browns as regards poetry. Her motto in fact is "Down with rhyme, down with metre, down with sense!" Not so very long ago she stopped Professor Goop and myself in the High Street and insisted



"I recite them to my friends."

upon reciting to us her very latest effort. It ran something like this:

"Oh!
Ah, ah, ah!
Beautiful pink-headed bald men!
Do you realise how extraordinarily
like eggs
Your head-pieces are?
Ah, ah, ah,
Oh!"

That, of course, is the goods. I mean to say that the person who can write that sees things as they really are. Her soul is thrilled to the core by the poignant urge of the submerged, and all that kind of thing. You see exactly, do you not?

Those Brutal Sports

Miss Worple explained a little haughtily that she never backed greyhounds because she was always so sorry for the poor, dear stag.

"But," I expostulated, "they don't chase stags; they chase stuffed hares."

"I don't care if they chase jugged hares," snorted Miss Worple, "all such sports are brutal."

Professor Goop, who has just perfected an electric worm to enable thrush racing to take place upon tennis lawns, looked a little hurt; but we did not pursue the subject. Since Miss Worple so strongly disapproves, he will probably not now go on with his other project, the electric lettuce leaf for tortoise races.

Continuing her remarks Miss Worple told us with some heat that it was never necessary for her to seek a publisher for her poems.

"I am my own publisher," she said, "for as you know, I recite them to my friends. Here is a little thing that came to me as I lay awake towards dawn this morning—"

I pulled out my watch.

"By Jove!" I said, "I am late already. You will excuse me—er—er——"

At this juncture the Professor remarked that he never could appreciate poetry on Tuesdays and Miss Worple switched off.

The Listeners' Magna Carta

"One moment," she begged; "when I said 'At last' I was referring to what we may call the broadcast listener's Magna Carta."

"His *what?*" queried the Professor and I simultaneously, but on wave-lengths far enough apart to avoid a heterodyne.

"His Magna Carta."

History has always been my strong point.

"Let me see," I mused. "William the Conqueror, one O double six. Wrong number. Still, I am getting warm. Henry — Stephen — Matilda. Oh, yes, I know! You mean the thing that Perkin Warbeck signed just after he had used Queen Elizabeth's cloak in order to cross a puddle dryshod, and just before they drowned him in a butt of Malmsey wine, after which he never smiled again.

"I remember all about it now. The Lord Mayor of London went out to Turnham Green, but ate too many lampreys and lost his Sunday shirt in the Wash. Then the cat said 'Turn again, Dick Whittington,' and the Duke of Wellington cried, 'Up Guards, and at 'em!' Ah, yes, and it was just about that time that the king, feeling a little seasick during a rough crossing from France in the White Ship, groaned, 'My kingdom for a horse,' and Sir Philip Sidney said 'Give this one to him, for his need is greater than mine!"

Controversial Broadcasts

Miss Worple gave me a withering glance.

"Magna Carta," she said, "is a synonym for charter of liberties. For five long years broadcasting has been hampered by the ban upon controversial matter. Now this ban has been lifted and we shall be able to realise that there are two sides to every question."

"The outside and the inside?" I asked, always eager to acquire knowledge.

"The right side and the wrong side," trumpeted Miss Worple.

I asked what in any case was the use of hearing the wrong side, but Miss Worple turned a deaf ear to my question.

That very evening, she told us, there was to be a debate upon the subject of Peace, and she hoped that the Professor, myself and all the other members of the Mudbury Wallow wireless club would come in force to her house in order to hear it via her new moving something or other loud speaker.

All loud speakers have a moving something, but I never can quite

"I always motor from place to place."

remember just what it is that differentiates one from the other. Mine has a floating kidney—I think it's a kidney, but it may be a diaphragm or some other internal organ; whilst the Professor's is altogether so moving that it generally moves

In Lighter Vein—*continued*

his friends to depart about two minutes after he has switched on.

Miss Worple told us that the idea was that we should listen to the talks upon peace given by the holders of different points of view, and that we should subsequently indulge in what she called a nice little friendly debate between ourselves.

I simply love debating. I mean so long as I am allowed to do all the talking there is really nothing that I like better. The silly part of it is that when I have said all that there is to be said upon a subject some stupid ass generally gets to his feet to make further remarks, and the chairman orders me to sit down when I rise to a point of order, just to show that he is talking nonsense. My own view is that in all debates only one man should be allowed to speak.

We All Turn Up

Secretaries of debating societies will please note that I am quite prepared to be that one man on any night in any part of the country for no payment whatever except for my travelling expenses. I should mention that I motor from place to place, and that I do not even charge for petrol provided that I am presented with a new Rolls-Royce saloon.

Miss Worple's suggestion appealed instantly to the Professor and myself. We promised that we would be there, and we undertook forthwith to whip up Primpleson, Tootle, Goshburton-Crump, Captain Buckett, Sir K. N.

"The Professor turned up in pyjamas and dressing gown."

Pepper, and all the other leading lights of the wireless club.

When we had run each of them in turn to earth and had obtained his promise to attend, the Professor and I departed, each to his own home. My last words to him were "Don't forget that you must come in evening kit."

It was probably an absent-minded mixing up of evening and night that made the Professor turn up in pyjamas and a dressing-gown. When I expostulated as we met at Miss Worple's door he claimed that anyhow he was in evening kit, even if it *was* rather late evening.

A Technical "Fault"

I need hardly tell you that Miss Worple's set utterly refused to work when, after we had all assembled in her drawing-room, what she described as the momentous hour arrived. Ever noted for their gallantry in times of feminine distress, Primpleson, Tootle and Goshburton-Crump leapt at the thing armed with spanners, screwdrivers, monkey wrenches and crowbars. When they had done their worst, I strolled out through the French windows and hooked on the aerial and earth leads.

Except for the fact that both the fellows who were conducting it talked the most consummate rot the broadcast debate was really jolly good. Realising that it was not yet my turn to have my say, I contented myself by mere interjections and gestures as it ran its course. Naturally, I bawled, "Hear, hear," when one chappie or the other *did* happen to say something nearly sensible, and "Bosh" or "Rats" or "Bilge" or "Tosh" when, as was most frequently the case, he merely drivelled. Still, I really don't see why Primpleson should have bonneted me with a wastepaper basket about half-way through. It was so tight a fit that I could not get it off, but had to content myself with tearing out the bottom, which fortunately happened to be loose.

The Debate Begins

When the broadcast debate eventually drew to a close, Miss Worple announced that Goshburton-Crump had kindly consented to lead off our discussion.

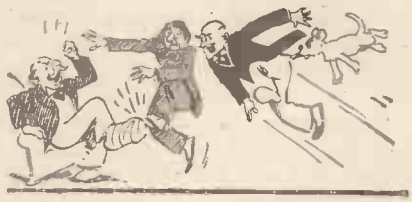
"The word 'Peace,'" he began, "is undoubtedly the most beautiful in all languages."

"Hear! Hear!" I cried, my voice rather muffled, owing to the presence of the wastepaper basket.

"Drivel," shouted the Professor, suddenly waking up and leaping to his feet. "Peace is a hideous and a loathsome idea——"

"My dear Professor," said Miss Worple soothingly, "do not, I pray you, introduce a jarring note."

The Professor assured her that he would not do such a thing for worlds. Still, he went on to say, when a cross-eyed, flat-footed, lop-eared, bandy-legged, half-witted, pimply-faced, ham-handed, bottle-nosed, long-haired, hump-backed son of a jackass like Goshburton-Crump got up and



"The Captain cannoned into Tootle."

talked tripe all that he could decently do as a scholar and perfect gentleman was to tell him straight out that he was a snivelling, and drivelling, canting, and ranting ignoramus.

Cries of "Shut up," "Sit down," "Go on," "Hear, hear," "Fathead," and "Attaboy" filled the room. Goshburton-Crump, purple in the face, struggled to find words. He had only found about two when the Professor grabbed a pot of tulips and flung it with such excellent aim that Goshburton-Crump did a back somersault over the sofa right on to Tumpsy-Wumpsy, Miss Worple's little dog, who was slumbering upon the hearth-rug.

End of the Mêlée

Not being quite sure what had hit him, Tumpsy-Wumpsy sprang into the air, and grabbed the nearest pair of pants, which happened to have Captain Buckett inside them. During his subsequent sprint round the room in an endeavour to shake off his small aggressor the Captain cannoned into Tootle, who lost his balance and staggered on to Sir K. N. Pepper's most prized gouty toe.

Things were going really merrily when Miss Worple, who is not much of a sportsman, made her way to the doorway and switched off the lights. This put a damper upon the proceedings, but we had to strike quite a lot of matches before we could prise open Professor Goop's jaws and free Goshburton-Crump's ear.

Somehow I don't think I shall attend any more of these drawing-room meetings unless they choose subjects such as "Knitting," or "Tiddley-winks."

Using the Thirty-One Tested Circuits.

In this, the fifth article of a series by the Editor dealing in detail with the "Thirty-One Tested Circuits" Booklet, presented free with the February issue of the "Wireless Constructor," the four-valve circuits are explained. This series of articles, together with the gift booklet, should be studied by every home constructor, and new readers are advised to obtain the back numbers through their newsagents.

The "Four-Valvers"

Two four-valve arrangements are shown in the circuit book presented with the February issue—G1 and G2; the first comprising one stage of high-frequency only, and the second two stages. Having studied the circuit book through to this point, the reader will already have found that many of the features in the various circuits are interchangeable, and that some of the three-valve circuits in the "F" series can be converted into four-valvers by the simple addition of a further stage of note magnification.

In order, however, to give readers as many circuit variations as possible, the four-valve circuits were not simple additions of one note-magnifying valve to the three-valve series, but have shown slight modifications in the high-frequency side as well. Compare, for example, circuit F1, with one stage of high-frequency, detector and one stage of note-magnification, with G1, which has a stage of high-frequency, a detector and two note-magnifying stages. In F1 a single coil is used for aerial and first grid circuit, the aerial being tapped off at a suitable point which is found by trial. In G1 a separate coil is used for the aerial circuit, and in this case varying degrees of selectivity and coupling can be tried by changing the coil L_1 for one of different size. Either arrangement can be used in either circuit, and whereas in F1 a standard six-pin aerial coil is used, in G1 two standard plug-in coils of the conventional type are adopted.

"Isolating" the Loud Speaker

Both circuits use standard six-pin split-primary transformers for coupling the high-frequency stage to the detector valve, and both have what is commonly called Reinartz reaction on the detector. In the four-valve arrangement a stage of resistance-coupling follows the detector, and this in turn is followed by a transformer coupling.

A further variation in the four-valve circuit is to include an output transformer so as to prevent the steady H.T. current supply for the output valve passing through the loud-speaker windings, having the further advantage of substituting a low-resistance primary winding for the fairly high-resistance loud-speaker winding.

This is a very important point with modern super-power valves, for when the loud speaker is included directly in the plate circuit of the last valve its relatively high resistance may cause an important drop in voltage, so that our output valve does not get the full voltage we aim to impress upon it.

A High-Frequency Stopper

The inclusion of a well-designed output transformer or output filter choke cuts this resistance loss down to a minimum. This means, among other things, that the loud speaker can handle slightly louder signals than is the case when the windings are included in the output valve circuit.

Do not fail to keep your booklet, for further articles from the Editor's pen discussing the various circuits included will appear from time to time.

Notice, too, that a resistance R_3, acting as a high-frequency stopper, is inserted between the condenser C_6 and the grid of the first low-frequency valve. This resistance is not always necessary and can be omitted frequently without harm, but in other cases, and particularly with a very compact layout, it will prevent awkward "chain" effects due to high-frequency currents getting through to the low-frequency side, being magnified, fed back to the aerial by radiation from the loud speaker or battery leads and back again to the set, giving objectionable howling or distortion effects. This resistance can be a standard ½-megohm grid leak, and a very simple way of joining up one type for this purpose will be found in the seven-valve super-heterodyne described in this issue.

Condensers C_7, C_8 and C_9 are three separate shunts across the high-tension positive tappings. Here, again, these are not always essential, but they never do harm and sometimes are very useful in preventing unwanted feed-back effects. I have also known sets work quite well without the radio-frequency choke shown between the plate of the detector valve and the resistance R_2, and reaction effects are generally obtainable without it, for the impedance of the path through the condenser C_5 and the coil is very low compared with that through R_2, and therefore the high-frequency currents prefer this path and produce the reaction effects required. At the same time, however, the omission of the radio-frequency choke shown increases the chances of high-frequency getting beyond the detector on the low-frequency side, and therefore its use is recommended in most cases.

When "Ganging" is Possible

The circuit G2, with its two stages of high-frequency, detector and one transformer-coupled low-frequency valve, when properly made up is a delightful instrument to use, but unless the condensers C_2 and C_3 are "ganged" and the coils and condensers well matched it is a little difficult to perform rapid searching. In this particular type of circuit it is not possible without a great deal of trouble to match the first grid circuit with the second and third, and therefore a separate condenser should be used for tuning C_1. If, however, in place of L_1–L_2 one uses a standard six-pin aerial coil, the ganging is sometimes possible, but one must in such cases sacrifice something in sharpness of tuning and amplification to obtain unity of control.

Unless the coils L_3–L_4 and L_5–L_6 are of the fieldless variety and well spaced, it is essential to screen them, or, better still, screen the whole stages. Standard square screening boxes can be used for this purpose, as

(*Continued on page* 214.)

A Good Switch

ANOTHER addition to the many excellent on-and-off switches now obtainable is the Duco, the general appearance of which is seen from the accompanying photograph. In size and general appearance it closely resembles many other switches now sold, but the method of making contact is a little different, for whereas most switches are fitted with two blades which make contact by pressing on the sides of a metal collar on the plunger, in the present case the phosphor-bronze spring contacts, which are quite strong, rub over an end-knob and almost touch. Not only does this give very good electrical contact, but it provides a very firm and positive "on" position, free from shake. At one shilling it is excellent value.

A Permanent Crystal Detector

From the Radi-Arc Electrical Co., Ltd., we have received the Radi-Arc "permanent" crystal detector, the appearance of which follows conventional lines, with a spring-controlled plunger at one end so that the best setting for contact between the two crystals can be obtained. Measured against our standard it came well up to the average performance expected from this type of detector, and can be recommended as a good example of the double crystal type. As we have found with most of the double crystal combinations, this detector works best when it is tapped across only a portion of the receiving inductance, both the signal strength and selectivity being better when it is joined across approximately a third

The comparative permanency of contact is a great advantage of this type of detector.

of the coil. For general crystal reception there is no question that the double crystal type is much preferable to the galena-cat's-whisker type, although often slightly louder signals can be obtained with the latter. In our opinion the comparative permanency of the double crystal type outweighs the advantage of the possible additional sensitivity obtained with the cat's-whisker type.

A MONTHLY REVIEW OF TESTED APPARATUS.

(NOTE: All apparatus reviewed in this section each month has been tested in the Editor's private laboratory, under his own personal supervision.)

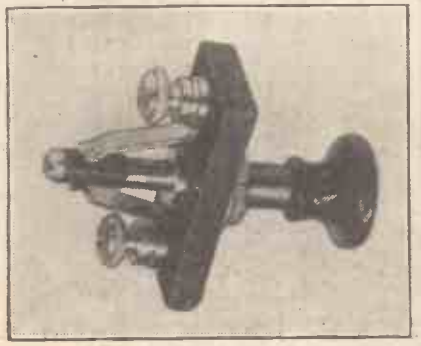
Short-Wave Chokes

The growing interest in short-wave reception has drawn attention to the efficiency of every component used for this type of receiver, many components which are quite suitable for the ordinary broadcast wave-length being totally unfitted for serious short-wave work. For smooth reaction control on the very short waves, a well-designed and special short-wave choke is necessary. While it is possible for the home constructor to wind such a choke for himself, it is not everyone who is skilled enough to make a really satisfactory choke which will cover a wide band of short wave-lengths. Messrs. Burne-Jones & Co., Ltd., who already produce an excellent choke for the ordinary broadcast band, are now providing a special short-wave choke to cover the range including the Australian short-wave stations, the Daventry short-wave transmissions, and the General Electric Co.'s Schenectady stations, 2XAF and 2XAD, which can be regularly heard in this country on a good short-wave set.

In outward appearance this choke resembles the Magnum choke for the ordinary wave-length band, but the internal construction is quite different. It is certainly effective on the band for which it is designed and can be used with advantage in any of the short-wave sets described in this journal.

Compact R.C. Unit

Messrs. Eric J. Lever (Trix), Ltd., have submitted for report two examples of their resistance-capacity units, types A and B respectively. These are particularly neat and well finished, being made up in moulded bakelite cases measuring approximately 1½ in. long by 1¼ in. wide by ⅞ in. deep, moulded lugs with screw-holes being provided for securing the units to the baseboard. Type A is stated to be designed for use with valves of medium impedance, and measurements of anode resistance and grid leak showed that the values are quite suitable for use with such valves. Type B, designed for use with high-impedance valves, has an anode-



The "Duco" on-off switch described above.

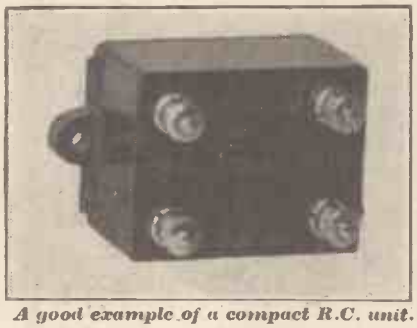
This choke is specially designed for short-wave work.

WHAT'S NEW

—*continued from page* 200

resistance value higher than we should choose for the purpose, while the coupling condenser is on the small side. Under practical tests, however, both units gave quite good results.

A slight falling-off on the Type B was only noticeable under critical observation, and probably would not be detected at all on the great majority of loud speakers in general use. In view of their popular price these units represent good value.



A good example of a compact R.C. unit.

A Coil-Driven Loud Speaker

The Rothermel Corporation, British Agents for The Magnavox Company of America, have submitted for report an example of the latest Magnavox moving-coil loud speaker designed to operate with field 6-volt excitation and including a transformer which acts as the output step-down transformer when any ordinary receiver is connected to the unit. The speaker is supplied without baffle board, but particulars are given in the accompanying leaflet of how to make this essential requisite. The tests of the instrument showed that the reproduction was of that very high quality which can only be obtained in the present state of the art from a well-designed moving-coil instrument.

The general principle of this type of loud speaker has already been explained on more than one occasion in the columns of the WIRELESS CONSTRUCTOR. Moving-coil loud speakers can be roughly divided into two types—those in which the strong field necessary is provided by permanent magnets, and those in which the field is set up by an electro-magnet. Electro-magnetic types can again be subdivided into those which work with a low voltage and relatively high current and those which work with a high voltage and correspondingly low current, the power consumed being approximately the same in both cases. In the present case the field current is taken from a 6-volt accumulator, the consumption being somewhat over half an ampere, but we understand that Magnavox units can be provided complete with an amplifier so arranged that the filament and H.T. current for the amplifier and rectifier valves and the field

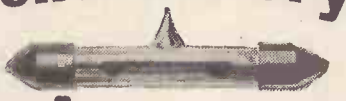
The "Elfin" condenser (Bowyer-Lowe Co., Ltd.).

current for the electro-magnet are all derived direct from A.C. or D.C. mains.

When fitted to a suitable baffle board and fed from a receiver properly designed to give high-quality

(*Continued on page* 204.)

different in every way



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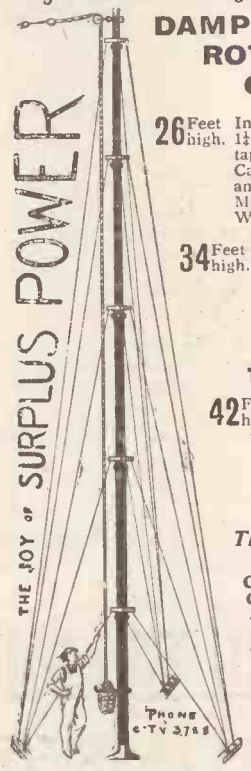

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WHAT'S NEW

continued from page 202

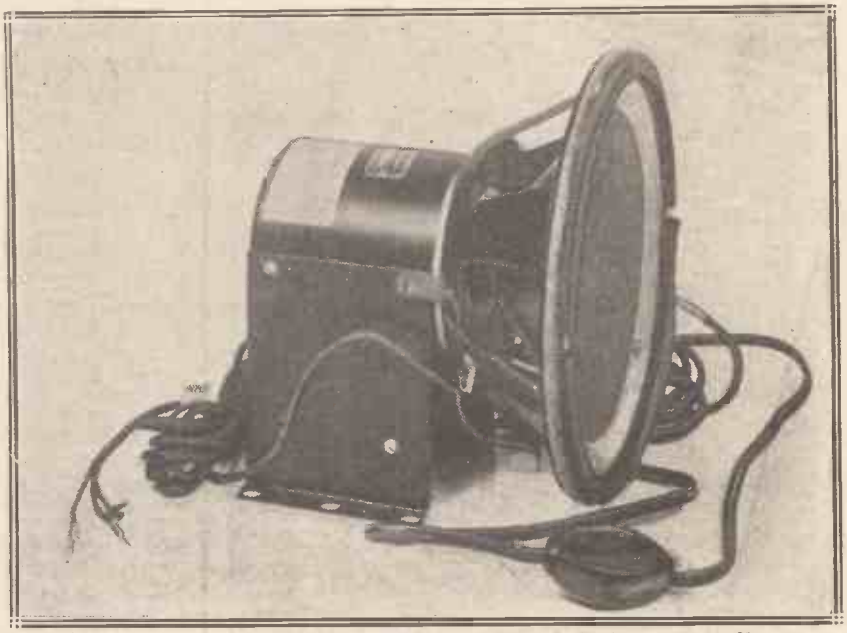
reproduction, this speaker gave a rendering of the programmes which was a sheer delight to a discriminating ear. It should always be remembered in using first-class loud speakers of any type that they cannot cure distortion already existing in the receiver, so that disappointment is bound to be experienced if this speaker is connected to a poor receiver.

The "Elfin" Condenser

The Bowyer-Lowe Co., Ltd., of Letchworth, Herts, have submitted for test and report a specimen of their new "Elfin" variable condenser, with plates shaped according to the so-called logarithmic law, and designed for reaction or tuning. Several ranges of capacity are available, that submitted to us having a nominal maximum of ·00015. The construction is strong and sound electrically, and the motion smooth with adjustment for wear.

Measurements in the laboratory showed the maximum to be ·00016 mfd. with the very low minimum of ·000008 mfd., a feature which makes the condenser very valuable in a wide range of circuits.

The two criticisms we would make are (1) that it seems a pity that the makers should adopt three-hole-mounting for so tiny a condenser when one-hole-fixing has become practically standardised for such instruments, and (2) that the terminals are much too small for any purpose other than securing soldering lugs, which might with advantage be provided. But for these two minor criticisms we consider the condenser to be an excellent specimen of sound design, worthy of the name this company has established for itself in high-grade components.



This "Magnavox" moving-coil loud speaker can be energised from a 6-volt accumulator from which it takes just over half an ampere.

OUR NEWS BULLETIN

Some of the More Interesting Happenings in the Radio World this Month.

Empire Broadcasting

MR. H. A. HANKEY, the Overseas Secretary of the Wireless League, has collected a good deal of data as a result of his visits to South Africa and Australia, and we understand that he has some interesting suggestions to make in connection with the financing of Empire broadcasting.

In Australia, Mr. Hankey had it proposed to him by the broadcasting authorities that the capital and part of the income necessary should be raised by an addition of sixpence on the Australian amateur's licence fee. As the overseas amateurs are those chiefly concerned in Empire broadcasting, this seems a very reasonable suggestion.

Paying for Programmes

In Mr. Hankey's opinion, a central station for Empire broadcasting should be erected at Canberra, the new capital of Australia, the revenue to be helped by the various organisations which would make use of the station for propaganda purposes.

But when Mr. Hankey suggests that in Great Britain an addition of threepence should be made to the receiving licence fee, he is asking for a lot of opposition. The station would be more or less in the form of a charity service in that case, as far as the British listener was concerned. 5 S W, although purely experimental, is entirely maintained by the B.B.C. as it is, but whether it will continue to give a service indefinitely remains to be seen.

An Australian 5 S W?

We have always been strong advocates of British Empire broadcasting, but it would be hardly fair to ask the home amateur to contribute to the entertainment of the resident in the Dominions. It is, of course, likely that if a permanent Empire broadcasting service were inaugurated, the overseas Dominions would reciprocate and give us a short-wave broadcasting service. If they did, then it would be a case of mutual co-operation and a mutual bearing of the expenses.

"The Near Future"

The publicity paragraphs which appear with such monotonous regularity in the newspapers with regard to television become even more and more amusing. In the "Sunday Pictorial" the other day we noticed one which said that such rapid advances have been made in perfecting the apparatus for television that, in the near future, the possibilities of enjoying the invention will be brought down to the individual listener-in.

The near future always figures largely in this television propaganda business, together with indignant remarks that it is a pity in this country so many detractors can be found for a purely British invention. To begin with, television is not a purely British invention, and, for

(*Continued on page* 208.)

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OF TESTED CIRCUITS

The following is a list of the "P.W." 6d. Blue Prints for Constructors in stock, showing the different circuits available.

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2. UNIDYNE DETECTOR VALVE WITH REACTION.
3. 1-VALVE L.F. AMPLIFIER.
4. CRYSTAL DETECTOR WITH L.F. AMPLIFIER.
5. H.F. (Tuned Anode) AND CRYSTAL WITH REACTION.
6. H.F. AND CRYSTAL (Transformer Coupled, without Reaction).
7. 1-VALVE REFLEX WITH CRYSTAL DETECTOR (Tuned Anode).
8. 1-VALVE REFLEX AND CRYSTAL DETECTOR (Employing H.F. Transformer, without Reaction).
9. H.F. AND DETECTOR (Tuned Anode Coupling, with Reaction on Anode).
10. H.F. & DETECTOR (Transformer Coupled, with Reaction).
11. DETECTOR AND L.F (With Switch to Cut Out L.F. Valve).
13. 2-VALVE REFLEX (Employing Valve Detector).
14. 2-VALVE L.F. AMPLIFIER (Transformer Coupled, with Switch to Cut Out Last Valve).
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OUR NEWS BULLETIN

—continued from page 206

that matter, nor is wireless. (Nor is it an invention, as is often erroneously supposed, entirely due to the genius of Senatore Marconi.)

However, there seems to be a growing appreciation among amateurs of the real worth of these silly newspaper paragraphs, which exaggerate the true facts about science to such an incredible degree.

That Television Licence

Another television paragraph which we came across the other day was in the "Bulletin and Scots Pictorial." It was to the effect that Mr. Baird is finding that to broadcast his invention he will require special licences and special wave-lengths. Mr. Baird contends that he is not going to broadcast signals, but merely a weird noise which is no worse than the hum of the dynamo or a motor-car. The paper goes on to say that it is an interesting point which may yet have to be decided by the authorities.

The gem of the paragraph lies in this statement: "At any rate, as Lord Haldane is president of the Television Society, there is no doubt that any difficulty which may arise will be amicably smoothed over."

It still seems to be the idea, then, that because a lord is president of a wireless society, or a television society, matters affecting the licensing of a wireless station can be "amicably smoothed over." The paragraph also suggests that Mr. Baird is merely going to broadcast weird noises. What on earth will they call television next?

Rain-Beams?

Dr. W. G. Murray, of South Africa, urges that Government meteorologists should give their close attention to experiments he has recently carried out in connection with making wireless provide rain in drought-stricken areas in South Africa.

He propounds the theory that wireless stations set up in the area a gravitational strain which will, in course of time, reach to a psycholic violence of such a nature that within two years the Beam system in its present form will have to be abandoned.

Artificial Gravitation

According to Dr. Murray, by the use of Beam wireless we produce a concentrated etherical stress; in fact, a powerful artificial gravitation area. Within that area the atmosphere is affected, and, in the same way that a stone falls to the earth by the eternal pressure of the ether, so the atmosphere is driven towards the source of the artificial gravitation area, and psycholic movements of limited width, but intense violence, are produced.

Receivers, Too!

Dr. Murray goes on to say that the psycholic violence will, of course, increase as it approaches the source of etherical disturbance. Ordinary wireless apparatus also produces an area of artificial gravitational force, and may possibly play a part in the acceleration of the movement's time. This theory sounds a little bit far-fetched, and we have not yet heard of any astronomer or physicist substantiating Dr. Murray's interesting but rather exaggerated theory.

Expensive Wireless

A man at Southampton was recently fined a hundred pounds because it was alleged that he was knowingly concerned in a fraudulent attempt at evasion of paying duty on thirty-six wireless valves and other goods. The magistrates considered the case a bad one, and awarded the amount sued for, with the alternative of six months' imprisonment.

The New Note

Listeners seem to be very satisfied with the alterations in the B.B.C. system of providing a tuning note. Instead of the usual preliminary to the programme—a buzzing noise produced by an oscillating valve—the chord of C major from four electrically-operated tuning-forks has now been inaugurated.

The Twin-Wave Stations

According to the "Daily Telegraph" wireless correspondent, it is likely that the B.B.C. engineers themselves will design the new regional stations, and that commercial firms will be invited to tender for the plant and buildings. A good deal of research work is going on at the B.B.C.'s special laboratory at Clapham, and the results of this work will probably show themselves when the new twin-wave super-station in the North of London is erected.

PCJJ's Programmes

The Dutch short-wave station, PCJJ, now broadcasts as follows:

Tuesdays and Thursdays: 5 to 9 o'clock B.S.T.

Fridays: 12 midnight to 3 a.m. B.S.T. (Saturday).

Saturdays: 4 p.m. to 7 p.m. B.S.T.

QUEER QUERIES

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allowed a film of enamel to remain. As everyone knows, enamel is a good insulator, and is, in fact, used for insulating wire, so owing to this piece of thoroughly bad workmanship on the part of the manufacturer the cat's-whisker itself was completely insulated from the cat's-whisker terminal on the detector and consequently there was an open circuit at this point.

The very care which had been taken to screw up the whole of the joints closely and carefully tended to give the impression that the connection was a sound one, but whilst that insulating film was allowed to remain no screwing tight could possibly persuade signals to come through. Two minutes' work with a file was all that was necessary to completely remove that insulation and to put the set into first-class order. Which just goes to show that even a simple set may provide a very puzzling problem, and that often the smartest-looking component is the very one that lets you down.

The Earth Connection

This is the time of the year when a good earth connection is a "pearl of great price." Many and various are the faults that can arise from an earth connection which has gone dry, but unfortunately the provision of a good earth connection is not quite so easy as it would seem to be.

Many a set that works quite well in the winter, when there is plenty of moisture underground, gives extremely indifferent results in the summer because there is no real connection between the buried "earth" and the soil itself. One of the best methods of ensuring good contact is to bring the lead up from the ground through a pipe, down which during the hot weather water may be poured at frequent intervals so as to saturate the soil around the buried earth.

An Underground Fault

Even this does not always effect a cure, especially if the soil is gravelly. Recently a very puzzling case of this kind came under notice where a crystal-set owner could not find a very satisfactory earth connection. First, he used a buried zinc pail, but as this gave poor results he dug it up again, increased the depth of the hole and soldered the earth wire

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BUILDING A 7-VALVE SUPER-HET

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set at a position not far from its minimum and left so set. Before you proceed further try the adjustment of the potentiometer again, and you will find that the set will go in and out of oscillation with a slight rushing noise. When two H.F. valves are in position the point of oscillation is somewhat different from that when you use the valves separately, but the set should go smoothly into oscillation with a rushing noise and out again without backlash as you turn the knob one way or another.

"Noise Level"

And now a brief word about the "noise level" of the super-heterodyne. As there is enormous amplification in this receiver, there is always a slight background noise like a continuous hiss when the circuit is properly tuned and adjusted. This hiss is not really objectionable and you will soon get used to it. It will not be noticed at all on loud transmissions. It is, indeed, very useful for indicating when the set is in its most sensitive condition, and when the oscillator variable condenser is properly adjusted to suit the frame-aerial variable condenser.

The first thing to do is to pick up your local station, and so sharp is the tuning of the set that you will perhaps not do so for a few minutes. From the test report you will be able to judge a rough position on the condenser for your local station, and if it is London it will come in around about 100 degs. Therefore set the frame-aerial condenser (that on the right) at 100, put the knob of the potentiometer as far as possible to the left, the reaction condenser at zero, and then rotate the oscillator condenser (that on the left) slowly, until, if all is well, you will suddenly find your nearest station come in at tremendous strength. You will find it at two positions separated by, perhaps, twenty degrees on the oscillator condenser.

Bringing Up Strength

If your local station is very near (say, up to ten miles) you may find it at four positions, two being very strong and the other two weak. You will find that, as you rotate the knob of the potentiometer towards the right, signals will increase in strength and at the same time the tuning of the oscillator dial will become somewhat sharper. A point will soon be reached when the set will burst into oscillation, but in any case long before this point signals will invariably be found so strong that you will want to detune the set.

Now adjust your frame-aerial condenser at some point, say, ten degrees away from the setting for your local station, and advance the oscillator dial about the same number of degrees. Now slowly turn the knob of the potentiometer until you hear the set oscillating and then turn it back just slightly. Leaving your frame condenser as set, very carefully move the oscillator condenser backwards and forwards until you come to a point at which you hear a breathing noise, which indicates that you have the correct adjustment for the oscillator for the particular setting of the tuning condenser.

If it is after dark you may find a station here, but if you do not find a station move the tuning condenser a degree or so, and readjust the oscillator condenser until you hear the breathing noise again.

Simple Procedure

The procedure is very simple, although not quite easy to explain in words, but you will soon find that it is easy by sitting down and tuning carefully to "follow" the tuning dial with the oscillator dial.

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QUEER QUERIES

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to a sheet of tin which he thought would be sure to give good results.

Becoming thoroughly dissatisfied with this, too, he tried all sorts of things, but nothing would improve signal strength until one day in desperation he stood in the bottom of the last hole he had dug and drove a long length of curtain rod as far towards the antipodes as he could push it.

The area of the rod, of course, was quite small, but the results were about twice as good as anything tried previously, the reason being that all his larger earths had been buried in gravelly soil through which water soaked away very quickly, but the curtain-rod had pierced right through the gravel and got down to a moist subsoil. The moral is never to stint the earth-plate's liquid refreshment.

BUILDING A 7-VALVE SUPER-HET

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When the potentiometer is set at its most sensitive point you will get a large number of stations after dark at tremendous volume, and in very many cases you will turn the potentiometer knob back to reduce the strength. The best quality reproduction is obtained when the set is somewhat below the most sensitive condition.

Best Oscillator Setting

When you have become accustomed to handling the tuning dials and to getting the best position on the potentiometer, try the affect of the reaction condenser. You will find this improves signals very considerably, at the same time sharpening tuning.

Another adjustment can now be made—that of finding the best setting of the rotating coil of the oscillator. It will generally be found that this works best when the coil is at a very slight angle to the main coil, but the position is not at all critical. Finally adjust the position of the baseboard filament resistor and you will find with 6-volt valves that a setting of about two ohms will give the best sensitivity for the whole set. With 2-volt valves, the resistance can be kept at a position where the resistance is cut right out.

Once the best positions for the coupling coil, oscillator baseboard condenser and filament resistance have been found they need not be touched again.

NOTE.—The slight breathing noise to which reference has already been made should not be confused with the noise made by a faulty grid leak or a faulty valve. When the set is adjusted to its most sensitive condition the rushing noise will be heard at two settings of the oscillator condenser dial only. Outside of these two settings, even when the potentiometer is very near the oscillation point, the set should be perfectly quiet. A faulty grid leak or a faulty valve will give a noise at any position of either condenser.

(More about this remarkable set next month.)

RADIOGRAMOPHONICS

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with their amplifiers should try a grid-stopper of about 100,000 ohms in series between the coupling condenser and the grid of the valve.

In the case of the amplifier mentioned this has proved to be a very effective remedy, pending a complete cure by removing the cause of the instability.

The old question as to what is the most satisfactory type of amplifier to employ for very large volumes keeps on cropping up.

Such cases occur when sufficient strength to fill a large hall for dance purposes and so forth is needed.

Well, I am rather of the opinion that in these days of super-quality transformers it is solely a question of H.T.

A.C. Advantage

For instance, if the mains are handy, and especially if they are A.C., it is quite easy to hitch up a mains H.T. unit designed to supply a high voltage in the neighbourhood of 300 volts or more, and to employ a straight resistance-capacity or resistance-transformer amplifier of conventional type.

The only point to bear in mind is that large valves of the L.S.5. type should be used, because ordinary valves are not designed to stand up to such high H.T. voltages. It is also advisable to connect two or more in parallel in the last stage. If, on the other hand, the only H.T. available is that obtainable from low-voltage D.C. mains, or from batteries, then I think that push-pull amplification has certain advantages.

Push-Pull Amplification

So, in cases where the maximum H.T. voltage available is not greater than 200 volts, I would suggest a good push-pull output stage, together with low-impedance valves having a long straight characteristic and a small amplification factor. Of course, these remarks only apply in cases where it is desired to fill a hall or to handle very large volumes.

For ordinary domestic purposes, the usual H.T. voltages of 120 or so are quite adequate, and it is only when something more than this is required that it becomes necessary to pay special attention to points in the design of the amplifier and to the H.T. supply.

CHATS AT THE WORK-TABLE

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tube and soldering the two together, using tallow as a flux.

Soldering Made Difficult

For some reason that I, at any rate, have never been able to discover, those who make soldering tags such as are frequently placed under the terminals of components have the strange habit of plating them with nickel, or some similar metal. Nickel undoubtedly looks very pretty, but from the solderer's point of view it is one of the most hopeless of metals, for with no other is one so likely to make a "dry" joint.

A dry joint is one which often looks perfectly sound, though actually there is no proper adhesion between its parts. If the wire is pulled firmly it comes adrift with a blob of solder adhering to its end, whilst the tag to which it was fixed shows its original bright surface without a trace of solder. Before soldering leads to them it is best always to make sure that the tags have a surface suitable for the purpose. Place a little flux on one end of them and apply a well-heated iron with a little solder upon it.

If the solder runs on thinly and evenly the tag is as it should be. On the other hand, supposing that the solder behaves rather like water on a greasy surface and refuses to flow properly you may feel perfectly certain that something must be done before a good joint can be made. Luckily, tags are never made of solid nickel; at any rate, I have never yet come across anything of the kind.

IMPROVING THE SHORT-WAVER

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With the normal value of H.T. (about 45 volts) the set should now be oscillating over the whole range of the tuning condenser C_2. If it is not, increase the "adjustable fixed" condenser to ·0005, or even ·001. When the value has been found which makes it oscillate, increase the capacity of the neutralising condenser until it *just* stops again, and make sure that it does not now break into oscillation at any point on the dial. These conditions having been reached, the set should be all ready for actual reception.

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IMPROVING THE SHORT-WAVER

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Probably the reader will already know roughly what coil sizes are necessary for the usual short-wave bands, but the following details may be useful as a rough guide. The numbers indicate the number of turns in the grid coil. In every case the reaction coil should have one turn more than this. The figures apply both to the detector and oscillator circuits.

Two, 16-24 metres; three, 18-28 metres; six, 26-38 metres; eight, 36-56 metres; ten, 42-65 metres; fifteen, 58-96 metres. These wave-length ranges are only fairly rough, but they do serve as an indication of the ranges which are covered by the coils; the tuning condensers being a ·00013 in the case of the oscillator, and a ·00025 for the detector.

Normally to keep the two circuits properly "in step" the grid coil of the detector will always be somewhat smaller than that of the oscillator. The writer obviated this, however, by winding the oscillator coils to a diameter of 2¾ in., and the detector coils to 2 in. only.

"Low-Loss"

Also, the "low-loss" mounting of the detector coils will enable one to tune down rather lower with a given coil than would be possible with the same coil mounted on a plug as in the case of the oscillator. Against this we have the slight loading effect of the aerial on the detector circuits.

The writer used the following valves and voltages, although many others were tried and found perfectly suitable. For the oscillator and detector similar valves were used, both being of the "H.F." class (that is to say, a valve with a "mu" of about 20 and an impedance of about 30,000 ohms).

The same H.T. is used on both anodes, the best value being between 45 and 50 volts. For the note-magnifier a small power valve with about 100 volts on the plate and 6-7½ volts negative grid bias was employed.

The battery connections are all taken to a seven-way plug at the rear of the baseboard; the telephone terminals, and the aerial and earth terminals, are separately mounted in two pairs.

No doubt the operation of a set of this kind will seem a little peculiar and tricky at first, but once one has

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IMPROVING THE SHORT-WAVER

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fallen into the way of handling the receiver tuning becomes a sheer joy. It is, at all events, no trouble whatever to tell when the oscillator and detector circuits come into resonance, for one suddenly commences to hear strong signals out of what was previously an expanse of "blank dial."

Receiving Telephony

It was to make this rather more simple that the oscillator and detector coils were placed in the same plane, so as to give a good coupling effect between the two circuits.

The writer makes no claim that this set is superior to any other short-waver for the reception of telephony; for C.W. "D.X." work, however, it is definitely superior to any short-waver with an oscillating detector that he has made or used. When one has become used to the set, however, it will be found that good use of the separate oscillator may be made even for the reception of telephony.

If the value of H.T. on the detector and oscillator is pushed up to about 90 volts the interaction between the two circuits becomes so strong that the oscillator tuning condenser becomes a kind of auxiliary reaction control, and by tuning dead on a station the whole receiver stops oscillating. By *de-tuning* the oscillator slightly the necessary beat note for C.W. reception is produced, but by tuning the circuits accurately into resonance telephony may be received at great strength.

Results Obtained

On the third morning after the set was completed the writer listened at about 6 a.m., and logged fifteen stations on the U.S. Pacific coast, some being in California and some in Washington.

These sixth and seventh U.S. district stations had always been regarded as among the most difficult amateur stations in the world to receive. Two Canadian fifth district stations were also heard (one being in Yukon and one in British Columbia), and on the following morning thirty-one Australian and New Zealand amateur stations were logged. Signals have, in all, now been logged from fifty-two countries, and every one heard has compared more than favourably with anything previously heard on the standard set.

USING THE 31 TESTED CIRCUITS

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they have been designed to take this particular coil together with a neutralising condenser and valve holder. A still further improvement is to screen the variable condensers C_1, C_2 and C_3 from one another, but this is one of those sets which requires very careful design and expert layout if proper results are to be obtained, and so the beginner is not recommended to try it "on his own." The set should be made either from a reputable published design or the advice of a skilled friend obtained.

One or two readers have written to ask why there is no grid condenser and leak in the circuit of the valve V_3 in G2. The circuit when examined will reveal that the grid return goes to negative and there is no obvious detecting arrangement. This is deliberately intended, for it will be observed that there is a separate high-tension tapping for this detector valve, and if this voltage is kept down to about forty-five, the valve will be found to detect excellently as it is, particularly on very loud signals. In such a case, where the set is well-designed, very considerable high-frequency magnification is given to the signals before the detector stage is reached, and the arrangement shown will be found, while not quite so sensitive on distant signals as the grid-leak and condenser arrangement, or an adjustable "anode-bend" scheme, to give first-class quality without "packing up" on very strong signals from the local station. If desired, however, the ordinary grid leak and condenser can be inserted between the upper lead of the condenser C_3 and the grid itself. The same remarks regarding detection apply to the circuit F4, in which the condenser C_6 and the grid leak R_1 can be omitted and the best detector voltage found by trial on H.T. positive 1.

ARE CRYSTAL SETS LESS POPULAR?

From a Correspondent

WHEREAS not so very long ago the windows of wireless shops were crowded with specimens of crystal, ingenious crystal holders and imposing-looking crystal sets, whereas the advertising pages of the technical and so-called popular Press contained a host of revolutionary information about various crystalline constructions which rivalled the valve in their efficiency, by comparison the crystal and its paraphernalia to-day are strangely inconspicuous. Why?

The crystal-lover's station, to wit 5 X X, is still in the land of the ether—or maybe it should be called a sea; 5 G B forms another crystal possibility to many, and though in these circumstances the conditions for crystal reception are improved over those existing a few years ago, how often do we now see anything said about the big manufacturers introducing a new crystal set or, better still, how often do you hear in the train that So-and-so has just made a new crystal set?

Thousands Still Used

One still sees various designs for the construction of these receivers; the Editor and the shopkeeper both know that they are still made, but notwithstanding these facts it seems that the majority of listeners are either using valve sets, or are in the process of building receivers of this type.

There are, it must be admitted, some thousands of crystal sets in use, and during the next few months there will be some thousands more "hooked on to the air." In reviewing the position, however, it may be said that the crystal set is popular only in those cases where the owner is financially unable to buy a valve set, or else is possessed of some physical infirmity which is less inconveniencing when the simple crystal outfit is used.

As a case in point, some of the early crystal receivers were as expensive to buy as are many of the present-day 1- or 2-valve sets, yet on asking a neighbour whether he would *exchange* the expensive crystal set for a less costly valve receiver he accepted without hesitation, because "having a valve gave a better chance of programme selection."

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ARE CRYSTAL SETS LESS POPULAR?

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To one whose first experience of wireless was very closely related to a crystal, and a cylindrical coil which rivalled the Nelson's Column in its dimensions, this eclipsing of the crystal set is almost akin to a bereavement, for such apparatus formed one of the first rungs of the very long ladder, the top of which we stand to-day. The development of the present-day coil is largely the outcome of crystal set experimentation; such experiments having as their object a design of coil which would give just a little bit more volume.

Coil Construction

The circuits of the majority of crystal sets are fundamentally the same, though some thousands of different arrangements have been tried; the crystals are much the same in their efficiency, that is, either good or bad, and the result of the many experiments has been to persuade designers to concentrate their efforts upon coil construction. It must be admitted that the number of coils produced are not lacking in variety; there have been cylindrical coils, square coils, X-shaped coils, hank-wound coils and round coils. The development of the present-day coils may be said to be confined within the years 1922 and 1927; for prior to 1922, it is safe to assume, that the most popular crystal set was cylindrical in shape.

During the last five years we have wandered to all sorts of shapes only to return to a shape very similar to that with which we started. However, it has all been to good purpose, for never before has the crystal set been so efficient as it is to-day, and never before to-day have so many crystal sets been in use. Though in view of so many people using valve sets it would seem that the crystal set has lost popularity—as a set, this is not rightly so.

"In Five Years Time"

The fact that there have now been such papers as the WIRELESS CONSTRUCTOR available to the public for a number of years, has brought about a higher standard of general wireless knowledge; further, since all these papers have been doing their best to explain to the public how they may construct multi-valve receivers, the only conclusion one may come to is that they have educated the public into standards above those set by the crystal.

Ostensibly, the crystal receiver is less popular; yet on the other hand its popularity is indicated by the fact that there are to-day some many hundreds more in use than was the case five years ago. Similarly, in five years time, by means of conversion, all the present-day crystal set users will probably be valve-set owners, while newcomers to wireless, fresh crystal advocates, may even out-number by far the 1927 census. As to whether crystal sets are *really* less popular our correspondence columns are open for your views.

DOPING COILS

IN the moist weather which occurs only too frequently at this time of the year, a coil which is "low-loss" on one day may be "high-loss" on the next, owing to the absorption of moisture by the cotton or silk covering of the wire. At one time it was thought that silk-covered wire was fairly immune to moisture effects, but careful tests show that silk absorbs moisture just as easily as the cotton covering.

It is always wise to dry the coil thoroughly after winding, and to dope it with some suitable material. Comparatively few substances are better than celluloid dissolved in amyl-acetate. Obtain some amyl-acetate from the chemist and put it in a wide-mouthed bottle, securely corked. Remember that it is highly inflammable! Take any old scraps of celluloid and put them in the bottle with the amyl-acetate, and after a time they will dissolve. Old photographic films from which the gelatine covering has been removed by soaking in hot water and scraping is a very good source of supply. When the solution has become fairly thick, but not so thick that it will not spread easily, take a well-dried coil and brush on the "dope" fairly liberally. This dope serves the double purpose of waterproofing the wire and holding it in position on the former.

A very useful tip when winding coils on paxolin, micanite or pirtoid tubes is to paint three thick strips of celluloid solution in the direction of the axis of the coil, and about equally spaced, before winding is begun. Now let the dope get "tacky." Proceed with the winding and each turn will adhere at three points. The whole coil can subsequently be doped.

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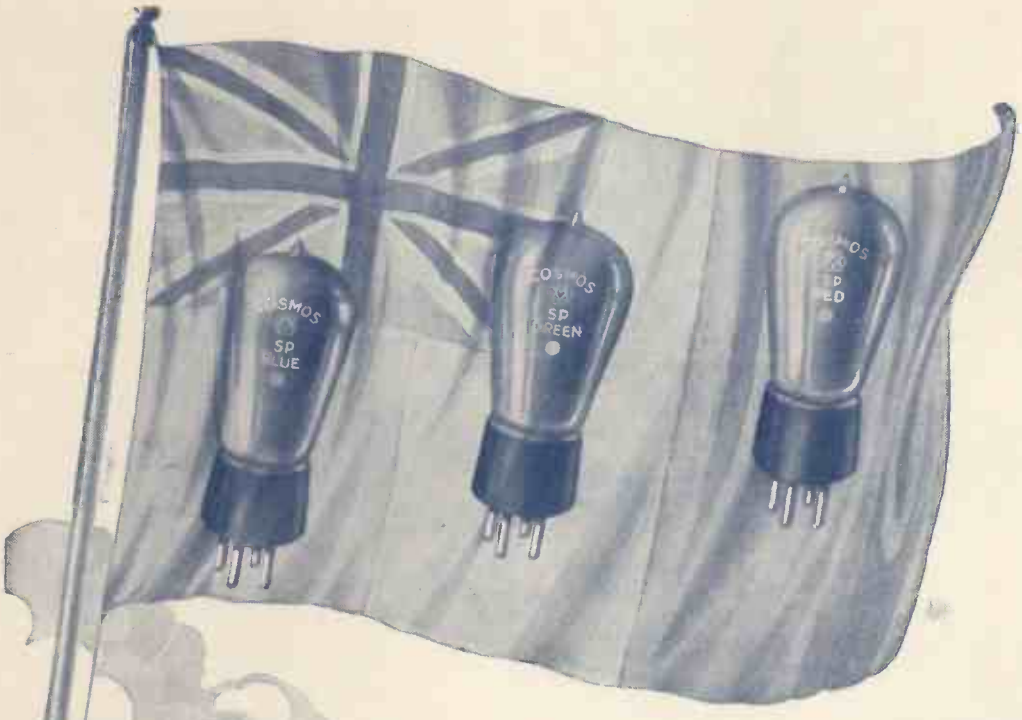

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