PROBLEMS OF RECEIVER DESIGN—See page 434

A NEWNES PUBLICATION

Edited by F. J. CAMM

Vol. 16. No. 411.

Practical Wireless and PRACTICAL TELEVISION

6D. EVERY MONTH

September, 1940.

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THE SHORT-WAVE THREE

Practical and Wireless
★ PRACTICAL TELEVISION ★
EVERY MONTH.
Vol. XVI. No. 411. September, 1940.
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COMMENTS OF THE MONTH

Once a Month

AS announced in our last weekly issue, this magazine temporarily appears as a monthly magazine owing to the acute paper shortage. All newspapers are now rationed as to their paper supply, and the ration allowed for this periodical would not have made it an economic proposition as a weekly publication. We have, therefore, used our ration of paper to produce a monthly edition, and it will be observed that we have increased the number of pages. It is, however, essential for us to stress a point of great importance to every reader. It is this: Whether you have previously had a regular order with your newsagent for the delivery of PRACTICAL WIRELESS each week or not, you must now place an order with him for the delivery of this paper monthly. When a weekly paper changes to a monthly it is automatically struck off the list of weeklies issued to newsagents from which they order their supplies. So every reader of this paper who wishes to make certain of receiving his copy of this paper each month must go to his newsagent and place a fresh order for it. This is the only way to ensure receiving your copy, as your newsagent is not able to return unsold copies, and will thus only secure from us the exact number ordered. You will be helping us as well as yourselves if you do this now.

Looking Back

IT is interesting in these critical times to reflect upon the past, and especially as it relates to wireless journals. When the first issue of this journal appeared on September 24th, 1932, there were numerous weekly publications and several monthly journals. Wireless was enjoying boom years, and home construction was almost a national hobby of thousands. We had perceived, however, that there were many drawbacks. In the first place, it was the custom for receivers described in the various journals to have alternative specifications. That is to say, for each item in the specification—valves, transformers, resistances, condensers, chokes, speakers, and so on, a number of different makes were recommended. It was our view that it was not possible to ensure that the receiver performed as the designer intended when the constructor was confronted with a specification which really amounted to a catalogue of all the firms making components. For, of course, it was impossible for a given combination of components to give satisfactory results. This is not a reflection upon the individual components. Each of these have their individual characteristics, and a certain combination of them will produce undesirable effects. It was our view that a specification drawn up in this way did not amount to a specification, since the reader was left with a free choice. The same effect could have been obtained by omitting such a specification altogether.

We soon discovered, after two or three issues had been published, that constructors shared our view. They had built receivers to published designs which for one reason or another failed to live up to expectations. We, however, remedied that by our solus specification. We specified just the parts which we had used. We did not say that other parts would not work equally as well, but we knew what the set could do when the parts used in the original receiver were employed. This enabled us to guarantee our receivers to do what we claimed for them and to undertake to service them free of charge provided that the parts which we specified were used.

One by one journals retired from the field of radio, and left us as the sole surviving weekly publication.

Now we have turned to monthly publication, but not because of lack of readership. We have been forced to publish monthly by virtue of the shortage of the essential material which makes publications of journals possible, namely, paper. Readers may accept our assurance that when this position improves, and adequate supplies of paper are again available, we shall revert to weekly publication. Our readers will understand that we have been compelled to make this move with great reluctance, and we should like to take this opportunity of thanking the many thousands of loyal readers who have supported us during our eight years of existence.

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

Owing to the rapid progress in the design of wireless apparatus and to our efforts to keep our readers in touch with the latest developments, we give no warranty that apparatus described in our columns is not the subject of letters patent.

Wireless Books

IN connection with this journal we have also produced in those eight years a library of wireless books, two of the latest being "The Radio Engineer's Vest Pocket Book," 3s. 6d., by post 3s. 9d., and "The Superhet Manual," 5s., by post 5s. 6d. A catalogue of our technical books will be sent free to any reader addressing a postcard giving name and address.

TUNER UNITS

Constructional and Experimental Work is Facilitated by Sectional Units of Standard Design

FROM time to time manufacturers have produced special units known as "Tuners" as an aid to construction. These have been in the form of either a set of coils and associated tuning condensers (such as the Linacore unit), or have included also certain valveholders ready wired into the circuit (an example is the Igranipak). The main idea underlying the production of these units was to simplify the work of the home-constructor by providing him with the most essential parts of a circuit, ready wired, tested and built to a standard. Those constructors who have used any of these units will know how adequately the requirements were met, and it was possible with some units to rebuild the set from time to time, always introducing the tuner as a main part without any worry as to the performance of that part of the receiver. Present-day experiments are, however, not so difficult as those of earlier days, and thus the tuner is not such a popular item now. However, by arranging to build a unit of this type on certain lines there is provided a wide field for various experimental tests, always with the knowledge that the tuning section is up to a given standard. This is especially the case with the superhet type of receiver, where it may be desired to carry out experiments with A.V.C. or other parts of the circuit.

General Features

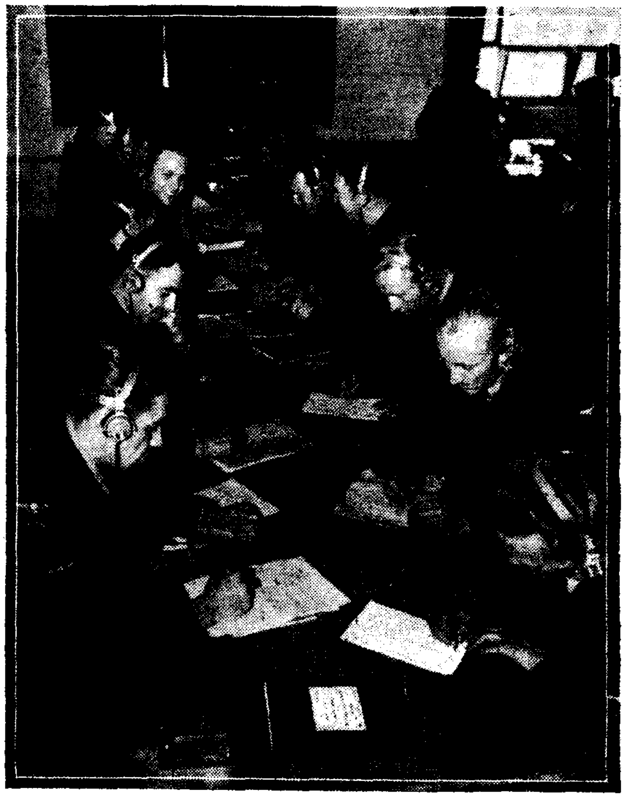
As has already been mentioned the main essentials of a tuner unit are the coils and tuning condenser, with, if the circuit calls for it, a reaction condenser also included. These are all wired, and ganging or trimming carried out. In the case of a superhet unit, of course, there are much more critical adjustments necessary, and this is therefore a more valuable unit. The oscillator tracking is carried out in this case, and all trimmers or pre-set condensers must be locked to prevent any possibility of movement. In modern tuners undoubtedly one of the most interesting features is the all-wave coverage which may now be obtained by the use of suitable coils, and it is here that the experimenter can devote a considerable time to the design of a really effective unit. Messrs. Bulgin, for instance, supply ready-wound multi-wave coil units of various types, and also small single coils for various wavelengths from about 10 metres upwards. With the aid of these, and with multi-point switches, it should be possible to design a unit which will give a wide range, and improved results could be obtained by changing the tuning condenser. On most modern receivers of the all-wave type, it will be found that standard .0005 mfd. tuning condensers are employed throughout. This means that on the short waves the coverage is very wide and, consequently, tuning is not a simple matter. For instance, a band from 16 metres to 35 or 50 is announced by some set manufacturers, whereas with a small tuning condenser 16 to 20 metres would be found very full. This means that tuning would be very much simpler, and if a bandspread condenser were added it would be quite an easy matter to tune in stations which could not be separated from others on the commercial arrangement.

Coil Units

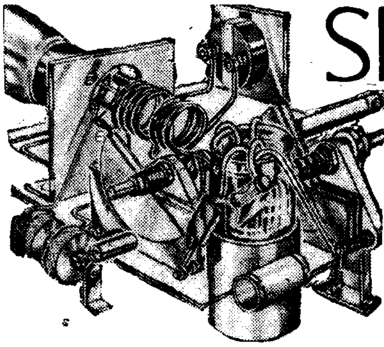
Taking the standard 4- or 6-pin plug-in coils, we see that the tuning range, using a .00016 mfd. tuning condenser, is given as 9-14, 12-26, 22-47, 41-94 metres, and so on. The smaller 1in. diameter coil units which are now available will be found to cover a very similar range, or coils could be home-made for the purpose. As soon as we come to the medium or long wavelengths, however, the small tuning condenser would be found useless in view of the small coverage and one way of overcoming this is to switch in a fixed condenser in parallel with the tuning condenser. This is not ideal, however, as the minimum condenser capacity will be at least that of the fixed condenser. This will preclude tuning to the lower wavelengths. The better plan is, of course, to arrange to change over the tuning condensers, the only drawback here being that long leads may be introduced in order to connect up the switch sections. There are two or three ways of overcoming this. Firstly, the shortest wavelengths may be considered as the most important, and the coils and condensers so placed that the wiring to these is the shortest, the medium or highest of the short-wave coils being placed at the most convenient position afterwards. Whilst this will permit of reducing the troubles to a minimum, it does not overcome every difficulty, and there is little doubt that the only way of doing this is to arrange for the coils to be moved *en bloc* so that the wiring from the contacts to the tuning condensers are exceedingly short, and are exactly the same for every range.

Mechanical Units

This provides plenty of scope for the mechanically-minded experimenter. Rack-and-pinion movements are undoubtedly the easiest to arrange, and the coils may be mounted on small bases with spring contacts made from the brass arms of flash-lamp batteries. Any good camera accessories dealer should be able to supply the rack movement, and in view of the present shortage of metal some form of wooden structure will have to be used. The necessary screening could, however, be arranged for with a minimum of metal which could perhaps be cut from old coil screens which may be found in the spares box. These should be cut open and flattened out, and strips cut to fit only those places where it is essential. An all-metal chassis would, of course, be the ideal scheme, but it is not now possible to obtain sheet aluminium or copper, and thus the experimenter is provided with yet another field for test work in devising means for overcoming the shortage. Finally, remember the main requirements of these tuners—shortness of wiring on the short-wave ranges; stability; mechanical robustness or rigidity; and standardised circuit design. With such a unit as a workshop accessory many interesting receivers could quickly be made up, and more time thereby devoted to tests with new or interesting circuit features with the knowledge that the tuning section is working correctly and at maximum efficiency.



Polish airmen now in England to carry on the fight alongside the British airmen, are now undergoing a thorough training in various branches of aeronautics. At the Royal Air Force Training School "somewhere in the North," Polish aircraftmen are receiving their teaching in the capable hands of the R.A.F. Instructors. They are seen here at a radio class practising Morse.



SHORT-WAVE SECTION

ULTRA—S.W. RESEARCH

What to Listen For and How to Carry Out Experiments Below Five Metres.

By W. J. DELANEY

MANY of the older hands, and also a number of young readers of this paper, are aware that the present use of short waves is due almost entirely to the amateur. Owing to the restriction of wavelengths in the past, and to other regulations, the amateur experimented on wavelengths which had been thought unusable, and some remarkable results were achieved. The time is now ripe for further amateur experiments which may result in some very valuable data being obtained—for which we can blame the war. Until last September conditions in the air were chaotic. One amateur transmitter after another "went on the air" until it was quite a common thing to hear an amateur say that he would have to cease his tests or experiments owing to difficulty in receiving the station with which he was working "in the clear." Now all this has stopped. The elimination of amateur transmitters in this country and in many others has left the ether practically clear, and tests carried out during the past few weeks have shown that there is now a good chance of proving many things which have for long been left in doubt, and also for reliable tests in given directions. Of these the performance of the ultra-short-wavelengths is undoubtedly the most interesting.

Optical Waves

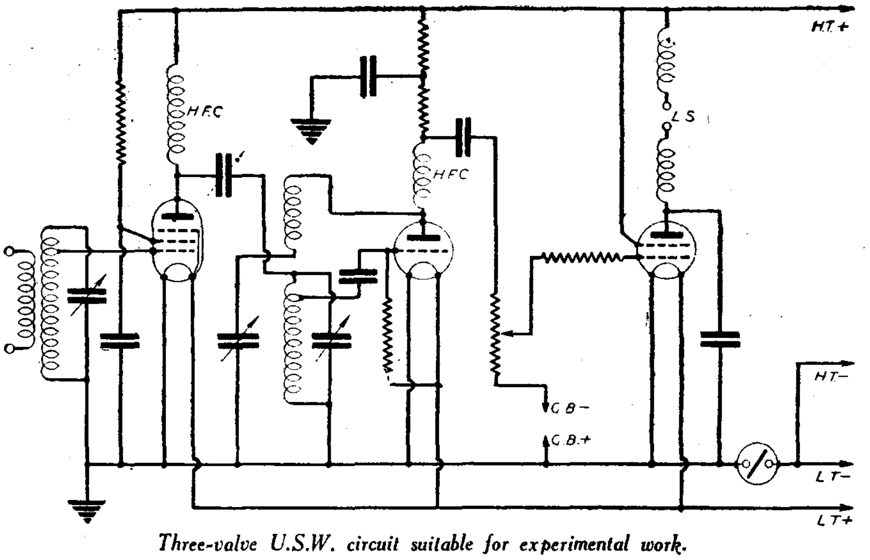
It has been a commonplace to refer to wavelengths below 10 metres as being "optical" or "quasi-optical" waves, in the belief that the radiations of such stations acted in the same manner as light waves. That is to say, it was originally thought that such signals could only be heard over distances which would normally permit of perception of a light. Such a fact has proved inaccurate as television viewers are aware. Signals from the London television transmitter have been picked up in both America and South Africa, whilst even back in 1935 harmonics round about 5 to 10 metres were picked up in this country from transmitters in various parts of Europe. There is little doubt, however, that these signals are affected by atmospheric conditions, and therefore in order that they may be properly studied systematic listening and a careful record must be kept of all signals heard. Although there are no nearby amateurs now transmitting on 56 mc/s or thereabouts, some Americans are using that frequency and it is possible to pick up harmonics of commercial transmitters in this region. Thus there is some data upon which to work, and the only problem for many readers is how to set about it.

Type of Apparatus

U.H.F. apparatus is not so simple to design, build or operate as normal short-wave equipment, and therefore if you do not yet possess a receiver of this type you should work to a published design, or circuit, and spend some time in finding out how it functions. With the scarcity of loud signals this may be found something of a difficulty, but by using headphones and a good aerial, and tuning very carefully you should succeed in picking up one of the commercial harmonics mentioned and thereby get some indication of the performance of the receiver. The type of circuit is critical. My recommendation is that you do not use a super-regenerative circuit but a perfectly straight arrangement, say, a detector-L.F. combination. Although it is admitted that a good super-regenerative set will provide better range, it is noisy and in the hands of a beginner may prove troublesome. A superhet will not function very well (if at all) below 5 metres and therefore I do not recommend that. An H.F. stage is desirable, and thus a 3-valver should be quite satisfactory for normal experiments.

A typical circuit is shown in the accompanying illustration from which it will be seen that the standard H.F.-Det. L.F. combination is used, both aerial and inter-valve circuits being tuned. The aerial should be a short dipole, with twin feeders coupled to the primary of the input transformer. Both grid coils should be tapped to reduce damping, and by using the small self-supporting coils such as the Eddystone or Bulgin components tapping points may first be found by experiment, and then connections soldered to those points. It should be remembered that the ultra-short waves (high frequency currents) travel on the surfaces only, and thus large gauge wire should be used not only for the coils but also for inter-connecting leads. Tubular coils are generally employed, but 16 or 18 gauge solid wire is quite satisfactory for the connecting leads.

All components should be of the best quality specially made for U.S.W. work, and care should be taken in the layout. The experimenter may carry out tests in this connection and no suggestions will therefore be made in order that a free rein may be given to individual ideas.



Three-valve U.S.W. circuit suitable for experimental work.

Measurements

In order to make all experiments conclusive some form of wavelength measurement is desirable on these U.S.W., and a good wavemeter should therefore be constructed. The only difficulty arising here is in the calibration of a home-made meter, but if you know a local amateur who has such an instrument you may be able to obtain his assistance in calibrating your unit against his. Alternatively it may be possible to pick up a harmonic or a powerful commercial broadcaster and use this as a datum point. Apart from the considerations of equipment there is the need for really well-kept records. A properly ruled book should be kept and a very careful note made of all weather conditions, as well as positions of sun and moon. If you are able to obtain details as to sun-spots (these not now being published) you may also note these as there has definitely been found to be some relation between sun-spot activity and ultra-short-wave performances. Co-operation between other amateurs is, of course, vital, and it will be found in many instances that conditions over only a few yards may be very different. Particular local conditions, such as the presence of a hill or even of a large metallic body such as a bridge or gasometer will have an effect upon the performance of some stations and thus a period of listening on a given wavelength to a definite station may prove more valuable than a mere searching round the dial to see what is available. At the moment we are not able to publish data concerning reception and weather conditions, but after the war some of the information gathered by amateurs may prove of the greatest value and therefore every constructor who is able should immediately take steps to commence his record in this direction.

Microphones: Their Design and Characteristics

Explaining how the Construction of These Instruments offers Great Scope for the Experimenter.

By L. O. SPARKS

THOSE amateurs who have had to relinquish their transmitting licences have been forced to seek fresh fields for their experimental and constructional activities, and from correspondence received it would appear that quite a number are concentrating on amplifiers and microphones. The various side issues embraced by these two items offer very interesting material for the enthusiast's energy and study, and another feature about such work which makes it particularly attractive at such times as these is the fact that the knowledge and apparatus now gained will prove most useful when the ether is once again allowed to respond to the call signs of the British amateur.

The subjects mentioned above are too comprehensive to be dealt with in a single article; therefore, as the title implies, this one will be solely concerned with the various types of microphone most suitable for general amateur work.

Essential Considerations

The first and most desirable quality in any microphone is faithfulness of reproduction. This could be expressed as a good frequency response, but not necessarily a response covering all the usual frequencies associated with the full scale of musical instruments and the various ranges of the human voice. The term faithfulness is really more satisfactory, as one type of microphone is not always intended to cover all possible sounds; for example, if one is solely concerned with the reproduction of the speaking voice, as in the case of most amateur transmitters, where intelligibility is the main consideration, then an instrument having suitable characteristics would be used which, while being ideal for the work in question, would possibly not be too satisfactory if it were called upon to handle the musical sounds produced by a full orchestra.

The second feature of prime importance to the amateur is that of sensitivity, as most of us usually require to keep the number of valves in the L.F. amplifier down to reasonable figures. Unfortunately, however, if one examines the estimated outputs of the individual type of microphones, it will be found that the better the "faithfulness of reproduction" factor the lower the output; therefore, with certain types one is forced, if some predetermined amplifier output is required, to add or incorporate additional L.F. stages or a pre-amplifier, the latter often being referred to as a "head-amplifier."

Such requirements not only add to the amount of apparatus required, but also to the cost of the equipment, and for these reasons the majority of amateurs make use of a good quality transverse-current type of microphone.

Transverse Current Microphones

Carbon, in several forms, has been used in microphone construction and experimental work since the initial stages of its development. It is still used to-day in the two most popular types, namely, the *solid-back* and the *transverse current* forms of microphone. The former system is widely used for the commercial line telephones, its great features being simplicity and exceptional sensitivity, but its frequency response is somewhat limited. The second type is a vastly superior instrument, and could be rated as the most popular amongst amateurs, and even commercial firms, for use with certain classes of public address equipment. It is sensitive, has a very satisfactory frequency response, according to its design and construction, but unless reasonable operating precautions are observed, it is liable to suffer, or rather the reproduction is, from what is known as "blasting."

Unlike the solid-back type, which often employs a very thin metallic diaphragm, the transverse current model has its diaphragm cut from flaw-free mica, the thickness usually being within the region of 1/1000th of an inch whilst its surface area will depend on the construction of the body of the instrument. Fig. 1 shows the essentials of the design and how fine carbon granules occupy a space formed between two carbon rods to which the actual connections are made. The granules are arranged in a layer, making contact between the two rods, and by means of an external battery and transformer a polarising voltage is applied to the two rods, the electrical circuit being completed by the granules. The current flows transversely, i.e., from rod to rod or at right-angles to the movement of the diaphragm. The model shown in Fig. 1 is fully described in the issue of May 20th, 1939, and it has proved most satisfactory in spite of its compactness and simplicity of construction.

To secure a satisfactory coupling and matching between the microphone and the input of the amplifier and to enable the necessary operating voltage to be applied, it is essential to use a good microphone transformer, having an average ratio of, say, 30 : 1, in conjunction with the instrument, and it cannot be stressed too strongly

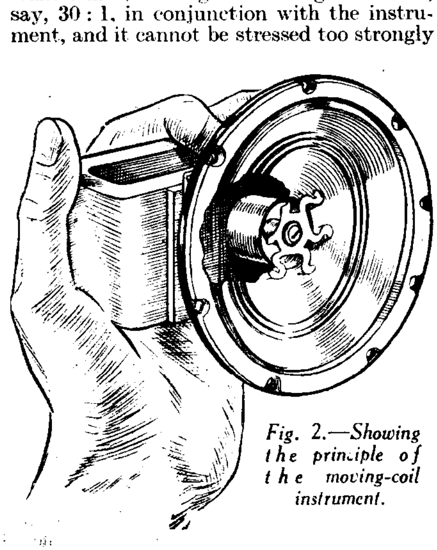


Fig. 2.—Showing the principle of the moving-coil instrument.

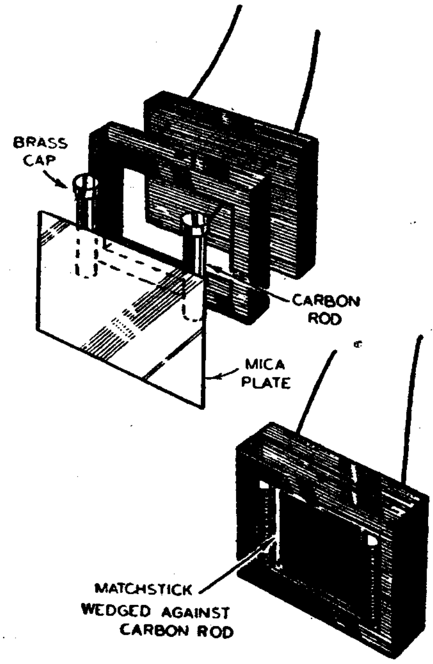


Fig. 1.—The essential component parts of a transverse-current mike. The size of the opening of the model shown is 1.9 in. × 1.4 in.

that it pays to buy a *good* make of transformer specially designed for the job. The output from a high-grade microphone of this type will be in the neighbourhood of .18 to .24 volts. There is one important item to watch when operating; owing to the construction of this particular type, it is susceptible to sound vibrations from practically all directions, and in view of this it is often necessary to take special care to secure suitable sound-screening or baffles to eliminate unwanted noises.

Moving-coil Models

Microphones coming within this class can be likened to the now popular moving-coil type of loudspeakers except that the operating process is reversed. With a speaker, energy (the signal) is fed into the speech coil, which forms a part of the cone assembly, and which is so located in a strong magnetic field that the currents cause the coil, and likewise the cone, to vibrate in sympathy with the signal. With the microphone, however, minute electrical currents are created in the counterpart of the speech coil, by the sound-waves causing it, viâ the diaphragm, to vibrate or more accurately oscillate within the magnetic field. To enable the currents thus created to be fed into the amplifier and, of course, to obtain a suitable matching between microphone output and amplifier input, a transformer having a ratio of 30 : 1 is used. The arrangement is very similar to that employed with the transverse current model, except that *no polarising voltage is required.*

As regards construction, Fig. 2 shows the general idea, but if any amateur is contemplating making one, and it is by no means beyond the possibilities of the enthusiast, it is very essential to note that, for most satisfactory response, the cone must be extremely light, small in diameter, perfectly suspended and, to reduce the resultant weight of the moving part, the coil wound preferably with aluminium wire. Needless to say, the stronger the magnetic field the better; therefore a good magnet should be used, and the gap, i.e., the distance between the magnet pole-pieces and the coil, kept as small as possible.

Velocity or Ribbon Microphones

These terms are now familiar with all constructors interested in P.A. or transmitting work, but it would appear that quite a number are not so familiar with the construction of the instrument or the derivation of the name.

The microphones already described depend for their operation on what can be termed the pressure of the sound waves, but with the type mentioned above one is concerned with the velocity of the waves, and it is this difference which allows rather better characteristics to be obtained with these models.

Before describing the actual construction, reference should be made to Fig. 3 which shows the fundamental details of the design, but it must be appreciated that the actual construction and shape varies greatly according to the producer. It will be noted that, like the moving-coil instrument, the main part of the assembly is a powerful permanent magnet. For simplicity, this is shown in the popular U form. To the ends of the magnet are fitted two pole-pieces so arranged and shaped to produce an oblong gap in which, by virtue of its narrowness, exists a concentrated magnetic field. Within this field is arranged an extremely light ribbon of metal, usually aluminium, having a thickness of, say, 1/5000th of an inch, and it is held in its position by the insulating clamps at its upper and lower ends. The output is taken from these ends of the metal ribbon, and owing to the fact that the resistance of the ribbon is very low, it is necessary to use a suitable transformer to secure matching to the line or amplifier input. A ratio of 20 : 1 or 25 : 1 is usually in order.

Mention has already been made of the desirability of providing the two types of microphones described, with effective sound screening under certain conditions, to prevent feed-back or unwanted sound from affecting the instrument. All this trouble is due to the fact that the microphones are susceptible to sounds, speaking in a general sense, from *any angle*, and it is in this direction that the ribbon mike scores. It will be found that the effective field of this type is practically limited to its immediate front and back, and that any sounds approaching it from the sides will have little or no effect.

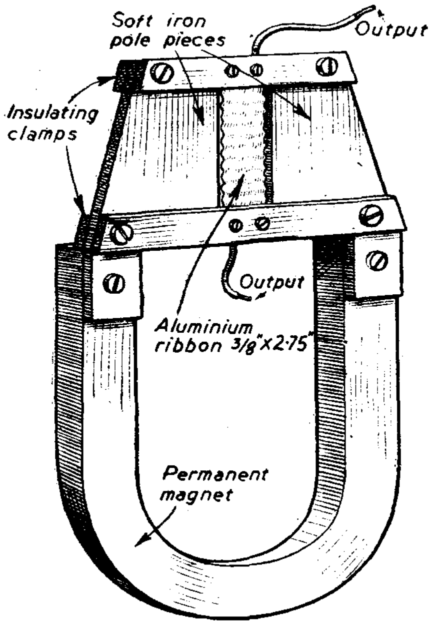


Fig. 3.—A simple form of construction suitable for an experimental ribbon microphone.

L.F. Amplifier Faults

Hints on the Location and Cure of the Simpler Faults Met With in Normal L.F. Circuits

WHEN any particular fault is thought to be due to the L.F. stages the first thing is to check this by eliminating them and connecting either a pair of 'phones or the loudspeaker in the anode circuit of the detector valve. This can be done in two simple ways, one of which consists of replacing by 'phones or loudspeaker the coupling component—primary winding of the L.F. transformer, the resistance or L.F. choke—connected between the high-frequency choke and the H.T. supply. The other method is to connect the speaker or 'phones in series with a 2 mfd. condenser between the "lower" end of the coupling component and earth. Both these systems are illustrated in Figs. 1 and 2. Of the two, the latter is generally to be preferred, because it does not disturb the normal and correct matching between the detector and its output circuit, and because it ensures that the 'phones are isolated from the H.T. supply. This isolation is of particular advantage in the case of a mains receiver and ensures against the experimenter receiving an accidental shock.

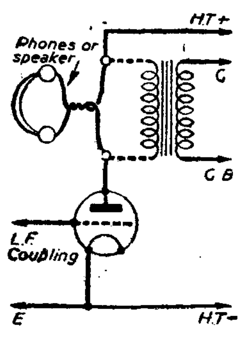


Fig. 1.—The easiest method of cutting out an L.F. stage is to connect a pair of 'phones or a loudspeaker in the anode circuit of the preceding valve in place of the normal coupling component (L.F. transformer, etc.).

Complete the Circuit

In carrying out the test in question by either of the methods described it is desirable that the L.F. valves should remain in circuit with the H.T. and L.T., and for this reason the normal loudspeaker terminals should be short-circuited. If it is found that signals can be heard correctly after making the connections described, one can be quite sure that the L.F. section is at fault; if not, the H.F. sections of the set must be tested. In regard to these tests it should be mentioned that distortion might not be so noticeable, nor cracklings and other noises so pronounced, due to the reduction in the amount of amplification prior to the reproducing component.

Once it has been definitely concluded that the L.F. amplifier is at fault the consequent tests can be directed entirely to that side of the receiver. If there are two or more low-frequency valves, each of these should be eliminated in turn by transferring the 'phones or speaker to the anode circuits of each valve following the detector, and in this way the valve stage in which the fault occurs can rapidly be located. After that it is not a difficult matter to test its various circuits to isolate the faulty one.

Noises

When the fault is in the form of crackling or rushing noises it is best to make a start by testing the components in the anode circuit, whilst using the connections shown in Fig. 2, and where the fault is in the stage immediately preceding, the speaker or 'phones. This will not necessarily apply, however, when there is only a single L.F. stage, or where it is the last one which is responsible for the trouble. In such instances it is best, where possible, to bridge the normal speaker terminals with an L.F. choke. Alternatively, when a moving-coil speaker is in use, the primary winding of the output transformer can be left in circuit and the secondary disconnected. While maintaining these connections the anode-circuit components should, if possible, be replaced in turn. This may not always be convenient, in which case the decoupling resistance (when used) should first be short-circuited; if that puts things right the resistance is obviously defective. When a decoupling resistance is not employed it is practically essential to replace the coupling component, although not necessarily by a similar one. For instance, the primary winding of a transformer might be replaced by a convenient L.F. choke, or even by a resistance of 10,000 ohms or so. The resistance will generally cause a reduction in signal strength, but if the cracklings cease it will be established that the previous component was faulty.

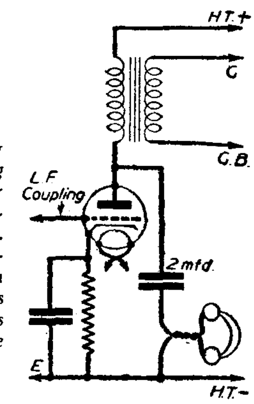
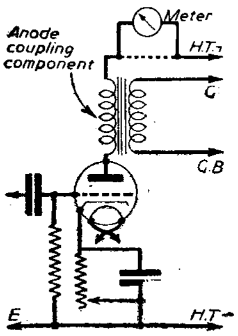


Fig. 2.—A better way of connecting the 'phones or speaker when cutting out an L.F. stage. This is particularly useful in the case of a mains set, since it isolates the 'phones from the H.T. supply.

Anode and Grid Circuits

Should it be found that the anode-circuit components are O.K., the next step is to check any other resistances which might be in circuit between the main H.T. supply leads and the valves under test; in most instances it will be safe to short-circuit these. There is no need to test the H.T. supply unit itself, because if that were defective the objectionable noises would have been heard when the reproducer was connected to the detector valve.

The grid circuit should be attended to next, and this often presents a more difficult problem. When resistance-capacity or choke-capacity coupling precedes the valve under test, the grid-leak can most easily be checked by replacement. It is not necessary to replace the component by an identical one, and any odd value can be tried for purposes of test. The coupling condenser also is best checked by replacement, although it is quite satisfactory to remove it from the set and apply the usual test with a battery and speaker. This consists of connecting a 60-volt battery to the terminals, allowing the condenser to stand for an hour or more and then touching the speaker leads against its terminals. When this is done a distinct "click" should be heard, so long as the condenser or speaker terminals have not, during the tests, been touched with the fingers. When a battery is used for G.B. supply, it is well to make sure that the wander-plugs are fitting tightly into the sockets and that the battery is not run down. In the case of a mains set, however, where G.B. is obtained across a resistance connected in the cathode return lead, the resistance should be tested by replacement. The condenser wired in parallel with the bias resistance can be checked simply by disconnecting one of its terminals: this might result in an increase of hum, but if crackling ceases the condenser is faulty.



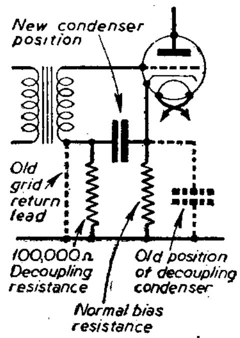


Fig. 3.—(Left) The best method to determine the correct G.B. voltage for an L.F. valve is to insert a milliammeter in the anode circuit and vary the bias until the correct anode-current reading is obtained.

Fig. 4.—(Right) Mains hum and L.F. instability in a mains set can usually be cured by fitting a grid decoupling resistance.

Overloading and Other Distortion

When distortion is experienced the valve which is responsible must first be located by transferring the reproducer to the anode circuits of the various valves, exactly as described above. When the responsible valve is traced the reason for distortion can be found without much trouble. With battery-operated sets, especially those which are a few years old, the most fruitful source of distortion is an overloaded valve. This can easily be checked by reducing volume either by means of the normal volume control (where fitted) or by substituting a short length of wire for the usual aerial. If a valve is overloaded the distortion will cease immediately the volume level is cut down. In order to find the valve which is responsible it might be necessary to transfer the reproducer from the anode circuit of one valve to that of another, as described previously. When the valve has been located it will be necessary to replace it (if an old one or if the wrong type), increase the grid-bias voltage applied to it, increase the anode voltage, or to connect a second similar valve in parallel with it. In many cases it will be found desirable to increase both the G.B. and anode voltages so as to enable the valve to handle a greater signal input voltage. Where a pentode is the valve which is overloaded the simplest cure will generally consist of replacing the valve by a triode.

It has been stated that distortion might easily be the result of an amplifying valve being wrongly biased, and this is actually a rather important point. The approximately correct bias voltage can always be determined by measuring the voltage between the anode and filament, or cathode, of a valve by means of a high-resistance voltmeter and then consulting the makers' tables, which give the appropriate G.B. voltages for various anode voltages. It is, unfortunately, practically impossible to measure the actual G.B. voltage between the cathode and grid with any degree of accuracy, although some idea can be gained if a high-class voltmeter is available. A simpler idea is to measure the anode voltage as just described and then to insert a milliammeter in the anode circuit of the valve, as shown in Fig. 3, and to compare the figure obtained with that given by the makers for the anode voltage employed. The G.B. voltage can then be adjusted, either by altering the positions of the plugs in the battery or by varying the value of the resistance in the cathode-return lead, until the correct anode-current reading is obtained. In the case of a set operated from batteries it should be switched off between each G.B. adjustment, while the same thing applies to a mains set unless a continuously variable resistance is made use of. Should it be found that alterations in bias voltage have no effect upon the anode current, it will be obvious that the grid circuit is broken at some point, and, therefore, the various components, such as transformer secondary, grid leak, decoupling resistance, etc., should be tested for continuity or checked by replacement.

Instability

Oscillation is generally indicated by a continuous high-pitched whistle of constant intensity, or by a general "thinness" of reproduction, or even by "cracking" on high notes. It can usually be checked by touching the anode terminal of each L.F. valve in turn until the trouble stops. A more reliable method is to insert a milliammeter in the anode circuit of each L.F. valve in turn (as in Fig. 3) and see if the readings change when the anode terminal is touched; if it does, the valve is oscillating. The simplest cure is to reverse the connections to the secondary or primary of the preceding L.F. transformer. Another way is to connect a fixed resistance of some 250,000 ohms in parallel with the secondary winding of the transformer.

A similar kind of trouble often results from the leakage of H.F. currents from the detector into the L.F. amplifier. Such leakage is indicated when the touching of the grid terminal of the first L.F. valve produces a noise in the speaker or a change in volume. A cure consists of using a more efficient H.F. choke, connecting a .0002 mfd. condenser between the anode of the detector and earth, or inserting a 100,000 ohm "stopper" resistance in the grid lead to the first L.F. valve.

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Latest Patent Applications.

11451.—Mullard Radio Valve Co., Ltd., and Payne, C. E.—Band-spread tuning circuits for radio-receivers. July 9th.

11654.—Leland Stanford Junior University, Board of Trustees of the.—Methods and apparatus for receiving, etc., radio signals. July 12th.

11655.—Leland Stanford Junior University.—Methods and apparatus for detecting a high-frequency signal. July 12th.

11656.—Leland Stanford University, Board of Trustees of the.—Devices for stabilising a high-frequency regenerative amplifier. July 12th,

11779.—Marconi's Wireless Telegraph Co., Ltd., Rust, N. M., Brailsford, J. D., Oliver, A. L., and Ramsay, J. F.—Radio circuit arrangements employing potential-variable capacity devices. July 16th.

Specifications Published.

523154.—Cole, Ltd., E. K., and Kennedy, F. W. O.—Tuning of radio-receivers.

523074. — Kolster - Brandes, Ltd., Beatty, W. A., and Chatterjea, P. K.—Radio-receiving systems.

523075.—Kolster-Brandes, Ltd., and Brand, P. M.—Control of television receivers.

523372.—Jackson, D., and Pye, Ltd.—Radio and television receivers or the like.

523439.—Jackson, D., and Pye, Ltd.—Television apparatus, (Divided out of 523372.)

523440.—Jackson D., and Pye, Ltd.—Screening-arrangements for radio. television, and like apparatus (Divided out of 523372.)

Printed copies of the full Published Specifications may be obtained from the Patent Office, 25, Southampton Buildings, London, W.C.2, at the uniform price of 1s. each.

ON YOUR WAVELENGTH

By Thermion

My Spare Time!

THE announcement that this journal will appear monthly until the paper position improves (when we shall, of course, revert to weekly publication), has elicited a large number of letters of regret that the war should inflict a wound on the only weekly technical journal. But so it is. All readers agree, however, that it is better to have PRACTICAL WIRELESS once a month than not at all, and pay graceful and grateful tribute to our services. Many readers who have kindly commented on the interest they find in my page, have asked me what I shall do with my spare time. They imagine that I shall have three weeks on my hands! It is true that it will take me less time to prepare one contribution than four, but I have other tasks of national importance to perform. I am, fortunately, or unfortunately, one of those restless individuals well able to occupy my time. When one outlet for my activities is restricted I am able to turn my attention to other things. But my interest in this journal, its policy, its readers, and its future will remain. I re-echo the hopes so many readers express that the time is not far distant when the war will be over, soon forgotten, and we can return to peaceful activities.

Those Cooking Items

I LISTENED in on a recent Sunday to the interrogation of housewives representing various English districts concerning the meals they were cooking, and how they cooked them. They were cross-examined by a woman expert associated with one of the Government departments, and there was a compère. Let me see. His name was, er—yes, I remember, Stone, Christopher Stone. I deny that there is any ulterior motive in picking a gramophone compère for a woman's programme. It seemed to me a great waste of Sunday programme time. Male listeners did not want to know how Mrs. Smith boiled her greens, and I felt relieved when Christopher Stone, having been round the various recipes, called upon the expert to sum up. My relief, however, was destroyed very soon. A Scots lady who imagined that her country had been slighted because she had not been called upon a second time, interjected, and so we had to listen to a description of her culinary methods. Every woman imagines that she knows the best method of cooking, as well as the most economical. Few women, therefore, will want to listen in to such programmes, and certainly no male. I suggest that they stop these programmes.

Correspondents

APROPOS our Roll of Merit I am receiving numerous requests from readers to be put into touch with correspondents. I am, however, not permitted to publish the addresses of readers on active service. I, therefore, undertake to put readers in touch with one another through the medium of this journal. One of my readers, W. L. Bicknell, wishes to correspond with anyone interested in wireless, and particularly short-wave work, in the South Raynham district of Norfolk. Letters addressed here will be forwarded.

Our Books on Active Service

LETTERS from readers on active service remind me of the fact that most of them have one or more of our technical books with them, and particularly our new Radio Engineer's Vest-Pocket Book. This is a veritable mine of information, strongly bound in cloth, with rounded corners, and a 15-page index. It is printed on thin paper so that it does not bulk the pocket, and costs 3s. 6d., or by post, 3s. 9d. The large demand has already eaten away a big chunk of the first print. Then the Wireless Encyclopedia has been round the world some hundreds of times on all types of ship; it has visited every port of every country in the world. Wireless operators on board ships in almost every case own every one of our wireless books. It is when you are away from home on active service, miles from bookshops and civilisation, that one appreciates the value of these books. Now is the time to collect a set together. It is less expensive than having to buy them all at once when you are called to the services. We have just published "The Superhet Manual," and "The Short-Wave Manual." Each costs 5s., or 5s. 6d. by post.

Generous Offer

J. E., of Twickenham, who has been an experimenter for some years, will shortly be called up for military service. He is prepared to present, free of charge, his collection of odds and ends of wireless gear to the first applicant. The collection includes, valves, condensers, coils, chokes, etc. Applicants should address a letter to me marked "Offer" in the top left-hand corner, and give their full name and address. I will pass along the first card received to J. E.

Our Roll of Merit

Our Readers on Active Service—Sixth List.

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(L/Cpl., 4th Camerons),
Inverness.

A. Tyers
(Wireless Section, R.A.),
Leeds.

Photocellogram

I COINED that word to apply to the ingenious new style of gramophone in which a celluloid film replaces the ordinary gramophone record. It contains a sound track similar to that used on talking films, and one roll of film, occupying very little more space than one record, will play continuously for about five hours. There is no soundbox or needle scratch for a photo-electric cell transforms the sound track into music or speech, through, of course, the usual amplifier and loudspeaker. Such gramophones were exhibited a few years ago at one of the Wireless Shows, but for one reason or another they did not live. I still think, however, that the idea will be revived for it seems an obvious move in the direction of progress.

NEW INVENTION WANTED

The bore's delight must be the "Mike,"
In front of which he yaps,
And at his own sweet will holds forth,
To teach we lesser chaps.

He knows we cannot answer back,
Or sharply cry "Enough!"
And so his voice runs on and on,
Yapping his stodgy "stuff."

We can, of course, shut off our set;
But then, he does not know it.
So what we want's some other means,
When bored, to plainly show it.

Come then, inventors, one and all,
A glorious field is here;
Devise a switch to "answer back,"
When bores torment the ear.

What joy if, in the studio,
Our voice could shout "Begone!"
Thus, silenced, might they not retire,
And brighter turns come on!

The world will hail as Genius,
Who brings this thing to pass,
Gives us the power, across the air,
To say: "Shut up, you ass!"

"TORCH."

Simple Volume Expansion Systems

Quality Schemes for Gramophone Record Reproducers

MANY systems for volume expansion and compression have been suggested, but such systems usually require the use of three or more valves, and are consequently relatively complicated and expensive. Some simplified arrangements have recently been disclosed by R.C.A. making use of heptodes and triode hexodes, and details are given below.

Referring to Fig. 1, the valve 1 is a heptode, and may be of the 6A7 or 6A8 type, and the signals to be controlled are applied to the inner grid 4.

The cathode 2, input grid 4 and anode 3 co-operate to provide an audio amplifier, and the amplified audio voltage is developed across the potentiometer resistor 5. One end of the resistor 5 is earthed, while its opposite end is connected to the plate electrode 3 by an audio coupling capacitor 6. The plate electrode 3 is connected to any desired source of positive potential through a plate resistor 7. The potentiometer is provided with an adjustable slider 8, and the audio voltage developed across resistor 5 may be regulated as to magnitude by adjustment of the slider 8 along the resistor 5.

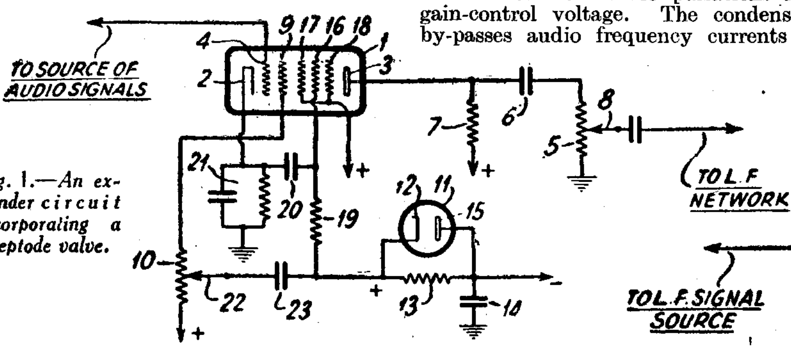


Fig. 1.—An expander circuit incorporating a heptode valve.

Gain Control of Amplifier

In order to effect expansion of the volume range it is essential to increase the gain of the audio amplifier as the intensity of the audio input energy increases.

The gain control of the audio amplifier is provided by a portion of the audio input energy to the audio amplifier. It is desirable to amplify the control energy prior to its rectification. Hence, the second control electrode 9 is employed as a plate, or anode, electrode, and the load resistor 10 is arranged in circuit with anode 9. Resistor 10 is connected to a source of positive potential. It will, therefore, be seen that the audio energy impressed on electrode 4 develops audio output voltage both across the output resistor 7 and the output resistor 10, both electrodes 9 and 3 functioning as audio amplifier output electrodes.

The audio voltage developed across output resistor 10 is impressed upon a rectifier 11, and the latter may be of the diode type. The cathode 12 of the diode is connected to earth through a path which includes the diode load resistor 13 and the condenser 14. The diode anode 15 is connected to the junction of condenser 14 and load resistor 13, the junction point, additionally, being connected to a source of negative direct current potential so as to provide an initial negative bias for the gain control electrode 16 of valve 1.

Gain control electrode 16 is the fourth control electrode of the valve, and is disposed between the screen-grid electrodes 17 and 18; the latter two grids are connected to a source of positive potential. It will be understood that the grids 17 and 18 provide an accelerating field for the electrons between grids 9 and 16, and between grid 16 and the plate electrode 3. The gain control 16 is connected to the cathode end of diode load resistor 13 by means of a resistor 19, which functions to filter out the audio pulsations in the gain-control voltage. The condenser 20 by-passes audio frequency currents from the grid end of resistor 19 to the cathode 2. The cathode itself is maintained at a positive potential above earth by means of the usual self-biasing resistor network 21 and, therefore, the control grid 4 is at a normal negative bias. The magnitude of the audio voltage impressed on the control rectifier 11 is adjusted by means of the variable tap 22 adapted to slide along resistor 10, the audio coupling condenser 23 connecting the tap 22 to the cathode end of resistor 13.

To explain the functioning of the arrangement shown in Fig. 1, let it be assumed that the audio signal is applied to grid 4. The amplified audio signal voltage is developed across the output circuit of valve 1. The gain of the audio amplifier is controlled by grid 16 in a polarity sense such that the gain of the audio amplifier increases as the audio signal input intensity increases. This follows from the fact that when the audio signal voltage applied to grid 4 increases, then the audio voltage developed across resistor 10 increases, thereby increasing the magnitude of the audio voltage impressed upon rectifier 11. In this way the voltage across load resistor 13 increases. Since the grid 16 is connected to the cathode, or positive, end of resistor 13, an increase in direct current voltage developed across resistor 13 causes the reduction of the initial negative bias on gain control grid 16. The result of this reduction of negative bias is to increase the gain of the audio amplifier. The amount of increase in gain and thereby the amount of volume expansion may be controlled by adjustments of tap 22.

Constant-pitch Winding of Grid

While it has been explained that valve 1 is of the 6A7 or 6A8 type, it is desirable to have the fourth grid 16 of a constant-pitch winding. It is pointed out that in a 6A7 or 6A8 type of valve the second grid 9 actually consists of the rod supports usually employed for supporting the grid winding. With this type of construction the rod supports have a minimum of influence on the main electron stream flowing to the audio amplifier output electrode 3. It will, therefore, be appreciated that the valve 1 not only provides normal audio amplification, but also supplies amplification of that portion of the audio input energy which is to be used for rectification at valve 11 in order to provide the expansion control voltage for grid 16.

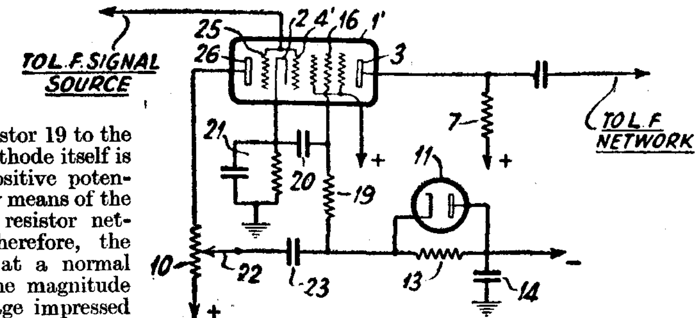


Fig. 2.—Similar arrangement to the Fig. 1 scheme, but with a triode-hexode valve.

Instead of the heptode, shown in Fig. 1, a triode hexode may be used as shown in Fig. 2. Thus, the cathode 2 provides an electron stream flowing through the control grid 25 to the output electrode 26, and

(Continued on facing page.)

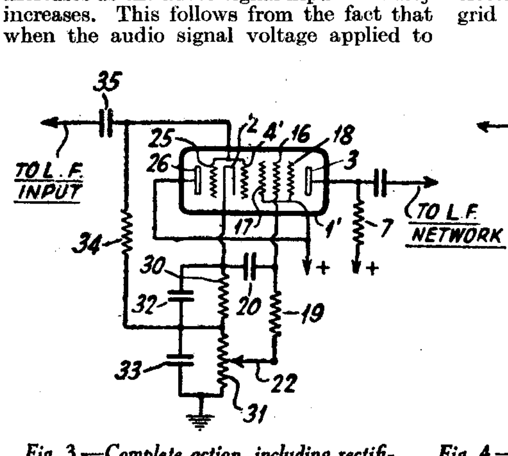


Fig. 3.—Complete action, including rectification, is provided in this circuit.

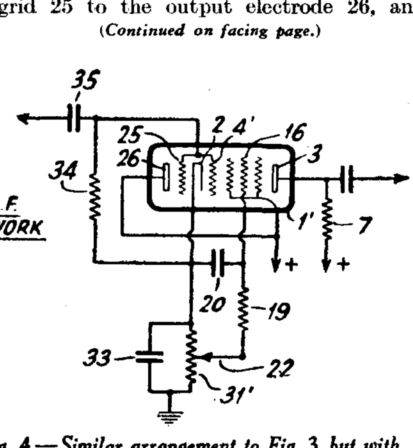


Fig. 4.—Similar arrangement to Fig. 3, but with grid rectification instead of anode rectification.

SIMPLE VOLUME EXPANSION SYSTEMS

(*Continued from opposite page*).

audio signal energy is impressed on grid 25. The output resistor 10 is included in circuit with the output electrode 26. In other words, cathode 2, grid 25 and plate 26 correspond respectively, in Fig. 1, to cathode 2, grid 4 and output electrode 9. The audio amplifier section of valve 1′ comprises the cathode 2, the grid 4′ and the output plate 2. The gain control electrode 16 is located between the positive screen grids, as in the case of valve 1 in Fig. 1.

The remainder of the circuit elements correspond to those shown in Fig. 1. Both signal grids, 25 and 4′ are connected to the source of audio input energy, and both of these grids are maintained at a normal negative bias by the self-biasing network 21. It is not thought necessary to describe the detailed construction of the combined triode-hexode type valve shown in Fig. 2; it being found merely necessary to point out that cathode 2 provides a pair of independent electron streams to a triode section and an independent hexode section. The advantage of this arrangement is that the control energy amplifier section has minimum influence on the functioning of the gain audio amplifier section. It is to be clearly understood that in either of Figs. 1 or 2 automatic compression will be secured by merely interchanging the connections to the cathode 12 and anode 15 of diode 11. For example, if the anode 15 is connected to resistor 13 in place of cathode 12, then with an increase of audio input energy intensity there will result a decrease in the gain of the audio amplifier.

Gain Control Voltage

It is not essential that independent rectifiers be employed for providing the gain control voltage. In Figs. 3 and 4 are shown circuit arrangements wherein the combined triode-hexode 1′ may be utilised for providing the rectification action as well as the automatic compression or expansion. In Fig. 3 there is shown an automatic compressor circuit. In this case the plate electrode 26 is connected to the same positive potential lead connected to the positive screen grids 17 and 18. The cathode 2 is connected to ground by means of a pair of series resistors 30 and 31, resistor 30 being shunted by an audio by-pass condenser 32, and resistor 31 being shunted by an audio by-pass condenser 33. The blocking condenser 35 connects the audio input circuit to the control grids 25 and 4′ which, in turn, are connected to the junction of resistors 30 and 31 by means of grid leak 34. The gain control grid 16 is connected to the resistor 31 through the series path, including filter resistor 19 and adjustable tap 22.

The condenser 20, connected between the grid end of resistor 19 and the cathode end of resistor 30, functions as a portion of the filter network 19-20. It will be seen that in the arrangement of Fig. 3 no diode rectifier is necessary, since plate rectification occurring in the triode section of tube 1′ is utilised. The resulting cathode current change through resistor 31 is employed to increase the grid bias of grid 16 as the audio input energy increases. In other words, as the audio input voltage impressed on grids 25 and 4′ increases there will be a greater flow of space current through resistor 31, and, therefore, the grid 16 will be biased increasingly in a negative polarity sense. This results in the reduction of the gain of the hexode section of tube 1′ such as is desired for automatic compression.

High Amplification Factor

It is desirable to design valve 1′ so that the triode section is normally biased close to cut-off, while with the same bias on grid 4′ of the hexode portion of the valve this latter portion is operating on a substantially linear portion of its characteristic. This is readily accomplished by utilising a higher mu, or amplification factor, for the triode section than for the grid 4′ to grid 17 portion of the hexode. In the 6K8 type of valve, for example, such a difference in amplification factor exists by virtue of the difference in spacing between grid 25 and plate 26 from the spacing of grids 4′ and 17. If the triode section mu is not sufficiently higher than the mu of grid 4′ to grid 17 of the hexode, satisfactory operation can still be obtained by lowering the positive voltage applied to the triode section plate 26 below that of the grid 17.

The circuit arrangement shown in Fig. 4 differs from that of Fig. 3, in that grid rectification is utilised in place of anode rectification in the triode section. The signal grids 25-4′ are connected to the audio signal source through the grid condenser 35 as in Fig. 3. The grid leak 34, however, in distinction to Fig. 3, is connected to cathode thus permitting grid rectification. Resistor 31′ connects cathode 2 to earth, the resistor being by-passed for audio frequencies by condenser 35. In this form of circuit the cathode 2, signal grid 25 and plate 26 provide a grid-leak detector circuit. Upon a signal intensity increase, the flow of space current through cathode resistor 31′ decreases due to the well-known action of the grid-leak and condener 34-35. As a result, the bias of grid 16 decreases; the gain of audio amplifier section 2-4′-16-3 thereby is increased. Expansion of the audio volume range results. If the hexode section has a sufficiently low mu so as not to be cut off for the strongest signals, distortion effects will be negligible. The triode section mu should be high, as in the case of the arrangement of Fig. 3.

NEWS AND NOTES

Radio Mechanics Wanted

SKILLED radio mechanics in the partially evacuated towns and other places who are finding it difficult to make a living under new circumstances should join the Air Force. There is a big demand for their services. Partly skilled amateurs are not wanted for these posts. Applicants should have a sound and thorough knowledge of both the theory and practice of wireless sets. They will not be trained, since the type required is the man who does not need any training. They will be asked, however, to pass a trade test. The right sort of men can be accepted up to the age of 50. They must be able to repair sets and understand what they are doing.

Pay is at the minimum of 3s. 9d. a day, with possibilities of rising to 5s. 6d. a day, with all found. Applications should be made in the first instance to a combined Recruiting Centre, the address of which can be obtained from any Employment Exchange.

Women Radio Operators for the Air Force

WOMEN of education and intelligence, from 18 to 35, are wanted for special duties and as radio operators. Good eyesight is essential. The main qualification sought is that applicants should be able to work under pressure and not get "rattled." The pay is 1s. 4d. a day while under training and 2s. 2d. a day when trained.

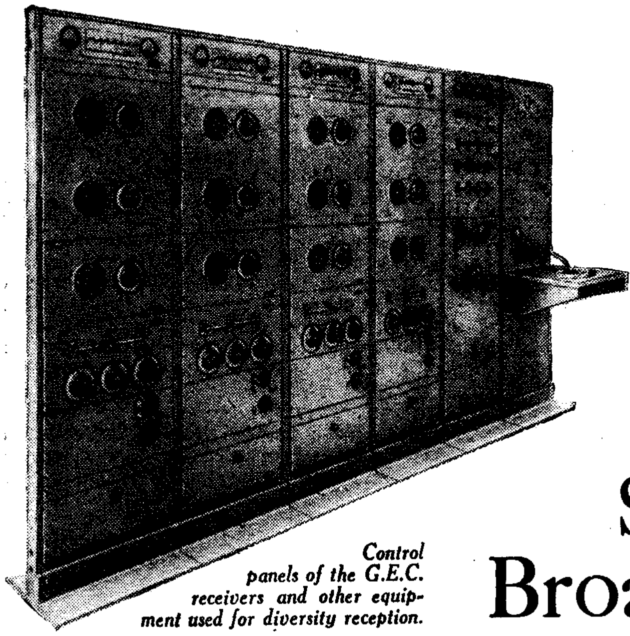
Women are also urgently wanted in the W.A.A.F. for slip-reading. They must be typists, and they go through a course enabling them to read Morse off a tape machine, and type it in clear. Pay is 1s. 4d. a day during training, and 2s. 4d. a day when they have satisfactorily completed their course. Age limits, 18-43. Other typists are required as teleprinter operators and for various clerical duties. Pay is 2s. 2d. a day when trained; age from 18-43.

Applications for any of these posts should be made, if possible, to one of the W.A.A.F. Area Headquarters, the address of which may be obtained from any Post Office or Employment Exchange, or to a Combined Recruiting Centre.

Link With Television to Disappear

WHEN the two 284ft. towers of the Crystal Palace, which withstood the fire of 1936, are demolished, a well-known London landmark and link with the development of television will disappear. The 1,600 tons of metal are to be used for war purposes. It will be recalled that the south tower was used by the Baird Company for its 30-line television transmissions demonstrated in 1935, and has since been used for experimental purposes.

The Columbia Broadcasting System of America take regular relays of news from this country. E. R. Murrow, European Director of the C.B.S. is seen in this picture making one of these twice daily broadcasts from Broadcasting House. On busy days he works up to twenty hours, all his talks, of course, being subject to censorship.



Control panels of the G.E.C. receivers and other equipment used for diversity reception.

South African Broadcasting System

Details of the Equipment Used for Re-broadcasting in the Union

A FEW miles west of Johannesburg, South Africa, there stands a small white building that is the broadcasting station Panorama. From this tiny centre in the heel of that vast continent, programmes of every kind are re-broadcast from the pick of Europe's stations and re-diffused throughout the whole of South Africa. Reception from Daventry, from Paris, from towns all over Europe is of such a consistently high order that it has been commented upon by technicians everywhere. Indeed, completed only during last July, the apparatus installed for the purpose bids fair to be ranked as near perfection as possible to-day.

The Aerial System

In describing the equipment it is of interest to consider first how the signals are picked up and to explain the aerial system used. This is a rhomboid arrangement of three aerials so placed that (1) is separated from (2) by 1,250ft., (2) from (3) by 1,240ft. and (1) from (3) by 2,250ft. At present the aerials are directional on Central and Western Europe, but it is intended that additional aerials shall later be set up to allow reception effectively to be obtained from all parts of the world. Although the present scheme is mainly intended for picking up signals on wavebands between 13 and 30 metres, it also functions effectively on the 49 metres band. Beyond this point reception cannot be maintained at peak efficiency.

The Receiving Apparatus

The radio receivers and associated gear are completely housed and mounted in eight racks each 5ft. 6ins. by 19ins. wide.

Rack 1 houses the aerial coupling board. Racks 2 to 5 carry the four receivers, and rack 6 holds the diversity locking equipment. The line and monitor amplifier equipment is housed in rack 7, while rack 8 is used for mounting the telephone apparatus.

The aerial coupling board is provided with flexible connectors allowing any aerial to be linked with any of the receivers. The aerial connectors and receiver inter-connectors are of the concentric co-axial cable type.

Each of the receivers is an eight-valve superhet, which was built by The General Electric Co., Ltd., for diversity reception. Several special features had to be considered in the design.

The specification of the Broadcasting Company called, for instance, for the supply of both high tension and low tension current from accumulators, to avoid risk of noise from background.

To maintain full efficiency each circuit in each receiver is individually tuned. There are six circuits to be tuned before reception from any station can be obtained, as opposed to the single tuning circuit of the ordinary home receiver, three being used for L.F. and three for R.F. tuning, the former, of course, being adjusted only in tuning the first station and subsequently left at the right setting then obtained.

Automatic volume control voltage is obtained from a valve which operates with its anode load return to the earth line and its cathode at minus 100 volts. The voltage developed across the anode load resistor of this valve is used to control the variable amplification valves. The stronger the signal therefore, the greater the negative value of the voltage developed.

As an indication of the performance of the automatic volume control circuits, there is a 0.9db. change in output for 60db. change in input above zero level, zero level being 10 microvolts.

When receivers are coupled in diversity through the diversity locking equipment, *i.e.*, when the outputs are coupled through a mixer unit and their automatic volume control lines bonded—the receiver which has injected into it the greatest signal will take charge of the total output. This is explained by the fact that the receiver obtaining the greatest signal will bias the other receivers back so as to make them almost—or possibly entirely—inoperative. As soon as the strongest signal on aerial 1, for example, fades, aerials 2 or 3 may be in the strongest signal field, and the receiver coupled to which ever is the stronger of these will then take control. Thus the total output is being supplied by all receivers in their turn as they receive the strongest incoming signal.

Locking Equipment

It is possible, of course, to couple the output of two, three or four receivers as desired, or to extract the outputs from each receiver separately. Precautions are taken to ensure that the outputs are coupled in phase, so that cancellation, noticeable in the bass frequencies, will not take place.

The line and monitor amplifier and equaliser is of value should it be desired to cut off the extreme high-frequencies of the audio output.

The telephone line equipment transmits the modulated signal to the distributing studio.

Stand-by Provision

It has been proved in practice that if aerials are separated by 1,000ft. or more, the signal they receive from a distant short-wave transmitter will fade only very seldom at all three such aerials simultaneously. It is not, therefore, economically worth while to use four or more receivers in diversity, as the reduction in fading per receiver, added in excess of a total of three

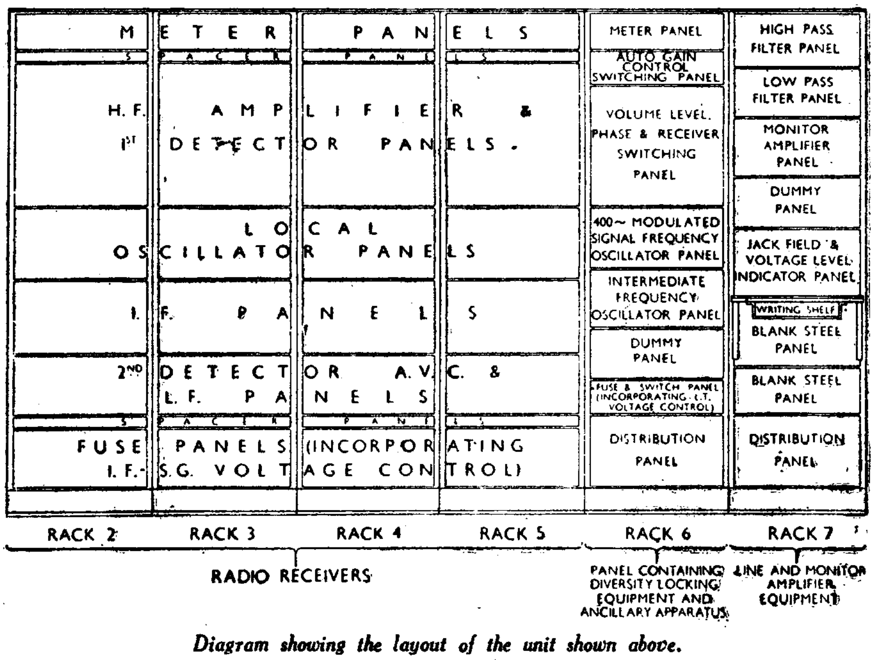


Diagram showing the layout of the unit shown above.

becomes very small. A fourth receiver is used, in order that a spare may be available for substitution in case of failure, or for use as a stand-by.

Selective fading, that is to say, the type of fading which is accompanied by severe distortion, is not diminished by diversity working. In other words, diversity only aids in the elimination of straightforward fading.

Power Equipment

The generator equipment is housed in an outroom which is electrostatically shielded in order to prevent any radiation of interfering signals. The generator set is of a petrol-electric type capable of delivering 3½ kW. at 220 volts, 50 cycles. It employs automatic starting so arranged that as soon as a load in excess of 60 watts is thrown upon it, it starts from a storage battery and will continue to run until the load is removed.

The charging equipment consists of a large rectifier unit for the low tension, employing two mercury vapour rectifiers capable of delivering a full wave rectifier current of 50 amperes. The charger for the high-tension supply employs a mercury vapour full-wave rectifier and is capable of charging the complete high-tension battery at 5 amperes.

The battery power for low-tension supply, i.e., 6 volts, is obtained from two batteries of nine cells, each connected in series parallel. The capacity of each cell is about 320 ampere-hours. Switching arrangements make it possible to have one set of batteries in use, while the other is in charge. The high-tension supply is obtained by the use of 33 13-plate, 6-volt motor-car batteries, with a capacity of approximately 60 ampere-hours. Provision has been made to transfer the house lighting to the high-tension battery should it be desired to discharge the high-tension cells more rapidly, or if it proves necessary to shut down the generator equipment at night.

Special arrangements have been made to provide a good earth connection by the use of 72 sq. ft. of copper plate consisting of a sheet 6ft. wide buried on end. The surrounding earth is regularly watered to maintain efficiency.

Care was also taken when installing the electrical wiring to ensure that no alternating current machinery could accidentally become connected to a direct current supply, all power points being wired to the generator circuit only.

A borehole and windmill are located on the property. Living quarters with all "modern conveniences" for one engineer are provided at the station. It is fully equipped with waterborne sewerage, hot and cold water and even an oil-burning refrigerator.

Identifying Coil Connections

Some Easy Methods of Finding the Correct Connections for Different Tuning Coils

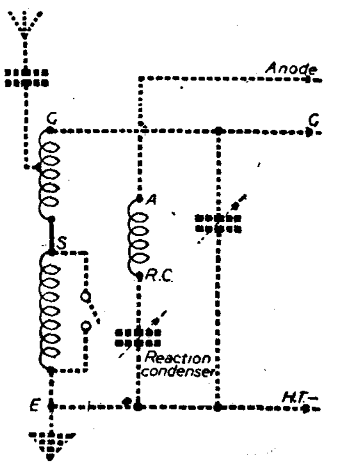


Fig. 1.—A tuner of the simplest type.

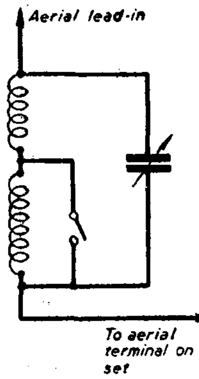


Fig. 2.—Simple test for the tuning winding.

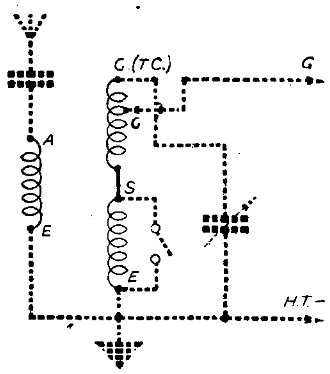


Fig. 3.—A coil with separate aerial winding.

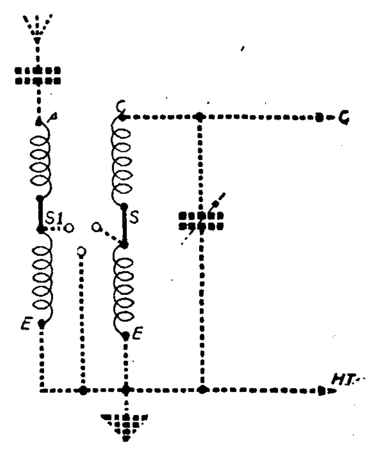


Fig. 4.—Aerial winding and wave-change switch acting on both windings.

IN a recent article I gave some simple instructions concerning methods of tracing the connections to mains transformers which are not marked with terminal indications. To a certain extent, the same general procedure can be adopted when dealing with tuning coils, although it is rather easier to verify the results of the tests when dealing with coils. On the other hand, there is such a wide variety that rather more ingenuity may have to be employed in order to ensure that the connections found are actually those which give best results.

Primarily, the method is to find which terminals are joined together by the windings and which are not inter-connected. Having done that, it is necessary to find to which parts of the various windings the terminals are joined. The matter is sometimes complicated to a certain extent due to the fact that two, or even three, windings may have one of their ends joined together. That would apply when there were aerial, grid and reaction windings, and when a portion of both aerial and grid windings had a wave-change switch wired across them.

Draw a Diagram

Before commencing any tests it is well to have in mind the possible winding arrangements, and a few of the most usual are shown in the accompanying diagrams. There are, of course, many other possible arrangements, but most are modifications or adaptations of those shown. For example, in the case of a coil intended for use on short as well as medium and long wave-bands it might have additional terminals and tappings. Very often this would be evident from a careful inspection of the coil, for it would probably be found that one winding, or a portion of a complete winding, consisted of comparatively few turns of a gauge of wire heavier than that used for the remainder.

Inspection might also reveal the number of windings. For example, the simplest type of coil, such as that represented by the diagram in Fig. 1, would have three windings with two of these in series. One of these would be the medium-wave grid coil and would consist of about 90 turns if the former had a diameter of 1in. Then there would be the long-wave winding with about three times as many turns—probably pile-wound toward the lower end of the former—and the reaction winding, with rather more turns than the medium-wave grid winding. The last-mentioned is often placed between the other two. This winding lay-out is by no means standardised but it is not unusual on the simplest type of coil.

Preliminary Inspection

By examining the inside of the former it might be possible to see how the ends of the winding are brought out, whilst a tapping on a winding would probably be evident from the fact that a double or looped wire was brought down from one winding to a terminal. A coil of this type generally has six terminals with the following connections: aerial, grid, earth, wave-change switch (other side to earth), reaction condenser, and detector anode. It will be seen from Fig. 1 that the aerial is connected to a tapping, and that the wave-change switch is joined to the junction between the medium- and long-wave windings.

If it is possible to form a fair impression of the number and general arrangement of the windings in the first place, subsequent testing will be simplified to a considerable extent. Having formed an impression as to the number of windings, a rough, preliminary diagram should be drawn. After that, simple continuity tests, by means of a dry battery and a pair of 'phones, a flash-lamp bulb or a milliammeter (in series with a 500-1,000 ohm resistor) can be made. By this means it should be possible to verify or disprove the original idea as to the circuit arrangement.

Should the coil be fitted with a built-in wave-change switch it is an easy matter to distinguish the grid winding by noting whether or not there is a change in meter reading or test-bulb brilliancy when the switch is moved from one position to the other. To find which is the tapping it is best to examine the inside of the former, since the difference in resistance between one end of the coil and the other, or between one end and the tapping, would be too small to measure with the simplest type of equipment.

A Good Test

If there is still some doubt as to which of the two windings is the grid winding a simple test can be made by using the coil

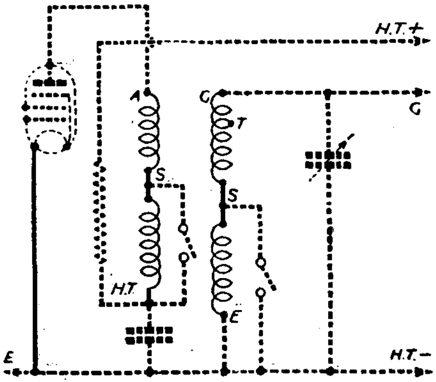


Fig. 5.—Connections for a typical H.F. transformer.

as a wave-trap, as shown in Fig. 2. A .0005-mfd. variable condenser is wired in parallel with the winding under test and the tuned circuit so formed is connected between the aerial lead-in and the aerial terminal on the set. If it is actually the grid winding which has been found, it should be possible to cut down the signal strength on the set to a marked degree by turning the condenser of the improvised wave-trap to one particular setting. This test can be repeated on both wave-bands—turning the wave-change switch on the wave-trap after turning that on the set and tuning in a strong signal on the other waveband.

Should it be found that the coil does not act as a wave-trap when used in this way it will be known that the wrong winding has been chosen, and that the test should be repeated on another winding. As each terminal is "found" it should be marked with a letter G or E, bearing in mind that the G terminal is generally that connected to the top of the winding.

Reaction-winding Connections

When there are only two windings it will usually be the case that the second is for reaction, and the terminals can simply be marked R. To find which of these should go to the detector anode and which to the reaction condenser, and then to earth, it will be easiest to connect the coil in the receiver and find which connections cause the set to oscillate when the reaction condenser (.0003-mfd. should be ample) is turned toward maximum capacity. If oscillation is not produced, and signal strength is cut down by advancing the reaction condenser, it will be known that the connections to the two terminals should be reversed.

In the case of a coil of the type represented by Fig. 3 there will probably be three windings, although the reaction winding has been omitted for simplicity. The separate aerial winding can be treated in the same manner as the reaction winding by trying the effect of reversing the aerial and earth connections. It is not essential to use the grid-winding tapping (if provided), but by connecting it to the grid (but leaving the tuning condenser connected to the top end of the winding) tuning will be sharpened.

Fig. 4 shows a coil similar in style to that in Fig. 3, but in this case a three-point wave-change switch is used to short-circuit a portion of both the aerial and grid windings when working on the medium waveband. There would probably be a reaction winding in addition to the two windings shown, but that could be considered separately.

An H.F. Transformer

The coil shown in Fig. 5 is again similar; in fact, it may be the same coil as that in Fig. 4, but this time it is shown used as an H.F. transformer. Because of that, and since the primary winding (which corresponds to the separate aerial winding) carries H.T. current to the preceding H.F. valve, a double-pole switch replaces the three-point switch shown in Fig. 4. Here again, there would generally be a reaction winding, and there might also be a tapping on the grid winding to give increased selectivity.

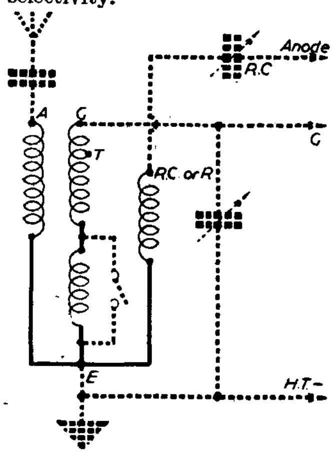


Fig. 6.—In some cases the "earth" ends of all windings are joined together inside the coil.

In many cases when there are three windings, the lower ends of all three are joined together and to the earth terminal, as shown in Fig. 4. This is inclined to make the identification of the three windings more difficult. Since the aerial and reaction windings may be similar it might be possible to interchange the connections, and for that reason it would be wise to try reversing the leads to the points marked A and R.C. in order to find which is better; this should be done while the coil is wired in a set. The idea of using a flash-lamp bulb and small dry battery mentioned in the article on mains transformers will usually serve to show which is the grid or tuning winding, since this will have the highest resistance—when the wave-change switch is "open"—and will therefore cause the bulb to give a dull glow, or even to go out.

RADIO CLUBS & SOCIETIES

Club Reports should not exceed 200 words in length and should be received First Post each Monday morning for publication in the following week's issue.

EASTBOURNE AND DISTRICT RADIO SOCIETY

Hon. Sec.: T. G. R. Dowsett, 48, Grove Road, Eastbourne, Sussex.

AT a recent meeting of the above society Mr. S. M. Thorpe, A.M.I.R.E., gave a lecture entitled "Radio Reminiscences."

First of all he told how everyone in the early days of radio had to make their own components, i.e., condensers, inductances, etc.; the many hours spent on trying different mineral mixtures in coherers. Gildredge Park and Beachy Head were brought into the story, of how when Mr. Thorpe and his friend tried transmitting and receiving experiments at these places with most discouraging results, the Marconi Co. were even unsuccessful when they tried out experiments on Beachy Head.

He told of the researches of various scientists such as Castelli, Lumis, Charles Maxwell, and Oliver Lodge. Next he explained the action of an electrolytic detector, and how one was always trying different crystal and catswhisker combinations.

Different valves were explained, of which he had some fine examples, and a demonstration of other materials was also given.

CHRIST'S HOSPITAL WIRELESS SOCIETY

Hon. Sec.: R. L. Denyer, Lamb B, Christ's Hospital, Horsham, Sussex.

THIS term we have continued to meet twice a week, as before. One evening is devoted to set constructing and the other is set aside for a lecture by a member. T. R. Munro started off this term by giving a lecture on "T.R.F. S.W. Battery Sets." Waller followed this, giving general hints on aerials and earths to beginners, P. A. Shears lectured on "The Superhet," and J. B. C. Bennett on "A.V.C." R. L. Denyer, the secretary, lectured on "Television."

Various members have promised to construct, or are constructing, pieces of apparatus such as coil winders, capacity bridges and multi-valve testers, for the use of the members.

We wish to thank Mr. Quick, of Horsham, for the large number of wireless components with which he has presented us.

The secretary would be pleased to correspond with any other school radio societies to exchange information and ideas.

ASHTON-UNDER-LYNE AND DISTRICT AMATEUR RADIO SOCIETY

Headquarters: 17a, Oldham Road, Ashton-under-Lyne.

Meetings: Wednesdays 7.30 p.m., and Sundays 2.30 p.m.

Hon. Sec.: K. Gooding (G3PM), 7, Broadbent Avenue, Ashton-under-Lyne.

SEVERAL letters have been received from members with H.M. Forces, and have been handed to members for reply after they had been read at a recent meeting.

Messrs. H. Hattersley and W. Taylor presented their report regarding the proposed Social to be held on August 7th at the club-room at 7.30 p.m. A programme for the evening was duly compiled, including demonstrations of superhets of similar construction by various members, demonstration of an automatic turntable, demonstration of an automatic Morse sender, and a Debate on "Regeneration *v.* Multi Stages in Superhets." It is hoped that all local amateurs will rally round and give the event their full support by taking advantage of the opportunity to enjoy a large scale post-war "rag-chew." Suitable refreshments will be supplied during the evening at an inclusive cost of 1s. per head. It is also hoped to feature a Morse Receiving Contest with prizes.

ROBERT BLAIR RADIO SOCIETY

Headquarters: L.C.C. Evening Institute, Blundell Street, Islington, N.7.

DESPITE many members being called up, the society still continues to function at the above address. We are pleased to announce several of our members have entered the Forces in the wireless field, one particularly being accepted in the R.A.F. as ground staff radio operator.

Until further notice we are meeting only on Thursday evenings from 7.30 to 9.30, and Mr. C. T. Bird, our new President, and Head of the Institute, wishes it to be known that anyone is welcome to pay us a visit, or join the society if they wish to do so.

For The Beginner

What is Impedance?

A Simple Explanation of the Term and How Many Problems May be Solved from a Knowledge of it

HAVE you often wondered why your set oscillates more easily as you reduce the capacity of the tuning condenser? Or what is the purpose of the H.F. choke connected in the anode circuit of a detector valve? Or why the "tone" of the set is altered by connecting a condenser across the primary winding of a low-frequency transformer? Or why the loudspeaker works best when it is properly "matched" to the output valve?

No doubt you have frequently asked yourself the above questions without being able to supply a really satisfactory answer. As a matter of fact all these little problems, and many more, can easily be solved if one has a passing acquaintance with the meaning of a word which is used very often in wireless circles and yet of which many people seem to be "scared." I refer to the word "impedance." Perhaps it does sound rather technical, but it is quite harmless and extremely useful.

Resistance and Impedance

You know what resistance is; it is the opposition which certain materials offer to the passage of electrical current. Impedance has a similar meaning, but is applied, not to direct current, such as one may obtain from a battery, but to alternating or high-frequency current of the kind which is used in a wireless set to produce sounds in the loudspeaker. It is measured, like resistance, in ohms.

Impedance of Condensers

Perhaps the simplest way to observe the difference between resistance and impedance is to consider for a moment an ordinary fixed condenser of the kind connected across the high-tension supply. It usually has a capacity of about 2 microfarads. The condenser has an infinite resistance to direct current—else it would short-circuit, or take current out of, the battery. But the purpose of that condenser is to allow unwanted alternating or speech frequencies to leak away. It must, therefore, present a low resistance—more correctly, impedance—to them. It does, because its impedance to frequencies of about 250 cycles per second (that of the average female speaking voice) is only about 300 ohms. At a frequency of 4,000 cycles per second (rather higher than that of the top note of a piano), it has an impedance of only 20 ohms. If the same condenser were inserted in series with the aerial lead-in, where the frequency of the alternating currents which would flow through it might be anything from 100,000 cycles upwards, its impedance would be practically zero.

In considering the latter points we have observed one simple but important fact; namely, that the impedance of a condenser varies with the frequency of the alternating currents passed through it—as the frequency is increased the impedance becomes less. Suppose we now think in terms of a "smaller" condenser, say, one having a capacity of .0002 mfd. or 10,000 times less than that previously referred to. Its impedance at 250 cycles is approximately 3,000,000 ohms; at 4,000 cycles it is 200,000 ohms and at 100,000 cycles it is still over 5,000 ohms. But at 1,000,000 cycles per second (corresponding to a wavelength of 300 m.), the same condenser offers an impedance of rather more than 700 ohms.

It can now be seen that the impedance of a condenser varies with its capacity, and with the frequency of the current passing through it. As a matter of fact the impedance is actually proportional to the product of the capacity and frequency and, given the values of the two latter factors, we can easily calculate the impedance of any condenser from the formula: $\text{Impedance (in ohms)} = \frac{1{,}000{,}000}{2\pi \times f \times C}$, where π is 3.14, f is the frequency and C the capacity in microfarads. However, we need not worry ourselves with mathematics at the present time, but the formula is given just to consolidate, as it were, our deductions.

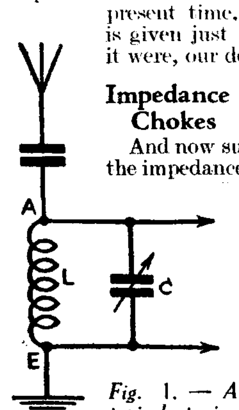


Fig. 1. — A typical tuning circuit. As the capacity of C is reduced a smaller "load" is placed on L, so that the impedance between points A and E becomes greater.

Impedance of Coils and Chokes

And now suppose we consider the impedance of different kinds of coils. A piece of 24 gauge wire 43 yards long has a resistance (to D.C.) of 3 ohms and its impedance to A.C. is not greatly different, provided the wire is kept in one straight line. But if it is wound into a coil of, say, 220 turns 1½ in. diameter — this would actually be a tuning coil for the long waveband—it would offer an impedance of 5 ohms to currents at 100 cycles per second or of 4,000 ohms at 200,000 cycles. Now suppose we were to fit an iron core into the coil, its impedance would go up to over 100 ohms at 100 cycles. And so we could go on making comparisons, but there is no need for this, since we have found that the impedance of a coil increases with a rise in frequency—just the opposite to that of a condenser. We can also see why an iron core is used in coils which have to deal with low frequencies, smoothing and L.F. chokes for example; it is to secure the necessary impedance at low frequencies.

Question Number One

Having arrived at these conclusions, some of the questions stated in the opening paragraph are easily answered. Starting with the first one: the aerial tuning circuit consists of a coil and condenser connected in parallel as shown in Fig. 1. To tune to a lower wavelength (higher frequency), the capacity of C is reduced. What does this involve? Well, in the first place the impedance of C is increased, which is equivalent to reducing the "load" on the coil L, and besides this, the impedance of L increases due to the higher frequency. As a result the impedance between the points A and E becomes higher, so that the signal voltages between these two points are made greater. Expressed differently, the "efficiency" of the tuning circuit is enhanced, and because of this the valve oscillates more readily.

Why Use an H.F. Choke?

Let us look at the second question: "What is the purpose of the H.F. choke connected in the anode circuit of a detector valve?" (See Fig. 2.) The choke has to do three things. It has to present an easy path for the direct current flowing from the H.T. battery to the anode of the valves; to allow low-frequency (or audio-frequency) current to pass from the detector to the L.F. valve and to prevent high (or signal) frequencies from getting into the L.F. amplifier. The first two tasks are easy and could be performed by a straight piece of wire, but the third tends to complicate matters. Let us think for a moment. We saw that a coil of wire—and that is all a choke really is—has less impedance to low than to high frequencies. Well, then, if a suitable size of coil is chosen it will have a fairly low impedance to audio-frequencies below 6,000 cycles or so, and a comparatively high one to signal frequencies ranging from 100,000 cycles upwards.

My desire to enter into mathematics at this point is no greater than yours, so I will merely state the results of calculations in respect to a choke of average ready-made type having a specified inductance (which we can take as being a measure of the number and diameter of turns) of 100,000 micro-henries. The impedance of such a choke to frequencies of the order of 6,000 cycles is about 4,000 ohms, whilst its impedance at 600,000 cycles (500 metres) is very nearly 400,000 ohms. Speaking comparatively, then, the choke will pass the lower frequency a hundred times more easily than the higher one and, therefore, it will satisfactorily fulfil its required purpose. As regards the choke's resistance to direct current, this can be ignored, as it will only amount to something like 200 ohms. In addition to the choke, a condenser is sometimes used to assist in the separation of high and low frequencies and is connected in the position marked C in Fig. 2. In so far as H.F. is concerned, the choke acts as a "rejector," but the condenser is an "acceptor." The meaning of these terms is almost too obvious to require explanation, since it is clear that

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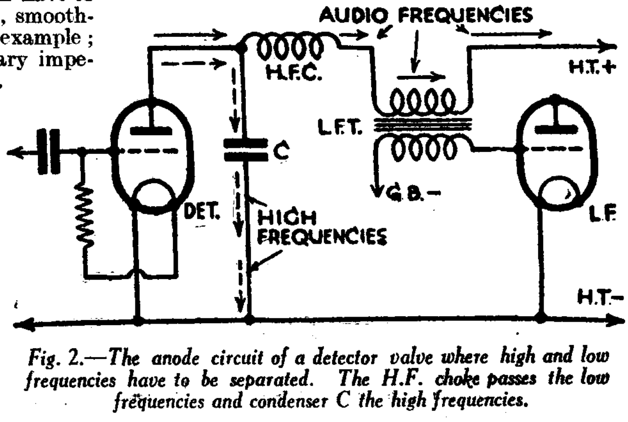


Fig. 2.—The anode circuit of a detector valve where high and low frequencies have to be separated. The H.F. choke passes the low frequencies and condenser C the high frequencies.

WHAT IS IMPEDANCE?

(Continued from previous page).

the condenser is to allow the high frequencies to leak away to earth, whilst the choke prevents their passage through it.

We can appreciate that the object of the condenser is just the reverse of that of the choke; it must have a low impedance to high frequencies and a high impedance to low frequencies. Again, however, the impedance in each case must be considered on a comparative basis, but since we established a "standard" of impedance for the choke we can work on the same figures. We must not consider the choke alone, though, because this is only a part of the detector anode circuit, and the L.F. currents have to pass through both this component and the primary winding of the low-frequency transformer. The latter will probably have an impedance of 100,000 ohms at 6,000 cycles, so this must be added to that of the choke. In other words, the total impedance to L.F. currents is 104,000 ohms.

It is evident, then, that the condenser must have an impedance of not less than 104,000 ohms at 6,000 cycles, or else it will "draw off" some of the L.F. as well as the H.F. Using the formula previously given, it is an easy matter to find that a .0003 mfd. condenser has an impedance of round about 100,000 ohms at 6,000 cycles, and so we know that this is the highest capacity that should be used under normal circumstances. As its impedance at 600,000 cycles is less than 100 ohms, it will provide an easy path for currents of such a frequency.

Tone Control

What would happen if the capacity of this condenser were increased? As we have seen, it would "rob" the transformer, and hence the L.F. amplifier, of some of its audio currents. The actual amount of current it would take would naturally depend upon its exact capacity and upon the frequency. For example, if the condenser had a capacity of, say, .01 mfd., its impedance at 6,000 cycles would be only about 2,500 ohms, so it would take away nearly all the audio current at such a frequency. But at 300 cycles its impedance would be about 50,000 ohms, whilst that of the transformer would probably be a good deal less, so that practically the whole of the current would pass through the transformer. From this explanation it will be seen that the condenser could be used as a tone control to give a cut-off to the higher notes, and by properly choosing its capacity any desired amount of high-note attenuation could be obtained. It will readily be appreciated that the condenser may be connected in the position shown in Fig. 2 or directly across the transformer primary winding—its function would be precisely the same in either case.

If it were desired to obtain a gradual variation in tone whilst the set were in use, it would be necessary to have a means of varying the impedance of the condenser. Obviously a variable condenser would serve the purpose, but one having a capacity so high as that required would be both cumbersome and expensive. A much easier solution, then, is to connect the condenser in series with a variable resistance as shown in Fig. 3. By altering the setting of the latter component the impedance between points A and B could be adjusted to any required figure, since a variation in resistance is equivalent to a change in capacity. In practice, a tone control of the type just referred to is not generally used in the position shown, but is connected across the speaker terminals as indicated in Fig. 4. Its purpose is to counteract emphasis given to the higher notes by a pentode valve.

In an arrangement such as this the most suitable capacity for the condenser must be based on the loudspeaker impedance, with which it is in parallel. Thus if the speaker were of 15,000 ohms at 6,500 cycles the most convenient impedance would probably be about one-third as much at the same frequency. A suitable capacity would be .005 mfd. and if it were used in conjunction with a 10,000 ohms variable resistance a variation of from 5,000 to 15,000 ohms would be possible. It is obvious that the proper values for the condenser and resistance we have just considered would be quite different if the loudspeaker impedance were, say, 20,000 ohms. In the same way, if a moving-coil speaker of only 5 ohms impedance (an average value) were fed through an output transformer, the condenser-resistance combination would have no effect if it were connected directly across the speaker terminals. *The values must be chosen in respect to the circuit in which they are to be used.* As a matter of fact, a condenser of 75 mfd. would be required to be connected between the actual loudspeaker terminals to produce the same effect as the .005 mfd. component across the primary of the output transformer.

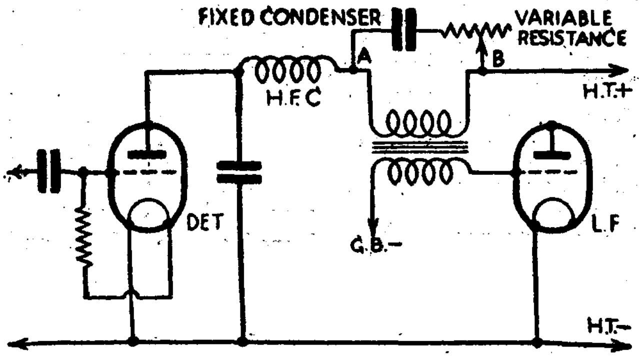


Fig. 3.—A simple tone-control circuit. If the impedance of the series condenser and resistance is made less than that of the transformer primary at any frequency, all sounds at that frequency will be reduced in intensity.

Matching Impedances

So far we have considered the impedances of condensers and inductances in a comparative way, so now we can study the question of "matching" impedances. In any receiver the most important points where matching must be attended to are the output and input circuits of the valves. The anode circuit impedance must be matched to the impedance between the filament and anode of the preceding valve, and to the impedance between filament and grid of the following one.

Output and Input Impedances

To obtain the maximum output from any valve the impedance in its anode circuit must be at least equal to that between its filament and anode (stated on the Instruction Sheet as "Anode Impedance"). In practice it is found best to make the former equal to twice the latter at *average* frequencies. I say "average" frequencies because, as we have seen, the impedance of a coil or transformer varies enormously with the frequency of currents passing through it. We are now able to see why a cheap transformer does not do justice to low notes: due to the small amount of iron used in the core and the comparatively few turns on its primary winding the transformer's impedance becomes much too small at low audio-frequencies—below, say, 500 cycles.

As to the input (grid-filament) impedance of a valve, this is always high in a low-frequency valve which is not passing grid current. Consequently, if we are properly to match this to the anode circuit impedance of the preceding valve a step-up L.F. transformer is employed. For best results the ratio between secondary and primary should be the same as the proportion between the grid circuit and preceding anode circuit impedances. In the case of a Class "B" valve, the conditions are exactly reversed. Since this valve passes grid current, its grid-filament impedance is lower than the anode impedance of the "driver" valve; hence a step-down transformer must be employed.

You know that a 1 : 1 ratio coupling (a tuned-grid circuit) is generally used between an S.G. and detector valve. The reason is now fairly obvious; an S.G. valve has a high anode impedance, and the detector has a (comparatively) low grid impedance since it passes a small amount of grid current. In practice the two impedances are just about equal, and therefore neither a step-up nor step-down effect is required between them.

Matching the Aerial Circuit

We now come to a point which is very frequently neglected—the matching of the aerial tuning circuit to the grid circuit impedance of the first valve. You know that the ordinary aerial-earth system is actually a condenser, and its capacity may be anything from .0001 mfd. to .001 mfd. We have also seen that a condenser has impedance, so that if a large capacity were joined between the ends of the aerial tuning coil it would have the same effect as a resistance connected between the same points. Thus, no matter how "good" the coil was, its efficiency would seriously be impaired and it would not match the grid-filament impedance of the valve it fed.

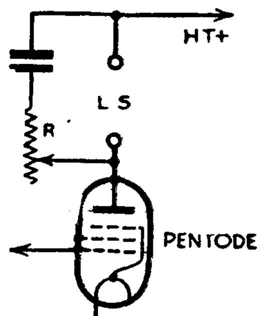


Fig. 4. — The arrangement used to counteract the high-note emphasis given by a pentode. The impedance of C and R must be less than that of the speaker at higher audio frequencies.

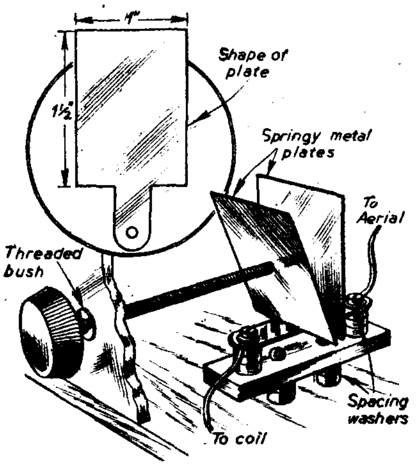
The Series Aerial Condenser

You can see now why selectivity may be improved by connecting a condenser in series with the aerial lead-in. It acts as a series impedance —you can consider it as a resistance if you like—and so increases the resistance in parallel with the coil. There are many other wireless problems that can be solved by applying the principles of impedance, but I will leave them for you to think out yourself.—R. E.

Practical Hints

Variable Aerial Series Condenser

THE parts needed for this condenser can be obtained from the junk box. They are: a screwed rod, about 2½in. long, a knob, two metal plates cut from a piece of tinplate, or better still, from springy sheet brass, a strip of ebonite, ¼in. by ¼in.



A novel variable aerial series condenser.

cross-section, and some cardboard for making spacing washers. The parts are assembled as shown in the diagram, and the nuts and bolts are screwed very tight. The central fixing screw is also screwed up tightly. The screwed rod must be threaded through a hole in the panel which is made a bit too small for it to push through. If there is a fear of cracking the panel, which, of course, must be of insulating material, a special bush with the rod threaded through it can be screwed into a hole made in the panel. When the knob is turned the rod is screwed in or out, and thus the condenser can be adjusted for maximum sensitivity, or for removing dead-spots.—J. GREASLEY (Freshfield, Lancs).

Novel Multi-meter Table

THE accompanying table provides a rapid method for reading correctly the various ranges of a multi-meter such as the Twelve-range Test-meter published in PRACTICAL WIRELESS, June 29th, 1940. To make the table obtain two sheets of graph paper and a sheet of very stiff cardboard, size 10in. by 8in. Glue the sheets of paper to either side of the cardboard. The scale of the meter is copied on to the top and bottom of both sides of the table as shown in the drawing, and between these scales are calculated the scales of the various ranges of the multimeter, on one side of the table volts, and on the other side milliamps.

The calculation of the various ranges is easy because after the horizontal lines have been drawn it is already divided into tenths by the pale blue vertical lines of the graph paper. All of these lines are marked one-tenth of an inch from the horizontal lines, and every second line is made two-tenths long: at every inch three-tenths.

THAT DODGE OF YOURS!

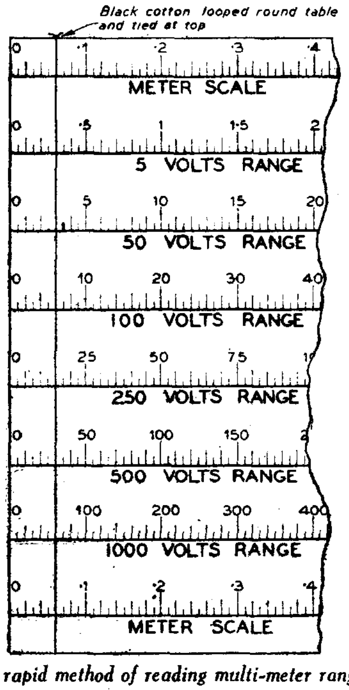
Every Reader of "PRACTICAL WIRELESS" must have originated some little dodge which would interest other readers. Why not pass it on to us? We pay £1-10-0 for the best hint submitted, and for every other item published on this page we will pay half-a-guinea. Turn that idea of yours to account by sending it in to us addressed to the Editor, "PRACTICAL WIRELESS," George Newnes, Ltd., Tower House, Southampton Street, Strand, W.C.2. Put your name and address on every item. Please note that every notion sent in must be *original*. Mark envelopes "Practical Hints." DO NOT enclose Queries with your hints.

SPECIAL NOTICE

All hints must be accompanied by the coupon cut from page 444.

The drawing explains how to mark them according to their values.

The black cotton cursor is moved along the table according to the position of the meter pointer when it is in use. The



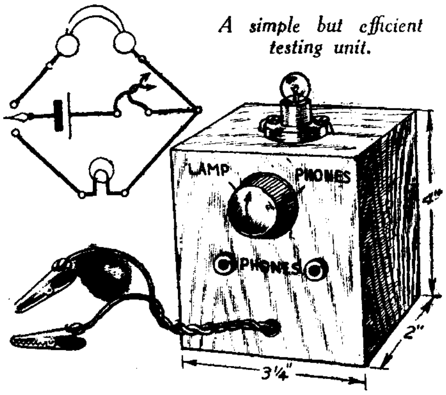
A rapid method of reading multi-meter ranges.

reading of the same range as that to which the meter is switched to is, of course, the reading required.—A. TEAGLE (Badminton).

Simple Test Equipment

RECENTLY I had a little trouble with a two-valve battery receiver I had built, and, not having any multi-range test equipment handy, I devised the following simple but efficient testing instrument. First I obtained the necessary components, consisting of a lamp, lampholder, two-way switch, 2 crocodile clips, 2 terminals, 1 cycle lamp battery, 1 pair of earphones, and a small wooden box measuring 4in. by 2in. by 3¼in. The lamp and 'phones are placed in parallel with the battery, which has a two-way switch, the necessary test leads being inserted in its leads. With the help of the accompanying illustrations, the apparatus may be easily constructed.

On the front panel of the box the selector switch is placed, and also the terminals for earphone connections. The test leads



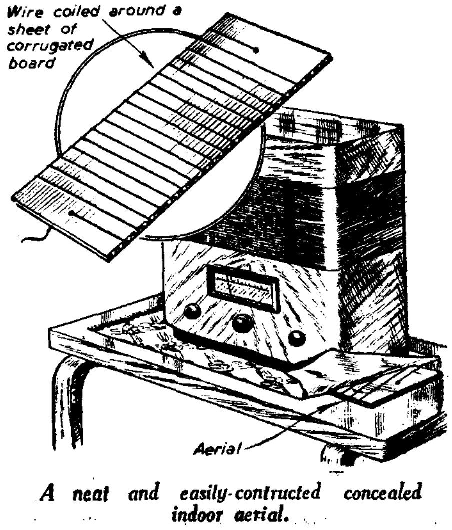
A simple but efficient testing unit.

protrude through a ⅜in. hole. The battery is placed in the box, and the leads are soldered to the prongs. A hinged door may be fitted at the back for replacing the battery.

The apparatus will be of great service for continuity, and insulating tests, etc.—J. HILL (Ruislip Manor).

A Concealed Indoor Aerial

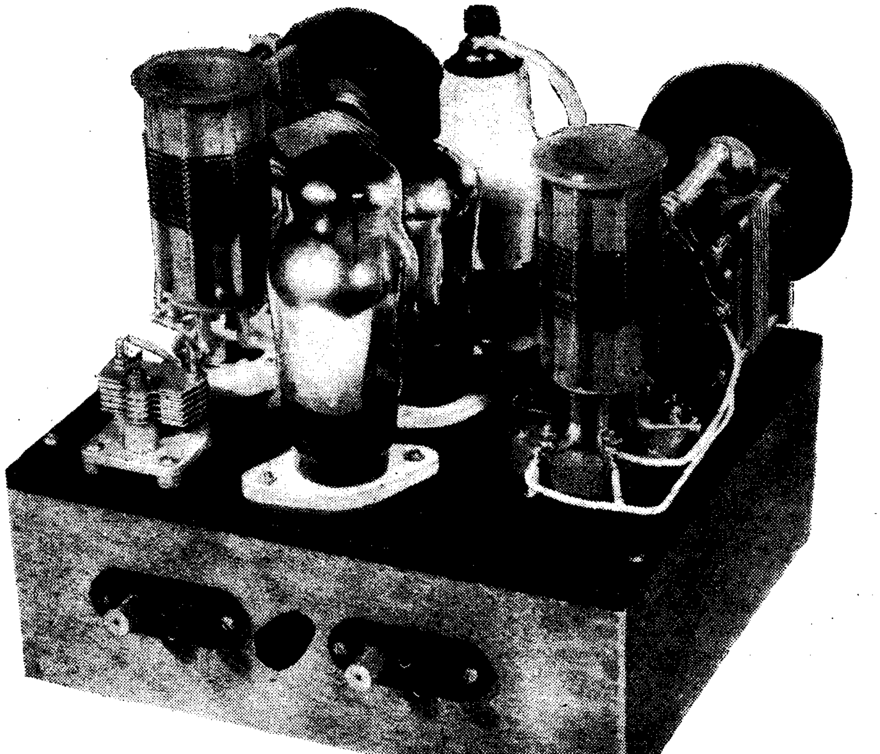
READING the article "Why Use an Aerial?" in a recent issue of PRACTICAL WIRELESS, I have found this simply-constructed indoor aerial very handy. It should appeal to those who object to the loose stringing of wire around the room, and who are at the same time interested in listening only to local stations. All that is needed is a piece of corrugated cardboard, and a length of flexible wire. The flexible wire is then wrapped around the cardboard, as shown in the drawing, which can then be slipped under the set, and concealed by a table mat. In most cases this pick-up will be found adequate.—E. L. DAVIES (Llanrwst).



A neat and easily-contructed concealed indoor aerial.

THE SHC

Constructional Details of



A rear view of the assembled receiver showing the aerial series condenser located in an easily accessible spot.

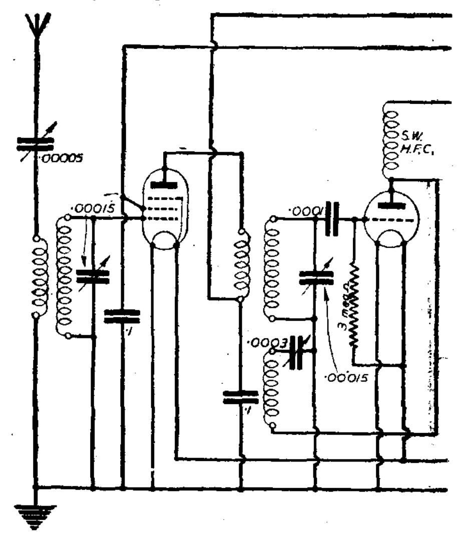
SHORT-WAVE apparatus is generally characterised by elaborate metal chassis, screens and complicated layouts, for which reason many experimenters are not taking advantage of the enjoyment of short-wave work, thinking that it is complicated or beyond their ability. Actually, of course, this impression is erroneous, and apart from the fact that tuning is slightly more critical and thus has to be carried out more carefully, there is nothing out of the ordinary in short-wave work. To prove that efficient short-wave apparatus may be made, even by the beginner, without elaborate screening or similar devices, the Short-wave Three has been designed and is illustrated and described here. It will be seen that the set is compact (the chassis is only 8in. by 7in. in size); the layout is quite ordinary, and the receiver is no more difficult to build than a standard broadcast receiver. Short-wave components must, of course, be used as the performance of the short-wave signals is a little different from the normal currents experienced on broadcast frequencies. Insulation is one of the most important properties in short-wave work, and accordingly only the best quality coil and valveholders are specified. Ceramic insulation is employed in all but one of these, the remaining six-pin coil holder not at the moment being available in this material. A special high-efficiency material is, nevertheless, used in the Eddystone component specified, and this will be found perfectly satisfactory.

The Circuit

The remaining components, namely tuning condensers and choke, are also of the special short-wave type, whilst fixed resistances, condensers and the transformer are of standard type. The circuit will show that the arrangement of H.F., detector and output stages is employed, transformer coupling being used in the tuned circuits. On the aerial side an air-dielectric pre-set condenser will take care of aerial loading, and a standard four-pin plug-in coil is used to feed the grid circuit of the H.F. pentode valve. This is of the "straight" type, with a floating H.T. lead for the screen so that maximum efficiency may be obtained by using the most suitable H.T. voltage on the screen. The next coil unit is of the six-pin type, having primary and reaction windings. The reaction circuit is arranged with the moving vanes of the reaction condenser earthed direct, thus avoiding hand-capacity effects, and standard values of grid leak and condenser are employed. The detector anode circuit is decoupled and at this point it will be seen that an alternative 'phone circuit is provided. When searching for weak stations, it is often found that headphones are very desirable, but if connected in the output stage distress is caused when a loud signal is passed. By cutting out the output stage, however, this trouble may be overcome, and when a suitable signal is tuned-in it may be transferred to the loudspeaker, or made louder in the 'phones by addition of the output stage. As an economy step in this connection the L.F. volume control is specified to include an on/off switch, and this is wired in the filament circuit of the output valve. Thus, when the volume is turned to minimum the switch is brought into circuit and the output stage is rendered inoperative, when the 'phones may be connected in the detector stage. The remaining valves are, of course, switched off by the usual on/off switch. The 'phones are filter-fed, using the L.F. transformer

LIST OF COMPONENTS FOR SHORT-WAVE THREE

- Two .00015 mfd. tuning condensers, Short-wave "Special," Cat. No. 2,043 (J.B.).
- One .0003 mfd. reaction condenser, "Dilecon," Cat. No. 2,094 (J.B.).
- Three ceramic valveholders (Eddystone):
  - One 4-pin, type 1,073.
  - One 5-pin, type 1,074.
  - One 7-pin, type 1,075.
- One 4-pin coil holder, type 949 (Eddystone).
- One 6-pin coil holder, type 969 (Eddystone).
- One 250,000-ohm volume control with switch, type J (Dubilier).
- One L.F. transformer, "Niclet" 5/1 (Varley).
- Three two-socket terminal strips. A, E and 'phones. (See text). (Bulgin).
- One H.F. choke, type H.F.3 (three-point) (Bulgin).
- One push-pull switch, type S.36 (Bulgin).
- Five fixed condensers (Dubilier).
  - One .0001 mfd, type 4601/S.
  - Two .1 mfd, type 4603/S
  - One .005 mfd, type 4601/S.
  - One 2 mfd, type 3016.
  - (One .1 mfd, type 4603/S—see text).
- Three fixed resistances (Bulgin):
  - One 15,000 ohm ½-watt type.
  - One 50,000-ohm ½-watt type.
  - One 3-megohm ½-watt type.
- One pre-set condenser, 50 mmfd. Cat. No. 2,144 (J.B.).
- One Z21, one L210, one PT2 valve (Osram).
- One pair 4,000-ohm headphones (Ericsson).
- Set of 4- and 6-pin plug-in coils (Eddystone).
- Chassis, wire, screws, etc.



For those who like to examine the theoretical c... they require. Note the

primary as an L.F. choke. An H.F. stopper is included in the output grid circuit to ensure stable working, whilst a by-pass condenser from the anode of the output valve will help to prevent "head capacity" effects.

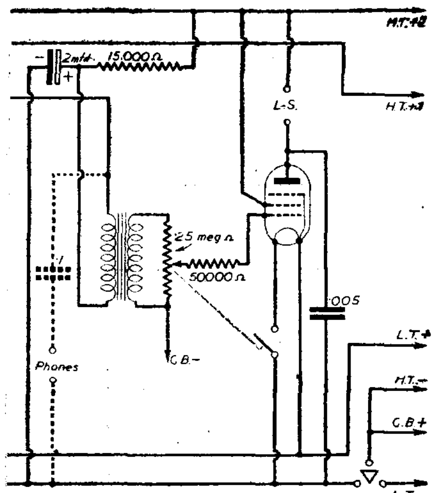
Construction

The chassis will have to be home-made, ordinary plywood serving quite well. The size, as already mentioned, is 8in. by 7in., with runners 2¾in. deep. A panel may also be cut, although in the original model brackets were used for mounting the parts in order that a more detailed illustration could be obtained without obscuring any of the parts or wiring. Furthermore, it will be seen from the illustration on our cover that simple dials have been fitted. For short-wave work it is generally desirable to use slow-motion drives, and there is a variety of these from which to choose. The drive will necessitate

...RT-WAVE THREE

... a Simple Short-Wave Receiver for the Beginner

that the condensers are mounted on brackets, but these will have to be placed back from the front edge of the chassis in order to accommodate the drive, and this may mean that the two coilholders will also have to be pushed more to the rear. There is, however, no other top of chassis component which will prevent this and there is thus sufficient latitude for any type of drive to suit individual preference. If a metal panel is used to provide screening no precautions need be taken regarding insulation of the panel-mounted components. The moving vanes of both tuning and the reaction condenser are intended to be earthed and thus they could be clamped to the panel. The push-pull switch is also on the earth-line and thus this is in order. The volume control which is specified has a "dead" spindle and therefore this is also in order. If, however, any departure is made from the specification this point must be watched as certain volume controls are supplied in which the spindle is "live" to the moving arm, and this will mean that if such a component is used and mounted



...ircuit this diagram will give them all the details ... alternative 'phone circuit.

on a metal panel without insulating bushes the grid of the output valve will be earthed and no signals will be obtained.

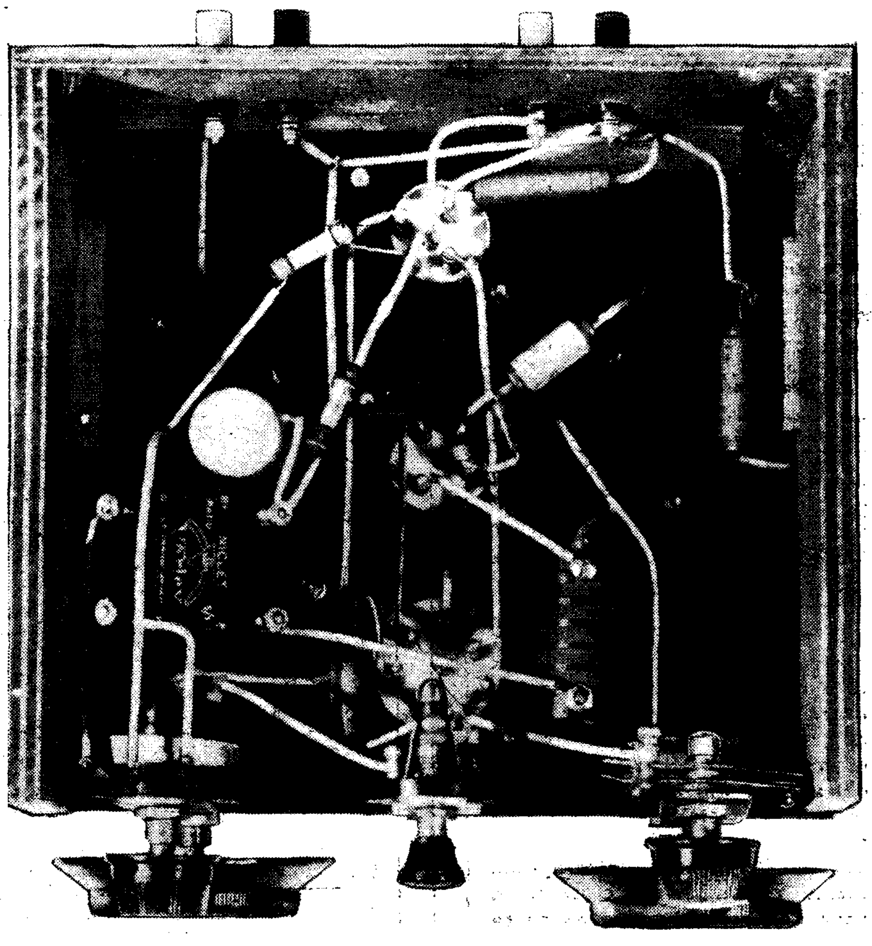
Holes for the three valveholders are drilled on the centre line, 1in. diameter holes being used for the four- and five-pin holders, and a 1¼in. hole for the seven-pin holder. The two coil holders are next screwed down in their respective positions, and on the underside the choke and transformer are screwed into position, after which wiring may be commenced. The wiring diagram is drawn to scale and therefore exact positions may be marked off from this. Some constructors prefer to assemble a complete receiver before undertaking wiring, but this is not always the best plan owing to the difficulty of obtaining access to certain parts. For instance, the contacts on the switch section of the combined volume control and switch will be found very close to the transformer casing, and if the control is mounted before being wired it may be found impossible to solder the leads to the switch. They may, of course, be soldered on to the switch before this is mounted, or alternatively the transformer may be left off until the wiring to the switch has been completed.

Each constructor will, no doubt, have his own ideas as to wiring, but when difficulty is experienced due to inaccessibility, it is not a difficult matter to remove a part to facilitate the work. However, in this particular receiver, it will be found that it is preferable to leave all panel parts until the last possible moment, wiring valveholders, fixed resistors and condensers, as they are needed, and finally connecting up the tuning condensers, volume control, reaction condenser and switch. Work through the circuit, marking off all leads as they are put in.

Testing the Receiver

When the set is completed there are two alternative courses available. Firstly, batteries may be connected, without the valves plugged in, and all voltages carefully measured. If everything is found in order, then valves may be inserted and current tests taken at each point. Then the aerial may be connected and signals searched for. The other method is merely to check that there is no H.T.-L.T. short-circuit, and then to insert the valves and commence by signal-searching. There should be no difficulty in this, using the 'phones in the detector stage for preference, and with the aerial pre-set condenser adjusted so that the vanes are completely intermeshed. Both condenser dials should be turned together, keeping them balanced as nearly as possible. The aerial condenser will be found slightly flatter in tuning than the intervalve condenser, and a search round the dial on the 20-metre band should enable you to locate some commercial transmitters. In the event of your being unable to find any signal, the reaction control should be advanced so that there is a rushing noise in the 'phones. Stop just short of the point where a whistle or howl is heard, and then search through the dial. If this is unproductive of signals it would tend to indicate some fault in the wiring, although it must be remembered that on certain bands signals cannot be heard at certain [illegible] of the day or night. As a guide w[illegible]e on the next page some of the stations which you should hear on the popular bands, but owing to the present conditions arising from the war, it may be found that these are not giving scheduled broadcasts.

(Continued on next page.



Plan view of the underside of the chassis, showing the exact location of parts and the associated wiring.

THE SHORT-WAVE THREE

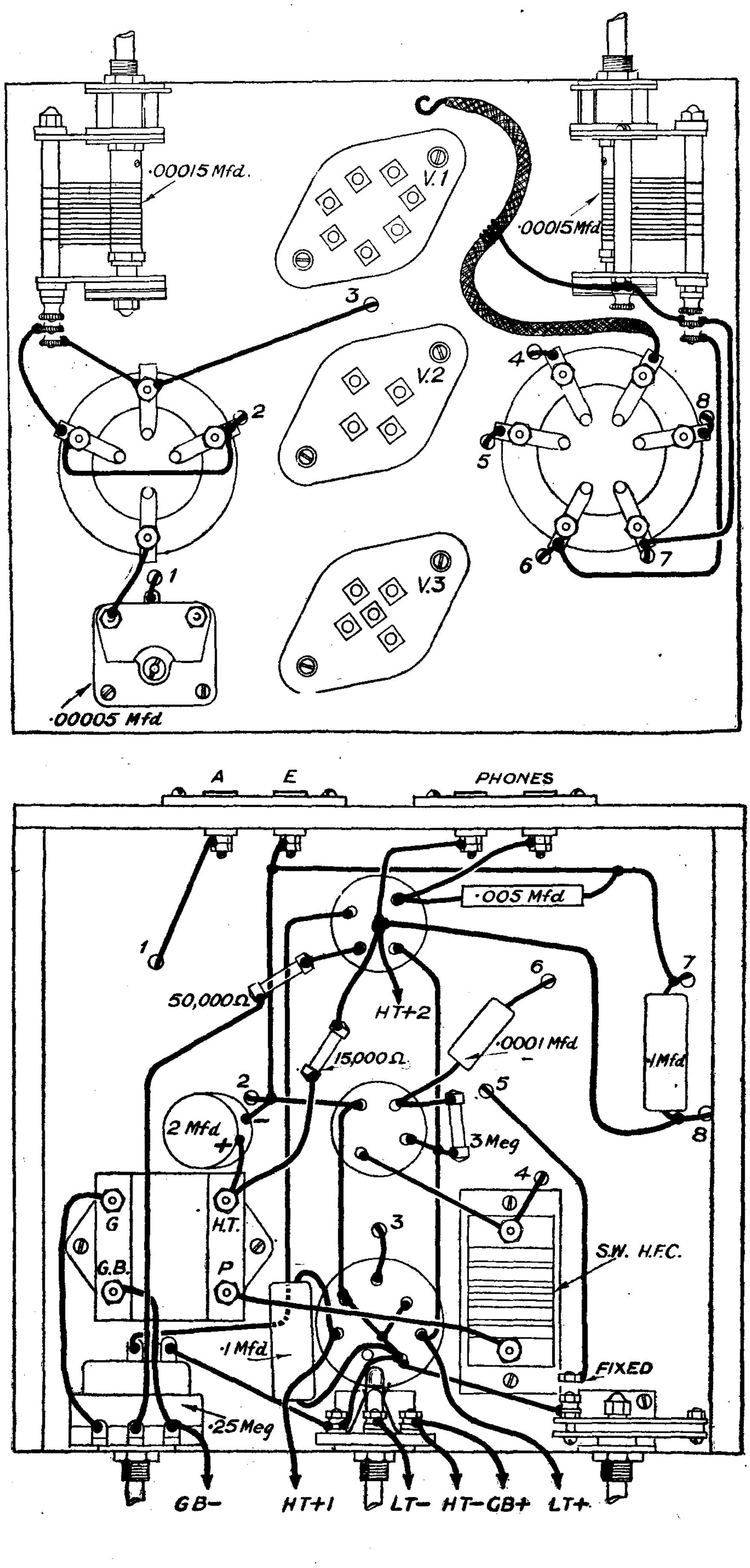
(Continued from previous page.)

Metres		
40-50 metre Band		
41.32	Lisbon (Portugal)	CSW8
41.32	B.B.C.	GSU
41.34	Tokio (Japan)	JBW
41.49	B.B.C.	GSW
44.94	Radio Nations (Switzerland)	HBQ
48.47	Schenectady (U.S.A.)	WGEO
48.86	Pittsburgh (U.S.A.)	WPIT
49.10	B.B.C.	GSL
49.59	B.B.C.	GSA
49.67	Boston (U.S.A.)	WRUL
49.75	Moscow (U.S.S.R.)	RW96
50.00	Moscow (U.S.S.R.)	RNE
30-40 metre Band		
30.96	B.B.C.	GRX
31.25	Moscow (U.S.S.R.)	RAL
31.25	B.B.C.	GRY
31.28	Sydney (Australia)	VK2ME
31.35	Pittsburgh (U.S.A.)	WPIT
31.41	Schenectady (U.S.A.)	WGEA
31.48	Tokio (Japan)	JZI
31.48	Schenectady (U.S.A.)	WGEO
31.70	Ankara (Turkey)	TAP
32.12	Radio Nations (Switzerland)	HBL
39.89	Moscow (U.S.S.R.)	RKI
20-30 metre Band		
20.64	Radio Nations (Switzerland)	[illegible]BJ
25.00	Moscow (U.S.S.R.)	RNE
25.21	Chungking (China)	XGOY
25.27	Pittsburgh (U.S.A.)	WPIT
25.29	B.B.C.	GSE
25.38	B.B.C.	GSM
25.45	Boston (U.S.A.)	WRUL
25.53	B.B.C.	GSD
25.58	Boston (U.S.A.)	WRUL
26.31	Radio Nations (Switzerland)	HBO
16-20 metre Band		
16.85	B.B.C.	GSV
16.86	B.B.C.	GSG
16.87	Bound Brook (U.S.A.)	WNBI
16.87	Pittsburgh (U.S.A.)	WPIT
19.47	Moscow (U.S.S.R.)	RW96
19.57	Schenectady (U.S.A.)	WGEA
19.60	B.B.C.	GSP
19.66	B.B.C.	GSI
19.67	Boston (U.S.A.)	WRUL
19.72	Pittsburgh (U.S.A.)	WPIT
19.74	Ankara (Turkey)	TAQ
19.74	Chungking (China)	XGOX
19.76	B.B.C.	GSO
19.76	Moscow (U.S.S.R.)	RW96
19.82	B.B.C.	GSF
19.83	Boston (U.S.A.)	WRUL
19.95	Moscow (U.S.S.R.)	RKI

IMPORTANT NOTICE TO ALL READERS OF "PRACTICAL WIRELESS" WHO MAY BE LEAVING THEIR PRESENT ADDRESS.

If you are moving from your present address into another district it is most important to place an order with your newsagent as soon as possible after arrival. By this means the copy cancelled at your old address will be made available in your new district, and you will be able to continue reading "Practical Wireless" without interruption. Please remember to order from your newsagent because owing to the paper shortage he cannot supply without your instructions in advance.

WIRING DIAGRAM OF THE S.W. THREE



ROUND THE WORLD OF WIRELESS

School Broadcasting in 1940-41

DETAILS of the year's programme of broadcasting for schools starting on September 9th next are now available. The Central and Scottish Councils for School Broadcasting are pursuing the policy of keeping as close to normal school broadcasting as is consistent with war conditions. Copies of the year's programme may be obtained on receipt of a 1d. stamp from the Secretary, Central Council for School Broadcasting, 6, Duchess Street, London, W.1. Since the Government evacuation scheme of last September, touch has been lost with many schools and all are specially asked to register with the Central or Scottish Councils.

The Candler System

IT is with regret that we announce the death of Mr. Walter H. Candler, the originator of the Candler System and founder of the Candler System Company. Mr. Candler has planned for a continuation of his work by training and preparing thoroughly qualified successors, and in this country no alteration is being made with regard to the London office, which remains at 121, Kingsway, W.C.2. Full details of this system of code training may be obtained from that address.

Circuit Data

MOST manufacturers supply circuit and data sheets of their products for the use of servicemen and others. Most important details are found on these sheets, but the Radio Corporation of America recently introduced an innovation in the circuit diagram, wherein they now indicate the stage by stage gain values. In view of the increasing use of the Signal Trace testing device this additional material will greatly facilitate fault finding.

Money in Radio

INTEREST has been aroused by the fact that a radio dealer who died last March left gross estate at £49,633, with net personalty at £35,395. This would seem to disprove the common belief that there is no money in radio!

Valve Boxes

DEALERS are asked by manufacturers to save all valve cartons in good condition, when they will be collected from time to time. It is hoped that by doing this future deliveries will still be possible in cartons, rather than in wrappers or other paper-saving devices. If cartons are soiled they will probably be stamped "reissued carton."

New Interval Signal

THE B.B.C. has announced that it has decided on a new interval signal based on the musical notes B, B, C, and that the new signal will be first used on Sunday, August 11th, after a short programme illustrating some of the many alternatives considered by the B.B.C.

Frequency Modulation

PRESIDENT SHEPPARD of the Yankee Network, speaking recently for FM Broadcasters, Inc., said that the investment of the Yankee network in frequency-modulation experiments to date was $250,000. He urged an increase of power limits from 1 to 50 kW.

Car Radios

SEVERAL firms are now taking up the question of conversion of car-radio receivers for indoor use. In some cases a small mains unit is being fitted, whilst in others complete mains sections, including rectifying valves, are being used. In many models it is necessary to exchange the loud-speaker for a permanent-magnet model or to rewind the field to a high resistance.

Young apprentices are being trained as mechanics at an R.A.F station "somewhere in the Midlands." Most of the boys are recruited at the age of 15½ years, and they serve an apprenticeship of three years.

H. F. Apparatus

IT is now necessary for all persons using diathermy, electro-therapy, eddy-current heating or similar apparatus, including H.F. furnaces, test oscillators or other H.F. equipment, to notify the authorities of such apparatus. Enemy aliens are prohibited from possessing any such equipment without a permit. Certain test equipment which comes under this heading is exempt but fuller details may be obtained on application to the nearest police station.

Schwarzenburg Transmitter

THE Swiss station at Schwarzenburg has now been rebuilt following the fire in 1939, which destroyed it, and it is being used for the direct U.S.A. wireless telephone service.

Air Battle Commentary

THE B.B.C. broadcast in July an account by Charles Gardner of an air-battle over the Channel. This caused some controversy, but was nevertheless a stirring eye-witness account of an attack on a convoy. This commentary has now been recorded by Decca and is available on a 12in. disc, No. SP35, price 2s. 6d. Profits from the sale of the record are to be devoted to the R.A.F. Comforts Fund.

Radio Provides Ambulance

MR. R. A. ROTHERMEL, well-known radio accessories agent, has made a suggestion which has led to the provision of an American ambulance unit to operate in this country in connection with air-raid casualties. Subscriptions have been made entirely by Americans resident in this country, and the first unit is to consist of 100 vehicles to be maintained by an organisation to be known as the American Ambulance, Great Britain.

Sir Edward Wilshaw

IT is announced that Sir Edward Wilshaw, chairman of Cables and Wireless has been honoured by His Majesty the King of Greece. The Cross of the Grand Officer of the Royal Order of George I has been awarded to him in connection with the development of Greek communications.

U.S.A. Sales

IT is stated that during 1930 the sales of radio receivers in the United States reached the figure of 10,500,000. More than a million of these were portables; roughly a million and a half were car-receivers and five million were table models.

Marconi International Marine

TWENTY-THREE radio officers in the service of the Marconi International Marine Communication Company have so far lost their lives during the war, according to Mr. H. A. White, chairman of the company. Included amongst these were three who were serving on the *Rawalpindi*.

Radio Cabinets

ALTHOUGH restrictions have now been placed on the supply of timber under the new Timber Control Orders, the Timber Controller has intimated that every endeavour will be made to supply certain wood for simple radio cabinets.

Old Valves for New

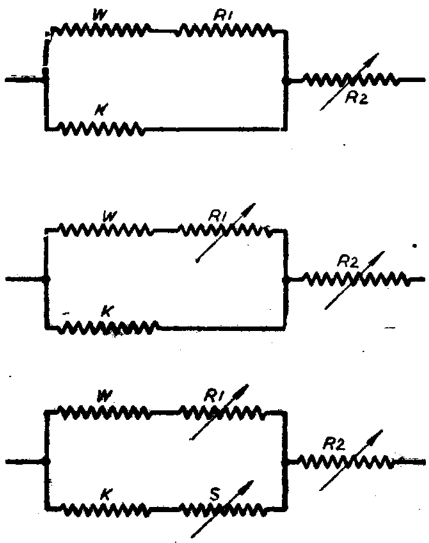
A RECENT order in Berlin provides that in future purchasers of new valves must give an old valve in part-exchange. This is similar to the order in force regarding gramophone records.

Reducing Temperature Effects in Permeability Tuning

Methods of Obtaining Reliable Tuning

IT is known that the value of an inductance wound upon an iron core can be changed by altering the current flowing through a polarising winding arranged on the same core, and it has been suggested that radio-receivers should be tuned in this way. When this method is used care has to be taken to ensure that the current through the polarising winding shall not be subject to undesirable casual changes, and it is found that one of the most troublesome causes of such changes is the variation of the resistances of the polarising winding with temperature. It is possible, however, to overcome this difficulty, and a few suitable circuits will now be described.

Fig. 1 shows the circuit in simplest



Figs. 1, 2, and 3 show the simplest effective circuit; how double regulation is obtained and finally the addition of the resistance S to assist in the matching of the temperature coefficients.

form. W is the polarising winding, the current through which is required to be independent of temperature. In series with W is a temperature-independent resistance R_1, and shunted across this series arrangement is a pure copper resistance K. In series with the whole shunt circuit is another temperature-independent resistance R_2. Other conditions being equal, the current through W has a positive temperature coefficient for smaller values of R_1 and a negative coefficient for larger values of R_1. The resistance R_1 serves to establish a divergence of temperature coefficients between the two parallel arms, and may be dispensed with if such a divergence already exists. As the temperature rises, the resistance of the coil W increases, and the resistance K also increases. This increases the total resistance of the whole circuit, and, therefore, the total current decreases. Since R_1 is practically temperature independent, the resistance in the upper arm in Fig. 1 rises less than that of the lower arm, so that though the total current is less, a greater fraction flows through the upper arm, thus the current in this upper arm may be maintained sufficiently temperature-independent.

Double Regulation

Fig. 2 illustrates an application of double regulation, the two resistances R_1 and R_2 being adjusted in opposition. The greater R_2 becomes, the smaller must be the resistance R_1 in series with W. Actually, to the extent that R_2 increases, the temperature coefficient of the whole circuit decreases: whence it follows that the compensation afforded by the divergence of the temperature coefficients of the two shunt arms, and therefore the divergence of these temperature coefficients itself, must decrease.

In Fig. 3 the matching of the temperature coefficients of the shunt arms is assisted by the resistance S, which is regulated in the same sense as R_2: at the lowest value of R_2, the value of S is zero or low.

In Fig. 4, R_1 and S are combined into a potential divider P, which enables the temperature coefficients of the two arms to be controlled in opposition in a very simple manner.

The methods of regulating indicated in Figs. 2 to 4 entail the disadvantage that when R_1 and S are regulated in the directions as shown, their effect opposes that of R_2 as regards variation of current through W. The arrangement of Fig. 5 is designed to avoid this difficulty: here the matching of the temperature coefficient of the arm W, R_1 with that of the parallel part of the circuit is done by means of a resistance T shunted across K and regulated in opposition to R_2. Over a very wide regulating range the regulation of the resistance T is limited below in such a way that the temperature coefficient of K, T does not fall below that of W, R_1. Over small regulating ranges the whole regulation may be performed by the resistance T, only two leads, A and B, being required between the device and the regulating point.

Component Values

The relative component values required for the circuit of Fig. 1 should be chosen according to the following equations, which relate to the case when the highest current in the regulating range is flowing through

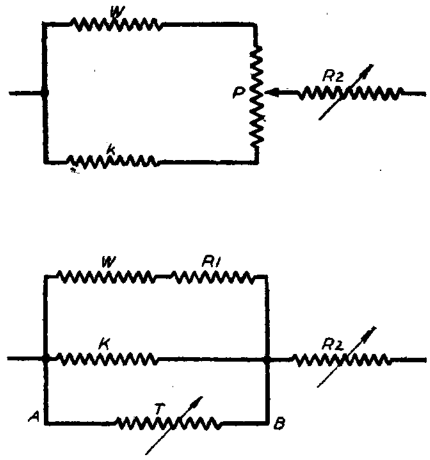


Fig. 4.—An elaboration of Fig. 3 and (Fig. 5) an arrangement to avoid the disadvantage of the other schemes which are illustrated.

the coil W: i.e., the greatest power consumption in W.

1. For least possible dependence on temperature:

$$\frac{R_1}{W} \cdot \frac{R_2}{W} = 1$$

2. For lowest total power:

$$\frac{R_2}{K} = 0.5 \text{ to } 1. \quad \frac{R_1}{W} = 2{\cdot}5 \text{ to } 3.$$

Relation (1) should always be observed, and relation (2) also observed when power losses are to be kept to a minimum.

A new battery superhet by Messrs. A. C. Cossor, using the latest form of permeability-tuned iron-cored I.F. transformers. It is known as Model 34 and covers three wave-bands, 16-50, 200-580, and 900 and 2,000 metres. Automatic grid bias is provided, and the controls are tuning, tone, volume and wave-change switch. The price is 11 guineas, and more complete details will be found in our issue of July 27th or in the descriptive leaflet obtainable from the makers.

More Short Cuts for the Constructor

Simple Calculations and Other Hints for the Non-mathematical Experimenter

THERE is a simple rule for finding the approximate grid bias for an L.F. amplifying valve of the triode type. It is obtained by dividing the H.T. applied voltage by twice the amplification factor of the valve. For example, suppose you have a valve, such as a Cossor 230XP, and want to know the correct grid bias, having mislaid the pamphlet issued by the makers. From the lists you find that this valve has an amplification factor of 4.5. Using the maximum anode voltage of 150 volts the grid bias required is 150 divided by 9=17 volts (approx.).

Mains Receivers

In the case of a mains receiver a knowledge of the correct bias voltage is not sufficient. The bias voltage is obtained by means of a resistance across which the required voltage is dropped. The value of this resistance is easily found by dividing the total anode current of the valve into the bias voltage and multiplying the answer by 1,000. Thus, if the makers state that the anode current of the valve is 10 milliamps at the maximum anode voltage of, say, 200, and the necessary grid-bias is 8 volts, the value of the required resistance is $\frac{8}{10} \times 1{,}000 = 800$ ohms.

The value thus arrived at also holds good for lower values of applied H.T. voltage, since with a lower voltage the anode current becomes less and so the drop in voltage across the bias resistance becomes less. In other words, when a lower H.T. voltage is used the grid bias automatically adjusts itself to a lower figure. There is one warning needed when calculating the value of a bias resistor for a pentode valve, and that is that the "total anode current" must include the current taken by the screen. For example, to find the value of bias resistor for a pentode taking 60 mA. anode current and 10 mA. screen current and requiring a bias voltage of 22 volts you must add together 60 and 10 milliamps, divide this into 22, and multiply the answer by 1,000, thus: $\frac{22}{70} \times 1{,}000 = 314$ ohms. Say 300 ohms, as the nearest round figure.

When we come to deal with the output stage of a receiver there are three very handy rules of thumb which are well worth knowing and which can easily be memorised. The first concerns the impedance of the external circuit when using an ordinary three-electrode valve. What is meant by the "external circuit" is either the speaker windings when the speaker is connected directly in the plate circuit, or the choke windings, when choke output is used, or, again, the transformer primary, when transformer output is adopted. In each case the impedance of the speaker, choke, or transformer primary should be one and a half to twice the impedance of the output valve. (The impedance of a valve is the same thing as its A.C. resistance.)

If you do not know the impedance of your speaker, then you take it as a rule that in the case of a moving-iron speaker it is approximately equal to its resistance. With a moving-coil speaker its impedance is about twice its D.C. resistance.

Speaker Matching

When endeavouring to match your speaker with the output valve, by means of an output transformer, the ratio of the required transformer is given by the formula: Ratio=

$$\sqrt{\frac{\text{Optimum load of valve}}{\text{Impedance of speaker}}}$$

The "optimum load" of the valve means the impedance of the external circuit which is most suitable. We have already seen that this, in the case of a three-electrode valve, is equal to one and a half to twice its impedance. In the case of pentode valves, however, there is no easy rule for finding the optimum load, and the makers should be consulted. As an example of how the formula is used, let us take the case of a speaker whose impedance is 2,000 ohms, and which is to be used with a valve requiring a load of 4,000 ohms. The ratio of the necessary transformer equals:

$$\sqrt{\frac{4{,}000}{2{,}000}} = 2$$

The square root of 2 is 1.41, and, therefore, the ratio of 1.41 to 1. The nearest standard ratio of 1.5 to 1 would be suitable.

An Oscillator Circuit for Short Waves

An Improved Arrangement Utilising a Small Reaction Coil for Maintaining Oscillation

IN order to reduce costs of production, it is important to limit the number of wave ranges of an all-wave receiver as far as possible. To cover the widest possible frequency range on one set of coils, the stray capacities of the tuned circuits must obviously be reduced to a minimum, but this is found to be difficult in the case of the oscillator circuit because large reaction coils have to be used to maintain oscillations at the highest frequencies, and such coils are found to resonate with their self-capacities to a frequency so close to the frequency to which the oscillator is tuned that they introduce a capacitative component into the tuned circuit of the oscillator.

This undesirable effect of the large reaction coil leads one to inquire into the possibility of generating oscillations more efficiently so that the reaction coil can be reduced.

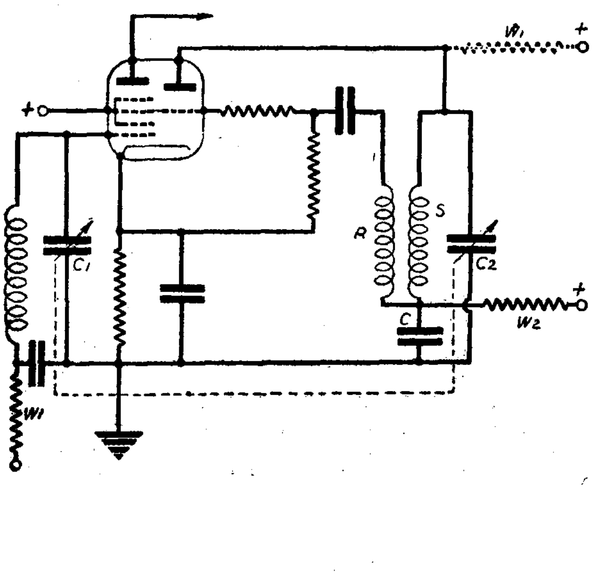
Frequency Changer

The accompanying illustration shows a conventional triode hexode frequency-changer with a tuned anode oscillator circuit in which feedback is provided by the coupling between the reaction coil R in the grid circuit and the coil S in the tuned anode circuit and additional coupling is provided over the padding condenser C. The anode voltage is usually fed via a resistance W1 connected to the upper end of the coil S. It will be observed that the resistance W1 is effectively shunted across the tuned circuit, and as it may be as low as 30,000 ohms, has a considerable damping effect on the tuned circuit. It is this damping which mainly necessitates the use of large reaction coils to maintain oscillation at the higher frequencies.

The damping can be largely removed by feeding the anode voltage to the anode of the oscillator valve, via a resistance W2 connected to the junction of the padding condenser C, and the coil S, as shown, so that the resistance W2 is in effect tapped down on the tuned circuit, and therefore introduces much less damping than would be the case were it connected directly across the circuit according to the usual arrangement previously mentioned.

By the adoption of this improved method of feeding the anode voltage to the oscillator valve it is found that the number of turns on the reaction coil can often be reduced to about half, and the capacity thrown into the tuned circuit of the oscillator by the reaction coil thereby greatly reduced, with the result that a useful extension of the frequency range for each set of coils is obtained.

It will be appreciated that a suitable H.F. choke may be substituted for the resistance W2.



Circuit of the oscillator stage arranged as described in the accompanying article.

Comment, Chat and Criticism

Outline of Musical History—11

Our Music Critic, Maurice Reeve, Reviews the Works of Liszt

THE name of Franz Liszt, 1811-1886, looms large in the history of music, and of the nineteenth century in particular, for many reasons. His title to greatness, apart from some splendid works, may best be founded on the influence he has exercised on almost all subsequent music. Few composers would be able, or would care, to admit that the greatest of all pianists had not powerfully affected their outlook in some way or other. Even the mighty Wagner cannot claim immunity—far from it.

Mr. Newman has styled Liszt "the greatest of the second-rank composers. 'Tis pity 'tis true, but pity 'tis 'tis true." For all that his is a striking name in the story of musical evolution, and his personality probably unique.

Born at Raiding, in Hungary, his life was a glittering cavalcade from start to finish. A scandal and a reproach, if judged from even the most liberal and unconventional standards, there were few facets of life of which he couldn't boast experience. From the age of twenty, and for about twenty years, he enjoyed an unexampled career as a pianist during which period he wrote most of his finest compositions for the piano. Strange to relate, his trashiest things, and his poorest operatic pot-pourris, were poured out in his old age when he was a lay abbé. Even to-day, an age of pianistic giants, the name of Liszt is still maintained at the head of them all.

Always a *poseur*, and the possessor of striking masculine beauty, he was the first pianist to play with his profile turned towards the audience.

At Weimar

He settled in Weimar in 1842 and later became conductor of the Court Theatre orchestra. He reigned there as undisputed sovereign of the musical world. Always an ardent admirer of Wagner, he produced many of that master's operas there and elsewhere. The story of their relations, of Liszt's many acts of charity, and of the influence each had on the other's music, forms a bizarre tale the last of which has not yet been heard. (See Newman's monumental "Life of Wagner" and the short but revealing "The Man Liszt.") Wagner's famous wife Cosima, formerly the wife of Hans von Bulow, was one of three daughters Liszt had by his liaison with the Countess d'Agoult.

A man of unlimited and boundless generosity, he was the prime force in raising the money for the famous Beethoven memorial at Bonn.

His spell over women must have been even more remarkable than that of Casanova or Benvenuto Cellini. Many have been known to leave husbands and homes, and to travel a thousand miles in order to try to obtain a few lessons from him, their sole impulse rising from having heard some of his exotic music played at a concert, or even through having merely bought it and tried to play it themselves.

Old Age

In his old age, in Italy, Liszt ran a "master class" of about twenty young pianists, who lived with him and studied with him as his guests. After having satisfied the master of their gifts they had to take a vow consecrating their lives to music. This remarkable class included many of the most famous pianists of the following generations such as Moritz Rosenthal, Siloti, Sauer, Sophie Menter, Tausig, Joseffy, Freidheim, etc.

In his last years he entered the Roman Catholic Church and became a lay priest. He died in Beyrouth.

Liszt's fame, like that of Schumann and Chopin, rests chiefly in a series of master works for the piano. But he also wrote much for the orchestra, choral work and songs. He didn't touch opera or chamber music.

His piano music ranges from the sublime to the ridiculous. At his best he is incomparable. Not even Chopin can eclipse him in sheer magic and brilliance. In some of his transcendental etudes and short pieces like "Au bord d'une Source," no one has equalled him.

He is the father of the modern concert grand piano, and firms like Steinways incorporated most of his suggestions in their models, such as the second sustaining pedal. In his pages the piano becomes a veritable orchestra, and no effect is impossible of achievement. In such works as the Sonata, the two Legends of St. Francis, the three Years of Pilgrimage, the Poetic and Religious Harmonies, the best of the Schubert arrangements, and a few others, piano music reaches its apotheosis; and although it is not all to everyone's liking, it remains a superb contribution both to piano literature, and to music itself.

Liszt is unquestionably at his best either when he is painting a little scene such as "Au bord d'une Source," "Feux Follets," "Gnomenreigen," etc., or when he indulges in Satanic or diabolic disquisitions like the inimitable Mephisto Valse, the Dante Sonata, parts of the Faust Symphony, and the "Dies Grae" Variations for piano and orchestra. In purely romantic or melodic music he is apt to cloy and oversentimentalise.

Valses Oubliées

In the first-mentioned genre, which also includes such little masterpieces as the three Valses Oubliées, two of the Consolations and many of the Years of Pilgrimage, he stands quite unrivalled; at least only Debussy can challenge his supremacy (his pupil, Rosenthal, wrote one piece, Papillons, which is at least the equal of anything the master himself accomplished). In the second category, not even Wagner himself surpassed him in sheer diablerie and hellishness.

The incomparable Sonata is a truly wonderful work in every way. Although in six "movements," which are more like sections, they are all linked up and the whole work is played through without a break. It is exotic, hothouse music, and bears absolutely no relation to the sonatas of Beethoven. Every possible source of the instrument is tapped for effect, as well as some almost impossible. The form of the work is more like that of Liszt's Symphonic Poems—copied later by Strauss—with "leitmotivs" running through it, than the ordinary sonata. It is fabulously difficult and none but the finest executants can ever hope to do it justice.

Hungarian Rhapsodies

The most famous of all Liszt's works are unquestionably the fifteen Hungarian Rhapsodies, marvellous confections of Hungarian folk tunes dressed up in all the passionate and wild beauty of the Puszta. The technical resources employed in the arrangement of these tunes, and their ornamentation and embellishment, are astonishing in their inventiveness and originality. Under the fingers of a skilled pianist, all the instruments of a Gipsy orchestra can be faithfully imitated. In talking of rhapsodies, the beautiful and brilliant Spanish one must receive special mention. Based on three famous Spanish folk tunes, including the Gota Aragonesa, it is at least as good as its Hungarian companions.

Liszt's transcriptions are a curious medley, reaching the perfection of artistry in such examples as Schubert's "Hark, Hark the Lark," and "Thou Art Repose," Schumann's "Dedication," Mendelssohn's "Spring Night," Chopin's "Six Polish Songs," Wagner's "Spinnerlied" from "The Flying Dutchman," and the closing scene from "Tristan and Isolde," etc., and passing to the depths of banality in Wagner's "Tannhauser Overture" and other Wagnerian excerpts, Schubert's "Ave Maria" and Serenade, most of the overtures from the Italian operas, Mendelssohn's "Wedding March," etc.

He made marvellous reductions of all the Beethoven symphonies, and a classic arrangement for two pianos of Berlioz's Fantastic Symphony.

Orchestral Music

Liszt's orchestral music, like much else, lacks sincerity and depth, though it is extremely brilliant and original. His chief works are twelve symphonic poems, a form which he created, and which has subsequently been used by Strauss, Scriabin, Saint-Saëns, etc. Mazeppa, Les Preludes, and one or two others, are in most repertoires to-day. The Faust Symphony, with choral attachments, is a huge, uneven work which takes over an hour to perform. And the marvellous Mephisto Valse, wherein we are made to gaze into the very jaws of hell without regret; in fact, with our appetite for another peep whetted!

Liszt piano works with orchestral accompaniment are as brilliant as would be expected. Two concertos, the Dance of Death (a gorgeous set of variations on the Dies Grae), the Hungarian Rhapsodie—No. 13 in the collection for piano—and an exquisite setting of Schubert's "Wanderer" Fantasie. All these lack the passionate depth and set purpose of a concerto by Beethoven, but they fascinate by their dazzling brilliance and wellnigh impertinent audacity.

In summing up, Liszt may be said to present the student and historian with a bundle of contradictions. Subtract the gold from the dross and few composers, if any, would be found to surpass him in the powers of imagery and suggestiveness, daringly original harmonisation, exquisite or exotic portraiture.

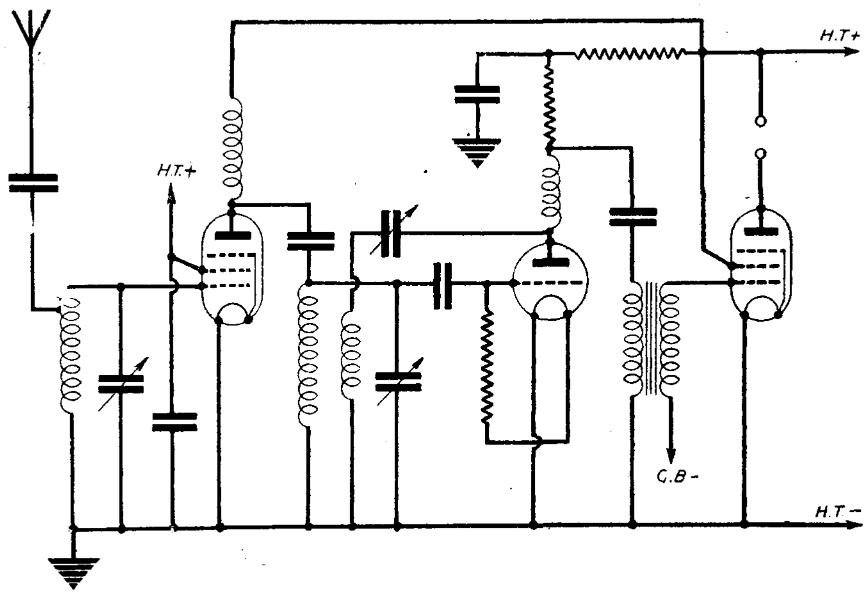


Fig. 1.—The basic skeleton circuit for an H.F.-Det.-Pen. receiver.

Problems of Amateur Receiver Design

Building Up the Complete Circuit from a Skeleton Diagram; The Incorporation of Special Features; The Effect of Different Available Components

By FRANK PRESTON

IN general, it is desirable that the home-constructor should adopt a complete PRACTICAL WIRELESS design when building a new set, but there are instances where this is not favoured. For example, a constructor who has been building receivers for a number of years may wish to break away from published designs so that he may exercise his own ingenuity and try out a few ideas which have occurred to him while handling other sets.

Provided that the inherent difficulties are recognised there is no reason why this procedure should not prove to be entirely successful. It must be appreciated that, after the set has been built, it may be necessary to carry out a good deal of experimental work to bring the receiver to the high state of efficiency desired. Additionally, it should be borne in mind that a few simple test instruments will prove extremely valuable when carrying out these experiments. It will, at least, be necessary to have a fairly good milliammeter, whilst a multi-purpose meter is better.

The Initial Circuit

It may be assumed that the constructor who proposed to design his own receiver will have decided on the general form of circuit to be adopted. Additionally, he will probably have in mind certain features which he will wish to incorporate. What is the next step? The first job is to sketch out the general circuit arrangements, preferably devoid of all "frills" and perhaps without the special features which are to be incorporated. When the skeleton-form circuit has been drawn on paper it will be possible to study it in greater detail. First it should be analysed in comparison with other complete published circuits which have been given in these pages, and which are of the same general form. That may bring to light one or two "weak spots" in the arrangement, or it might make evident the fact that, say, the H.F. coupling system could be improved.

Fig. 1 shows an example of the type of initial skeleton circuit which I have in mind; this is of very simple type, but it will best serve our present purpose. Looking over this, it would be realised that tuning would probably be too flat. We might, therefore, substitute an H.F. transformer with tapped secondary in place of the tuned-grid coil. The screening grid of the H.F. pentode is fed from a tapping on the H.T. battery; it would be better to provide a fixed potentiometer in this circuit. Turning to the reaction circuit, it would be noticed that hand-capacity troubles would be less likely if the reaction condenser were placed on the "earth" side of the reaction winding.

V.M. and Auto-bias

Variable-mu volume control would certainly be desirable so provision should be made for this. At this point it may be thought that automatic grid bias would be desirable; and so it would, but it could not always be provided satisfactorily when using variable-mu, because the current passing through the bias resistor would vary according to the setting of the variable-mu control. In practice, this difficulty need not be of great importance provided that the V.M. valve passes a small anode current in relation to the total H.T. consumption of the set, and that it is of the short grid-base type. This means, in effect, that if the output pentode passed, say, 7 mA while the maximum current consumption of the H.F. valve was 2 mA (under the working conditions of screen and anode voltage which will apply) it is probable that auto bias would be satisfactory. This is because the total maximum consumption of the set would be about 10 mA (allowing one mA for the detector) and the minimum would probably be between 8½ and 9 mA. Thus, the percentage variation would be no more than 15.

Current and Voltage

If we work out a few figures this point will be clarified. Supposing that the output valve required a G.B. voltage of 4½, the required bias resistor would have to be of 4½ divided by 10 and multiplied by 1,000 ohms. This is 450 ohms, and we should therefore use 500 ohms, as being the nearest standard resistor value. If the total current were cut down to 9 mA the theoretically correct value for the bias developed would be exactly 4½ volts. Should the current be reduced still further the bias voltage would also be reduced by a further small amount, but this would not be of very great importance. It should be noted that figures similar to those given would apply only when using a short

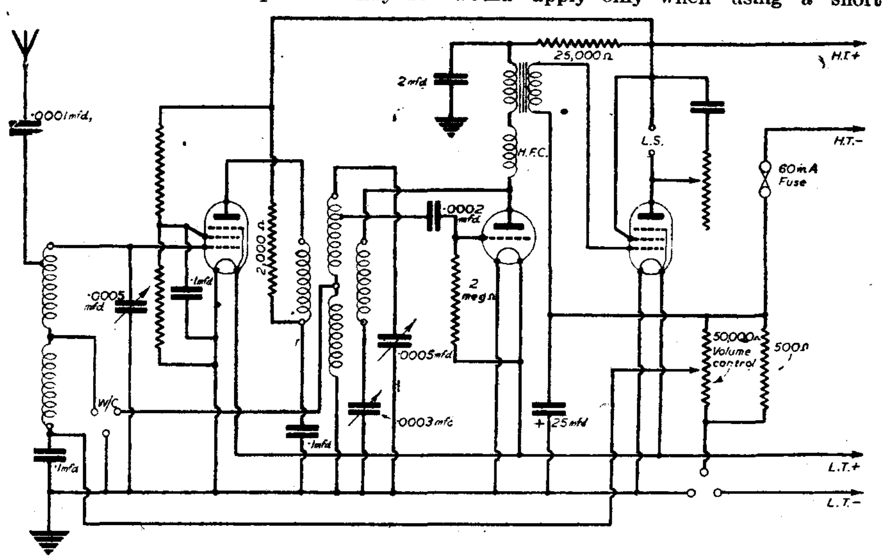


Fig. 2.—The final circuit including the features referred to in the text. V.M. control is provided by means of a potentiometer in parallel with the auto-bias resistor, but since the resistance of the potentiometer is relatively high it does not have any marked effect on the fixed bias. Component values not shown are those which should be taken from valve-maker's literature.

grid-base V.M. valve and a small output pentode, tetrode or triode.

The L.F. Stage

Turning to the L.F. coupling it will be seen that a parallel-feed transformer is shown in Fig. 1. This would be perfectly satisfactory, but reproduction would probably be just as good if a direct-feed transformer of reasonable quality were used, since the anode-current consumption of the detector valve is assumed to be only 1 mA. The choice of coupling would therefore be governed largely by the particular L.F. component available.

When using a pentode in the output stage it would be desirable to introduce some form of time compensator or control. In most instances a .02 mfd. fixed condenser in series with a 10,000 ohm variable resistor would be most convenient.

The above are just a few representative points which would call for consideration, and they help to show the lines on which the amateur designer would work. They are all incorporated in the complete circuit shown in Fig. 2. It is not suggested that this is an ideal circuit, although it should be perfectly satisfactory, but it does illustrate most of the important features, and show how the skeleton circuit may be used as a basis for building up a final layout.

Component Values

After reaching this stage the original circuit may have been drawn several times; if so, it is all to the good, for the constructor will know the circuit by heart. After reaching the final stage, make a "clean" drawing and start to mark in the component values. Many of these are practically standardised and in any case each constructor has his own ideas about such points as the best combination of grid leak and condenser for a particular valve, and would use those values even if he were told that others were better.

In indicating the resistance values of the resistors forming the fixed potentiometer for the screen of the H.F. pentode it is wise to be guided by the recommendations of the maker of the valve to be used. There is little point in experimenting with alternatives, since the maker's research department will already have carried out exhaustive tests before making recommendations.

Throughout the process outlined above the amateur designer will also have had in mind another very important point; the selection of components. In this he will no doubt have been guided by a knowledge of the collection which he has on hand or in the junk box. This is of especial importance to-day when cost has to be considered so closely, and when difficulty may be experienced in obtaining certain parts due to their makers being engaged in the production of war materials. In most cases coils will be a deciding factor, because these have a marked influence on the exact circuit which can be used. Valves must also be taken into account, whilst L.F. coupling components are not without importance.

Form of Construction

Having drawn up a final circuit and decided upon the components to be used, it becomes necessary to consider the form of construction to be employed. Here again, experience will help in coming to a decision. Besides, if a cabinet is available, this might be a deciding factor. In general, however, it is best to use a metal or metallised chassis, since this is most convenient and efficient and also helps to give a neater appearance.

We must leave a discussion of chassis or baseboard layout until a later article. Other articles in this series will also deal with mains receivers and superhets, and with the special problems which are likely to arise in designing them.

Prize Problems

PROBLEM No. 411.

JENKINS had a commercial battery 3-valver provided with auto-bias circuits. This gave very good results but was not quite loud enough, and he found that volume could be improved by replacing the output triode by a pentode. He purchased the valve, calculated the modification required in the bias resistor, and made the necessary change. When he tested the receiver in the new condition results were disappointing, signals being not quite so loud as previously, and distortion was present. He checked and made certain that the bias modifications were correctly carried out. What was wrong? Three books will be awarded for the first three correct solutions opened. Entries must be addressed to The Editor, PRACTICAL WIRELESS, George Newnes, Ltd., Tower House, Southampton Street, Strand, London, W.C.2. Envelopes must be marked Problem No. 411 in the top left-hand corner and must be posted to reach this office not later than the first post on Monday, August 19th, 1940.

Solution to Problem No. 410.

Sturvis overlooked the fact that the short-wave tuning condenser would not give the required coverage with broadcast coils and accordingly he could not tune high enough to obtain the Home Service transmission.

The following three readers successfully solved Problem No. 409 and books have accordingly been forwarded to them:

J. W. Davison, Roosebeck, Redrow, Morpeth, Northumberland.
O. L. Smith, Mount Royal, Carleton Road, Carlisle.
C. Martin, "Lynton," Pound Road, Bursledon, Southampton.

Electronic Brevities

Notes on U.S.W. Working, and Cathode-ray Tube Development

Washing, cleansing and examining cathode-ray tube bulbs is a very important process.

C.R. Tubes and Graphite

AT first sight there does not seem to be any link-up between cathode-ray tubes and graphite, but if some of the tubes used for special purposes are examined carefully it will be seen that the interior walls of the glass envelope have applied to them a conducting layer which extends from a position on the neck of the tube where the electrons are emitted at high velocity from the cathode and anode electrodes to the edges of the fluorescent screen itself. This layer has an important function, and being conducting has, by design, been made to assist in carrying out accurate focusing of the stream of electrons. If a lustrous surface is used for this conducting layer, then internal reflections produce many types of diffusion in the locality of the focused spot, and annoying halations frequently destroy the sharpness of any tracing being observed on the screen, or give imperfectly focused pictures when the tube is incorporated in a television receiver.

Graphite Films

IN some tube designs, therefore, it is found necessary to have a conducting layer which provides complete opacity and a dark matt surface. Graphite films are specially advantageous in this respect, particularly when formed through the agency of colloidal graphited water of the proper concentration. Yet another important factor with these types of films is that they are very highly resistive to oxidation and, in addition, acquire "getter" properties when baked, and possess a low coefficient of expansion. It has been found that films formed with colloidal graphited water adhere equally well to metallic parts when such a course is found necessary with certain of the cathode-ray tube electrodes, or even lead-in wires. When these graphite films were employed initially the course adopted arose from the requirements of opacity and dark surfaces, but subsequently tests showed that the conductivity of the graphite deposits made it quite unnecessary to treat the glass envelope interiors with metallic elements.

Absolute Cleanliness

A CATHODE-RAY tube is an accurate precision instrument which is capable of providing invaluable visual observations of every conceivable form of signal. Apart from its utility in all types of television receivers, no laboratory or research engineer's equipment is complete without an oscillograph. It is for this reason that so much individual attention has to be given to the manufacture of each tube, and the watchword throughout every process stage is absolute cleanliness. Any trace of impurity, no matter how minute, is liable to spoil the tube's final performance and turn it into a reject on the final test-bench. Foreign matter which is present during the application of the fluorescent screen can produce patches of the wrong colour, and in consequence the washing, cleansing and examination operation is a vital factor. The accompanying illustration shows this stage in one important factory, and the bulbs are placed in wooden racks before the long neck is welded on. A vertical column of water is injected into the tube and left running for some hours so that every trace of impurity is removed. As will be seen on the right, the small circular opening is then covered and the glass envelope dried thoroughly in readiness for the next process.

Electron Stream Modulation

WHEN electron multipliers are used under certain special conditions it is necessary to undertake a modulation of the stream during the passage from the initial emissive cathode to the final collecting anode. If reference is made to a multiplier of the Weiss type, as an example, it is found that a large proportion of the electrons strike against the meshes of the regularly spaced grids to which is applied a progressively increasing voltage. This, of course, is the normal process of secondary emissive multiplication, but due to the finite size of the apertures in the grids and the infinitesimal size of the electrons themselves, some of the electrons will follow a straight path right through without impact against the grids. Naturally, these electrons will possess a higher velocity than the secondary electrons released at each grid stage and attracted to the subsequent stages by the graded voltage field. It has been proved that if a modulation is to be applied to this device it is preferable to carry out this operation on those electrons in the stream which have approximately the same velocity. The method employed in practice to carry this into effect is to place a modulating grid at right angles to the path of the main stream, that is to say, the plane of the grid is parallel to the mid axis of the stream direction. A voltage is applied to this grid to deflect the electrons of a predetermined velocity, and these are attracted to the grid to be multiplied in intensity by normal secondary emissive grids before reaching a second collecting anode. Electrons with a velocity in excess of the required one pass over the grid to a separate collecting electrode and serve no purpose in the modulating action.

Local U.S.W. Interference

THE exigencies of radio communication in war-time necessitate the use of a very large proportion of the available frequency spectrum in order to meet the needs of the fighting and civil services. That is to say, not only are the medium and long waves employed but also the short and ultra-short waves to an extent far in excess of that existing in peace-time. Furthermore, due to a variety of special needs these multitudinous carrier frequencies radiated into space do not necessarily carry simple speech modulation for telephony or morse characters for C.W., but may have other forms of modulation for special purposes. It is therefore possible that when ordinary broadcast listening is undertaken within the vicinity of an ultra-short-wave transmitter, owners of some of the earlier forms of home-constructed radio receivers may experience interference in the form of a whirring sound or high-pitched whistle. As a rule, this is not noticeable on a modern type of commercial receiver, and must in no way be confused with the all too familiar electrical interference, which evidences itself as crackles, due to a variety of causes. Perhaps the poor frequency response of the home set prevents the U.S.W. interference being heard, but when the trouble is apparent, then the cure is quite simple. It can be effected by inserting a grid-stopper in the detector valve circuit. The connection to the grid terminal of the detector valve should be broken and between that connection and the grid terminal of the valve-holder insert a 10,000-ohm one-watt resistance in series. In the majority of cases this will be found quite effective, but if the trouble still persists, then a choke in series with the aerial down lead can be tried. Ten turns of wire spaced ¼in. apart on a 1in. former will generally be found to be quite satisfactory, although adjustments either side of this number can be tried where necessary.

Open to Discussion

The Editor does not necessarily agree with the opinions expressed by his correspondents. All letters must be accompanied by the name and address of the sender (not necessarily for publication).

Curing a Fault

SIR,—In reference to your article in July 13th issue regarding "Electro-chemical Faults," I would like to bring to your notice a fault that I recently witnessed.

I was called in to service a commercial mains model which was of the Rect. S. Grid, Det. and Pentode type, the speaker being built on to the chassis.

The receiver would function clearly for a time and would then break into distortion and instability.

This set incorporated two aluminium 8 mfd. smoothing condensers, and on pushing one of these chassis-mounting components the set played perfectly. The condenser could not be removed from the chassis, and you will readily realise how impossible it was to apply a soldered wire to earth.

On the ohm-meter from chassis to casing a resistance reading was shown.

Seeing that I could not remove the condenser, the fault was cured by applying a wedge-shaped piece of metal between the casing and a metal upright of the chassis, this tending to bear the condenser slightly over and thus cancel out the resistance. The set in question was about four years old and gave a perfect performance after this cure was effected.—F. J. GRANT (Andover).

Radio Lectures from Station WRUL

SIR,—I was interested to read your note in the July 20th issue of PRACTICAL WIRELESS on the radio courses recently broadcast by station WRUL in Boston. U.S.A.

Up to a month or so ago when conditions permitted I have tuned this station in regularly on 11.79 mc/s. to listen to this feature. I have also heard it on 15.25 mc/s. and this last few weeks I have been very disappointed at being unable to tune it in on either band.

As I am one of those readers who have not the time to delve into books apart from my PRACTICAL WIRELESS (I find time to read that), listening to these lectures by C. Davies Belcher was certainly most interesting.

As you will know, this station is a non-commercial organisation and is maintained, I understand, mostly by voluntary subscriptions.—NIGEL J. NICHOLS (Doncaster).

On Active Service

SIR,—I have been a regular reader of PRACTICAL WIRELESS for the past four years and have obtained most of my knowledge of radio from your excellent publication.

Like many other readers, I have been called to the Colours and am serving in the Royal Artillery. Although on active service, I still find time to read PRACTICAL WIRELESS which, by the way, is sent to me each week from home, being unable to obtain it locally. PRACTICAL WIRELESS is my only means of keeping in contact with the radio world.

Wishing PRACTICAL WIRELESS every success in these trying times.—C. W. T. GREEN (Bognor Regis).

SIR,—Being a regular reader of PRACTICAL WIRELESS, I cannot let this fine chance of sending a line along pass by without response. Many thanks for a fine magazine and also the many interesting pages of good reading.

I still do my daily dozen on the key to keep in trim for peace-time again, when I hope to again apply for a ticket. I have made a diversity amplifier for P.A. work at camp and for dances. In my bunk I also have a small commercial all-waver (28 mc/s to 600 mc/s.) battery operated, which helps to pass away the long evenings in camp.

Wishing PRACTICAL WIRELESS the best of luck.—E. M. VARLEY (Selby, Yorks).

H.T. Battery Problems

SIR,—In reply to S. Peach, of Penzance, I wish to state that until quite recently I used to make my own H.T. batteries, but unlike Mr. Peach, I used to press out my own cells and when bound with zinc they used to slip into 1lb. jam jars. Of course, this type of battery takes a lot of room, but as to performance, I made one in April, 1939, and it's still going strong with a drop of 10 volts.—A. STANLEY (Dent. Sedbergh).

A "Spares Box" Superhet

SIR,—Will you kindly consider preparing for us a "Spares box" superhet to make up when the long evenings come?

Failing this, perhaps you would consider a "Straight" Four from the same source—preferably with A.V.C.

Parts are very difficult to get now, and in many cases the prices have gone up so that a minimum of new parts is very desirable in these days.—H. EDGAR PARKER (Southampton).

[*What do other readers think of this suggestion?*—ED.]

Audible Radio Frequencies

SIR,—I am very much obliged to Mr. Gerald R. W. Lewis for his letter in your issue dated July 27th, and I can assure him that it is apprceiated. Your correspondent appears to deal with the matter from the point of view of the audio-frequency output, and it is agreed that this is difficult at first to believe. Your correspondent states that the effect of shifting the datum line (which personally I prefer to call the zero voltage line) of a wave, whether modulated or not, can be achieved by adding to it a source of constant potential, i.e. D.C. I am afraid that I cannot agree with this, but am willing to be corrected, and should like your correspondent to forward further detailed particulars.

The writer has spent many years on this subject, and the theory was first published four years ago, and has been circulated in many countries of the world. I have forwarded your correspondent a copy of the book as originally published. The writer hopes that he is not being personal when he says that he has entered into correspondence with technical experts and scientists in this country and America, and the correspondents are sincerely thanked, but no one has forwarded any experimental proof to prove that it is wrong in any fundamental. The nearest they have approached to this is on the question of sidebands. That, however, has been a difficult subject, and it is agreed that it has not previously been stated clearly enough, but in the new theory it is not claimed that there are no sidebands.

The writer is hoping to be able to write one or two articles entering into the sideband question in more detail and, it is hoped, more clearly.

Although the theory as first published was perhaps a little difficult to understand, it is hoped that the letters and articles which the writer has contributed have cleared up many points, and have helped to make it capable of being more clearly and more simply understood.—D'ARCY FORD (Exeter).

Back Number Wanted

SIR,—As a regular reader of PRACTICAL WIRELESS, and a B.L.D.L.C. member, I would be glad if any reader who has a copy of "Wireless Magazine" in which the A.C. Standard Four-Valver "WM391" is described will kindly drop me a postcard stating how much he would sell the copy for. I will refund postage to anyone who will oblige.—JOHN PARKIN, Junr., 18, Rowley Grove, Cottingham Road, Hull, Yorkshire.

Proposed Club for Bradford

SIR,—I much regret that, owing to pressure of work and A.R.P. duties, I am compelled to abandon, at least for the present, the idea of forming a radio club for the Bradford district. Will local readers please note?—G. HARRISON (Heaton, Bradford).

Correspondents Wanted

J. HUTCHESON, 86, Inglemire Avenue, Hull, is anxious to get in touch with any local reader who is building the "Students Three."

A. Simons, 361, Roman Road, Bow. E., would like to hear from another reader residing in the district with a view to practising morse together on one or two nights a week.

E. M. Barlow, "Burnside," Bawtry Road, Canklow, Rotherham, S. Yorks, would be pleased to meet at his QRA, or hear from, any S.W. enthusiasts—about seventeen years of age—living in the Sheffield-Rotherham district.

E. Pickin, 16, Michael Road, Blaencwm, Treorchy, is anxious to get in touch with another reader interested in radio service and repair work. He would also be glad if Mr. Moyes, of Bury St. Edmunds, would communicate with him again.

In reply to your letter

Filament Supply

"Would it be possible to use 2 Leclanche cells with a resistance instead of a 2-volt accumulator for the L.T. side of a battery wireless set? I have recently made up two such cells and in the L.T. lead (–) I have inserted a resistance—home-made. As I am moving to a country district where the facilities of getting the accumulators charged are very erratic, and having regard to the fact that valves are now on the market which take their current from a 1.5 volt dry cell, I do not see why cells of this nature could not be used for 2-volt valves if the voltage could be brought down."—A. H. (Lerwick).

YOUR suggestion is quite in order, and there is no difficulty in using dry cells for the L.T. supply. The only problem is in the resistance, and to ascertain the value of this you must add together the current of each valve in use and then divide this into 1, which is the difference between the source of supply and the required voltage. We assume, of course, that you are connecting your two cells in series so as to obtain a 3-volt supply. Alternatively, you could use the cells singly or in parallel to feed modern 1.4 volt valves.

Erecting a Mast

"I am thinking of building up a mast for my garden, and I have a fair quantity of wood which I intend to use. There is a point which I think may cause some difficulty and that is in the method of getting the mast up. Is it best to build the mast on the flat and then pull it up (I think I should have sufficient room for this), or can it be raised stage by stage? I have not decided upon a pattern and should be glad if you could also help me in this direction."—L. T. R. (Tewkesbury).

THERE are two methods available. You can, if there is sufficient room, assemble the mast in any desired form whilst it rests on the ground, and then pull it into a vertical position, or it may be built section by section and raised during building. The method to adopt depends mainly on the design. Thus, if you assemble on the lattice principle you would undoubtedly find it best to adopt the latter procedure, attaching guy ropes or wires; and when the top section has been built, raise this and support it in place whilst the next section is built. The top is then lowered on to the finished second section, bolted in place and the two raised by pulley and tackle, and the process repeated. The guys should be paid out regularly, and thus you would need two or three assistants, but the mast would go up perfectly easily and without difficulty. If you try to haul such a mast from a horizontal position you may find that it will buckle or break in the centre. A single mast, however, could be raised in this way by hauling on several rear guys and with others running through suitable guides.

Mains Unit

"I believe it is possible to use rectifying valves in series or parallel in order to obtain an improved output, but I am not certain regarding the arrangement and should be glad if you could explain it to me."—H. B. A. (Camden Town).

THE scheme is to use two valves in parallel, each valve being of the half-wave type. The usual centre-tapped transformer winding is employed, the ends of the H.T. section feeding each anode, and the filaments being operated from a single winding capable of delivering the current required. It is also possible to use a bridge circuit, wherein there are two further valves fed from separate filament windings, and the output is then taken from the junction of the two anodes of the additional pair of valves. The centre-taps of the filament windings for the additional valves are connected to the anodes of the first pair.

RULES

We wish to draw the reader's attention to the fact that the Queries Service is intended only for the solution of problems or difficulties arising from the construction of receivers described in our pages, from articles appearing in our pages, or on general wireless matters. We regret that we cannot, for obvious reasons—

1. Supply circuit diagrams of complete multi-valve receivers.
2. Suggest alterations or modifications of receivers described in our contemporaries.
3. Suggest alterations or modifications to commercial receivers.
4. Answer queries over the telephone.
5. Grant interviews to querists.

A stamped addressed envelope must be enclosed for the reply. All sketches and drawings which are sent to us should bear the name and address of the sender.

Requests for Blueprints must not be enclosed with queries as they are dealt with by a separate department.

Send your queries to the Editor, PRACTICAL WIRELESS, George Newnes, Ltd., Tower House, Southampton Street, Strand, London, W.C.2. The Coupon must be enclosed with every query.

Abbreviations

"I have noted several times in your paper, and also in others, amateur abbreviations which are not clear to follow. I have been unable to find them in any other publication and should, therefore, be glad if you could explain to me what 'x' stands for. A letter you published some time ago from a reader referred to his Rx. What is this? DX I am told means long distance, but I should like to have a ruling on this."—M. S. B. (Lisburn).

THE letter "x" is now used for various things, although originally it was used to replace the prefix "trans." Thus xmitter stood for transmitter; xmission for transmission and so on. Now we have DX meaning distance; WX meaning weather; PX meaning press, and so on. The only "rule" that can be offered is that any part of a word may be omitted and the letter "x" substituted, but as with all abbreviations it is essential to be judicious in the use of them.

Screening Boxes

"A book which I recently read (American origin) said that it was not advisable to use a common screen between adjacent stages. I should be glad if you would explain why this remark should be made, as I always understood that the screen was connected to earth and therefore should be neutral so far as any stage is concerned. What difference can it make, therefore, if a single screen is interposed between two stages?"—R. R. (Jedburgh).

ALTHOUGH it is quite true that the screen is at earth potential the reason for the remarks referred to is that there is a risk of instability due to the screen carrying currents from adjacent stages. If the coils, for instance, are so placed that the screen cuts into the fields, it is possible for the two stages to be coupled together through the screen—although earthed. This may sound rather paradoxical, but a few tests will show that it is quite true. It is therefore preferable to use separate metal boxes for adjacent stages, and to leave an air space between the two inner surfaces. You will, perhaps, remember that we have also previously mentioned this fact in connection with certain short-wave superhets where it was found desirable to insert a separate "lid" to the bottom of I.F. screens in order to prevent coupling between the I.F. transformers.

Poor Insulation

"I have a very old set which I was thinking of converting to a modern design, but there are two points which I cannot quite understand. First, I can take out the grid leak in the detector stage without any difference in signals, and secondly, if I put the aerial off the aerial terminal and straight on to the tuning coil, the set is twice as loud. Could you explain this?"—S. T. E. (Paisley).

THE first peculiarity is probably due to the fact that as the set is an old one the material from which the valveholder is made is of poor insulation. There is thus a leakage path from the grid terminal which acts just as a grid leak. Replacing the valveholder by a modern component made from good insulating material should overcome this. The aerial problem may be due to a similar fault, the leakage taking place between aerial and earth terminals or, on the other hand, the input circuit may be in the form of an H.F. transformer, and this never gives such loud volume as a direct coupled coil, although, of course, it gives better selectivity. Thus, when you transfer the aerial lead you probably cut out the primary winding and this naturally results in improved volume.

REPLIES IN BRIEF

The following replies to queries are given in abbreviated form either because of non-compliance with our rules, or because the point raised is not of general interest.

G. E. R. (York). The coil is not suitable, as it does not tune down low enough for modern needs. It could be used temporarily.

K. E. (Bangor). The 66-volt supply is not sufficient. Get another battery and connect them both in series.

F. R. C. (Portsmouth). Transmitting apparatus or similar equipment is now illegal.

H. N. (Hull). The case may be iron and this is quite suitable on the L.F. side. Make sure it is effectively earthed.

P. P. S. (Wokingham). The resistance of the coil should be in the region of 5 ohms.

C. P. U. (Watford). Spring clips would suffice, but they must be strong so that a sound contact is made.

The coupon on page 444 must be attached to every query.

The British Long-Distance Listeners' Club

Super One-valvers

CONSIDERABLE interest has been caused by our remarks about hotted-up single-valve receivers, and although we have received quite a large number of letters about the subject, we are still waiting for a member to send along a copy of the circuit he has found successful, together with sufficient constructional details to enable others to try to emulate the successes achieved by so many of the older S.W. fans. We have, however, heard from Member 6,583, of Dunfermline, who gives us some details of the log he has been able to compile with a home-made one-valver. To quote a part of his letter: "I am 15 years of age and started S.W. listening a little over a year ago. My first set was an 0-v-0, constructed from odd parts, home-made coils and grid-leak rectification. It afforded great experience of S.W. listening as I was able to receive India, Japan, Canada, U.S.A., Northern Rhodesia, and Guatemala, together with others which brought my log up to 36 countries. Nearly all the stations logged were amateurs, amounting in all to approximately 300. Quite a number of Q.S.L. cards were received in reply to my frequent reports, and during half the time I spent on listening, the aerial I used was a bedstead!"

While we certainly agree with the owner of this little set that his log is certainly very satisfactory, we hope that too many members will not make use of the same aerial system; but this only goes to show that a keen enthusiast is not going to hold up his hobby for the want of an orthodox aerial arrangement.

A Suggestion

While making his application for the A.C.R., which has been duly granted, Member 6,679 makes the following suggestions. "Regarding your article in a recent copy of PRACTICAL WIRELESS I should like to see a section of your F.B. paper set aside to inform readers the best time to hear certain DX transmissions. Some readers may be getting a certain station every night by just knowing what time and frequency to listen, while other readers may have been patiently listening for the same station without results because they do not know the best time to listen. If your paper could give just a few stations in each issue, and the best time to listen, I think many readers would appreciate it, and would be willing to help by sending in information of any DX station of which they had the schedule; and if any readers care to send in reports of the stations mentioned in your paper, comparisons could be made between various areas. Another item that could be included is a 'Radio Quiz,' questions of interest to amateurs and S.W.L.s of an educational nature."

As mentioned before, we are always ready to receive suggestions, but before devoting space to any proposal it is very essential for us to know if they have a general appeal, especially during these days of restricted space. It doesn't take long to write us a letter or postcard, and it is far better to spend a few seconds doing that than to continue hoping that this or that feature will be incorporated in this page.

Contact Wanted

We are very pleased to receive an interesting letter from one of the early members of the club, namely, Member 1,139, of West Hartlepool (ex-G3LS), and the main object of his letter was to let other members in his district know that he will be very pleased to make contact with them, with the hope that it might be possible to form a small club to keep interest in radio alive and up to date. To enable direct contacts to be made we would mention that the member's address is 8, East View Terrace, Seaton Carew, West Hartlepool, Co. Durham.

Many thanks to Member 6304, of Bridgwater, for an interesting letter, and for the trouble he has taken is sending us a photo of his receiver. Unfortunately, however, the snap is lacking sufficient detail and contrast for reproduction. The circuit is of the o-V-2 type using the Eddystone band-spread tuning unit, Eddystone coils and pentode output. An aerial of the inverted L type, 75 feet in length, is used running east to west.

Practical Wireless
BLUEPRINT SERVICE

These Blueprints are drawn full size.
Copies of appropriate issues containing descriptions of these sets can in some cases be supplied at the following prices *which are additional to the cost of the Blueprint*. A dash before the Blueprint Number indicates that the issue is out of print.

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The index letters which precede the Blueprint Number indicate the periodical in which the description appears: Thus P.W. refers to PRACTICAL WIRELESS, A.W. to *Amateur Wireless*, W.M. to *Wireless Magazine*.
Send (preferably) a postal order to cover the cost of the blueprint, and the issue (stamps over 6d. unacceptable) to PRACTICAL WIRELESS Blueprint Dept., George Newnes, Ltd., Tower House, Southampton Street, Strand, W.C.2.

PRACTICAL WIRELESS

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Cameo Midget Three (D, 2 LF (Trans))	—	PW51
1936 Sonotone Three-Four (HF Pen, HF Pen, Westector, Pen)	—	PW53
Battery All-Wave Three (D, 2 LF (RC))	—	PW55
The Monitor (HF Pen, D, Pen)	—	PW61
The Tutor Three (HF Pen, D, Pen)	21.3.36	PW62
The Centaur Three (SG, D, P)	—	PW64
F. J. Camm's Record All-Wave Three (HF Pen, D, Pen)	31.10.36	PW69
The "Colt" All-Wave Three (D, 2 LF (RC & Trans))	18.2.39	PW72
The "Rapide" Straight 3 (D, 2 LF (RC & Trans))	4.12.37	PW82
F. J. Camm's Oracle All-Wave Three (HF, Det., Pen)	28.8.37	PW78
1938 "Triband" All-Wave Three (HF Pen, D, Pen)	22.1.38	PW84
F. J. Camm's "Sprite" Three (HF Pen, D, Tet)	26.3.38	PW87
The "Hurricane" All-Wave Three (SG, D (Pen), Pen)	30.4.38	PW89
F. J. Camm's "Push-Button" Three (HF Pen, D (Pen), Tet)	3.9.38	PW92
Four-valve: Blueprints, 1s. each.		
Sonotone Four (SG, D, LF, P)	1.5.37	PW4
Fury Four (2 SG, D, Pen)	8.5.37	PW11
Beta Universal Four (SG, D, LF, Cl. B)	—	PW17
Nucleon Class B Four (SG, D (SG), LF, Cl. B)	—	PW34B
Fury Four Super (SG, SG, D, Pen)	—	PW34C
Battery Hall-Mark 4 (HF Pen, D, Push-Pull)	—	PW46
F. J. Camm's "Limit" All-Wave Four (HF Pen, D, LF, P)	26.9.36	PW67
"Acme" All-Wave 4 (HF Pen, D (Pen), LF, Cl. B)	12.2.38	PW83
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Double-Diode-Triode Three (HF Pen, DDT, Pen)	—	PW23
D.C. Ace (SG, D, Pen)	—	PW25
A.C. Three (SG, D, Pen)	—	PW29
A.C. Leader (HF Pen, D, Pow)	7.1.39	PW35C
D.C. Premier (HF Pen, D, Pen)	—	PW35B
Unique (HF Pen, D (Pen), Pen)	—	PW36A
Armada Mains Three (HF Pen, D, Pen)	—	PW38
F. J. Camm's A.C. All-Wave Silver Souvenir Three (HF Pen, D, Pen)	—	PW50
"All-Wave" A.C. Three (D, 2 LF (RC))	—	PW54
A.C. 1936 Sonotone (HF Pen, HF Pen, Westector, Pen)	—	PW56
Mains Record All-Wave 3 (HF Pen, D, Pen)	—	PW70
Four-valve: Blueprints, 1s. each.		
A.C. Fury Four (SG, SG, D, Pen)	—	PW20
A.C. Fury Four Super (SG, SG, D, Pen)	—	PW34D
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F. J. Camm's 2-valve Superhet	—	PW52
Mains Sets: Blueprints, 1s. each.		
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D.C. £5 Superhet (Three-valve)	—	PW42
Universal £5 Superhet (Three-valve)	—	PW44
F. J. Camm's A.C. Superhet 4	—	PW59
F. J. Camm's Universal £4 Superhet 4	—	PW60
"Qualitone" Universal Four	16.1.37	PW73
Four-valve: Double-sided Blueprint, 1s. 6d.		
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SHORT-WAVE SETS. Battery Operated.		
One-valve: Blueprint, 1s.		
Simple S.W. One-valver	23.12.39	PW88
Two-valve: Blueprints, 1s. each.		
Midget Short-wave Two (D, Pen)	—	PW38A
The "Fleet" Short-wave Two (D (HF Pen), Pen)	27.8.38	PW91
Three-valve: Blueprints, 1s. each.		
Experimenter's Short-wave Three (SG, D, Pow)	—	PW30A
The Prefect 3 (D, 2 LF (RC and Trans))	—	PW63
The Band-Spread S.W. Three (HF Pen, D (Pen), Pen)	1.10.38	PW68
PORTABLES.		
Three-valve: Blueprints, 1s. each.		
F. J. Camm's ELF Three-valve Portable (HF Pen, D, Pen)	—	PW65
Parvo Flyweight Midget Portable (SG, D, Pen)	3.6.39	PW77
Four-valve: Blueprint, 1s.		
"Imp" Portable 4 (D, LF, LF (Pen))	—	PW86
MISCELLANEOUS		
Blueprint, 1s.		
S.W. Converter-Adapter (1 valve)	—	PW48A

AMATEUR WIRELESS AND WIRELESS MAGAZINE

CRYSTAL SETS.		
Blueprints, 6d. each.		
Four-station Crystal Set	23.7.38	AW427
1934 Crystal Set	—	AW444
150-mile Crystal Set	—	AW450
STRAIGHT SETS. Battery Operated.		
One-valve: Blueprint, 1s.		
B.B.C. Special One-valver	—	AW387
Two-valve: Blueprints, 1s. each.		
Melody Ranger Two (D, Trans)	—	AW388
Full-volume Two (SG det, Pen)	—	AW392
Lucerne Minor (D, Pen)	—	AW426
A Modern Two-valver	—	WM409
Three-valve: Blueprints, 1s. each.		
£5 5s. S.G.3 (SG, D, Trans)	—	AW412
Lucerne Ranger (SG, D, Trans)	—	AW422
£5 5s. Three: De Luxe Version (SG, D, Trans)	19.5.34	AW435
Lucerne Straight Three (D, RC, Trans)	—	AW437
Transportable Three (SG, D, Pen)	—	WM271
Simple-Tune Three (SG, D, Pen)	June '33	WM327
Economy-Pentode Three (SG, D, Pen)	Oct. '33	WM337
"W.M." 1934 Standard Three (SG, D, Pen)	—	WM351
£3 3s. Three (SG, D, Trans)	Mar. '34	WM354
1935 £6 6s. Battery Three (SG, D, Pen)	—	WM371
PTP Three (Pen, D, Pen)	—	WM389
Certainty Three (SG, D, Pen)	—	WM393
Minitube Three (SG, D, Trans)	Oct. '35	WM396
All-Wave Winning Three (SG, D, Pen)	—	WM400
Four-valve: Blueprints, 1s. 6d. each		
65s. Four (SG, D, RC, Trans)	—	AW370
2HF Four (2 SG, D, Pen)	—	AW421
Self-contained Four (SG, D, LF, Class B)	Aug. '33	WM331
Lucerne Straight Four (SG, D, LF, Trans)	—	WM350
£5 5s. Battery Four (HF, D, 2 LF)	Feb. '35	WM381
The H.K. Four (SG, SG, D, Pen)	—	WM384
The Auto Straight Four (HF Pen, HF Pen, DDT, Pen)	Apr. '36	WM404
Five-valve: Blueprints, 1s. 6d. each.		
Super-quality Five (2 HF, D, RC, Trans)	—	WM320
Class B Quadradyne (2 SG, D, LF, Class B)	—	WM341
New Class B Five (2 SG, D, LF, Class B)	—	WM340
Mains Operated.		
Two-valve: Blueprints, 1s. each.		
Consoelectric Two (D, Pen) A.C.	—	AW403
Economy A.C. Two (D, Trans) A.C.	—	WM286
Unicorn A.C.-D.C. Two (D, Pen)	—	WM394
Three-valve: Blueprints, 1s. each.		
Home Lover's New All-Electric Three (SG, D, Trans) A.C.	—	AW383
Mantovani A.C. Three (HF Pen, D, Pen)	—	WM374
£15 15s. 1936 A.C. Radiogram (HF, D, Pen)	Jan. '36	WM401
Four-valve: Blueprints, 1s. 6d. each.		
All Metal Four (2 SG, D, Pen)	July '33	WM329
Harris' Jubilee Radiogram (HF Pen, D, LF, P)	May '35	WM386
SUPERHETS.		
Battery Sets: Blueprints, 1s. 6d. each.		
Modern Super Senior	—	WM375
'Varsity Four	Oct. '35	WM395
The Request All-Waver	June '36	WM407
1935 Super-Five Battery (Superhet)	—	WM379
Mains Sets: Blueprints, 1s. each.		
Heptode Super Three A.C.	May '34	WM359
"W.M." Radiogram Super A.C.	—	WM366
PORTABLES.		
Four-valve: Blueprints, 1s. 6d. each.		
Holiday Portable (SG, D, LF, Class B)	—	AW393
Family Portable (HF, D, RC, Trans)	—	AW447
Two HF Portable (2 SG, D, QP21)	—	WM363
Tyers Portable (SG, D, 2 Trans)	—	WM367
SHORT-WAVE SETS. Battery Operated.		
One-valve: Blueprints, 1s. each.		
S.W. One-valver for America	15.10.38	AW429
Rome Short-Waver	—	AW452
Two-valve: Blueprints, 1s. each.		
Ultra-short Battery Two (SG, det, Pen)	Feb. '36	WM402
Home-made Coil Two (D, Pen)	—	AW440
Three-valve: Blueprints, 1s. each.		
World-ranger Short-wave 3 (D, RC, Trans)	—	AW355
Experimenter's 5-metre Set (D, Trans, Super-regen)	30.6.34	AW438
The Carrier Short-waver (SG, D, P)	July '35	WM390
Four-valve: Blueprints, 1s. 6d. each.		
A.W. Short-wave World-beater (HF Pen, D, RC, Trans)	—	AW436
Empire Short-waver (SG, D, RC, Trans)	—	WM313
Standard Four-valve Short-waver (SG, D, LF, P)	22.7.39	WM383
Superhet: Blueprint, 1s. 6d.		
Simplified Short-wave Super	Nov. '35	WM397
Mains Operated.		
Two-valve: Blueprints, 1s. each.		
Two-valve Mains Short-waver (D, Pen) A.C.	13.1.40	AW453
"W.M." Long-wave Converter	—	WM380
Three-valve: Blueprint, 1s.		
Emigrator (SG, D, Pen) A.C.	—	WM352
Four-valve: Blueprint, 1s. 6d.		
Standard Four-valve A.C. Short-waver (SG, D, RC, Trans)	—	WM391
MISCELLANEOUS		
S.W. One-valve Converter (Price 6d.)	—	AW329
Enthusiast's Power Amplifier (1/6)	—	WM387
Listener's 5-watt A.C. Amplifier (1/6)	—	WM392
Radio Unit (2v.) for WM392 (1/-)	Nov. '35	WM398
Harris Electrogram battery amplifier (1/-)	—	WM399
De Luxe Concert A.C. Electrogram (1/-)	Mar. '36	WM403
New style Short-wave Adapter (1/-)	—	WM388
Trickle Charger (6d.)	—	AW462
Short-wave Adapter (1/-)	—	AW456
Superhet Converter (1/-)	—	AW457
B.L.D.L.C. Short-wave Converter (1/-)	May '36	WM405
Wilson Tone Master (1/-)	June '36	WM406
The W.M. A.C. Short-wave Converter (1/-)	—	WM408

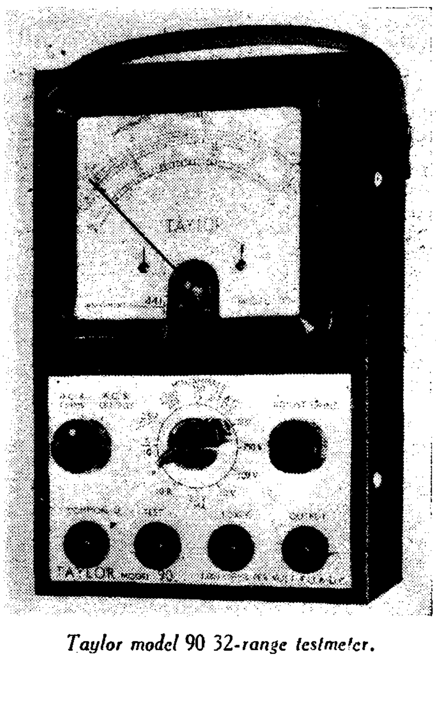
NOTES FROM THE TRADE

Ohm's Law Simplified

ALTHOUGH the well-known Ohm's Law is not a difficult mathematical calculation, it does offer at times some trouble in arriving at an answer. Ionic Laboratories, appreciating this fact, have therefore produced a handy pocket calculator in ivorine which enables all problems which are solved by the application of this law to be answered without calculation. The device consists of three discs, the outer 5in. in diameter, the inner 2¼in. and the remaining one 3¾in. in diameter. A transparent cursor is hinged at the centre and carries a hair-line. The inner disc is marked logarithmically with resistance values from one hundredth of an ohm to nine hundred thousand ohms; the next disc is marked with voltages from .1 to 1,000, whilst the outer disc carries current and wattage ratings in milliamps and amps.. and milliwatts and kilowatts. With the aid of indicating points and the cursor it is thus a simple matter to arrive very quickly at an answer to a problem, the method of applying Ohm's Law being fully detailed on the back of the device. The price is 4s. 6d. from the makers, Ionic Laboratories, 514, Ipswich Road, Trading Estate, Slough, Bucks.

The Latem Lamp

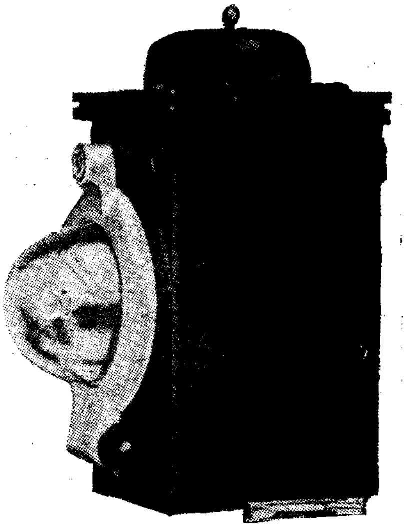
THE recent introduction of the Varley dry accumulator has resulted in the production of a number of interesting devices which have hitherto not been very very popular on account of the problems of battery replacement. The latest device to be brought to our notice is the Latem lamp illustrated on the right. This is designed primarily for use in air-raid shelters, and is of heavy iron construction, provided with a secret switch if desired, and is practically indestructible. The Varley cell fitted to it provides about 26 hours' continuous light per charge. The lamp may be attached to a ceiling or wall and the arrangement of the cover glass and switch is such that no unauthorised person can obtain access to the inside and thus the lamp may be relied upon at all times. It is 7¾in. high by 5in wide and 6in. deep. The price is 45s., and the makers are Latem Electrical Co., Latem Works, Eastwood Street, Hall Lane, Bradford.



Taylor model 90 32-range testmeter.

Taylor Testmeter No. 90

A NEW 32-range meter has been produced by Taylor Electrical Instruments and is illustrated on this page. This has a 4½in. square meter movement and gives the following readings: Up to 1,000 volts A.C. or D.C.; up to 2.5 amps. A.C.


The new Latem lamp.

or D.C., and resistance values up to 1 megohm with the incorporated battery. A higher resistance range may, of course, be obtained in the usual way by addition of another external battery. The sensitivity of the meter on all A.C. and D.C. ranges is 1,000 ohms per volt, the total resistance on the highest volt range being 1 megohm. The resistance scale is actually marked from 10 to 100,000 ohms and the desired readings are ascertained in conjunction with a range selector switch which indicates at one setting the values marked on the dial, on another setting values are one-tenth of these, and on the third resistance setting they are 10 times the marked values. The internal battery is of the 9 volt type and is easily replaced by removing the panel screws. Special and novel arrangements have been adopted by the makers of this instrument to ensure that the resistors used for the various ranges will not materially change during the life of the instrument, automatic compensation being provided to overcome changes in value due to temperature, "fatigue," or other similar external factors. As a result the instrument may be relied upon to operate effectively over its entire range, indefinitely and it represents very good value at £8 15s. 0d. The makers are Taylor Electrical Instruments, Ltd., 419/422, Montrose Avenue, Slough, Bucks.

PATENTS AND TRADE MARKS.

Any of our readers requiring information and advice respecting Patents, Trade Marks or Designs, should apply to Messrs. Rayner and Co., Patent Agents, of Bank Chambers, 29, Southampton Buildings, London, W.C.2, who will give free advice to readers mentioning this paper.

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EACH paragraph will commence with the first word printed in bold face capitals. Additional words in bold face capitals are charged at 4d. per word.

ALL communications should be addressed to the Advertisement Manager, "Practical Wireless," Tower House, Southampton Street, London, W.C.2.

PUBLIC APPOINTMENTS

VACANCIES IN THE AERONAUTICAL INSPECTION DIRECTORATE. MINISTRY OF AIRCRAFT PRODUCTION.

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(a) Applicants for the General Engineering Branch must have had practical experience in an engineering works. An elementary knowledge of materials testing is desirable.

(b) Applicants for the Instrument Branch must have knowledge of physics and training in light engineering or instrument making. Candidates with knowledge of optical instruments are also required.

(c) Applicants for the W/T Branch must have practical knowledge of W/T and electrical equipment with technical training in radio communication equal to City and Guilds final examination standard.

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LOUDSPEAKER repairs, British, American, any make. 24-hour service, moderate prices.—Sinclair Speakers, Pulteney Terrace, Copenhagen Street, London, N.1.

REPAIRS to moving coil speakers. Cones/coils fitted or rewound. Fields altered or wound. Prices quoted, including eliminators. Pick-ups and speaker transformers rewound, 4/6. Trade invited. Guaranteed satisfaction. Prompt service.

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FULL range of Transmitting Keys, Practice Sets, Oscillators, Recorders and other Radio Telegraph Apparatus, designed and manufactured by T. R. McElroy, World's Champion Telegraphist. Sole distributors: Webb's Radio, 14, Soho Street, London, W.1. 'Phone: Gerrard 2089.

FREE ADVICE BUREAU
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This coupon is available until September 7th, 1940, and must accompany all Queries and Hints.
PRACTICAL WIRELESS, September, 1940.

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ARMSTRONG COMPANY have a limited number of chassis not included in the current catalogue, but carrying the makers' guarantee. Chassis are offered at especially economical prices. Several examples are given below.

ARMSTRONG RF96 All-wave Radiogram chassis with R.F. pre-amplifier, supplied complete with matched moving-coil speaker. **£6 10s. 0d.**

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2 WATT Q.P.P. Battery Amplifier complete with W.B. P.M. loudspeaker and 3 valves in cabinet, 30/-—Hedgeland, 8, Hayle Road, Maidstone.

HALLICRAFTER Sky Champion receiver, as new, £13. Peto-Scott Preselector, brand new, £7. Valves, transformers, components, etc. Stamp for replies. Send in your requirements to: N. V. Davies, 42, Cranbourne Road, Salt Hill, Slough, Bucks.

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SMALL ELECTRIC ROTARY CONVERTOR, 110 volts D.C. input, 10 volts at 30 amps. output. Useful for garage charging, **55/-**, C/F.
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X-RAY TRANSFORMERS, input 120 volts 50 cy., 1 phase, 40,000 volts 800 Va. output, **£7 10s.** Another same input, 64,000 volts 2 Kva. output, **£11 10s.** Carriage forward.
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Terms: Cash with Order.
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LISSEN rectifier valve U650, **2/11** each.
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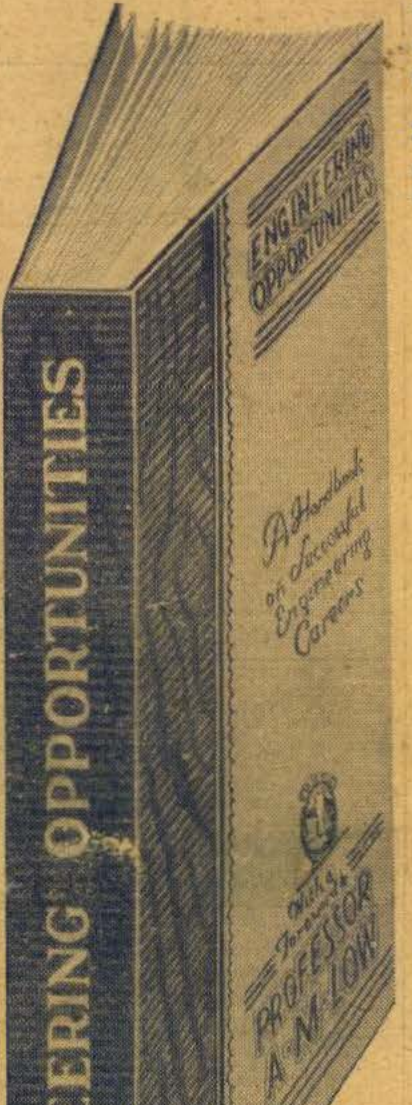

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