NEW IDEAS FOR THE EXPERIMENTER

Practical Wireless

AND AMATEUR TELEVISION
EDITED BY F.J. CAMM.

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Please send me full-size constructional chart of the new Cossor Melody Maker.
State which model required. 

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PRAG 3790.
B.B.C. Symphony Orchestra on Tour

The B.B.C. announces that the B.B.C. Symphony Orchestra, under the direction of its conductor, Adrian Boult, will visit four provincial cities during the forthcoming season—Manchester on December 5th; Bristol on February 13th; Birmingham on February 27th; and Dundee on April 5th. Listeners, therefore, in these areas will have the opportunity of hearing this orchestra at first hand. Arrangements have also been made for the orchestra to visit Brussels on March 12th next.

Danger!

Lovers of dramatic events should make a point of hearing the first of a series of thrilling tales of adventure, under the general title of "Danger," which will be broadcast by Captain F. C. Hendry on October 8th. Captain Hendry, who gives his story the name of Flat Aback, served as an apprentice and an officer in ships sailing round Cape Horn, and obtained a square rigged extra master's certificate. He has also commanded steamers sailing the South China seas. He served for some time on the North West Frontier of India and in Mesopotamia for over four years. Under the nom de plume "Shilmar," Captain Hendry has also published numerous tales and novels, mostly about the sea.

About the Stars

In Lesson 3 of the "Wonders of the Earth and Sky," which is being broadcast to Scottish schools by Mr. D. B. Duncanston, Lecturer in Science, Jordanhill Training Centre for Teachers, Glasgow, on October 8th, the subject will be "What do the Stars tell us?" Mr. Duncanston will supply some very interesting information about these distant bodies and remove one or two misconceptions.

Some Unpublished Works

The first concert of a series in which only unpublished works by Welsh musicians will be performed will be given for West Regional listeners on October 9th. The artists will be Walter Glynn (tenor) and the Cardiff Ensemble. The Cardiff Ensemble has been in existence for over four years, and during that time more than a hundred concerts have been given, many of which have been broadcast. The aim of the ensemble is to create a love of Chamber Music among ordinary listeners.

A Prize Band Concert

A Concert by the Cambourne Town Band, conducted by A. W. Parkin, will be relayed for West Regional listeners on October 12th. This band has been in existence for more than half a century and during the last nine years has won prizes to the value of £2,000; it also won the Prince of Wales Trophy three times, in addition to the Championship of Devon and Cornwall. Bernard Fishwick (baritone), who will be the artist in this concert, was an engineer in the North of England; he joined an operatic society, and began to study with D'Arcy de Ferrars of the Old Opera Comique. After some further study he took up singing professionally.

A West Country Play

Eden Phillpotts has written a new play specially for broadcasting, called "Old Bannerman," and it will be produced for West Regional and London Regional listeners, on October 8th, by Cyril Wood. It is interesting to learn that this distinguished West-country author had never been in the habit of listening to wireless plays, but when "The Farmer's Wife" was produced in the West Region in February this year he decided to hear it, for in spite of its run of several years he had never seen his popular play on the stage. As a result of listening, he realized for the first time the many possibilities which radio opens up for the dramatist and decided to try his hand at a radio play. Cyril Maude, the well-known actor, will play the part of Old Bannerman in the broadcast on October 8th.

A Band Change

One of the regular broadcasting bands, that of the 2nd Battalion King's Own Royal Regiment, has left the Midland Region, but the Band of the 1st Battalion The South Staffordshire Regiment is now quartered at Whittington Barracks, Lichfield. It will provide a programme in the Birmingham studio on October 7th. James Turtle has been conductor of this band for the past thirteen years during which time it has had a term of service in India, when it took part in the Bombay Tattoo.
"Songs from the Films"

JOHN WATT will be both compere and producer of No. 2 of the new series, "Songs from the Films" which will be broadcast Regionally on October 12th in the evening, and at a matinee the following day.

B.B.C. Symphony Concerts

DURING the coming winter months twelve symphony concerts will be given by the B.B.C. in Queen's Hall, starting on October 6th. The conductors are Dr. Adrian Boult, Sir Thomas Beecham, Albert Coates, Sir Hamilton Harty, Igor Stravinsky, Dr. Felix Weingartner, and Sir Henry Wood.

Among the works which will be heard for the first time in England are Stravinsky's "Perséphone"; Yuri Shaporin's Symphony in C minor; a Scherzo from an unfinished symphony by Gustav Holst; excerpts from Alban Berg's opera "Lulu"; and a new symphony by Vaughan Williams.

Two Short Broadcast Plays

TWO short plays which have been specially written for the microphone are to be broadcast in the National programme on October 18th in a dual bill. The first, "Delayed Drop," is by Alan Byrne, and will be produced by S. Bullock, who is coming over from Belfast for three months whilst Lance Sieveking takes his place in Belfast. The action of the play takes place in and over a flying club in Great Britain.

The second of these productions is a problem play, entitled "Fours into Seven--Won't Go," by Val Gielgud and Stephen King-Hall. Northern China is the scene of the action, and the time is the present.

Another A. J. Alan Story

THAT well-known mystery story-teller, A. J. Alan, is to make another of his rather infrequent appearances before the microphone. On this occasion he will broadcast a special story for the Children's Hour in the National programme on October 6th.

Gounod's "Faust"

ON October 13th the first act of Gounod's "Faust" will be relayed from Sadler's Wells Theatre, in the Regional Programme. The action of the play takes place in and over a flying club in Great Britain.

"In Town To-night"

THIS topical supplement to the week's programmes has proved popular with listeners last winter, will return to the programmes on Saturday evenings, beginning on October 6th.

Talks on Town and Country Planning

A Regional talks this winter, the most important series is to be one dealing with town and country planning. The talks will be given by G. M. Bomphey, whose broadcasts on Roman Roads were a feature of the National programme last year, and the general title is "Ripe for Development."

PRACTICAL WIRELESS

October 6th, 1934

ROUND the WORLD of WIRELESS (Continued)

INTERESTING and TOPICAL PARAGRAPHS

The White Coons

STANLEY HOLLOWAY is, as usual, the bright star of the White Coons' broadcast on October 6th in the National programme. He will be supported by C. Denier Warren, Wynne Apello, Eve Becker, Dudley Rolph, and Joe Morley.

MODERN MASS PRODUCTION METHODS

A corner of the battery-valve room in Messrs. A. C. Cossor's well-equipped factory, showing the conveysors, artists who are closely associated with broadcasting in general and with the White Coons in particular.

"The Limits of Technical Education"

FOR his address as the new President of the Union of Educational Institutions, Sir Josiah Stamp has chosen "The Limits of Technical Education." This will be relayed from the Thirty-seventh Annual Meeting of the Union in the Council House, Birmingham.

Two Broadcast Thrillers

THE Martyn Webster series "Don't Listen to This!" reopens with two thrillers which will be heard on October 13th. In the first, the scene is a large and rather decayed suburban villa, where a murder has taken place a year before. It is called "An Anniversary." The author is Rupert Croft-Cooke, of Salterton, Gloucestershire. The second play, "Retrospect," by Loftus Wigram, has a plot in which the robbing of a family vault is the principal incident.

"When the King Came Home"

ANN CASSON, who is playing this season at the Coventry Opera House with the Repertory Company there, is to take the principal part in a Robin Hood play which Midland Regional provides for all Regional Children's Hours on October 18th. The play is called "When the King Came Home," and has been written by Ruth Adam, who is the author of the Literary Tour of Nottingham which was recently broadcast.

SOLVE THIS!

PROBLEM No. 107

Bradbury had a two-valve receiver and decided to add a third stage. He used B.C. coupling, utilizing separate resistance and condenser, but when tested out it failed to function. As the previous two-valve had functioned correctly he naturally decided that one of the new components was faulty, and he tried the valve by substitution and also tested the anode resistance and grid leak with battery and phono. Thescanshows that these were not broken. Thinking therefore that the condenser was faulty he tested this in a similar manner, and failed to hear the sound. Three books will be awarded for the first three correct solutions opened. Address your envelopes to "Ann C. Cossor," Practical Wireless, Grosvenor, Ltd., 111, Southwark Street, Strand, London, W.C.2. Envelopes must be marked Problem No. 107, and must be posted to reach here not later than the 2nd post Monday, October 9th, 1934.

Solution to Problem No. 106

The accumulator used by Simpson was in poor condition, and although it was fully capable of delivering his receiver it could not deliver the additional charges required by the Class B valve. The following three readers correctly solved Problem No. 106, and have accordingly been forwarded to them: H. Young, Nelson, Urmston, Manchester Road, Abersytwth, Norman Roe, The Hock, Good East, Rousell C. Jones, 5, Railway Road, Church Street, West Bromwich, Staffs.
NEW IDEAS FOR THE EXPERIMENTER

This Article is Intended Chiefly for the Amateur Who Wishes to Experiment with Various Circuits and Arrangements. A Number of Time- and Money-saving Hints are Given. By FRANK PRESTON

The experimenter is not content to build a new set, and then simply listen to it. The building of the receiver is only a preliminary to the real work, work, work, work, and so on. It is this latter part of the work which provides enjoyment for the keen amateur, and which enables him to extend his knowledge and make new discoveries.

There are dozens, perhaps hundreds, of readers who have not taken up wireless experimental work at all seriously and who would like to do so if only they knew how to get started. An almost ideal way would be to make every one of the sets described in PRACTICAL WIRELESS. At present, although there are some people who do not use them, they are the best things to use, and the components can always be arranged just as they would in any specially-designed complete receiver. In addition, no one is ever desired to cease experiments for a time; the receiver is complete and self-contained so that it can be housed in a cabinet and used as a normal "family" set.

The Coils

Keeping in mind the idea of having the components readily interchangeable, it is best to use coils of the plug-in type. In this it is not intended to imply that the coils should be of the obsolescent honeycomb plug-in type, but wound on 6-pin formers. When this is done either 6-pin holders or separate sockets must be mounted on the chassis. The separate sockets will, in most instances, prove most convenient, since wiring can then be carried out on the under-side of the chassis without having to take leads through holes. Provision can be made for three coils by fitting three sets of sockets in a line from back to front of the chassis, and about 3in. from the left-hand edge. Unfortunately, it is not possible to buy 6-pin coil formers fitted with screening cans, but the latter can be bought separately (they should be 3in. diameter) and fitted as shown in Fig. 2, by drilling the ends of the cans and the bases of the coils and fitting a couple of 6 B.A. screws.

Use a Separate Set

The best method, therefore, for the experimenter to adopt is to build one complete PRACTICAL WIRELESS receiver for general use and for "family" listening, and to have something entirely different for experimental purposes. For preference the experimental receiver should be completely adaptable to almost any arrangement; whilst it should be easily re-arranged for any number of experiments for a time, the receiver is complete and self-contained so that it can be housed in a cabinet and used as a normal "family" set.

The Chassis

In view of the latter remarks, it is not intended to imply that the coils should be of the obsolescent honeycomb plug-in type, but wound on 6-pin formers. When this is done either 6-pin holders or separate sockets must be mounted on the chassis. The separate sockets will, in most instances, prove most convenient, since wiring can then be carried out on the under-side of the chassis without having to take leads through holes. Provision can be made for three coils by fitting three sets of sockets in a line from back to front of the chassis, and about 3in. from the left-hand edge. Unfortunately, it is not possible to buy 6-pin coil formers fitted with screening cans, but the latter can be bought separately (they should be 3in. diameter) and fitted as shown in Fig. 2, by drilling the ends of the cans and the bases of the coils and fitting a couple of 6 B.A. screws.

Make Your Own Coils

An alternative method is to use coils made according to the instructions given in the series of articles entitled "Making Your Own Screened Coils," published in the issues of PRACTICAL WIRELESS dated December 9th to December 30th, 1933 (inclusive). These coils were mounted on a base-plate fitted with terminals, and so on. It is an easy matter to replace the latter by banana plugs which will fit into corresponding sockets mounted on the chassis. By following this idea a variety of different tuning circuits can be tried out in a minimum of time, whilst there is no difficulty in adapting the set to any wavelength range.

The secret of success in using this

(Continued overleaf)
system rests with the use of a fairly standardized method of connecting the condenser terminals. For example, terminal 1 should always have the grid connection, terminal 2 the cathode connection, and so on. When this is done it will rarely be necessary to modify the wiring of the set when changing from one coil to another.

The "plug-in" idea can readily be extended to such components as L.F. transformers, an ebonite, socketed mount being fixed to the chassis and a plug-base arrangement used for transformer, and so on, as shown in Fig. 3. The extra cost of the odd pieces of ebonite plugs, etc., is very small, and the convenience of the arrangement will easily justify its use. It will be appreciated that, when using the plug-in transformer scheme, a change can be made from direct coupling to parallel feed or to a variety of auto choke connections without altering the resistance-condenser assemblies of the type shown in Fig. 4. Each assembly consists simply of a tap-copper plate fitted with any required number of terminals to which the wire leads from fixed condensers or tubular condensers can easily be attached. The positions given in Fig. 4 are suitable for all the average types of component, but they can be modified to suit special requirements. It will be seen that soldering tags are provided to take the normal set wiring, the terminals being employed as means of anchoring the looped ends of the component connections.

It will generally be found that two of these assemblies will be required: one for the high-frequency stages, and another for the detector and low-frequency portion. Generally speaking, the detector grid condenser and grid leak should not be mounted along with the anode-circuit decoupling components, and it is better to mount the grid components either on a separate unit, or to wire them up in the normal manner.

With regard to the tuning, reaction, and switching components, it is essential to mount these on angle brackets attached to the chassis. Any number can then be added without making any major alterations and without having to alter drilling of a panel. As in normal receiver design, the tuning condensers should be mounted as near as convenient to the coils, the other controls being arranged symmetrically around them. In the experimental set, however, symmetry of lay-out is somewhat unimportant item which is not nearly so important as the matter of ensuring the shortest possible wiring.

Battery Speaker Connectors

The method of connecting the batteries (when used) aerial, earth, and speaker is of some importance, and the greatest possible amount of care should be taken to guard against short-circuits which can so easily take place in the course of experiments. Flexible leads attached directly to the components in the set have something in their favour, but it is nearly always better to fit series of sockets to the rear of the chassis. The sockets can be arranged to take corresponding plugs attached to the flexible leads from the batteries, etc. The advantage of this system is that all leads can be removed instead of making the set more convenient to handle and easier to adjust. To avoid damage to components and/or the H.T. supply it is essential that a fuse be fitted to the experimental set. In a battery receiver a fuse-holder of the type which takes a screw-in fuse is probably more convenient, and this should be fitted to the chassis in the most accessible position. In the case of a mains set the most convenient type of fuse is one which is fitted into the mains connector, although this position may possibly be augmented by another, of the cartridge type, inserted in the mains H.T. positive lead from the rectifier.

Mains Power Equipment

The bulk of the remarks made above refer to battery receivers, but they apply equally well to the receiver portion of mains instruments. By "receiver portion" is meant the set proper, without its associated mains equipment, because it is strongly recommended that an experimental mains set (the same remarks often apply to a receiver of normal type) should be made with all the power-supply equipment as an entirely separate unit. It is also preferable that the mains unit, also another, of the transformer type, is provided in the H.F. set.

It is best to include the voltage-dropping and decoupling resistances in the receiver portion when there will only be four supply leads from the power unit, the mains, two for H.T. and two for L.T. The connections can then be brought out to the terminals of a valve holder, wire connection being made by means of a standard valve plug.

A MATEURS are often involved in difficulties by what is known as the "skin effect" of high-frequency alternating currents. It is a matter of great importance, both in regard to radio reception and transmission. "Skin effect" is a term which we use with regard to the tendency which always accompanies alternating currents to show always flowing along the outer surface of a conductor. The greater the frequency of the current the more it shows a tendency to confine itself to the surface. Direct current will utilize the whole of the cross section of the conductor, low-frequency alternating current about two-thirds of the conductor, and high-frequency alternating current the outer skin of the conductor. This is a point which should be considered by those who are experimenting with radio circuits, and particularly those for short-wave work. It will be seen from these remarks that the higher frequency (which means, of course, the shorter the wavelength), the more important it is, in wiring the set, that the conducting wire should have the maximum of surface area in order that as little resistance as possible should be present. This is also one of the reasons why stranded copper wire of the 22s variety is the best wire for aerial work, since it would be also be borne in mind that if the utmost efficiency in a set is desired the resistance must be cut down to a minimum. Some time ago I visited the works of a particularly active radio society, and found quite a number of young men, and, strange to relate, two ladies, all busy building or re-wiring radio receivers. One youth I noticed was rewiring his set with a very fine gauge wire. When I asked him why he was using so fine wire, he replied, "Well, you see, I found when the set was wired with a heavy gauge, I was not getting the results anticipated, so I have come to the conclusion that the received signals get away to earth too quickly, and I think by retarding them improved reception will be obtained. I never heard the result of that experiment, but knew what it was going to be. It was little use endeavouring to explain to the individual in question, who appeared to me to be one of the type who could only be taught by experience. I have not gone into this question very fully, for there are other things, such as eddy currents and the effects of coiled wire. All have their particular bearing, but it can be taken for granted that increasing signal intensities are desired then heavy-gauge wire should be used." C.D.K.
MEASURING INDUCTANCE AND CAPACITY

When A.C. Mains are Available, L.F. Chokes and Condensers may be Measured by the Use of Simple Apparatus

PROBABLY no radio components in general use present such difficult problems to the experimenter as L.F. chokes, transformers, and fixed condensers. One great difficulty with L.F. chokes and transformers is that their characteristics vary considerably under different conditions. For example, a particular L.F. choke may have an inductance of 30 henries when it is passing a D.C. current of 20 milliamps, but increasing the current to 50 milliamps may have the effect of reducing the inductance to 15 henries or even less. In a similar connection one well-known L.F. transformer has a primary inductance of some 180 henries with 1 milliamp D.C. flowing through the primary, but only 80 henries with 6 milliamps flowing.

As it is essential to have an approximate knowledge of the behaviour of every component under working conditions, and fairly accurate data in some cases, the following details of simple methods of inductance measurement may prove of interest.

It is only possible to employ these methods when an A.C. mains supply of known frequency is available.

Chokes and Condensers

The circuit shown in Fig. 1 is suitable for measuring chokes which are normally called upon to carry a D.C. current of 1 or 2 milliamps. Chokes having an inductance up to 150 henries, and condensers of 0.07 mfd. upwards, can be tested by this arrangement.

The mains transformer used may be of any type, providing it has a secondary giving 4 or 6 volts output. The D.C. supply should be a battery or mains H.T. unit giving a variable voltage up to 50 to 60 volts, and this will enable a D.C. current of 1 milliamp to be passed through the highest inductance choke or a greater current through lower inductance chokes.

The valve voltmeter need not be calibrated, and suitable values for this are indicated in the diagram. Unless an ohm meter is available it will be found desirable to calibrate the variable resistance by means of a milliammeter and battery, and to provide these with scales showing the resistance for various settings of the knob, as shown in Fig. 2. This method of resistance measurement is probably familiar to the reader, and space does not permit a complete description in this article.

Balancing Process

The choke or condenser on test is connected to the terminals provided, and if no D.C. current is required the D.C. switch is set at 1. The valve voltmeter should then be connected in turn across the resistance, switch position 1, and the choke or condenser, switch position 2. If the A.C. voltage across the choke indicated by the valve voltmeter is greater than

The resistance adjustment must be increased.

Having found a balanced setting the frequency of the choke or condenser. We can assume that the impedance of a choke is equal to its resistance, and since the D.C. resistance of the majority of chokes is low compared with the reactance, this will give sufficiently accurate results for most purposes.

Determining Inductance

Having found the impedance of the choke its inductance can be obtained from the equation, inductance in henrys = impedance in ohms / \[6.28 \times \text{supply frequency}\].

In the case of a condenser the capacity in microfarads can be calculated from the equation,

\[
C = \frac{1}{\left(6.28 \times \text{supply frequency}\right)^2 \times 1,000,000}
\]

If it is desired to allow for the D.C. resistance of a choke it will be necessary to use the equation,

\[
\text{Inductance in henrys} = \sqrt{\text{impedance} - \left(6.28 \times \text{frequency}\right)^2}
\]

where \(r\) is the D.C. resistance of the choke.

With careful operation the foregoing method will give results sufficiently accurate for all practical purposes. It is convenient to use the 50,000 ohms variable resistance

(Continued overleaf)
in 1,000 ohm steps, the 1,000 ohms resistance being used as a vernier adjustment. In order to determine the inductance of a choke while passing a higher D.C. current than 1 or 2 milliamps, the arrangement shown in Fig. 3 should be used. For this it is necessary to use a calibrated valve voltmeter.

With chokes having a D.C. resistance not greater than 1,000 ohms, a D.C. supply up to 100 volts will be required to provide a D.C. current of up to .50 milliamps through the choke. As with the arrangement shown in Fig. 1, the D.C. current is varied as required by increasing or decreasing the D.C. voltage.

The operation of the system shown in Fig. 2 is quite simple, and simply consists of measuring the A.C. voltage across the choke, and across the 1,000 ohms resistance. The choke impedance can then be determined by the equation when adding up the resistance wire.

A.C. volts across choke
A.C. volts across 1,000 ohms resistance \times 1,000 = choke impedance in ohms

Having determined the total impedance of the choke its inductance can be calculated as previously described.

Calibration Methods

Probably the simplest method of calibration when a low-voltage A.C. voltmeter is not available is that shown in Fig. 4. A length of Eureka resistance wire of 34 or 36 s.w.g., about 30in. long, is stretched out and secured by drawing pins. The ends of the wire are connected to the heater terminals of a 4-volt A.C. valve in a mains receiver, the receiver being switched on while the calibration is being done. Obviously, across each inch of the resistance wire an A.C. voltage of .13 will be developed, and this will enable the valve voltmeter to be calibrated up to 4 volts.

Fig. 4.—An A.C. voltage of .13 is developed across each inch of resistance wire. The choke impedance can then be determined by the equation

\[ V = \frac{I}{Z} \]

where

- \( V \) is the A.C. volts across 1,000 ohms resistance
- \( I \) is the D.C. current
- \( Z \) is the choke impedance in ohms

The difficulty is that no receiver appears to be selective enough for the demands made on it, as it is not of the superheterodyne type, and that does not altogether fill the bill because there is an impression that the best type of reproduction is not to be obtained with this kind of receiver. What is required over there is a very selective or four-valve type of battery receiver with which the operator is assured of being able to discriminate between the innumerable stations receivable. Such a set would probably command a ready sale, and it might be worth while for some of our manufacturers to look into the matter.

H.T. Battery Troubles

Perhaps the greatest difficulty which has to be contended with by the owner of a wireless set in the very remote districts of the Colonies and Dominions is the H.T. battery trouble. Owing to the heat, dry batteries soon become ineffective, and in some parts of Africa the running costs of average radio sets is about 12/- to 15/- a month, which is mainly made up from this cause. This, of course, is a very serious factor, and has prevented many people in that country from taking up radio. H.T. accumulators are out of the question because the majority of the homesteads are equipped with lighting plant which only permits of 12- or 15-volt accumulators being charged. The British firm, Milnes Radio Co., of Church St., Bingley, Yorkshire, have introduced a special H.T. supply unit which fulfils the requirements of these outlying homes. The unit consists of indestructible nickel-iron cells which are kept automatically fed from the low-tension battery. The difficulty, however, is to be contended with by the accumulators; this is stated to be excellent and all stations, whether of high or low power, can apparently be received. The difficulty, however, is to be contended with by the accumulators.

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The L.T. Supply

The same low-tension accumulator can be used for working the set, as well as supplying the high-tension cells, and requires very little extra charging. The “Alkium” nickel and steel plates which are used in the unit are immersed in a steel preserving solution. Sulphation is an impossibility, and the cells may be overcharged and discharged at practically any rate without fear of damage. This information will also be read with interest by readers at home as the battery is just as efficacious in this country as abroad.
POINTERs IN MAIN-SET DESIGN

A Collection of the Special Details Which Should Receive Attention by the Constructor When Designing and Building His Own Mains-operated Receiver.

Use a Variable Bias Resistance

The L.F. stage does not usually present much difficulty, although particular care should be taken to ensure that exactly the right value of bias resistance is connected in the cathode lead. For experimental purposes it is wise to use a fixed resistance of about two-thirds the value recommended by the valve makers, in series with a variable one having a maximum resistance of 1,000 ohms.

It is then possible to find the optimum resistance while the set is in operation, which might be found that the valve can be rather over-biased without impairing the quality of reception, thus increasing its life.

Separate Mains Unit

A point which often arises concerns the actual lay-out of the receiver and power unit sections of the complete receiver. It is certainly possible to have both of these on the same chassis, so long as care is taken to keep mains transformer and smoothing choke right away from the H.F. components, but it is nearly always better for the beginner to make the two sections on separate chassis. There are two advantages to be gained by following this scheme: one is that the risk of mains hum and L.F. interaction is minimized, and the other is that the mains unit may afterwards be used for an entirely different receiver. In following out this idea it is advisable to fit all the voltage-dropping and decoupling resistances in the receiver portion so that only four leads (two H.T. and two 4-volt A.C.) are required to connect the two sections together.

Simple connection can then be made by means of a valve plug adaptor and a valve holder, as shown in Fig. 2.

When serious experiment with two or more receiver circuits is contemplated, it is an excellent idea to include the L.F. amplifier with the mains unit, whilst if an energized speaker is to be included, this might be included in the mains portion, as shown in Fig. 3, which is a section of the "Luxus" A.C. super-het. described in Practical Wireless dated October 14th, 1933.

Choke Decoupling for Power-grid

The decoupling of the detector valve coils for particular attention, especially if this valve is intended to operate on the power-grid system. This is because a power-grid detector requires the highest possible anode voltage up to the maximum at which it is rated to work. When, therefore, the detector from the rectifier and smoothing system is only slightly more than 200 volts the question of providing adequate decoupling becomes rather difficult of solution. The simplest way out consists of using an L.F. choke for decoupling purposes; this must be a good, high-inductance component capable of carrying up to 10 milliamps without its inductance value falling below approximately 25 henries. Choke-capacity coupling is also most suitable in most cases for use with a power-grid detector, and the complete anode circuit becomes like that in Fig. 1.

Another point which should receive attention is the anode circuit of the detector is the anode by-pass condenser joined between the anode and earth. This is a practical essential in a high-efficiency set, although it can often be omitted from a battery set without any ill effect resulting; a value up to 0.0005 mfd. can be employed for a 4-milliamp. A.C. component.

The circuit of a power-grid detector using choke capacity L.F. coupling and a choke for decoupling, as mentioned in the accompanying text.

(Continued overleaf)
POINTS IN MAINS SET DESIGN
(Continued from previous page)
Using a Mains-energized Speaker
Mention of using a mains-energized speaker led up to another point which is
frequently overlooked. This type of speaker, if properly used, is usually some-
what more sensitive than a corresponding permanent-magnet type, but it requires a
minimum amount of power for its correct operation. That minimum varies slightly,
according to the particular instrument chosen, but can generally be taken to be
about 21 watts. This amount of power can be dissipated in the case of a 2,500-ohm
field coil (used as a smoothing choke, of course) by passing through it a current of
a little over 30 milliamps, or in a 1,500-ohm field coil, a current of about 40 milliamps.
In both instances it must be realized, however, that a fairly large voltage drop
must necessarily occur across the winding. The actual figure for the 2,500-ohm field is
75 volts and for the 1,500-ohm one, 60 volts, so the conditions referred to above.
It is evident that the voltage "output" from the rectifier must be great enough to
compensate for this voltage loss: but it must also be remembered that the figures
given are minimum ones, and it is in every case better to exceed them if anything
approaching the full efficiency of the speaker is to be secured.

Where R.C.C. Scores
When the mains unit and receiver portion are to be mounted together on a common
chassis, and if the parts cannot be widely separated, particular care must be taken to
avoid the setting-up of troublesome mains hum. If the parts are not carefully
arranged—and sometimes if they are—hum is caused due to feedback between the
mains transformer and the L.F. transformer. One method of avoiding this is to use R.C.C.
instead of this general coupling, although this is rather "begging the question." This
method cannot usually be employed when power-grid detection is in use due to the
fact that the detector anode voltage is unduly reduced, but it is definitely worth a
trial if ordinary leaky-grid detection is incorporated. Not only does the resistance
overcome the feedback trouble, but it often also improves reaction control. Contrary to
expectations, it rarely cuts down the volume to a very appreciable extent, and if a pentode
is used in the output stage the slight loss is not noticeable.

The Variable-mu Control
When a variable-mu valve is employed in the high-frequency stage it is not
uncommon to find that the useful range of the volume control resistance is
very small. This might be due to the use of a resistance value which is too high,
or to the fact that fixed resistance produces a "grading" effect, due to the
movement of the volume control resistance. It is hardly necessary to add that the screening
metal must be effectively earthed, as also should the cores of the transformers.

THE IMPORTANCE OF THE EARTH

It would be amusing if it was not such a serious point that so many people
spend a great amount of time and care in erecting a perfect aerial, but imagine
spending a great amount of time and care in erecting a perfect aerial, but imagine
what More sensitive than a corresponding

Aerial As Well

It should be borne in mind that the efficiency of the earth connection is just
as important as that of the aerial and the receiver. It is not generally understood
that the signal waves received by both the aerial and the earth, since they act as
the plates of a large condenser, with the air between them as the dielectric. The
plates of a good condenser must be made of a good conducting material and, for the same
reason, the earth connection must be a good conductor. Dry earth is of little use,
and it is necessary in some cases to deep down into the ground until wet clay
is found. The common way of arranging an earth is to connect a wire to a cold
water pipe. A good earth becomes a good earth because the pipes run down deep into the
ground.

Don't Use Gas

In order to get the best service from this type of earth the connection should be
made as close to where the pipe enters the building as possible. The gas pipe should
never be used for an earth, as there is in almost every installation a non-conductive
material introduced in all the joints.

In the absence of water pipes, the best method of reaching the earth moisture
is to drive a copper tube of from three to five feet long into the ground. A metal
plate is also good, but requires more time and labour to do it satisfactorily.

Water Is Effective

In remote country places a very good earth can be made by fastening a piece of
lead to the end of a wire, and dropping it to the bottom of a well, which, should, of course,
be close to the house. No matter what kind of earth is used, the wire leading to the
set should be soldered at every joint. An earth which is very good in the winter
may be very poor in the summer when the ground becomes dry. This accounts to
some extent for the better reception we get during the rainy seasons.
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SECTIONAL PHOTOGRAPH

Part of Anode and Screen cut away to show inner electrode system.

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DECIDING ON A CIRCUIT

Brief Particulars are Given in this Article of a Wide Variety of Receiver Circuits which have been Spacially Developed for "Practical Wireless" Readers

Whenever a new set is contemplated the question arises as to the minimum amount of money which it is proposed to spend, since the final choice must be very largely dependent upon this. If the amount is five pounds or less it will generally be found that a simple three-valve battery-operated receiver will be most suitable, and it would be hard to improve upon the popular "Leader Three" described in an issue of Practical Wireless dated March 5th, 1934. If a still cheaper set were desired, the "Sixty-Shilling Three," for which details were given in our issue dated December 2nd, 1933, would prove very suitable.

Limitations of the Simple Circuit

In building sets of this type one must realize that the limitations which are imposed, for, although both receivers mentioned are as good as any in their class, they cannot be compared with such high-class sets as the "All-Pentode Three" and the "Summit," which have been described more recently, and which are appreciably more expensive. Nevertheless, the "Leader Three," for example, will enable extremely good reception to be obtained from ten or more stations, at the same time proving amply selective for use up to five miles or so of a Regional transmitter or some twelve miles of Droitwich. This does not mean that the set would be useless inside the radius mentioned, but that it could scarcely be expected to cut out the local station within 30 metres or so on each side of its wavelength, except when using a small aerial—which would limit the reception of more distant transmitters.

On the score of volume the "Leader" might fall rather short of some readers' requirements, since it has only a single L.F. stage, this comprising an ordinary small power valve. In such cases, and where selectivity is not of very great importance, such as, for instance, when the set is used fifty miles or more from a Regional station, or where really good reception of only about half a dozen stations is required, the "Sixty-Shilling Three" described in the issue dated December 2nd, 1933, with its two L.F. stages, is to be preferred.

A Two-valve Mains Set

If a mains supply is available, it is possible to get somewhat better value for the hypothetical five pounds, and a two-valve receiver will give even better reception than a three-valve for battery operation. A two-valve mains set which has proved extremely popular is the "A.C.-D.C. Two," and this was fully described in our issue dated October 7th, 1933. This set can be operated from either A.C. or D.C. mains, it will give real "mains-set" volume, and several readers have reported the reception of over twenty stations on it. The set is, however, chiefly intended for full-volume reception of four or five stations when true reproduction is desired. Though not super-selective, this set will easily separate the two "locals" at a range of five miles, even when a good outdoor aerial is used.

When one Relis justified in spending between five and ten pounds is a much greater choice of excellent home-constructor receivers. If the set is for battery operation, and "hair-line" tuning is required, combined with good range and reasonable volume, the latest Practical Wireless receiver, the "All-Pentode Three," will prove ideal. This set employs up-to-date iron-core coils and has three accurately tuned circuits, the first two of which are in the form of an inductively coupled band-pass filter. The set is provided with an efficient volume control acting upon the variable-mu pentode first valve, whilst a very smooth control of reaction is available, due to the employment of an H.F. pentode in the detector stage.

Low-priced Selectivity

A slightly less expensive receiver with similar characteristics, but rather lower degree of selectivity (even so, it will cut out the London transmitters at six miles within 14 degrees of the condenser scale), is the "Summit," which was one of our 1934 "Radiolympia" sets, and described in the issue dated August 18th. Incidentally, it should be mentioned that the "A.C.-D.C. Two" and "Summit" can all be obtained from a standard type of H.T. battery, since they require only about 8-10 milliamps. current. Additionally, any one of them can be fed from a simple type of H.T. battery eliminator.

For the Connoisseur

For the reader who wants a superlative performance in the way of long-distance reception in moderate conditions, or when only a comparatively poor aerial

(Continued overleaf)
WIRELESS AT BRITISH AIRPORTS

The recent demonstration of air-and-ground wireless communication at Newtownards, Belfast, was made an address from the air to the crowd, is a reminder of the progress that has been made by the British Air Ministry this year in equipping new civil airports with wireless apparatus.

Hull (Hedon), Portsmouth, and Belfast now all have up-to-date aerodrome wireless stations in regular operation, the equipment consisting of Marconi transmitters suitable for either telephone or telegraph operation, and directional receivers enabling navigational aid to be given to aircraft in flight.

Mobile Apparatus

The transmitters and receivers are of a type designed for mobile use and can be accommodated, together with all necessary running machinery, switchboards, and batteries, in a motor lorry or trailer. This point is of some interest in the present stage of rapid development of British civil aviation, when the airports which may eventually attain the greatest importance for wireless services have to be determined.

The Marconi transmitter adopted by the Air Ministry for these stations has a rated power of 500 watts (to the valve anodes on continuous-wave telegraphy) and is known as the Type D.M.A. It is particularly suitable for aerodrome work, as it is arranged for quick wave-changing and remote control, and can therefore be used very conveniently for any of the various classes of service for which a modern aerodrome transmitter must be capable. These include telephone and telegraph communication with aircraft in flight, contact with other aerodromes for the exchange of traffic information.

The Marconi directional receivers for Hull, Portsmouth, and Belfast are of a type that have not been selected by the Air Ministry after extensive tests. They can be used both for general reception and for direction finding by the Bellini-Tosi system.

We have not touched upon every recent Practical Wireless receiver, but mention has been made of a representative range, one of which is sure to appeal to every reader. New readers, or others who have missed the beautiful in the issues in which the sets were described, can obtain them for 4d. each post paid upon application to The Back Number Dept., Messrs. Geo. Newnes, Ltd., Exeter Street, Strand, London, W.C.2.
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![Diagram of Twinil Valve Doubler](image)

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Litz Wire Connections

**Litz** wire is excellent for coils, particularly L.W. coils, but the difficulty always arises, when one contemplates using it, of soldering twenty-seven wires round the periphery of a small screw or pin, which is invariably fixed on the coil. Here is an easy way of doing it. Inside an old H.T. or G.B. battery at the top of the carbons are to be found a number of small wander-plug sockets. Detach one of these, and solder it on to the screw, as shown in the sketch. Find a piece of rod, or studding, a loose fit in the socket, and it is then a simple matter to clamp the wires firmly round the rod's periphery. To make a firm job they can be soldered in place.—Mr. P. Newton Nield, in the issue of July 28th, 1934, of *Practical Wireless*.

A Small Transformer

**A** small, but efficient, 1 to 1 ratio transformer can be constructed by the method described below. Take a pair of ordinary headphones and remove one ear-piece, cutting the flex and leaving about 6 ins. attached. Next, remove the cap and the iron diaphragm. As the two magnets are joined in series it will be necessary to part the two centre connecting wires. These are usually lightly soldered and a tooth with a hot iron will part them. A short length of thin cotton-covered copper wire is then soldered to each of these bare ends, after which a little wax is melted on to each connection to provide the necessary insulation. The primary winding connections are to one of these flex leads, and to the central wire lead of the same magnet winding. The secondary connections are made to the other magnet windings in the same way. The ear-pieces may then be mounted on a small wooden base by fixing tightly between two wood screws, and four terminals can be fixed to take the primary and secondary leads.—**George Hill** (Bradford).

A Flat-dweller’s Aerial

**W** here a very short garden is attached to a house, or a flat dweller desires an aerial capable of giving better results than an indoor type of aerial, the method illustrated should be adopted. It will be seen that long spreaders of bamboo are fitted to each chimney stack, and wires are stretched from one to the other. The lead-in should be taken from the ends of the two wires, and a bridle should be made from the wires as shown, a single leading wire being taken to the set or the aerial-earth switch. Keep the wires well apart and also clear of the chimney stacks and roof. The minimum distance between the wires should be considered as 3ft.

**Soldering in Awkward Positions**

The following method, used in conjunction with the tinning bath described by Mr. F. Newton Nield, in the issue of July 28th, 1934, of *Practical Wireless*, will be found invaluable in cases where space does not permit of the use of an ordinary soldering iron. Two 9in. lengths of one-eighth inch diameter copper wire are slightly bent and shaped at one end, as shown in the illustration, and a yard of heavy amperage twin flexible wire is soldered to both, and large crocodile clips are attached to the remaining ends. A piece of sleeving is passed over each of the copper electrodes as a precaution against short circuit with other components. The actual soldering is very simple and speedy, the crocodile clips being connected to a 4- or 6-volt accumulator (preferably a car battery or cells of the multi-plate variety), and a little flux applied in the usual way to the connection to be soldered. The copper electrodes are dipped separately in the tinning bath, and then applied on either side of the connection. A temporary “short” will take place, the electrodes becoming hot, and the solder running freely and forming a sound connection.—**C. H. Hall** (Buxton).
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WHERE a very short garden is attached to a house, or a J. W. Hill (Bradford).

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50 Tested Wireless Circuits

BY F. J. CAMM

Obtainable at all Bookstalls or by post

By F. J. CAMM (Editor of "Practical Wireless")

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October 6th, 1934
A few years ago it was claimed that the B.B.C. stations provided far more faithful transmissions than receiver technique justified. This was undoubtedly a fact, and is still true in the case of many receivers. The congestion of the medium and long wavebands prevents frequencies above some 3,500 to 4,000 cycles being reproduced, if heterodyne and other interference are to be avoided when receiving other than local stations.

To obtain perfect reproduction it would be necessary for all frequencies between 30 and 15,000 to 20,000 cycles to be amplified and reproduced equally. In practice, no broadcasting stations transmit frequencies above 9,000 or 10,000 cycles, and a range of 30 to 9,000 cycles can be taken as providing practically perfect reproduction.

Those who happen to reside within thirty miles or so of a Regional transmitter can obtain almost perfect reproduction of this station’s programmes if they wish to do so, but when a programme relayed over a long land line before it reaches the transmitter is reproduced on a high quality receiver, the loss due to the land line is usually very noticeable.

L.F. Distortion

The distortion caused by an L.F. amplifier is of three kinds, amplitude, frequency, and phase distortion. Amplitude distortion is always present to some extent, but it occurs to an appreciable amount when the input to any of the amplifying valves is greater than the valve is intended to accept. This kind of distortion is the most common cause of the mutilated reproduction given by many receivers.

Amplitude distortion can be reduced to a minimum by arranging the amplifier so that each valve, other than the output, is only called upon to deal with an input voltage of about half the grid bias voltage.

Frequency distortion is due to the amplifier amplifying some frequencies more than others. A certain degree of frequency distortion is barely noticeable, but most L.F. transformers cause severe frequency distortion above 6,000 cycles or so. Using resistance-capacity coupling enables frequency distortion to be reduced to a negligible degree over the required frequency range.

Phase distortion is generally considered to be unimportant in sound reproduction, but in television amplifiers it must be avoided.

L.F. transformers, and iron-cored apparatus in general, introduce severe phase distortion, and also amplitude distortion. Apart from this cause and overloading, this form of distortion is caused by the non-linear operation of valves. Except from the output stage this source of amplitude distortion can be kept at a negligible level by working the valves at less than their maximum capacity, as already mentioned.

In the output stage the distortion due to amplitude distortion is not appreciable if a valve of adequate over-handling capacity is used. However, it can be reduced by using push-pull output.

Resistance-capacity Coupling

It will be obvious from these considerations that for a high-quality amplifier it is desirable to use resistance-capacity coupling. The slight distortion introduced by an output transformer, or choke, is negligible, and in any case this component cannot economically be eliminated. When using resistance-capacity coupling it is essential that the coupling components be of the correct values, as otherwise serious frequency distortion may occur. When designing a resistance-coupled stage, as shown in Fig. 1, the values of the anode and decoupling resistances should be determined first. The total resistance in the anode circuit should be such that the maximum permissible voltage is applied to the anode of the valve. For example, in Fig. 1 a total H.T. voltage of 400 may be available, and V.1 may take 6 milliamps with an anode voltage of 200. In this instance the total anode circuit resistance should be approximately 35,000 ohms, and this would permit an anode resistance of 25,000 ohms to be used with a decoupling resistance of 10,000 ohms.

The grid-leak resistance should be...
DEALING WITH

REPRODUCTION

ifiers for Sound or Television

six or seven times that of the anode
stance, 150,000 or 200,000 ohms being
ated for V.2, 100,000 ohms anode
stance. In order to keep high-note loss
imum, comparatively low value
esistance and grid leak should be
the other end of the frequency range
ondenser capacity is of
ance. The impedance of the coup-
denser at 30 cycles should be
ner than one-tenth of the grid-leak
stance. 150,000 or 200,000 ohms being

turing whether the same setting of the V.2
t will be out of phase with the grid
.2 and V.3 may require
cation of V.2 it is possible to tap
f the voltage required for the grid of V.3.
The correct potentiometer setting is
obtained by inserting a pair of headphones
X, and turning the potentiometer knob
zero signal is heard in the 'phones.
the A.C. voltage of V.2 it will be out of phase
the grid voltage of V.2.

Grid-bias Adjustment

Before making a final setting of the
ometer the grid-bias adjustments
should be set so that each pair of valves,
V2, V3 and V4, V5 take identical anode
currents. If desired, a check may be
plied to the output stage by connecting
phones as shown by dotted lines, and
oting whether the same setting of the V.2
ode potentiometer gives zero signal.
Another phase reverser circuit is shown

A QUALITY
AMPLIFIER

畜

comprising V.2 and V.3 may require
The input voltage applied
to the grid of V.3 must be 180 degrees
out of phase with the input to V.2.
The A.C. voltage developed in the anode
circuit of a valve is 180 degrees out of
phase with the voltage in the grid circuit of
the same valve. Obviously, if the voltage
on V.3 grid is in phase with the anode
A.C. voltage of V.2 it will be out of phase
with the grid voltage of V.2.

By using a potentiometer in place of the
V.2 anode resistance it is possible to tap
off the voltage required for the grid of V.3.
The correct potentiometer setting is
obtained by inserting a pair of headphones
X, and turning the potentiometer knob
zero signal is heard in the 'phones.
If the phase reverser is accurately set,
no signal should be heard in the 'phones
with the amplifier working at maximum
capacity.

Grid-bias Adjustment

Before making a final setting of the
potentiometer the grid-bias adjustments
should be set so that each pair of valves,
V2, V3 and V4, V5 take identical anode
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anode potentiometer gives zero signal.
Another phase reverser circuit is shown

(Continued on page 113)
The fact that as signal strength is increased background ratio to signal volume is also increased is sometimes overlooked, and it is a good idea to arrange for a two-valve output for use with headphones during periods of adverse conditions.

It is not the writer's intention to deal with H.F. amplification in this article, and whilst there are definite advantages to be gained by the addition of one or more stages of H.F. if one can afford the extra H.T. consumption, it is foolish to add an S.G. stage merely as a cure for threshold adverse conditions.

Financial considerations are a ruling factor in that respect. Under the circumstances, the O-V-2 is worthy of consideration. If constructed on modern principles, this well-tried type of circuit will give highly satisfactory results. The writer numbers amongst his receiving apparatus an O-V-2 and an S.G. multi-valve, and bases his opinions upon personal results and is not in the least influenced by outside reports. Every circuit has its limitations. One must realize that, and quite apart from its limitations, the effects of location and short-wave phenomena should not be forgotten.

To think in terms of volume, and to attempt the construction of an O-V-2 from a theoretical diagram without previous experience, to substitute L.F. transformers where R.C.C. units are specified, and to attempt the design of a receiver exactly where R.C.C. units are specified, and to attempt the design of a receiver exactly one's own liking before constructing a receiver to published specification, is wrong.

Aerial Coupling

Aperiodic and aerial series capacity coupling (neutrodyne type variable in series with aerial) are well known to old hands. The beginner naturally wishes to know which is best. Try both and decide for yourself. I favour aperiodic coupling, as the noise level is slightly lower than when the other system is used and selectivity is slightly better. Aerial series capacity, however, gives a slight increase in volume, but is more susceptible to pick-up of outside interference.

The Detector Valve

The choice of a detector valve may appear to be difficult. The modern H.L. 210, which is metalized, provides exceptionally smooth regeneration, good sensitivity (other things being equal), and complete freedom from microphonic noises. High impedance valves, 25,000 ohms or so, are the most suitable for S.W. detection. Always remember, however, that the higher one goes above this figure, the more chance there is of being troubled with microphonics.

Extension Rods

If a designer specifies long extension rods between condensers and tuning dials, use them. If not, do not re-build your receiver and incorporate them in order to cure instability. Clearly it is your own work which is at fault, and by trying various methods in order to get things right you will learn quite a lot. It is a good plan to keep a data book, and whenever you come across a cure relative to short-wave receiver troubles, make a note of it straight away. Do not trust to memory—however good. It is far better to have half a dozen remedies in a book than two in your head—because the remedy suitable to one receiver may not be successful when applied to another, and to find that those you remember don't seem to work is, to say the least, annoying.

THE WAVE EXPERIMENTERS

By ALF. W. MANN.

The dimensions are 4½in. x 4½in. x 6½in. for a three gang, and therefore occupies a very small space in a Receiver.

Permeability Tuning at last!

This is an entirely new system of tuning incorporating Iron Cored Coils, the inductance of which is varied by smoothly gliding iron cores in and around the Coils, whilst the quality and selectivity remain constant over the wave-range.

The dimensions are 4½in. x 4½in. x 6½in. for a three gang, and therefore occupies a very small space in a Receiver.

The wave-range on short waves has been increased, covering from 200 metres to 650 metres. By this method of tuning stations are less


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The choice of a detector valve may appear

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Real Permeability Tuning at last!
The Function of a Condenser

Before explaining how a condenser can be "inductive" or "non-inductive," it is well to remember that a condenser is a device for use in circuits where the electric current is fluctuating. It has no use whatsoever where only a steady direct current is present. At first this statement may appear to be open to question. "What about the use of condensers across direct-current mains and in D.C. eliminators?" you may ask. Well, the answer is, of course, that the mains current is not a steady one. It rises and falls slightly due to the nature of the dynamo producing it, while it may also fluctuate owing to local electrical interference. This interference results in tiny alternating currents being induced in the mains, and these being superimposed on the main current cause it to fluctuate in strength. To use a simple analogy, a steady direct current may be compared to a train moving at a steady rate. Now suppose a man is walking up and down the corridor of the train. His walking movement may be used to represent the small alternating current due to the interference. First it flows in one direction and then in the other. Now if you consider the combined effect of the man's walking and the train's movement you will see that, in relation to the ground over which he is passing, the man is travelling at a varying speed. Thus when he walks towards the front of the train his speed increases, while on his return walk it decreases. This combined movement of man and train is like the current flowing in the mains. It is still a direct current in that it travels all the time in one direction; but it is not a steady direct current, which is the usual interpretation of the words "direct current."

How it "Passes" a Current

One of the chief uses of a fixed condenser in wireless is to give a free passage to alternating currents but to stop the flow of direct current. Currents which flow backwards and forwards—either very rapidly (high frequency) or more slowly (low-frequency)—are often present in the same circuit with a steady direct current, and it is the object of the condenser to divide their paths. To understand how a condenser makes the separation in this manner an analogy is given. Fig. 1 represents an arrangement of two inter-connected pistons working in two cylinders. Each cylinder is joined to a pipe containing water, while the pistons are maintained in position by a spring behind each. The pipes represent wires, the water electricity, and the cylinder and piston arrangement represents a condenser.

When a direct current attempts to flow through the condenser the current traveling along the wire is here represented by water flowing from A towards B the water pours into the left-hand cylinder and forces the piston P to the right against the pressure of the spring. It will push it until the resistance of the spring equals the pressure of the water, when it will stop as in Fig. 2. Since the two pistons are joined together this action will mean that PI will also be pushed to the right and some of the water in the right-hand cylinder will be expelled towards B. Now if you consider the action of the device from the time the water enters at A until the pistons stop in the position shown in Fig. 2, you will see that for all intents and purposes the pipe from A to B might be continuous. Thus water flows in at A and an equivalent amount flows out at B. This is exactly similar to the action of a condenser when it is connected in a circuit in which direct current is flowing. The current pours into one plate of the condenser, and out from the other until the condenser is fully "charged." Once it has arrived at this state it is not possible for any more current to flow, and the condenser acts as a definite barrier in exactly the same way as the pistons P and PI act as a barrier to any further passage of water.
once they have reached the limit of their movement, it will be readily understood from this simple analogy how a condenser offers no passage to a direct current except during the very brief moment whilst it is charging up.

Now let us see how the condenser behaves towards an alternating current. This type of current flows first in one direction and then in the other. Thus, to refer once again to the diagram, it is obvious that when the current attempts to flow from A to B it will force the two pistons to the right as in Fig. 2. In with alternating current this opposition is called its impedance. The impedance of a condenser is dependent mainly on two things, namely, capacity and inductance, and the capacity of a condenser will affect the opposition it offers to a current, because the smaller the capacity the smaller will be the current which it will pass. A condenser of small capacity is similar to having small cylinders in the water-pump device in Figs. 1 and 3. If the volume of water which attempts to flow into and out of the cylinders is greater than they will hold, then the flow will be restricted. What is perhaps more important still is the fact that the impedance of a condenser due to its capacity varies according to the speed with which the current fluctuates, that is, according to the frequency of the current; thus the higher its frequency the less is the impedance offered by the condenser. This is why, for decoupling and such purposes, it is possible to use smaller condensers in the high-frequency parts of the circuit than in the low-frequency stages. A small condenser by-passes a high-frequency current as readily as a large one would a low-frequency current.

### Impedance and Inductance

Having disposed of the fundamentals, we are now in a better position to understand the more abstract properties of the condenser. Like any other component used in wireless, a condenser offers a certain opposition to the flow of an electric current, and as we are dealing in fact, negligible. However, with the paper type of condenser, in which long strips of metal foil are wound with an interleaving dielectric of paper, as in Fig. 5, there is a marked similarity to a tuning coil. The rolled-up foil acts as a small coil, and possesses considerable inductance. Now the effect of inductance in a condenser is the reverse of that of capacity, for whereas the impedance of the condenser due to its capacity decreases with an increase in the frequency of the current, yet the impedance increases with the frequency. To take a simple example, suppose we are choosing a fixed condenser for decoupling purposes between the grid and cathode of a screen-grid valve or H.F. pentode valve. This condenser must provide the minimum possible impedance to high-frequency currents, in other words, it must provide a short circuit for high-frequency currents. If the condenser which we install in this position is theoretically a perfect one possessing 10° inductance, then one of a capacity of, say, 1 mfd. would be suitable. This would have a very low impedance of something like one-seventh of an ohm at a frequency of 1,000 kilocycles (300 metres). However, if we use an ordinary paper condenser which has not been specially constructed to render it non-inductive, then it may offer an impedance of as much as 2 ohms or more. Moreover, this impedance will increase rapidly at higher frequencies (lower wavelengths). This is because the impedance due to inductance becomes increasingly greater with the increase in frequency, and more than outweighs the decrease in impedance due to capacity. It is because the presence of a small amount of inductance produces such a marked increase in the impedance of a condenser at high frequencies that non-inductive types are specified in the H.F. stages of a receiver. In the L.F. stages, however, a non-inductive condenser is used so as to render it non-inductive.
Random Jottings

Selectivity and Rainy Weather

Many radio fans complain that during rainy weather the tuning of their receiver becomes much broader. Investigation of this will reveal that the most important point that would have shown that for the most perfect and clear reception, it is desired to have a high resistance to the flow of current due to the aerial. Large aerials should always be used, but not heavy enough to place a strain on the aerial wire. The lead-in wire should be kept well away from the house to avoid leakage of current in wet weather.

The Aerial System

The magnetic waves transmitted through the ether are picked up by the aerial and transferred to the receiver. The function of the aerial is to transfer to the receiver the small electric currents which are set up by the waves from the aerial to the receiver, and the most selective aerial offers the best results. The lead-in wire is joined to the aerial to create the path for the flow of current due to the aerial. The lead-in wire should be kept well away from the house to avoid leakage of current in wet weather.

Soldering Iron to Steel

A DIFFICULTY often experienced by constructors is that of soldering iron to steel. One old and very useful device is to use a coating of copper on the iron. Soldering Iron to Steel.
There you are, my dear... as good as new. You can't deceive a PIFCO ROTAMETER.

There's no doubt about a PIFCO ROTAMETER. It traces faults in no time—any kind of radio fault. There are 9 distinct meters in one handy-sized polished bakelite case. The new De-Luxe model moving-coil ROTAMETER has a resistance of 200,000 ohms ensuring absolute accuracy, whilst the scale reading for voltage tests goes up to 400 volts. With these ranges available there is no test you cannot make with a PIFCO ROTAMETER.

9 SEPARATE METERS IN ONE ROTAMETER-DE-LUXE
1. 0-5 volts.
2. 0-25 volts.
3. 0-100 volts.
4. 0-400 volts.
5. 0-10 milliamperes.
6. 0-50 milliamperes.
7. 0-250 milliamperes.

PIFCO ROTAMETERS
PIFCO ON THE SPOT WILL TRACE YOUR TROUBLES LIKE A SHOT

Electrolytic Rectifier Solution

EVIDENTLY there are a large number of amateurs using, or considering the use of, electrolytic rectifiers, judging by the number of inquiries we have received asking for information on how to make the solution. The solution is prepared by dissolving pure borax in distilled water. The borax is added to the water until no more can be dissolved. The solution should then be poured off to allow the extra borax to settle in the form of crystals at the bottom of the container. For test purposes only a small amount is needed, and so a proportion of two or three stations can be served.

Soldered Joints

ALTHOUGH a great number of radio kits are so arranged that no soldering need be done, there is always the risk, when the leads are simply screwed down beneath terminals, of their becoming loose eventually with consequent scratching noises in reproduction. It is far better to have soldered connections, and these can be properly made after a little practice. The best plan is to apply some solder to each section of the joint first, after putting a little flux on each. Then when the two ends are held together the soldering iron is applied until the joint is made and the flux is evaporated. The finished joint should be cleaned by wiping it with a clean rag moistened with alcohol.

An Aerial Question

IT is difficult to understand why there should still be any doubt as to how an aerial should be erected, but there appears to be one point concerning the down lead which is not properly understood by some readers. The mistake should never be made when erecting an aerial of having two separate lengths of wire, one for the horizontal section, and one for the down lead. The aerial should be in one piece from the free, or mast, end to the lead-in tube. When the down lead leaves the horizontal section the end of the wire should be passed through the insulator and then wrapped round the straight section three or four times before being led down to the tube. When this is done there is no risk of loose contacts, and corrosion can be prevented by covering the twistis with a length of insulation tape.

Wired Wireless

WE occasionally hear from a reader seeking advice regarding the advantages of installing a wireless set, or using at a small cost per week the service of wired wireless which is being given in many districts. While the latter system has quite a number of advantages, it is really only the forerunner of owning your own receiver. The reproduction and service is good, and the plan entirely practical and useful in densely populated areas where difficulty is experienced in erecting aerials, but it will never supersede the wireless set. The one quality of a broadcast receiver which has gripped public interest is its freedom. It reaches everywhere, and is free for all who provide themselves with receiving sets and licences, whereas with wired wireless there is a limit of reception to two or three stations.

Random Jottings

(Continued from previous page)

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WHEN it is desired to transfer a television signal from one point to another, a line channel must be used which at least part of the way, even although the main link may be constituted by a radio channel. In order, therefore, to preserve the characteristics of the signal which are essential to the proper reproduction of a television image at the receiving station, the lines which are employed must either possess certain electrical features or be artificially imbued with them.

A Perfect Transmission Line

Any uniform two-conductor line possesses resistance, inductance, capacity, and leakage (the last-named is generally represented as a resistance between the lines, as shown in Fig. 1). Mathematically it can be proved that if there is to be no phase divergence of the various components which go to make up the television signal, and which differ in frequency, then the simple expression

\[ L = c \]

must hold throughout. A line possessing this continuous balance of inductance, capacitance, etc., is termed a distortionless line, but in practice such a line is necessarily either expensive or wasteful of power, or a mixture of both. Artificial methods have therefore been adopted in an effort to make transmission lines more nearly perfect, and the cheapest form of carrying this out is known generally as lumped correction, which is simply the introduction into the line channel at some convenient point of a network, or cascade of networks, designed to have a characteristic approximately the reverse of that line.

A Complex Wave

Since any television signal consists of a complex wave containing many components for at least a range of frequencies, it is essential that frequencies throughout its range be transmitted without attenuation, and that the phase of each be maintained. The first condition is difficult to achieve, and the second is even more difficult. To achieve the first condition it is sufficient to pass those frequencies which are most susceptible to attenuation in the line at sufficiently great amplitude to enable them to be separated from line noises and parasites in subsequent amplifiers. The less attenuated frequencies can then be attenuated artificially to their correct relative level.

The second condition will be fulfilled if the line has, or can be artificially imbued with, such a characteristic that all frequencies are retarded in phase by an angle at frequencies below, and a leading angle at frequencies above, a given frequency. Networks which are designed to produce the first condition are called equalizers or just equalizers, while those made to ensure the second condition are called phase correctors.

Filters

As an indication of the practical applications of schemes of this character reference can be made to Figs. 2 and 3. The first represents an ordinary two-section T-filter for passing high frequencies and attenuating low ones. By a careful choice of values for capacitances and inductances the series impedances can be made fairly small at those frequencies which it is desired to pass, while the shunt impedance (through the coils) can be made reasonably low at low frequencies without attenuating very much the high frequencies to be passed by the filter. Fig. 3 shows an ordinary two-section T-filter of this type.

Fig. 4.-A modified circuit designed to give a band pass.

\[ R^2 = \frac{L_1}{C_1} \]

is the relationship which must hold to fulfill the equalization conditions. Besides the inverted-L type of structure many others may be devised with identical characteristics, the transition from one type of structure to another proceeding according to simple formulae connecting the values of the elements in the various branches.

Turning now to the design of circuits for phase correction it is possible to use networks having properties analogous to those used for constant resistance equalization. That is, to say, these networks present an impedance equivalent to a constant pure resistance at all frequencies to input currents, giving, in addition, relative phase shift in various parts of a range of frequencies without relative attenuation. A circuit of this nature is shown in Fig. 6. This has a lagging phase angle at frequencies below, and a leading phase angle at frequencies above the condition for which the expression

\[ 4\pi fL_C = \frac{1}{C} \]

holds good. As before, mathematically it can be shown that the constant resistance condition is given by

\[ R^2 = \frac{L}{C} \]

Filtering systems, therefore, in practice are used for both purposes.

A modified circuit giving a band-pass is shown in Fig. 4, the tuned circuits in the shunt branches being designed to resonate at the same frequency, somewhere in the region of the band of frequencies which it is desired to pass, while the series circuits are also designed to resonate at the same point. The subject of "networks" is a vast one, and interested readers can turn to books of reference if desired, but in practice a very special type of network is used for lumped equalization and correction. One of the distinctive properties is that it presents an impedance which is equivalent to a pure resistance of constant value when it is closed at the output end with a pure resistance of that value.

Particular Cases

An inverted-L circuit of this type is shown in Fig. 5, being designed for equalization, and mathematically it can be shown that

\[ R^2 = \frac{L_1}{C_1} \]

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\[ R^2 = \frac{L}{C} \]

(To be continued)
B.T.H. Gramophone Motors

For the 1934-5 season, the British Thomson-Houston Co., Ltd., is putting forward three types of electric gramophone motors, comprising the “Truspeed-A.C.”, the “Truspeed-D.C.”, and the “Universal” models. Each of these motors has its own particular characteristics, but all possess ample power to deal with the heaviest recordings without speed fluctuations. Also they eliminate entirely the ceaseless spring-winding which detracts so much from the pleasure of gramophone music. The distinctive features of each motor are given below, but it may be mentioned here that all are fitted with an automatic “on” and “off” stop switch, adjustable to any make of tone arm and operative on any record with a run-off groove, and a 12-inch plush turntable. The models are attractively finished in Florentine bronze. The “Truspeed-A.C.” motor is the only self starting synchronous motor offered for gramophone work. Apart from its low purchase price, its playing speed is electrically controlled without variation, and it costs only about 6d. a year to run. It is provided with ample bearings and good gearing, and has no rubbing contacts, so ensuring silent and trouble-free operation. Also it is free from radio interference. This model is suitable for portable or cabinet gramophones, and is priced at £2 2s. 6d.

The “Truspeed-D.C.” universal model was designed primarily for D.C. circuits, but can be used on A.C. or D.C. circuits if desired. It is silenced in operation and extremely economical to run, the consumption being only 15 watts. Correct playing speed is maintained by a well designed governor, and is adjusted by a speed regulator. The totally-enclosed motor cannot be fouled by dust or dirt, and the bearings are self-aligning. The torque exerted is ample for the heaviest record passages. The price of this model is £3 7s. 6d.

The Universal model is a powerful A.C. or D.C. motor of universal application for arduous service in the home, club, or café, and for those districts where the supply may be changed from direct to alternating current. The turntable is driven direct from the motor spindle, and complete speed control is afforded by a well-designed governor and speed regulator. As with the other models, care has been taken in the design to ensure that this machine is completely silent in operation. The price is £4 19s. 6d.

T.C.C. Price Correction

In our issue dated August 25th we referred to the new No. 2 T.C.C. interference suppressor. It was stated that the price of this component was 12s. 6d., and we now understand from the makers that the price is actually 18s. 6d.

A Magazine Hack-saw

A novelty in hack-saw designs has recently been received for test from Messrs. James Neill and Co. (Sheffield), Ltd. The frame, which is of tubular design, utilizes the bow to form a magazine in which five spare blades of assorted pitch are carried. In addition, the handle is engraved with a useful table setting out the correct type of blade for any kind of job. Both tension pieces may be turned instantaneously to enable cutting at right angles to be carried out. This is a most handy saw for the engineer, electrician, or radio amateur, and the price, complete with six 10in. Eclipse flexible blades, is only 5s.

Wilson Metal Chassis

We have received from Wilson Radio Electric, of Newson Street, Ipswich, a sample metal chassis for the Midget Short-Wave Two recently described by us. This is a fine sample and fully meets our demands of a high-class article at a reasonable cost, and we have no hesitation in recommending it to our readers. We understand that this firm is able to supply aluminium or steel-sprayed chassis for any type of receiver, and readers who are interested should get in touch with them.

Two New Cossor Valves

Two interesting valves have now been added to the range of Cossor valves, and these include a 2-volt Pentagrid and a Universal (A.C./D.C.) H.F. Pentode valve. The former has a .1 filament and is designed for use with a maximum anode voltage of 150, and its use is, of course, in a superheterodyne receiver, where it performs the dual function of first detector and frequency changer. The second valve has a 15 volt .2 amp heater, and is designed for a maximum voltage on the anode of 200, with 100 volts on the auxiliary grid. In addition to its normal use in the high-frequency stage, it may also be used as a highly efficient detector. The price of this valve is 17s. 6d., whilst the other valve costs 18s. 6d. The reference type numbers are 210 P.G. for the battery valve, and 13 S.P.A. for the Universal H.F. Pentode.
practical tests working against the clock would take away a little apparent self-consciousness. The ability to follow the voice of the amateur, and a little more besides. It is clear, "Another Servicemen," that your informant failed to bring you down to earth, and I hope therefore, that this letter will have the desired effect—"EXPERIENCED" (Middleborough).

DISTORTIONLESS REPRODUCTION

(Continued from page 101)

in Fig. 3, and while this has the advantage of requiring no balancing adjustment it complicates the input connections.

H.F. Amplifier-detector Unit

The H.F. amplifier-detector unit used to feed an amplifier of this type, should be designed so that high-note loss, due to sharply tuned circuits, is not appreciable. If it is desired to use the receiver and amplifier for reception of the more powerful distant stations a single H.F. stage preceded by a hand-pass filter and followed by a double-diode detector, would be suitable. A double-diode-triode could conveniently be used in this case, the triode section being used as V.J of the amplifier shown in Fig. 2.

To prevent heterodyne, and similar interference, when receiving stations, other than the focal, a heterodyne filter could be arranged to be switched into circuit when desired.

ELECTRA DIX RADIOS

Selected Bargains from our New Sales List "N."

ELECTRA DIX.—6-in. octagonal moulded bakelite Forts; improve speaker appearance; black, 1/-

ELECTRA DIX.—4-in. Chokes, breeding in 20 H. to 2,500 ohm centre tap, 5/-; mains 2 amp.

ELECTRA DIX.—Stand-off Insulators; 4 in. ribbed, 6d.; a small set type, 100. Aerial lead-in Steatite, at 91.; 12 in. of 1.5. Provide your aerial, 7/22 cop. stand, 2/6; 9/6; 2/6.

ELECTRA DIX.—West Vacuum, Dual, 10 in. octagon moulded Bakelite, all sets, 2/-; Bell Wire, 6d. to 1/-; Pye .00035, with small dial, 2/6. 1,000-v., 5 of doz., total, 3/-.

ELECTRA DIX.—Veeder Turn Counters, 3/-;

ELECTRA DIX.—Variable Tuning. Pomo Log de Luxe, .0001 mfd., 1/-; Ainsco 2-gang .0005 mfd., 1/3; mains 1 amp. centre tap, 5/-; mains 2 amp.

ELECTRA DIX.—Speaker Magnets, large 4-claw, 10/6; small 2-claw, 8/6; without shackles, 6d. A proves with mains 2 amp., 1/3; mains 1 amp., 2/6; mains .5 amp., 7/6.

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NEW REMARKABLE UNIT
This new Heayberd Mains Unit has an output of 150 volts at 15-50 ma. The voltage regulation is practically constant at 150 volts throughout the whole scale of current. Suitable for any set and especially suitable for Class "B" working. Absolutely free from hum and background. The variable 60-130 volts.

This is the """""""."""" Ermas' aid E

SLIDE RADIO
MULTIPLE Electrode Valves,"" was the title of the lecture given by Mr. E. N. Shaw, of the Marconiophone Co., Ltd., at the last meeting of this Society. After stating that he would deal with the diode and its developments, he drew what he styled ""the family tree"" of valves. Starting with the diode he gave suitable circuits for the various valves, illustrating the changes of the Class A, Class B, and double diode triode, also explaining the various points in connection with each type. A.V.C., delayed A.V.C., amplified delayed A.V.C. and squelch systems were explained, also balancing control and squelch systems, together with automatic modulation control. Hon. Sec., 110, Hilliards Road, Gravely Hill, Birmingham.

INTERNATIONAL SHORT-WAVE CLUB (LEICESTER CHAPTER)
These members of the Leicester Chapter hold a special meeting on the 29th, Thursday, at 8 p.m., on the occasion of a personal visit of Mr. A. H. Bear, the European representative of the International Short-Wave Club. Mr. Bear gave a very interesting talk on the formation of the IS.W.C. A.S.W.C. members in the U.S.A. five years ago, and went on to say that the club has now over 5,000 members in 34 different countries of the world. The club has the support of many well-known broadcasting stations, of which Bear, now a very fine distributor of the IS.W.C., is the membership of the I.S.W.C. is only 4-6s. per year, and includes the club's monthly magazine, International Short-Wave Radio. Any readers of PRACTICAL WIRELESS are invited to attend the Leicester Chapter's headquarters at 4b, Pyrmont Road, West Heath, Leicester, on Thursday evening after 8 p.m. Secretary, C. Cramp, 4b, Avenue Road, Leicester.

EXETER AND DISTRICT WIRELESS SOCIETY
The programme for the Autumn Session, 1934, is as follows:
- October 2nd: ""The New Radio Season's Developments"" by Mr. E. F. Gibbs, of A.C. Crossor, Ltd.
- October 9th: ""Recent Advances in Quality M.E.C."" by Mr. D'Arcy Ford.
- October 16th: ""Recent Short-Wave Notes."" A lecture by the Marconiphone Co., Ltd.
- October 22nd: ""The Orthochromatic Theory. Is it Wrong?"" A reply to Mr. F. F. Dancy, by Mr. A. H. Bear.
- October 29th: ""'When shall we get real Television?'"" A lecture by Mr. E. F. Gibbs, of A.C. Crossor, Ltd.

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There's no place like HOLMES
W.B. SPEAKERS

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Free delivery to all letters containing the widest Technical Tips, Service & Aliment. Packed with Technical Tips, Service & Aliment.
Chassis Design

"In looking at many old receivers, as well as many up-to-date commercial receivers, I notice that a flat base with a vertical control panel is used. On the other hand, many commercial sets (especially mains types) as well as all of your designs are fitted with an inverted tray type of base either of metal or metal-covered wood. I am only a recent subscriber to your magazine and should be glad if you would explain the differences in these methods of building."—R. W. E. (Aberystwyth).

Apart from the simpler method of construction which the flat base calls for, there is a much wider wiring plan possible when the tray type of base is employed. The greatest point in favour of the latter method of construction is to be found in the increased stability which results from the separation of individual circuits. Thus, the mode-circuit components may be arranged beneath the tray and the grid circuits on top (or vice versa), and the metal tray, which is earthed, completely separates the two sections and prevents instability due to interaction. The final receiver is also more compact.

Improving the Leader

"I have built the Leader 3, and am exceedingly pleased with the results. I get dozens of stations, but many of the foreigners are not quite loud enough on the speaker to be comfortably audible, and I therefore wish to add a further L.F. stage. Are there any special precautions which I should watch when adding this stage? I intend to use a standard arrangement with separate H.T. vullage for the present output stage."—G. B. (Blackpool).

Apart from the fact that we do not advise your making changes in our published circuits, there is the fact that the addition of a further L.F. stage will introduce difficulty due to overloading of the extra valve on many stations. The only practical manner of obtaining a greater output from the circuit in question is the substitution of a pentode valve for the present output stage, but you must carry out this modification at your own discretion.

Eccentric Aerials

"My neighbour has recently carried out a modification to his aerial wire, the addition of a number of spiders of wire at frequent intervals giving him greatly improved results. I am informed that this is a standard method of improving pick-up, yet I believe that such schemes are bad from a technical point of view. Can you tell me whether this is, in fact, so?"—K. A. (Highbury).

We have seen a number of aerials decorated in this way in recent issues, but in the majority of cases it has been found that the improvement is very slight, and could have been improved upon by arranging two twin wires in place of the existing single wire with its decorations.

The only advantage is the increased area of wire which allows better reception, and it is possible to spoil a good single wire aerial by adding old pieces of wire in the manner indicated. Two wires separated by a distance of not less than three feet will be found of advantage where only a short garden space is available.

H.F. Choke Unnecessary

"I have an old three-valve set in which R.C. units are employed between the valves. I have recently cleaned up the set and have started to take an interest in set building, following the various details published in your pages. I notice with alarm that there is no H.F. choke in the detector circuit of my set, yet reception is perfectly smooth and controllable. I should like to know whether a choke must be included?"—B. T. A. (Worthing).

The choke was customary some time ago to omit the choke when a high value anode resistance was employed, but we would certainly recommend the inclusion of a choke as it path exists differently at various frequencies from the resistance, and you will be more certain of keeping the H.F. currents out of the A.C. circuit with the possibility of purer reproduction.

What is a Coherer?

"I have been reading some old wireless books and have come across the term coherer. I should be glad if you could explain briefly what this device is, and where it is included in a modern set, or what has taken its place."—T. H. (Bangor).

The coherer was the original form of signal detector, and consisted in principle of a glass tube in which were loosely arranged some iron filings. A cork plugged each end and wires were led into the corks. On the application of a signal the filings became "energised," and consequently joined up or "cohered." Theoretically, on the cessation of the signal the filings would fall apart again and thus break the circuit. The crystal took the place of the coherer and the valve has superseded the crystal.

No Grid Leak

"I have an old two-valve set in which a straight detector and output arrangement is used. I was trying out some experiments recently and found that signals were still obtainable in undiminished strength when the detector grid leak was removed. Can you account for this, as I understood the valve would choke if no leak was fitted?"—W. E. (Stockport).

Provided that signals could be obtained for long periods without the leak, it tends to show that there is already a leak in circuit. In an old receiver it is possible that the valve-holder is made from an inferior moulded material and a leakage path exists between the grid and filament terminals, thus providing the necessary path without the inclusion of a separate grid leak.
PREMIER SUPPLY STORES

Postage Gd. extra, I.F.S. and abroad, carriage extra.

Goods at a Fraction of the Original Cost; offer the following Manufacturers' PREMIER SUPPLY STORES

SCREEN GRID.

ILL.,

charger, 8/- extra; 150v., 30 milliamps, with 4v., 2-4 resistances and diagram, 120v., 20 m.a., 20/-; ELIMINATO 25Z5, 36, 38, $3, 39, -14, -14, connections, input 200-250v., 40-100 cycles, all windings really sound job, 15/-.

screengrid leads, any value 1-watt wire end resistances, to 50,000 ohms, 2/-; 25 watts, any value up to 50,000 ohms, 2/-; 5 kw., 2-5000 ohms, 2/-; 25 watts, any value up to 50,000 ohms, 2/-; 5 kw., 2-5000 ohms, 2/-; 25 watts, any value up to 50,000 ohms, 2/-; 5 kw., 2-5000 ohms, 2/-; 25 watts, any value up to 50,000 ohms, 2/-; 5 kw., 2-5000 ohms, 2/-; 25 watts, any value up to 50,000 ohms, 2/-; 5 kw., 2-5000 ohms, 2/-; 25 watts, any value up to 50,000 ohms, 2/-; 5 kw., 2-5000 ohms, 2/-; 25 watts, any value up to 50,000 ohms, 2/-; 5 kw., 2-5000 ohms, 2/-; 25 watts, any value up to 50,000 ohms, 2/-; 5 kw., 2-5000 ohms, 2/-; 25 watts, any value up to 50,000 ohms, 2/-; 5 kw., 2-5000 ohms, 2/-; 25 watts, any value up to 50,000 ohms, 2/-; 5 kw., 2-5000 ohms, 2/-; 25 watts, any value up to 50,000 ohms, 2/-; 5 kw., 2-5000 ohms, 2/-; 25 watts, any value up to 50,000 ohms, 2/-; 5 kw., 2-5000 ohms, 2/-; 25 watts, any value up to 50,000 ohms, 2/-; 5 kw., 2-5000 ohms, 2/-; 25 watts, any value up to 50,000 ohms, 2/-; 5 kw., 2-5000 ohms, 2/-; 25 watts, any value up to 50,000 ohms, 2/-; 5 kw., 2-5000 ohms, 2/-; 25 watts, any value up to 50,000 ohms, 2/-; 5 kw., 2-5000 ohms, 2/-; 25 watts, any value up to 50,000 ohms, 2/-; 5 kw., 2-5000 ohms, 2/-; 25 watts, any value up to 50,000 ohms, 2/-; 5 kw., 2-5000 ohms, 2/-; 25 watts, any value up to 50,000 ohms, 2/-; 5 kw., 2-5000 ohms, 2/-; 25 watts, any value up to 50,000 ohms, 2/-; 5 kw., 2-5000 ohms, 2/-; 25 watts, any value up to 50,000 ohms, 2/-; 5 kw., 2-5000 ohms, 2/-; 25 watts, any value up to 50,000 ohms, 2/-; 5 kw., 2-5000 ohms, 2/-; 25 watts, any value up to 50,000 ohms, 2/-; 5 kw., 2-5000 ohms, 2/-; 25 watts, any value up to 50,000 ohms, 2/-; 5 kw., 2-5000 ohms, 2/-; 25 watts, any value up to 50,000 ohms, 2/-; 5 kw., 2-5000 ohms, 2/-; 25 watts, any value up to 50,000 ohms, 2/-; 5 kw., 2-5000 ohms, 2/-; 25 watts, any value up to 50,000 ohms, 2/-; 5 kw., 2-5000 ohms, 2/-; 25 watts, any value up to 50,000 ohms, 2/-; 5 kw., 2-5000 ohms, 2/-; 25 watts, any value up to 50,000 ohms, 2/-; 5 kw., 2-5000 ohms, 2/-; 25 watts, any value up to 50,000 ohms, 2/-; 5 kw., 2-5000 ohms, 2/-; 25 watts, any value up to 50,000 ohms, 2/-; 5 kw., 2-5000 ohms, 2/-; 25 watts, any value up to 50,000 ohms, 2/-; 5 kw., 2-5000 ohms, 2/-; 25 watts, any value up to 50,000 ohms, 2/-; 5 kw., 2-5000 ohms, 2/-; 25 watts, any value up to 50,000 ohms, 2/-; 5 kw., 2-5000 ohms, 2/-; 25 watts, any value up to 50,000 ohms, 2/-; 5 kw., 2-5000 ohms, 2/-; 25 watts, any value up to 50,000 ohms, 2/-; 5 kw., 2-5000 ohms, 2/-; 25 watts, any value up to 50,000 ohms, 2/-; 5 kw., 2-5000 ohms, 2/-; 25 watts, any value up to 50,000 ohms, 2/-; 5 kw., 2-5000 ohms, 2/-; 25 watts, any value up to 50,000 ohms, 2/-; 5 kw., 2-5000 ohms, 2/-; 25 watts, any value up to 50,000 ohms, 2/-; 5 kw., 2-5000 ohms, 2/-; 25 watts, any value up to 50,000 ohms, 2/-; 5 kw., 2-5000 ohms, 2/-; 25 watts, any value up to 50,000 ohms, 2/-; 5 kw., 2-5000 ohms, 2/-; 25 watts, any value up to 50,000 ohms, 2/-; 5 kw., 2-5000 ohms, 2/-; 25 watts, any value up to 50,000 ohms, 2/-; 5 kw., 2-5000 ohms, 2/-; 25 watts, any value up to 50,000 ohms, 2/-; 5 kw., 2-5000 ohms, 2/-; 25 watts, any value up to 50,000 ohms, 2/-; 5 kw., 2-5000 ohms, 2/-; 25 watts, any value up to 50,000 ohms, 2/-; 5 kw., 2-5000 ohms, 2/-; 25 watts, any value up to 50,000 ohms, 2/-; 5 kw., 2-5000 ohms, 2/-; 25 watts, any value up to 50,000 ohms, 2/-; 5 kw., 2-5000 ohms, 2/-; 25 watts, any value up to 50,000 ohms, 2/-; 5 kw., 2-5000 ohms, 2/-; 25 watts, any value up to 50,000 ohms, 2/-; 5 kw., 2-5000 ohms, 2/-; 25 watts, any value up to 50,000 ohms, 2/-; 5 kw., 2-5000 ohms, 2/-; 25 watts, any value up to 50,000 ohms, 2/-; 5 kw., 2-5000 ohms, 2/-; 25 watts, any value up to 50,000 ohms, 2/-; 5 kw., 2-5000 ohms, 2/-; 25 watts, any value up to 50,000 ohms, 2/-; 5 kw., 2-5000 ohms, 2/-; 25 watts, any value up to 50,000 ohms, 2/-; 5 kw., 2-5000 ohms, 2/-; 25 watts, any value up to 50,000 ohms, 2/-; 5 kw., 2-5000 ohms, 2/-; 25 watts, any value up to 50,000 ohms, 2/-; 5 kw., 2-5000 ohms, 2/-; 25 watts, any value up to 50,000 ohms, 2/-; 5 kw., 2-5000 ohms, 2/-; 25 watts, any value up to 50,000 ohm...
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